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Performance of VIX Straddle and Strangle strategies in Portfolio Management

André Luís Ferreira Serafim

Dissertation presented as partial requirement for obtaining the Master's degree in Statistics and Information Management

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PERFORMANCE OF VIX STRADDLE AND STRANGLE STRATEGIES IN PORTFOLIO MANAGEMENT

by

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Advisor / Co Advisor: Jorge Miguel Ventura Bravo

ABSTRACT

Volatility products have seen a growth in trading volume, partly due to the interesting characteristics these products demonstrate in relation to the market. The Chicago Board Options Exchange's S&P 500 Volatility Index (VIX) is seen as a fear gauge and as such is normally used to hedge against big drops in market value as a form of insurance for a portfolio. This thesis extends the original Dash and Moran framework and tests new ways to use the exchange traded product associated with VIX. I study whether VIX option strategies, in specific Straddle and Strangle, can improve the risk adjusted performance of a portfolio of stocks, bonds, and commodities. The study takes place between the periods of 2006 and 2013 and relies on simulations of different portfolio combinations including the main instrument (equity, bond or commodity) and a percentage invested in the VIX strategy. We find that, in general, straddle strategies are not recommended since we obtain a lower volatility and Value-at-Risk with the impact of much lower returns making it an unattractive investment for any investor. On the other hand, the strangle strategy shows improvements in the overall performance of the equity and commodities portfolios mainly in the periods during which securities prices fall and with a low allocation to the strategy (lower than 2%) and highly Out-of-the-Money.

KEYWORDS

Volatility, VIX, Portfolio Selection, Diversification, Options, Straddle, Strangle, VIX options.

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INTRODUCTION

Investors always desire a higher expected return and a lower risk of not achieving that return. One of the most common techniques used to accomplish a good balance between risk and return is diversification. This is because diversification may allow for the same expected return with reduced risk. Assuming that past performance has some indication of future performance, holding assets that have low or negative correlations with each other may enable a portfolio to either increase its expected return while keeping risk constant or decrease risk while keeping the expected return constant. This is a simple and fundamental aspect of modern portfolio theory, even though finding negatively correlated assets is typically a hard task. These ideas have been started with Markowitz (1952) and then reinforced by other economists and mathematicians in the following years. Accordingly, adding volatility exposure to a portfolio can offer interesting opportunities for long-term investors. Daigler and Rossi (2006) conclude that the strong negative correlation between assets offers significant diversification benefits.

As a result, the Chicago Board Options Exchange's (CBOE) Volatility Index (VIX)[1] has received a lot of attention from both professionals and academics. First VIX futures were launched on March 26, 2006. These were the first of a now well-known asset class of volatility products available in the exchange market. Currently, the VIX options and futures are one of the most tradable contracts at the CBOE counting to up to 238.773 future contracts traded in 2016[2]. The implied volatility indexes and their derivatives are now available on a real-time basis to be traded so investors and academics can analyze the future expected volatility that the market is expected to have in the next 30 days.

Including volatility positions in an investment portfolio can be justified for two main purposes: portfolio diversification or risk management (hedging). One of the biggest reasons why VIX gained popularity is the new information that we can derive from it mainly from the negative correlation between the volatility indexes and underlying equities that make possible the study of asymmetries patterns.

Although these new assets certainly offer new forms of investment, a good understanding of the behavior of the instruments in different times and markets will improve the knowledge of VIX options and how they can be used in conjunction with different asset classes in a profitable way (commodities, bonds, and others). This work will build in upon the framework of Dash and Moran (2005) and Szado (2009) of building portfolios of different assets and allocating a certain percentage of the investment to a volatility asset and studying the performance of such portfolio. The main differences from this paper to these two works are the period analyzed that is much larger, thus giving more robust results (less noise) and the VIX allocation, which is a more specific strategy in line with the extensions delineated in Arak, Michael Ian. (2013). In this case, we are going to use two VIX options strategies - strangle and straddle - and a simulation approach in order to assess how well the VIX contributes to the risk-adjusted performance of investment portfolios.

Three different periods were analyzed to increase the robustness of the study. The data used is from 2006 to 2013 for a large spectrum of asset classes (equity, bond and commodities) and we use both call and put

[1] The VIX calculation formula averages the weighted midpoints of the bid-ask spreads for at-the-money and out-of-the-money puts and calls on the S&P 500 index, which incorporates information from the volatility skew, to derive expected volatility.

[2] Data from 2016 Recap Archives in CBOE Blogs.

options at different strike prices. The analysis will incorporate data from 2006 to 2013 this time frame should eliminate the market noise that can distort results when analyzing short periods of time. Furthermore, with the goal of better understanding the strategies' behaviors, we study the timeframes 2006 to 2009 and 2009-2013 due to the different market behaviors observed in these periods. From 2006 to 2009 the market was in decline and between 2009 and 2013 the opposite occurred. We simulate various portfolios, building them using a naïve approach, for the different periods arriving at the daily returns and value of the portfolio consisting of the ETF and the Stranddle or Strangle strategies with different allocation percentage and OTM levels. With the values of the simulation we compute the different performance indicators.

The main motivation for this study is the lack of insight in this specific strategy of holding both call and put volatility options of a volatility product that in theory should result in lower volatility and in certain cases higher, also the longer period of time analyzed is important since at this point VIX options are only studied in short time periods in the case of portfolio analysis, not comprehending the long term impact of holding this strategy. Great care should be taken when interpreting the results of this analysis. We have to take in consideration that past results don't dictate future expected results.

The remaining part of this paper is organized as follows. In the next section, we review the main literature. Section 3 looks at the data used in the study and the methodologies to create the simulated portfolios, how we allocate the VIX exposure and justify how the portfolios will be readjusted over the analysis period. Section 4 reports the results. Section 5 summarizes the main recommendations future research and limitations of the work.

LITERATURE REVIEW

Research literature extensively documents the characteristics of the volatility indexes, mainly the strong negative correlation with the underlying asset and the positive impact that this can have for diversification purposes. When we focus on the topic of diversification and performance of the VIX Exchange Traded Products (ETP's) the pioneering work was Dash and Moran (2005). According to the authors, the VIX tends to have a strong negative correlation with the S&P 500 Index. Their research focused on three different portfolios: (i) a simple portfolio without VIX allocation, (ii) one allocating VIX spot at a constant 5% and (iii) other having a tactical allocation of 0-10% depending on the previous month movement. They found that the portfolio with the best Sharpe and Sortino ratios was the tactical allocation. The biggest drawback of this paper was the inability to invest in VIX spot so even if the results were promising more tests with exchange-traded products had to be done.

To summarize the literature in a more visualizing matter we present in table 1 the main studies on Volatility assets that are the basis point for this research. This helps us understand the different contribution, methodologies, and conclusions of the literature.

Reference	Contribution	Methodologies	Conclusions
Brenner, Ou and Zhang (2006)	The objective of this paper is to introduce a new volatility instrument, an option on a straddle, which can be used to hedge volatility risk.	The design and valuation of such an instrument are the basic ingredients of a successful financial product. In order to value these options, we combine the approaches of compound options and stochastic volatility.	The numerical results show that the straddle option is a powerful instrument to hedge volatility risk. An additional benefit of such an innovation is that it will provide a direct estimate of the market price for volatility risk.
Brière, M., A. Burgues e O. Signori. (2009)	Understand that for a European investor it is advantageous to invest in the US or European equity volatility.	The measure of the benefit is the Mean /Modified-CVaR portfolio optimization.	A long volatility strategy based on VSTOXX futures offers better protection than a similar one based on VIX futures. It reduces the risk of an equity portfolio more significantly while providing more attractive returns.
Szado, (2009).	The goal of this study is not to make a strategy recommendation for an ongoing risk management program, but rather to consider the impact that a long VIX exposure could have had in this particular time period. The increased correlations among diverse asset classes in the latter half of 2008 generated significant losses for many investors who had previously considered themselves well diversified.	This case study considers the effect of different levels of portfolio allocation to a variety of long VIX exposures (VIX futures, ATM VIX calls, OTM VIX calls). It will, however, refrain from suggesting a single universally appropriate strategy. The purpose of the study is to determine whether exposure to VIX could have helped diversify one's portfolio during the crisis as opposed to deriving an ongoing long-term diversification strategy.	While long volatility exposure may result in negative returns in the long term, it may provide significant protection in downturns. In particular, investable VIX products could have been used to provide some much-needed diversification during the crisis of 2008. In addition, the results of this study suggest that dollar-for-dollar, VIX calls could have provided a more efficient means of diversification than provided by SPX puts.

Brière, Marie (2010)	Benefits from adding volatility as an asset class to their portfolio.	Four different portfolios used, with modified VaR as a risk measure. For the period of February 1990- August 2008.	With the inclusion of volatility, we got the result that was better than a traditional portfolio. It possible to build portfolios that are more efficient than a pure-bond or equity/bond investment.
DeLisle, Jared, James S. Doran and Kevin Krieger (2010)	Alternative methods of hedging the S&P 500 with assets that mimic the VIX index in hopes of taking advantage of the asymmetric relationship between volatility and returns.	Add both VIX index and futures to a portfolio and than then compute the mean return, standard deviation, median and correlation. Then beta and alpha.	We consider alternative methods of hedging the S&P 500 with assets that mimic the VIX index in hopes of taking advantage of the asymmetric relationship between volatility and returns.
Deng, Geng, Craig McCann e Olivia Wang. (2012).	It is proposed if VIX-related ETPs can effectively hedge a portfolio of stocks. The Volatility Index (VIX) computed by the Chicago Board Options Exchange (CBOE) in recent years has been negatively correlated with large stock market declines. However, investors can not directly invest in the VIX index.	The S&P 500 VIX Short-Term Futures Index Total Returns (SPVXSTR) index. The SPVXMTR index. The first is a portfolio 100% invested in the largest S&P 500 ETF, SPY. The second is a combination of stock and bond mutual funds, VTSMX and VBMFX. VTSMX, Vanguard's Total Stock Market Index fund, tracks the MSCI US Broad Market Index, which covers over 99.5% of market capitalization of U.S traded stocks.	Our findings cast doubt on the potential diversification benefit from holding ETPs linked to VIX futures contracts.
Arak, Michael Ian. (2013).	The purpose of this thesis is to investigate the benefits of allocating part of a portfolio to exchange-traded products (ETPs) based on the Chicago Board Options Exchange's Volatility Index (VIX).	Allocating two different VIX exchange traded products, the iPath S&P 500 VIX Short-Term Futures ETN (ticker: VXX) and the iPath S&P 500 VIX Mid-Term Futures ETN (ticker: VXZ) to an equity portfolio represented by the SPDR S&P 500 ETF (ticker: SPY) and a bond portfolio represented by the iShares Core Total U.S. Bond Market ETF February 27, 2009 to March 1, 2013.	VIX ETPs are beneficial only during specific time periods and that a static allocation to a VIX exchange-traded product is more detrimental than beneficial. Therefore, extensions of this thesis should attempt to develop a tactical allocation scheme in order to take advantage of the negative correlations of the VIX exchange-traded products, without subjecting the portfolio to its relatively high probability of negative returns and large volatility.
D'Auria, Leonardo (2013).	In this work, we describe a method to perform risk simulations of VIX futures, according to the historical-simulation model.	We assume a stochastic volatility mean-reverting constant elasticity of variance process to model the VIX dynamics. Following the non-arbitrage argument, the market expectation of VIX futures price results in a function of three financial variables: the spot VIX, the long-run mean of the mean-reverting VIX process, and a time scale parameter.	In conclusion, we can consider our risk historical simulation of VIX futures spreads efficient and reliable, as it is performed in a proper theoretical framework.

Jabłecki, Juliusz (2014)	Changes in investment portfolio performance after including VIX futures.	There were applied two models of portfolio selection (Markowitz and Black Litterman). Data: S&P500, Bonds (GSCI) and Commodities (WGBI) indexes.	The inclusion of VIX Futures does not always deliver higher returns or sharp ratios between 2006 and 2013. There are better results in case of very high volatility in financial markets.
Lin, Yueh-Neng e Anchor Y. Lin. 2016).	The contributions of this paper are threefold. First, closed-form solutions to American futures call options under two SPX price processes are derived. Second, the concept of forward volatility risk applied to VIX futures and forward-start strangles is introduced. Third, this study derives the hedging ratios of VIX futures and the forward-start strangles that are convenient to practical participants for risk management purposes.	This study demonstrates that VIX futures could offer more effective volatility-risk hedge for an investor who has a short position on the S&P 500 futures call option. In particular, the delta-Vega-neutral hedging strategy incorporating stochastic volatility on average outperforms in out-of-sample hedging. Adding price jumps further enhances the hedging performance during the crash period.	Overall, the results support the claim that VIX futures are a better alternative to the traditional forward-start strangles for managing the implied forward volatility risk of a short position on the SPX futures call option. In particular, VIX futures not only perform better in a stochastic-volatility and/or price-jump economy but also are practically implementable.

Table 1 - Literature Review. This table resumes the main literature used in this work.

Brenner, Ou and Zhang (2006) extended previous research by testing the possibility of introducing a new volatility instrument - an option on a straddle - with the intention of hedging volatility risk. Their results show that for this new instrument there is an immense hedging potential, and go into detail about the design and valuation of such instrument.

This is the point where the literature splits into three main branches. The first is the valuation of VIX derivatives (Mencía and Sentana, 2013; Yueh-Neng Lin, 2013). The second refers to the hedging potential of VIX products with the more recent works of Basher and Sadorsky (2015) and Yueh-Neng Lin and Lin (2015). Finally, the third branch of literature refers to the performance and diversification properties of the VIX as an investment tool, started by Dash and Moran and then revisited by other authors, which will be the main focus of this thesis.

Szado (2009) builds upon the Dash and Moran framework by conducting tests with VIX futures and options in various portfolios with different asset classes in two different time frames, one consisting of two years' time and one of one year the period involving the big crash of 2009. As expected, the author concludes that the VIX offers the portfolio a bigger return considering its negative correlation with the market. Szado also found that the inclusion of VIX products in downturn markets it's beneficial but the small time frame was seen as a downfall for the long-term investor. Another important finding in Szado's work was that having exposure to VIX futures, calls and puts does not mimic holding in the spot levels of VIX given that the mean-reversing nature of derivatives instruments is priced into their value.

Other related studies included Warren (2012) and Alexander and Korovilas (2012). First, Warren (2012) finds that the potential of volatility products depends on the risk-and-return characteristics of the investor. Alexander and Korovilas (2012) analyze in detail VIX futures on ETNs showing that a VIX futures ETN portfolio with a long position in mid-term VIX Futures and a short position in short term VIX futures provides better returns in terms of Sharpe and Sortino ratios and the maximum daily loss.

More recently, the idea of volatility as an asset class, supported by a 2007 paper from Goldman Sachs entitled "Volatility as an Asset"[3] brought to debate the premise that volatility should be considered an asset class because of its potential return and the fact that volatility provides diversification benefits in "hostile" markets. Brière et al. (2009) discuss how long-term investors can benefit from adding volatility as an asset class to their portfolio. Two types of structural exposure are tested: long implied volatility and long volatility risk premium. The more appealing one was the implied volatility exposure can be used to significantly reduce the risk profile of the portfolio.

Jones (2011) builds upon the analysis of Szado (2009) and Dash and Moran (2005) by testing the benefits of VIX futures to different combinations of stocks and bonds. He also incorporates his own tactical allocation strategy. Similar to Szado (2009), the main drawback of Jones' analysis is that the only looks at the Sharpe ratio, not the Sortino ratio or ICV.

There have been several more studies about incorporating VIX spot, VIX futures, and VIX options into a portfolio. DeLisle, Doran and Krieger (2010) discussed the differences between VIX futures and options and concluded that options outperform futures, but there is no combination of put and call options tested and some sort of tactical allocation and strategy can improve portfolio results to long-term investors. Finally, an important topic in academic discussion was if investing in VIX products would improve risk-adjusted portfolio returns. This was in part answered by Arak (2013) in an investigation in which the author focuses on allocating part of a portfolio to ETF based on the VIX. The author extends the framework of Dash and Moran (2005) by introducing VIX ETP's and including optimization and found that the VIX ETP's can improve risk-adjusted returns but only in certain scenarios, mostly in highly volatile markets.

Following the results of the aforementioned authors and regarding the contribution of this paper, it will build on the framework of Dash and Moran (2005) and will adopt Szado's (2009) approach of simulating portfolios with different asset allocations and in different time frames. Portfolios were simulated using SAS Enterprise Guide and Excel especially build routines. The study takes the case of different long-term investors managing a plethora of portfolios consisting of equities, commodities and bonds, and seeking to add exposure to volatility in order to assess how the different investments develop over a considerable period of time. Different VIX options strategies will be tested so that we can understand how each one of them can benefit from the risk profile of their portfolios.

We believe this research is original for two reasons. First, it offers a different view on the options' strategies of VIX, complementing the research done on long call and put VIX options that have been so far examined separately. Second, the research will enlarge the base of asset classes in study. With the inclusion of volatility in portfolios composed of different asset classes (commodities, bonds, and equities) we expect to improve the knowledge on the impact that VIX options have on the return of different risk profiles of the investors.

[3] A follow up to another paper: "Volatility as an Asset?" by M. Toikka, E.K. Tom, S. Chadwick, and M. Bolt-Christmas, Feb. 26, 2004. CSFB Equity Derivatives Strategy. Where it was suggested that the negative correlation between S&P 500 and implied volatility is strongest in large down moves.

Previous research only focused mainly on equity portfolios, in the majority of the cases is the S&P500 index, the asset used in line with the well-documented negative correlation with the VIX index.

METHODOLOGY

DATA

In the first part of this section, we will make a brief analysis of the data used. The analysis will incorporate data from 2006[4] to 2013 (A). This is a time frame robust enough such that noise in the markets is assumed to be eliminated and we can expect to see more clearly the behavior of the portfolios. Within this time frame, we will look at different windows of time mainly 2006 to 2009 (B) and 2009-2013 (C) due to the different market behaviors observed in these periods. Between 2006 and 2009 the market was in decline (bear market) and between 2009 and 2013 securities prices experienced a bull market period. In 2008, the S&P500 experienced a drawdown of almost 50% due to the credit crisis, from 2009 onward the market had 4 years of positive results overall, however, the market value didn't reach the vales of 2007 as seen in Figure 1. The consideration of two sub-periods aims to understand how the different combinations of VIX options behave in different market conditions.

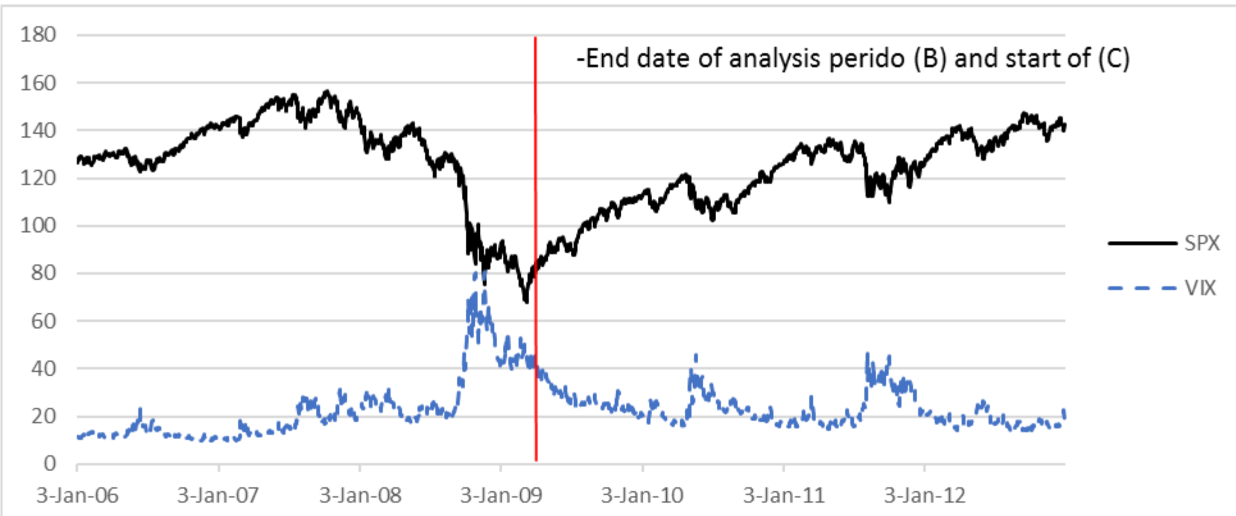

Figure 1 - Historical Values of the spot VIX and the SPY (2006-2013)

Source: author's preparation based on data provided by Yahoo Finance for the SPX and VIX futures.

The data chosen includes daily prices of assets for the main investor types, with a large range of risk profiles, from a more defensive approach (bonds) to a more risky one (commodities). As touched upon in the work of Martellini and Milhau (2011), we must take into account basis risk. This is because we are using a volatility instrument that follows the S&P 500, and by using other assets as the main portfolio investment we can get misaligned results. However, we think that VIX is a good market volatility indicator and this paper tries to identify the performance of different asset classes with a volatility strategy with the goal of reducing variance and if possible reach higher returns.

[4] While VIX options were introduced in February of 2006, the analysis begins only on March 22, 2006. This allows us to avoid the first month of trading to avoid liquidity limitations.

Equity

Our universe of equity instruments encompasses two daily indices prices between 2006 and 2013. The main reason why we chose ETF's as our base portfolios is based on the growth of the amount of money invested in ETFs globally.

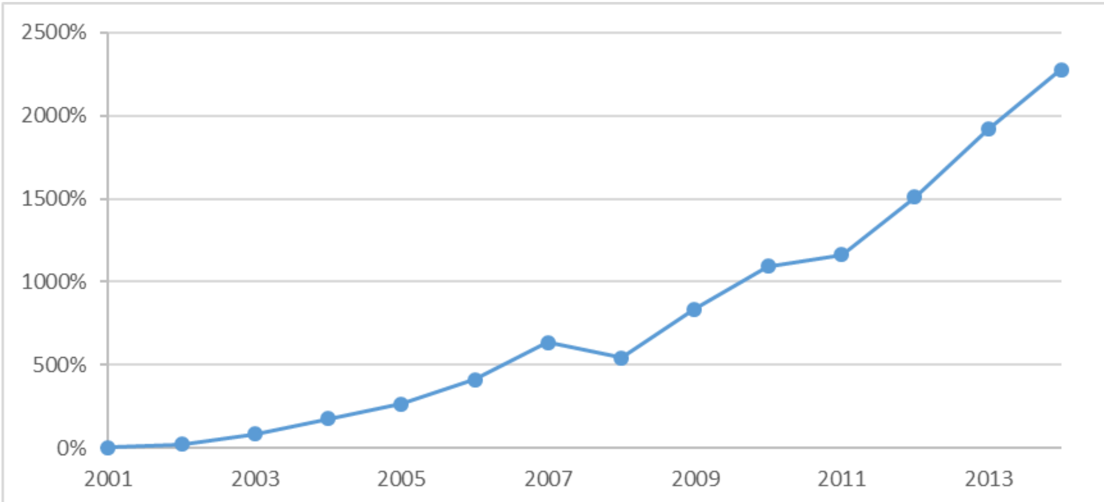

Figure 2 - ETF Growth percentage change in Assets Since 2001. Data from ETFDB.com

The returns will be computed as the variation of the price index relative to the previous date. All the data used was obtained from Bloomberg and has daily values. The first ETF is SPY. This is the default base investment used by the researchers due to the high negative correlation with the VIX index values in Table 1 and because SPY is one of the largest and most heavily-traded ETFs in the world, offering exposure to one of the most well-known equity benchmarks the S&P500, the investment strategy of SPY is simply to mimic the S&P500.

The other equity ETF used is the Vanguard FTSE Emerging Markets ETF (VWO). As one of the largest ETFs in the world is has been embraced by investors as an efficient way to establish exposure to emerging markets. This ETF is composed of mainly Asian equities and 30% invested in financials and 20% in technology companies.

Figure 3 - Time series plot for the Equities ETF's VWO and SPY

Bond

For simplification purposes, we use ETF's as our bond instrument (TIP - iShares TIPS Bond ETF and AGG - iShares Core U.S. Aggregate Bond ETF). The data is available from 2006 to 2013 and we use daily values. TIP is composed of bonds issued by the U.S. featuring principal that adjusts based on inflation. On the other hand, AGG is a building block for any investor constructing a balanced long-term portfolio as well as a potentially attractive safe haven for investors pulling money out of equity markets.

The two ETF's are similar in terms of investment strategies, AGG is focused in tracking an index of US investment-grade bonds. The ETF includes Treasuries, agencies CMBS, ABS and investment-grade, AGG's has a Yield to Maturity of 2.66%. On the other hand, TIP's tracks, a US Treasury inflation protected securites so, in terms of risk, it is a low risk ETF with an average spread of 0,01% (60 days) and with a Yield to Maturity of 2.12%.

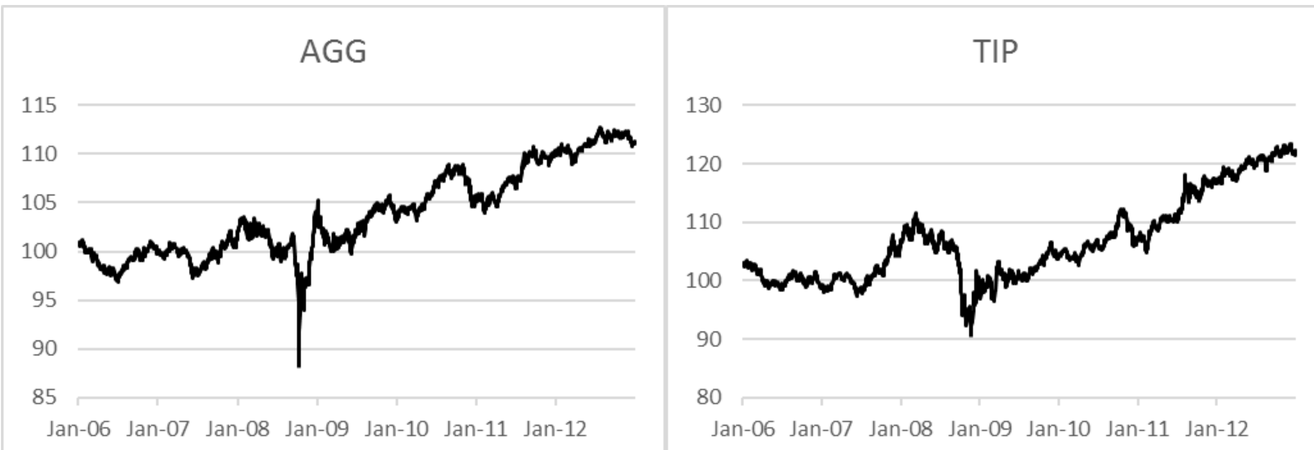

Figure 4 - Time series plot for the Bond ETF's AGG and TIP

As we can observe in the above figures the two ETF's are similar to each other, the main difference is that TIP has a higher standard deviation that AGG it is expected that results for both AGG and TIP will be very similar.

Commodity

We obtain data from Yahoo Finance for two ETF's DBC (PowerShares DB Commodity Index Tracking Fund) and GDL (SPDR Gold Shares ETF) as they provide data for relevant areas: energy, agriculture BDC and precious metals with GDL over the period of 2006 to 2013. GLD is the largest ETF that invests in physical gold, so the spot price of gold is in line with the GLD ETF. DBC tracks 14 commodities futures and looks to minimize the contango in the futures curve.

All the indices are available over the same period of time and as with equity and bond indices data, we obtain returns on commodities from variation in ETF's points from one month to another divided by previous month's value. The commodity ETF's give a better picture to more risk driven investors.

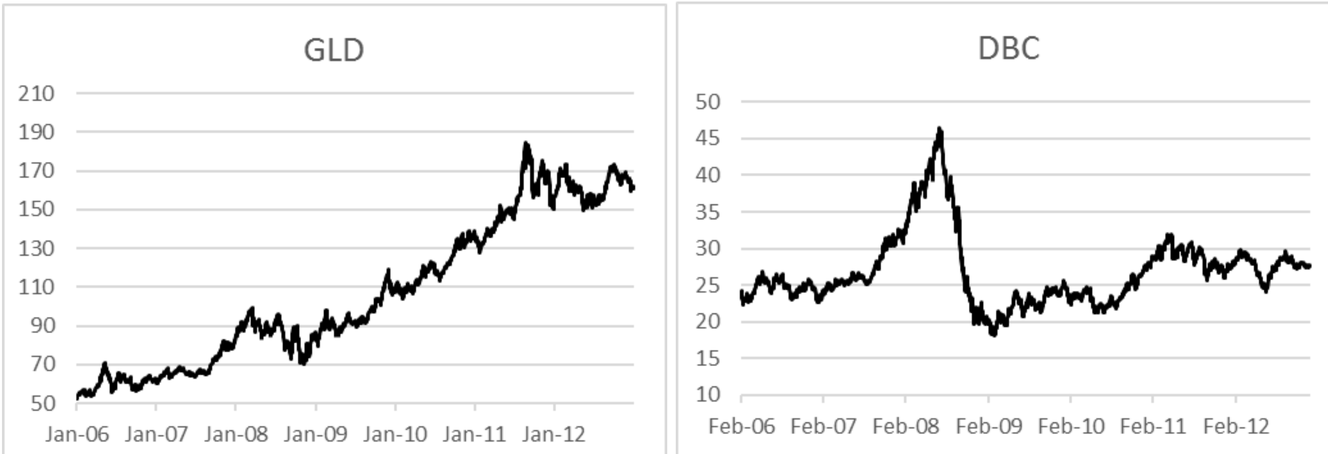

Figure 5 - Time series plot for the Commodity ETF's GLD and DBC

VIX

As discussed VIX offers investors a way to access equity market volatility, an asset class that may have appeal thanks primarily to its negative correlation to U.S. and international stocks. VIX future data is obtained from Yahoo Finance, the options data was provided by Marcus Felker and is only available from 2006 to 2013, data original obtained from CBOE data base. We use both VIX indexes values to compute initial statistic values like correlation and options as the core instrument in the simulations. As seen in the two tables below, the VIX has a strong negative correlation with SPY and VWO, which can lead us to think that it will perform well in conjunction with these instruments. The high standard deviation seen in both VIX and SPY is a good indicator of a possible profit by the strategies used. Also, the high standard deviation of the GLD ETF can lead us to think that the strangle strategy of the VIX options can be useful for achieving a better risk-adjusted performance.

In the simulations, we use both straddle and strangle option strategies. A Straddle is an option strategy that invests in both calls and put long options with the same strike price and maturity date. This strategy is used mainly by investors who want to make a profit regardless of whether the underlying moves up or down. A Strangle is a strategy where the investor buys both long call and put options (in the same proportion) with different strike prices but the same expiration date. This strategy is similar to the straddle but here the investor only profits from bigger movements in the underlying value with the benefit of the smaller cost to the strategic investment. For the sake of simplicity in the strangle strategy only OTM (out-of-the-money) options are used. This means that the underlying price is in the middle of the strike prices in the moment the strategy takes place.

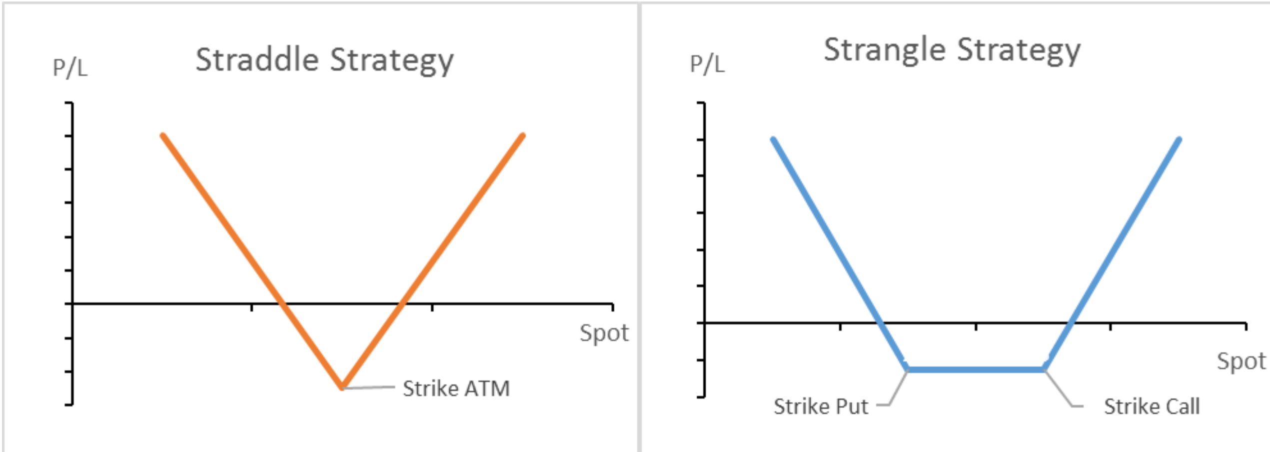

Figure 6 - Examples of a Straddle and Strangle profit and loss distribution.

Source: Created by the author using Microsoft Excel

The options used in the research are one month to maturity in line with the work of Szado (2009) and the day before the expiration they are rolled into the next month with the same percentage of portfolio value allocated to the strategy. This is done by computing the portfolio value at the moment of the roll into and calculating the value to apply in both the ETF and the options strategy. The main idea behind these two strategies is that with a certain allocation of the investment to the VIX option basket we will be able to reduce the Value-at-Risk by having the strategy act like a safety net to the portfolio, at the same time with high positive movements in the market (normally associated with a lower volatility) we can profit as well, this hypothesis is raised by Arak (2013).

Research Method

In this section, I discuss the assumptions, how the simulations were made and the equations used to analyze the effect that allocating part of a portfolio to a VIX options strategy has on the risk adjusted return of a portfolio. As touched upon, I build from previous works by Dash and Moran (2005), Szado (2009), Jones (2011) and Arak (2013) and extend the framework used by analyzing combinations of options as the volatility instrument added to the portfolio.

Assumptions

The premise of this paper is that the VIX will be negatively correlated with the SPY and will have a negative correlation with the other ETF in the study. Therefore, I must first check and verify if this is true. In order to do this I calculate the correlation matrix as seen Table 1 and, as shown, all the assets minus the GLD ETF show a negative correlation with the VIX having the SPY and VWO the highest negative correlation of the six. Another thing to note is the high correlation between the two bond ETF's (TIP and AGG) and the GLD ETF pointing to a possible low performance of the strategy by manifesting random behaviors.

Pearson Correlation Coefficients, N=1678							
	VIX	SPY	VWO	TIP	AGG	DBC	GLD
VIX	1	-0,7214	-0,5172	-0,1679	-0,0858	-0,1735	0,0419
SPY	-0,7214	1	0,7069	0,2710	0,0269	0,4811	-0,0199
VWO	-0,5172	0,7069	1	0,4007	0,2672	0,6009	0,2750
TIP	-0,1679	0,2710	0,4007	1	0,9058	0,3303	0,8889
AGG	-0,0858	0,0269	0,2672	0,9058	1	0,0073	0,9351
DBC	-0,1735	0,4811	0,6009	0,3303	0,0073	1	0,11929
GLD	0,0419	-0,0199	0,2750	0,8889	0,9351	0,11929	1

Table 2 - Correlation Matrix.

Source: Created by the author using data from Yahoo Finance for all the ETF's and using SAS for the calculations.

Additionally, for the Strangle and Straddle strategies to work, VIX must have a high standard deviation so that the impact of high volatility can be transported to profits by the options table 3 shows us that this is true VIX have a high standard deviation (10.88).

In order to use Sharpe Ratio, I assume that returns are independent and identically distributed normal random variables. The analysis of this can be found on the plots of the returns for each ETF in the Figures 3, 4 and 5. I first want to check the standard deviation of all assets over the period analyzed. This will help understand the likelihood of the VIX allocation being beneficial to the portfolio. Since VIX has a rather high standard deviation, it is a good indicator that the benefit for portfolios with high volatility will be notable. In contrast, the bond ETF's that show low volatility will more likely be negatively impacted by the VIX option strategy.

Variable	N	Minimum	Maximum	Mean	Standard Deviation	Skewness	Kurtosis	1st Percentil	5th Percentil
VIX	1678	9,89	80,86	23,13	10,89	1,9024	4,6642	10,24	11,35
SPY	1678	68,11	156,48	124,50	18,75	-0,7245	-0,1140	76,87	86,95
VWO	1678	18,60	58,34	40,27	7,66	-0,54ss99	0,1638	20,98	24,06
TIP	1678	90,73	122,85	106,28	6,96	0,6986	-0,4476	94,59	98,29
AGG	1678	88,40	112,70	103,71	4,39	0,3147	-0,9231	96,26	97,90
DBC	1678	18,15	46,44	26,89	4,98	1,4343	2,3929	19,20	20,77
GLD	1678	53,83	184,59	106,00	36,70	0,4129	-1,1565	55,63	59,90

Table 3 - Main Statistic Values for the ETF's

Source: Created by the author using SAS, data from Yahoo Finance from 2006 to 2013

Simulation

To understand the impact that the aforementioned strategies have when added to different portfolios, we are going to simulate the portfolio value over the designated period of time.

We use five parameters in the simulation process that tell them apart:

- ETF: This variable is used to choose the ETF we want to use in the simulation.
- Strategy: This is self-explanatory and it indicates if we are going to apply straddle or strangle option strategy.
- OTM Percentage: In this parameter, we chose the percentage that we want the options to be out-the-money, this will be an important factor in the selection of the options each month. We will use a naïve approach and will use 1%, 5%, 10%, 20%, 30% and 40%. As a simplification, the straddle strategy will consist of options where the strike value is the closest to the underlying value at the moment of the roll into the next month in practice the OTM percentage will be 0%.
- VIX Percentage: The percentage of the investment that is allocated to the VIX. This value is constant all through the period of study and as such will be used as the target weight for the options in the process of recalculation the portfolios at the month's end. Here we will simulate values from 0.01% until 25% with a total of 501[5] different percentages.
- Period: The time-frame that we are going to analyze 2006 to 2013, 2006 to 2009 or 2009 to 2013.

Returns for all portfolios analyzed are done by the end-of-day value. For the sake of analysis, all the portfolios will have a benchmark. This consists of the ETF with no VIX exposure and will be the principal comparison driver of the study. We use 1000 units as the initial investment amount for simplification purposes. As the maturity of the option expires, we calculate the roll into the next maturity date using the portfolio value as the current investment amount. For the straddle strategy, we computed simulations for each ETF, whereas for the strangle strategy we computed more than 9000 simulations for each ETF times the different OTM percentages, allocation and time periods, which is why we have a much larger number of simulations compared to the strangle strategy where we don't change the OTM percentage.

As mentioned before in the process used in the simulation we followed the Szado (2009) framework. Outlining in detail the simulations, first, the variables above listed are selected. Then some data preparations occur. We construct the data selecting the moments in time where there will be a repositioning of the strategy and constructing the portfolios. Then we formulate simulations of the value the portfolio has during the analysis period. With the portfolio values during the period, we then calculate the performance indicators. We use a naïve approach that involves holding a portfolio with a certain percentage of the initial investment being invested in the risky assets. This approach does not involve any optimization and completely ignores the data. Despite this, using six different allocation values strengthens the results.

PERFORMANCE INDICATORS

Here we are going to present equations and formulas used to obtain the main statistical indicators used for my analysis the Sharpe ratio and Value-at-Risk (VaR).

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[5] Following Szado's (2009) work the allocation levels can seem quite high and this was done with the goal to have a clearer illustration of the impact of the options strategies even though when we analyze the results we see that beyond the 7% allocation we don't see any improvement to the portfolios.

— Risk-Free Calculation

First we are going to look at the Risk-Free calculations since the Sharpe ratio requires the risk-free rate for his calculation. I used the U.S. 1-year Treasury bill as my risk-free rate since returns are annual. Data obtain from Bloomberg.

— Sharpe Ratio

For the calculation of the historical Sharpe Ratio, I will assume that the portfolios are normal distributed, which will be verified later. In line with Sharpe (1994) the ratio is a risk-adjusted return measure that identifies the historical average excess return per unit of historical variability of the excess return:

$$S_h = \frac{\overline{R_p} - \overline{R_f}}{\sigma_p}, \qquad (1)$$

This formula assumes that the risk-free rate is constant equal to the mean of risk-free rates over the period (calculated for the risk-free rate above), where $\overline{\mathrm{R_p}}$ is the average return of the portfolio and $\overline{\mathrm{R_f}}$ is the average risk-free rate.

— Value-at-Risk

Value-at-Risk (VaR) gives the investor the worst expected loss under average market conditions over a certain time interval at a given confidence level. In other words, VaR gives the risk manager a sense of what he or she can expect to potentially lose in a given time interval, assuming “normal” market conditions. We use the Delta-normal VaR as used by Groot (2009). This method assumes normally distributed underlying risk factors. We assume that the returns are normally distributed. The returns from the different insurance methods can be used for the calculation of the standard deviation of the returns. We obtained the formula from Hull (2008) that is commonly used to calculate the standard deviation:

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{N-1}^{N}(r_y(t)| - \bar{r_y})^2} \qquad (2)$$

Due to the assumption of normally distributed returns, the 95 percent confidence level can be calculated by taking the 5 percent quintile for each strategy. The corresponding number for the first quintile is -1,645 according to:

$$\text{If X} \sim \text{N}(0{,}1), \text{P}(\text{x} \leq -1{,}645) = 0{,}05$$

The interpretation is that the probability is set in such a way that in five percent of the observations the return will exceed the value at risk critical value if the returns are normally distributed.

RESULTS AND DISCUSSION

I compute the principal key indicators used in the analysis: the annual expected volatility and annual expected return, Sharpe ratio, skew and kurtosis and Value-at-Risk (1% and 5%). By considering the shift of the benchmark portfolios: (i) into the initial portfolio with the addition of both, (ii) the strangler strategy with different levels of OTM (5%, 10%, 20%, 30% or 40%) and (iii) the straddle strategies.

For simplification proposes the best performing allocations are chosen and are presented in tables 3,4,5,8,9,10. This report looks at the highest annual expected return, lowest annual expected volatility, lowest VaR and best Sharpe ratio for each investment, six in total. This framework will be used throughout the three periods. First, we are going to analyze the period from 2006 to 2013 (A) afterwards the periods from 2006 to 2009 (B) and then from 2009 to 2013 (C). As we can see in figure 1, this will give a more robust analysis since the different periods will capture different market movements.

	Annual Expected Return	Annual Expected Volatility	Daily Return Geometric Mean	Sharpe Ratio	VaR (99%)	VaR (95%)	Kurtosis	Skew
2006 To 2013								
AGG	1,94%	6,13%	0,0077%	0,0386	-0,0089	-0,0051	68,24	-2,68
DBC	2,81%	23,25%	0,0111%	0,0479	-0,0432	-0,0241	1,70	-0,28
GLD	18,09%	21,88%	0,0665%	0,7492	-0,0391	-0,0220	4,99	-0,09
SPY	1,72%	23,73%	0,0068%	0,0008	-0,0450	-0,0233	12,05	0,26
TIP	2,89%	7,38%	0,0114%	0,1612	-0,0129	-0,0069	6,65	0,12
VWO	3,59%	37,09%	0,0141%	0,0510	-0,0729	-0,0352	9,93	0,52
2006 To 2009								
AGG	1,91%	7,90%	0,0076%	0,0270	-0,0133	-0,0057	57,64	-2,94
DBC	-3,87%	25,62%	-0,0158%	-0,2173	-0,0449	-0,0269	1,51	-0,22
GLD	16,57%	25,70%	0,0613%	0,5786	-0,0477	-0,0265	5,16	0,05
SPY	-12,22%	26,99%	-0,0522%	-0,5159	-0,0549	-0,0244	15,30	0,54
TIP	-0,54%	8,34%	-0,0022%	-0,2683	-0,0158	-0,0084	5,22	-0,07
VWO	-11,75%	45,12%	-0,0500%	-0,2980	-0,0860	-0,0416	9,60	0,69
2009 To 2013								
AGG	2,28%	4,27%	0,0090%	0,1349	-0,0069	-0,0045	3,12	-0,27
DBC	9,88%	20,98%	0,0377%	0,3901	-0,0355	-0,0213	1,56	-0,27
GLD	20,23%	18,39%	0,0737%	1,0075	-0,0318	-0,0187	1,94	-0,32
SPY	16,96%	20,71%	0,0627%	0,7368	-0,0378	-0,0219	3,30	-0,05
TIP	5,43%	6,52%	0,0212%	0,5729	-0,0099	-0,0062	8,06	0,54
VWO	21,10%	29,30%	0,0766%	0,6623	-0,0494	-0,0286	2,66	0,14

Table 4 - Benchmark Results. Here we have the main statistic information for the benchmark simulations where we allocate 100% of the portfolio to the ETF.

Note: Results are based on the performance of the ETF’s with no strategy implemented.

Table 4 summarizes the descriptive statistics[6] of the naked ETF's, equity, bond and commodities for the three periods, which will be the basis of performance for the investor prior to implementing a volatility strategy. From looking at the general performance of the portfolios we can confirm that the analysis period B is in fact in a downwards movement and in period C all the funds show a positive annual expected return having the bond portfolios the lowest values.

Other note worthy values to point out are the high Sharpe ratios of the GLD with an expected annual return larger than 15% and an annual expected volatility rounding the 20%. The VWO is the ETF that shows the highest volatility and worst Value-at-Risk. Analysing Skew and Kurtosis AGG has a negative skew (-2.68) and high kurtosis which means it has "heavy tailed" distribution (68.24), for period A, indicating that frequent small negative outcomes and extremely bad scenarios are not as likely. On the other hand SPY and VWO have a positive skew rounding the 0.5 indicating that the right tail is long relative to the left tail.

Also, it is important to note that negative Sharpe ratios provide little to no information. Sharpe ratio is calculated based on expected return, if an investor is expecting it to be negative, all wealth should be allocated to cash for the period. Even when returns are positive one should be wary of the risk-adjusted measures. The inclusion of options can generate skewed or kurtotic return distributions, and Sharpe ratio assumes that the returns are normally distributed.

To determine the interest of adding straddle strategy to the different portfolios we considered three impacts that we want to achieve: higher Sharpe ratio, lower VaR and lower expected volatility. Performance measures for the straddle strategy are provided in table 8 for the GLD portfolio. When results were analyzed we find out that the Bond ETF's have the worst results from the three investment types. This can be attributed to the low volatility already present in the ETF.

Overall, we see improved VaR but this comes at a high reduction in returns so the strategy is not attractive. Also, we inferred that when we start to invest in the straddle strategy we have a decrease in the expected volatility of the portfolio but at the same time, we see a steep downwards movement of the expected returns. This can be associated with the high value of the options when they are near the strike value and this strategy is overall not profitable.

SPY and VWO show noticeable improvements in the portfolio's volatility, but this comes at a big impact on the mean returns. When comparing asset classes, the best asset class analysed are the commodities. They exhibit an improvement mainly when looking at GLD portfolio, the best performing one when staying at allocation levels between 0,05 to 0,3% and we can observe a slight improvement in the overall portfolio performance. However, from an investor standpoint, it is not a clear investment choice because, as we can see in figure 7, the value of the VaR(95%) decreases when the Sharpe ratio increases, showing some vulnerability of the strategy.

[6] Many of the return distribution presented are highly non-normal. We need to take care when interpreting the results. See Arditti [1967].

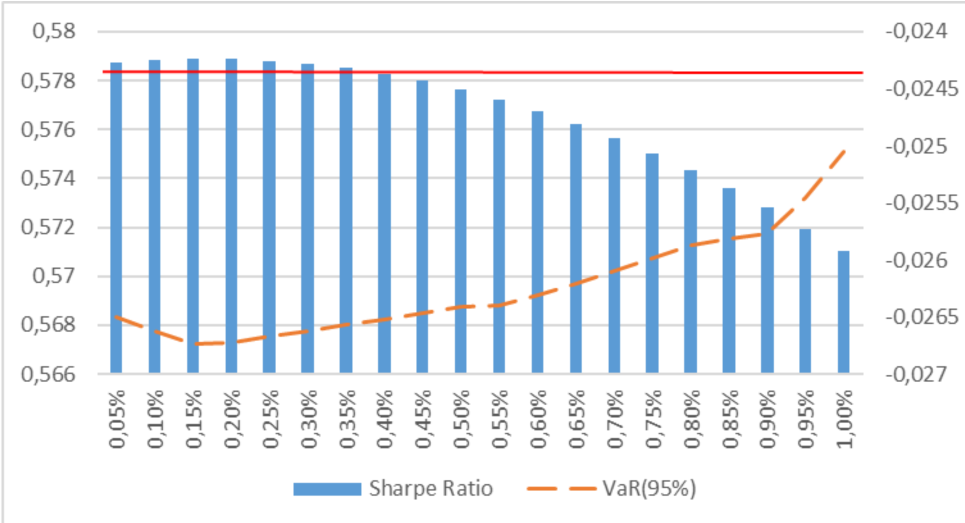

Figure 7 - Sharpe Ratio and VaR (95%) of GLD for the period between 2006 and 2009 (B).

Note: The continuous line is the benchmark Sharpe ratio for GLD in the period B.

When looking at the VaR values we have consistent results for the different investment profiles. In general, when we allocate a percentage below the 5% mark of the portfolio to the straddle strategy, it results in a lower overall value of the VaR meaning that the inclusion of the straddle strategy has a big impact on the worst return possible.

Tables 8 and 9 show an improvement in VaR for all but the bond portfolios. It is clear that, with the exception of the gold ETF in the period B (Figure 7), all the straddle strategies did not improve the Sharpe ratio values compared to the benchmark indicating the poor performance of the strategy on a return basis. Compared to the benchmark, investing in an option straddle allocating between 0.05% and 2% of the portfolio to the strategy will, in general, lower the expected volatility and VaR. However, this will have a negative impact on the returns (tables 8 and 9) making it a riskier investment option. We can conclude that the Straddle strategy does not represent an overall improvement in the risk-adjusted performance of investment portfolios.

Let us move now to the results obtained for portfolios using the strangler VIX options strategy. Recall that this strategy represents the bulk of the simulations. With this in mind, here we highlight only the top performing results for each of the impact objectives. First, we need to understand the impact that the Out-of-the-money percentage has in the results. In logical terms, whenever we have options closer to the exercise price, we are taking less risk due to the higher probability of being able to exercise the option. However, the options price is higher taking into account the lower risk and high probability of profit. This means that for the same level of allocation of the portfolio, we are able to purchase more options to integrate the strategy for a lower cost the higher the out-of-the-money they are and, as such, when these cheaper options are exercised, the payoff is higher than the previously closer to the money options.

Looking first at the Sharpe ratio behavior, Figures 9 and 10 indicate that equities show the best results. This can be traced to the high volatility the ETF's used. When we look at the different time periods (figure 9), we can understand how important is the market behavior on the performance of the strategy. We can observe that there is a big difference between periods B and C. In the second period we can say that there is almost no benefit from investing in a strangler strategy. Inspecting Figure 8, the VaR has an interesting behavior when looking at the most volatile period (B) the strategy that uses the 40% OTM options has the best results for the majority of the allocations[7]. The same is not seen in the period with the lowest volatility (C). Here, the 40% OTM options seem to perform better in almost null allocations (0.01% to 0.15%), higher allocations have good performances when options have five to twenty OTM percentages. This analysis leads us to believe that the best way to choose the level of OTM is to look at the percentage of the portfolio that the investor is looking to apply to the strategy. The higher the allocation the closer to the exercise value the options should be.

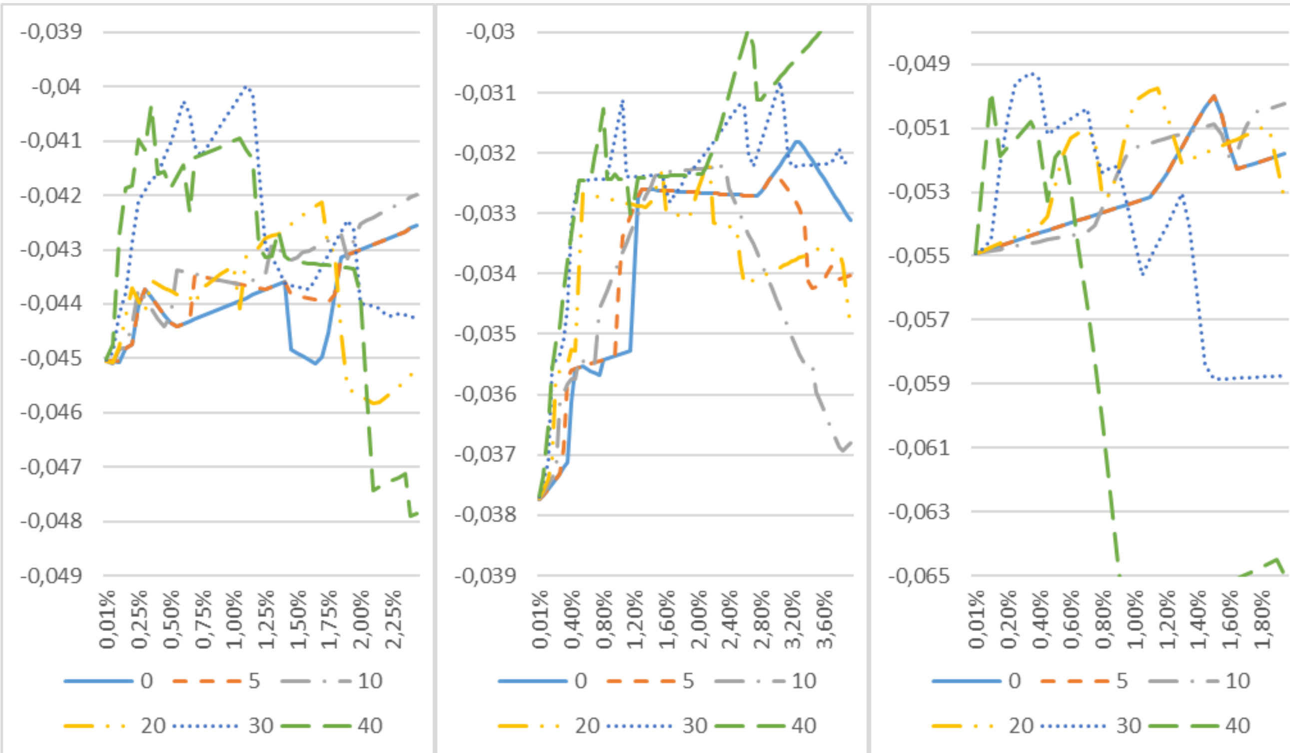

Figure 8 - From left to right we have the SPY VaR (99%) for the period (A) 2006 to 2013, VaR (99%) for SPY 2006-2009 in the middle and VaR (99%) for SPY 2009-2013 on the right. Source: Created by the author using the results of the simulation for SPY ETF.

Focusing now on the differences between asset classes we must keep in mind the different investment profiles and what they are theoretically willing to risk. For example, for a bond investor, the volatility impact of the strategy may have a bigger weight when deciding if the strategy is worth taking.

In line with this thought, we look first at the bond asset class. Table 5 shows the best performing portfolios in period A for the bond portfolio comprising the TIP and the strangle strategy. When looking at the best performing portfolio in terms of annual expected returns (0.9% allocation and 40% OTM) we see that for an improvement of almost three quarters we have to go from an annual expected volatility of 7.38% to 27.19% making it a risky investment. The inferior Sharpe ratio further supports this claim.

The two portfolios that can make for a good investment strategy are the TIP ETF with 40% OTM and 0.01% and 0.1% allocation. The first one shows a slight improvement overall and the second one has the best Sharpe ratio overall making them a good diversification option for a passive investor. Still, we have to keep in mind that the bond portfolios are among the worst performing ones when applying the Strangler strategy.

[7] As stated from the five percent allocation in general portfolios don't show any improvement this can be associated with the low success rate of the strategies.

A-2006 To 2013	Annual Expected Return	Annual Expected Volatility	Daily Return Geometric Mean	Sharpe Ratio	VaR (99%)	VaR (95%)	Kurtosis	Skew
TIP – BM	2,89%	7,38%	0,0114%	0,1612	-0,0129	-0,0069	6,65	0,12
OTM-5								
0,10%	2,68%	7,42%	0,0106%	0,1316	-0,0127	-0,0069	6,44	0,15
OTM-40								
0,01%	2,94%	7,37%	0,0116%	0,1686	-0,0129	-0,0069	6,47	0,13
0,10%	3,38%	8,48%	0,0133%	0,1978	-0,0129	-0,0071	24,48	-0,05
0,90%	5,03%	27,19%	0,0196%	0,1224	-0,0194	-0,0098	199,17	3,87

Table 5 - Descriptive Statistics for TIP ETF and Strangler VIX option strategy. Source: Created by the author using the results of the simulation for the TIP ETF between 2006 and 2013 applying the VIX Strangler Strategy.

For equities, we are going to analyze the SPY performance. In Table 4, we can see that in order to achieve the least volatile portfolio we should invest in options closer to the strike value (10% OTM), but this comes at a big loss in profits, making it a non-plausible investment option. A more balanced strategy with lower allocation and more distant strike prices turns out to be the best option when analyzing the overall portfolio. For example, allocating 0.85% of the amount invested in 40% OTM options results in a change from 0.0008 Sharpe ratio to 0.1246 with improvement in annual expected return of more than three times compared to the benchmark also VaR (95%) improved

A-2006 To 2013	Annual Expected Return	Annual Expected Volatility	Daily Return Geometric Mean	Sharpe Ratio	VaR (99%)	VaR (95%)	Kurtosis	Skew
SPY – BM	1,72%	23,73%	0,0068%	0,0008	-0,0450	-0,0233	12,05	0,26
OTM-10								
1,85%	-1,99%	20,97%	-0,0080%	-0,1758	-0,0427	-0,0195	10,16	0,21
OTM-30								
0,25%	1,71%	21,84%	0,0068%	0,0005	-0,0421	-0,0218	8,46	0,18
OTM-40								
0,85%	5,38%	29,56%	0,0210%	0,1246	-0,0412	-0,0194	98,42	1,89
1,20%	5,66%	34,16%	0,0220%	0,1160	-0,0430	-0,0184	133,89	3,42
2,30%	4,00%	46,14%	0,0157%	0,0499	-0,0472	-0,0173	158,86	5,65

Table 6 - Descriptive Statistics for SPY ETF and Strangler VIX option strategy. Source: Created by the author using the results of the simulation for the SPY ETF applying the VIX Strangler Strategy.

Our results for the commodities portfolio (GLD) indicate that just like for equities the effectiveness of holding volatility strategies to a long investment portfolio. We can clearly see that, as stated before, a good investment to decrease the risk of the portfolio is to allocate a small percentage of the portfolio to close to exercise value options but this is not a good investment option for the commodities portfolios. In Table 10, we observe that the inclusion of this type of strategy leads to highly negative Sharpe ratio. On the other hand, the high return that the GLD portfolio has over the period demonstrates makes the Sharpe ratio improvements almost none existing. Nevertheless, as we can see in the figure 13 the DBC portfolio shows good performances mainly due to the low level of return it had during the studied period.

A-2006 To 2013	Annual Expected Return	Annual Expected Volatility	Daily Return Geometric Mean	Sharpe Ratio	VaR (99%)	VaR (95%)	Kurtosis	Skew
GLD – BM	18,09%	21,88%	0,0665%	0,7492	-0,0391	-0,0220	4,99	-0,09
OTM-5								
0,55%	16,69%	21,72%	0,0617%	0,6900	-0,0382	-0,0219	4,86	0,02
0,75%	16,16%	21,74%	0,0599%	0,6653	-0,0380	-0,0217	4,83	0,06
OTM-40								
0,10%	18,55%	22,03%	0,0681%	0,7650	-0,0383	-0,0225	4,84	0,08
0,85%	19,97%	31,45%	0,0728%	0,5809	-0,0421	-0,0228	71,39	1,53

Table 7 - Descriptive Statistics for GLD ETF and Strangler VIX option strategy Source: Created by the author using the results of the simulation for the GLD ETF applying the VIX Strangler Strategy.

Thus, there clearly seem to be efficiency gains to be made[8] by using strangle VIX strategy for portfolio diversification mainly within high volatility.

[8] Figures 11 to 14 further help to visualize this portfolio improvement.

GLD- Straddle	Annual Expected Return	Annual Expected Volatility	Daily Return Geometric Mean	Sharpe Ratio	VaR (99%)	VaR (95%)	Kurtosis	Skew
A-2006 To 2013								
Benchmark	18,09%	21,88%	0,0665%	0,7492	-0,0391	-0,0220	4,99	-0,09
0,05%	17,99%	21,86%	0,0662%	0,7450	-0,0388	-0,0220	4,98	-0,08
0,10%	17,88%	21,84%	0,0658%	0,7408	-0,0382	-0,0221	4,97	-0,07
0,15%	17,77%	21,82%	0,0654%	0,7365	-0,0382	-0,0222	4,96	-0,06
0,20%	17,66%	21,80%	0,0651%	0,7321	-0,0381	-0,0222	4,95	-0,06
0,25%	17,55%	21,79%	0,0647%	0,7276	-0,0381	-0,0222	4,94	-0,05
0,30%	17,44%	21,78%	0,0643%	0,7230	-0,0382	-0,0223	4,93	-0,04
B-2006 To 2009								
Benchmark	16,57%	25,70%	0,0613%	0,5786	-0,0477	-0,0265	5,16	0,05
0,05%	16,55%	25,66%	0,0613%	0,5787	-0,0474	-0,0265	5,15	0,06
0,10%	16,53%	25,62%	0,0612%	0,5788	-0,0471	-0,0266	5,14	0,07
0,15%	16,52%	25,59%	0,0611%	0,5789	-0,0468	-0,0267	5,14	0,07
0,20%	16,50%	25,56%	0,0611%	0,5789	-0,0465	-0,0267	5,13	0,08
0,25%	16,48%	25,53%	0,0610%	0,5788	-0,0462	-0,0267	5,12	0,09
0,30%	16,46%	25,51%	0,0610%	0,5787	-0,0459	-0,0266	5,11	0,10
C-2009 To 2013								
Benchmark	20,23%	18,39%	0,0737%	1,0075	-0,0318	-0,0187	1,94	-0,32
0,05%	20,05%	18,38%	0,0731%	0,9984	-0,0319	-0,0187	1,95	-0,32
0,10%	19,88%	18,38%	0,0725%	0,9891	-0,0319	-0,0187	1,95	-0,31
0,15%	19,70%	18,37%	0,0719%	0,9798	-0,0319	-0,0187	1,96	-0,31
0,20%	19,52%	18,37%	0,0713%	0,9704	-0,0320	-0,0187	1,97	-0,30
0,25%	19,34%	18,36%	0,0707%	0,9609	-0,0320	-0,0187	1,98	-0,29
0,30%	19,17%	18,36%	0,0701%	0,9514	-0,0320	-0,0187	1,99	-0,29

Table 8 – GLD Straddle Strategy results. In this table, we have the Straddle results for the GLD ETF the best performing of the 6 ETF's when using a VIX Straddle strategy. Even though we simulate this strategy allocating up to 25% of the portfolio to the VIX options we don't see any improvement from the .3% onward.

SPY- Straddle	Annual Expected Return	Annual Expected Volatility	Daily Return Geometric Mean	Sharpe Ratio	VaR (99%)	VaR (95%)	Kurtosis	Skew
A-2006 To 2013								
Benchmark	1,72%	23,73%	0,0068%	0,0008	-0,0450	-0,0233	12,05	0,26
0,05%	1,65%	23,62%	0,0065%	-0,0022	-0,0451	-0,0232	12,00	0,26
0,10%	1,58%	23,53%	0,0063%	-0,0052	-0,0451	-0,0231	11,94	0,26
0,15%	1,51%	23,43%	0,0060%	-0,0083	-0,0448	-0,0229	11,89	0,26
0,20%	1,43%	23,33%	0,0057%	-0,0114	-0,0447	-0,0228	11,84	0,26
0,25%	1,36%	23,24%	0,0054%	-0,0146	-0,0446	-0,0229	11,79	0,27
0,30%	1,29%	23,15%	0,0051%	-0,0178	-0,0446	-0,0229	11,75	0,27
B-2006 To 2009								
Benchmark	-12,22%	26,99%	-0,0522%	-0,5159	-0,0549	-0,0244	15,30	0,54
0,05%	-12,22%	26,87%	-0,0521%	-0,5179	-0,0549	-0,0243	15,24	0,53
0,10%	-12,21%	26,76%	-0,0521%	-0,5199	-0,0548	-0,0242	15,17	0,53
0,15%	-12,21%	26,65%	-0,0521%	-0,5218	-0,0548	-0,0241	15,11	0,53
0,20%	-12,20%	26,54%	-0,0520%	-0,5237	-0,0548	-0,0239	15,05	0,52
0,25%	-12,19%	26,43%	-0,0520%	-0,5256	-0,0547	-0,0237	14,98	0,52
0,30%	-12,19%	26,33%	-0,0520%	-0,5275	-0,0547	-0,0235	14,92	0,52
C-2009 To 2013								
Benchmark	16,96%	20,71%	0,0627%	0,7368	-0,0378	-0,0219	3,30	-0,05
0,05%	16,81%	20,61%	0,0621%	0,7329	-0,0376	-0,0219	3,28	-0,05
0,10%	16,66%	20,52%	0,0616%	0,7288	-0,0375	-0,0218	3,25	-0,04
0,15%	16,51%	20,44%	0,0611%	0,7246	-0,0374	-0,0215	3,23	-0,03
0,20%	16,36%	20,35%	0,0606%	0,7204	-0,0373	-0,0213	3,21	-0,02
0,25%	16,21%	20,26%	0,0601%	0,7160	-0,0372	-0,0210	3,20	-0,01
0,30%	16,06%	20,18%	0,0596%	0,7116	-0,0371	-0,0208	3,18	-0,01

Table 9 - SPY Straddle Strategy results. In this table, we have the Straddle results for the SPY ETF the decision of adding this table was based on the characteristic of the SPY compared to the other ETF's being the one freed of basis risk. However, we can clearly see that there was no performance improvement from the addition of the strategy. As in table 5, we only use allocations 0.05% to 0.3% due to the bad performance of the indicators when allocating more capital to the straddle strategy.

A-2006 To 2013	Annual Expected Return	Annual Expected Volatility	Daily Return Geometric Mean	Sharpe Ratio	VaR (99%)	VaR (95%)	Kurtosis	Skew
DBC - BM	2,81%	23,25%	0,0111%	0,0479	-0,0432	-0,0241	1,70	-0,28
OTM-5								
1,15%	0,74%	22,58%	0,0029%	-0,0427	-0,0422	-0,0228	1,78	-0,25
OTM-30								
0,75%	2,23%	23,79%	0,0088%	0,0221	-0,0422	-0,0225	5,82	-0,38
OTM-40								
0,70%	5,94%	29,79%	0,0231%	0,1423	-0,0431	-0,0232	59,93	0,59
1,20%	6,41%	36,60%	0,0249%	0,1288	-0,0442	-0,0233	103,71	2,51

Table 10 - Descriptive Statistics for DBC ETF and Strangler VIX option strategy

Our results show that only in rare occasions does the straddle strategy benefit the portfolio's variance making it less risky for the investor when allocating small amounts of the investment to it. For the strangler strategy we unveil that the VIX options can improve the performance of a portfolio, firstly by reducing the variance mainly when the options are close to the exercise value (5% OTM) and increasing the expected returns and diversification (Sharpe ratio) when it's allocated a relatively small percentage of the portfolio (0.01% to 1%) to the strategy and we use highly Out-of-the-money options this follows the logic that the options are cheaper and as such we can get more options for the same price and bigger profits when the options are exercised with the downfall of higher expected volatility. The period where the portfolios benefited the most from this strategy was the period B (2006-2009), where the market was in decline following the 2009 housing crisis, which was expected, as in this period we have the bigger volatility spikes and as such the strategy performs better. We can also see that in the period C (2009-2013) there are few to none gains from applying either strangler or straddle strategies.

CONCLUSIONS

This analysis highlights that the use of option strategies as a good diversification tool for portfolios when used with a pinch of salt. The Volatility Index (VIX) created by the CBOE has been negatively correlated with large stock market declines and with the research implied to VIX futures and call our put naked options it is viewed as an inefficient asset. However, investors may choose not to directly invest with the simple goal of capturing advances or declines in the market and can try to profit with big volatility and large movements in the general market.

Compared to relevant literature, the study outlines the main usages for the VIX options when applied with strangle or straddle strategies. In line with M. Brière (2010) and Szado (2009) we conclude that it is true that the majority of the investments with volatility assets normally result in negative returns, but as seen we can say that the inclusion of volatility improved the overall results of the portfolio and we showed that is possible, under certain conditions, to construct portfolios that are more efficient than an equity/bond investment. This strategy bypasses the finding of Michael Ian Arak (2009) and extends on his work, such that we can say that the Strangle strategy takes advantage of the negative correlation to the market and does not subject the portfolio to high negative returns when allocating a small amount of the investment to the strategy.

The core of the study was to make strategy recommendations for an investor with a long term orientation and that wants to reduce risk and improve return on the investment with the help of VIX options. The constant volatility in markets can be used to our advantage if captured and the strategies used can be employed for this goal. The results are positive and show that a well-thought allocation of the portfolio to a Strangle strategy will be reflected in the risk adjusted values providing significant protection in downturns.

LIMITATIONS AND RECOMMENDATIONS FOR FUTURE WORKS

One of the limitations found in the study relates to the period analyzed. Although the period from 2006 to 2013 is representative of both bull and bear markets the lack of options data available from 2013 onwards is detrimental to the analysis of the impact the strategies have over a bigger period of time (ten plus years). One interesting continuation to this work would be to explore the extent to which volatility options strategies are a satisfactory hedge of the volatility risk during periods of stress and sharply rising realized volatility. In any case, an essential aspect of using volatility as an asset class is the significant possibilities it offers for tailoring a portfolio to an investor's needs, especially if he is risk averse. Over the long term, volatility strategies make it possible to build portfolios that are more efficient than a pure-bond or equity/bonds and in some instances pure-equity investment and a continuation of this topic can further improve the knowledge on this topic.

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APPENDIX

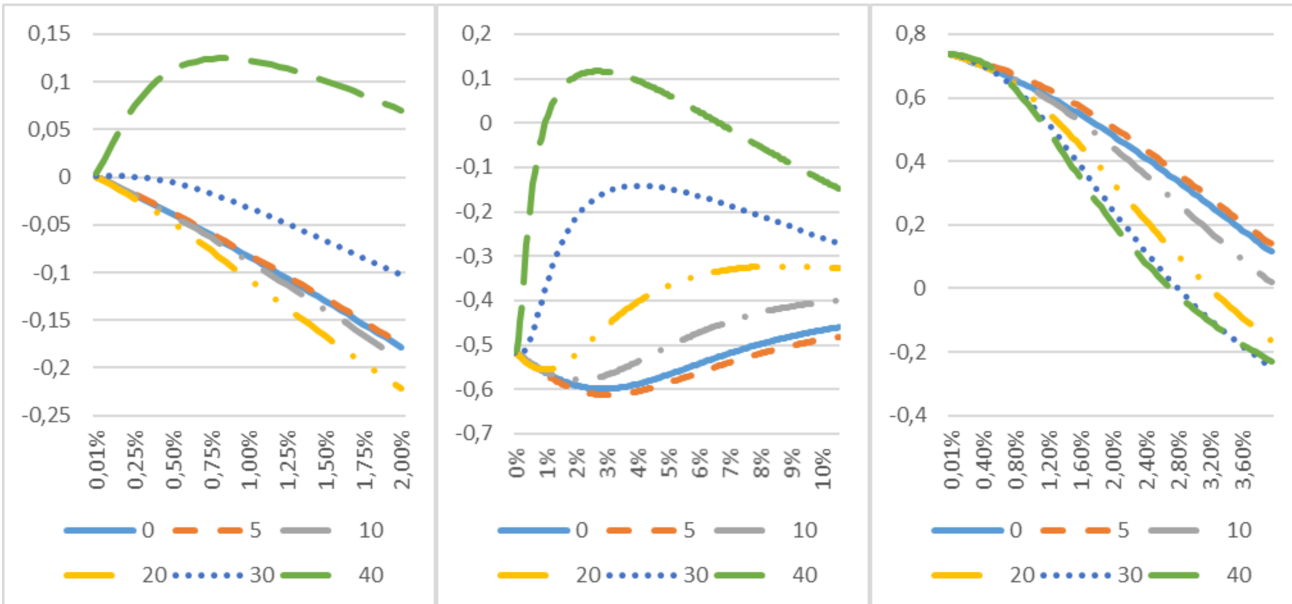

Figure 9 - Sharpe Ratio behavior for SPY for periods from left to right: 2006-20013, 2006-2009 and 2009-2013

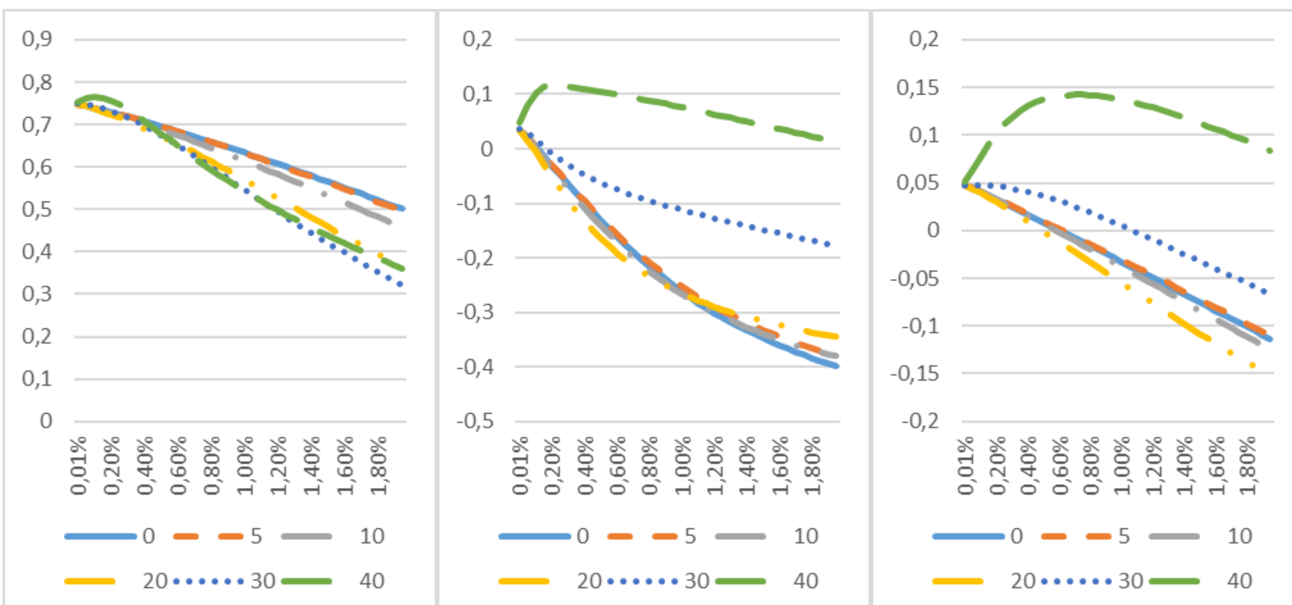

Figure 10 - Sharpe Ratio Behavior for the Period between 2006 and 2013 for portfolios from left to right: GLD, AGG and DBC

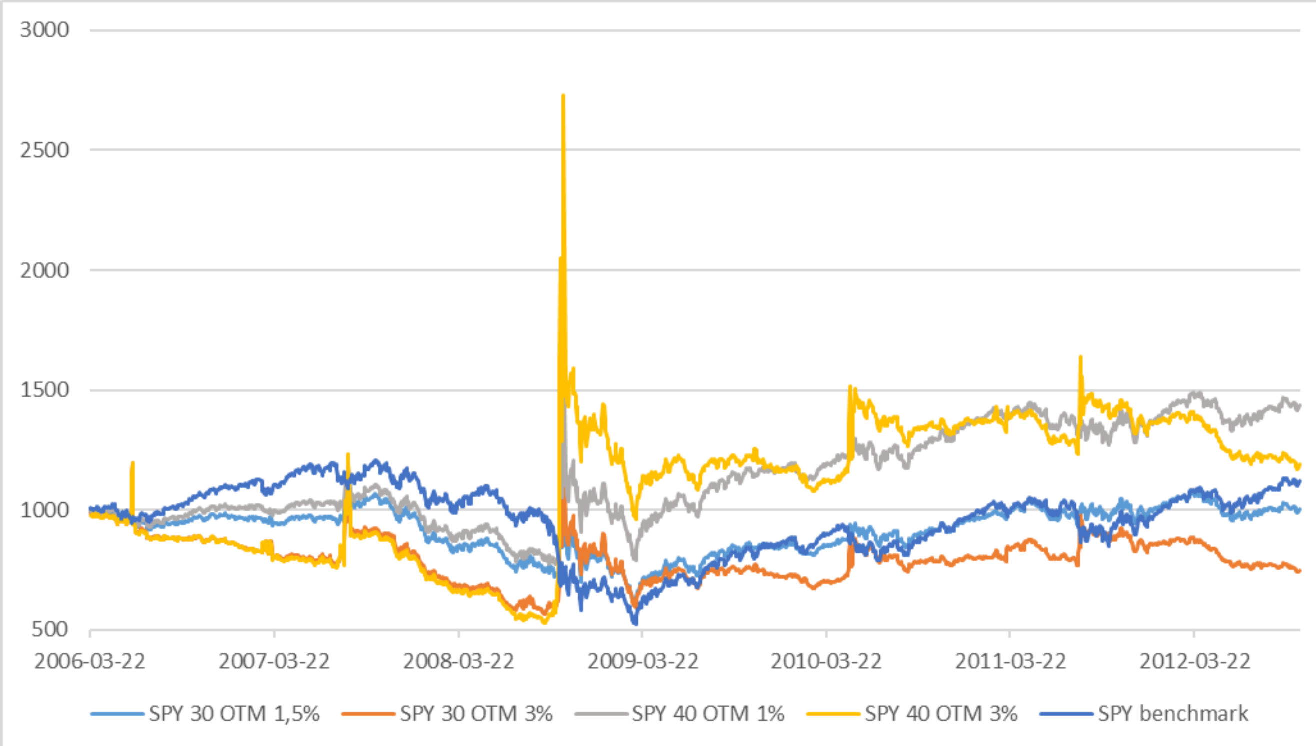

Figure 11 - SPY 2006-2013 Portfolio Values from the simulations.

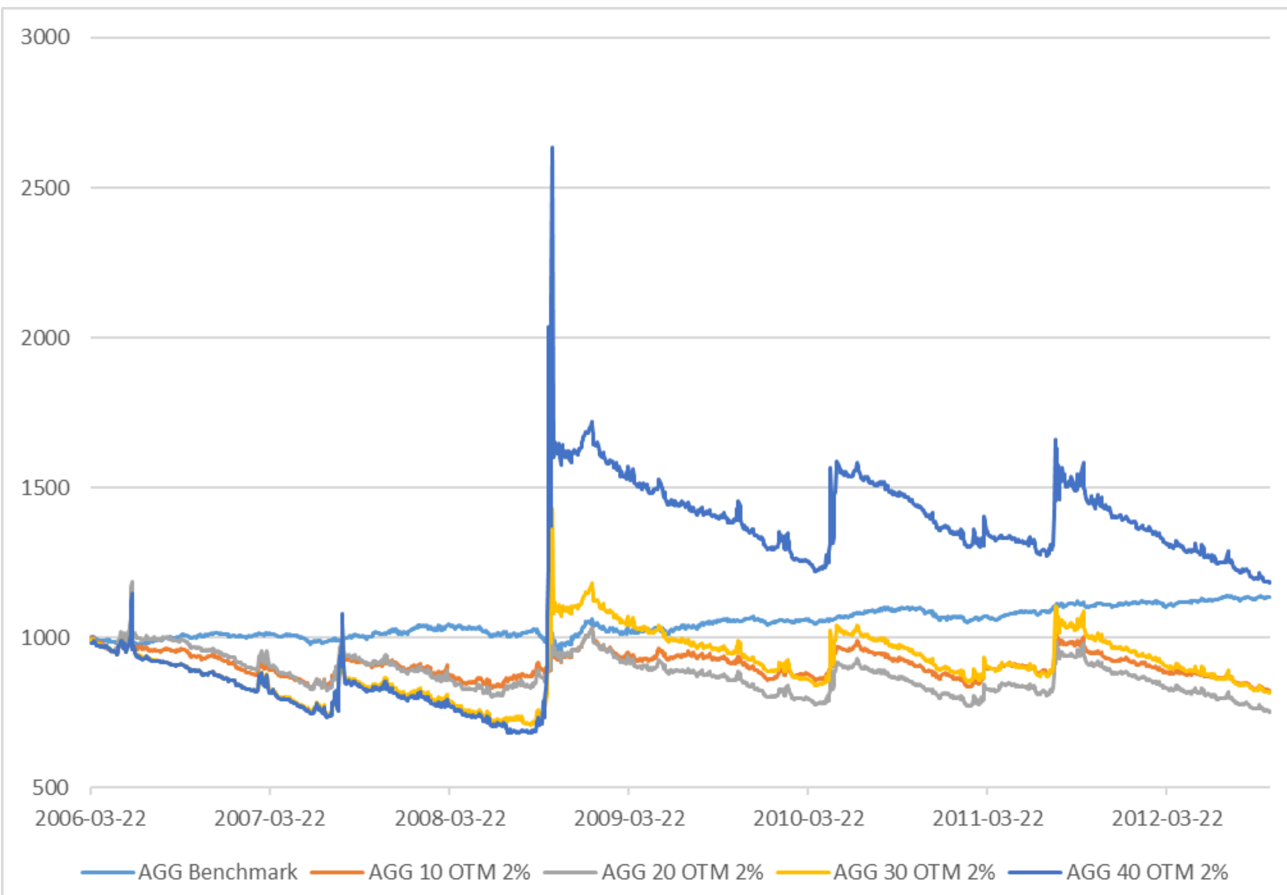

Figure 12 - AGG Portfolio Values for the period 2006-2013

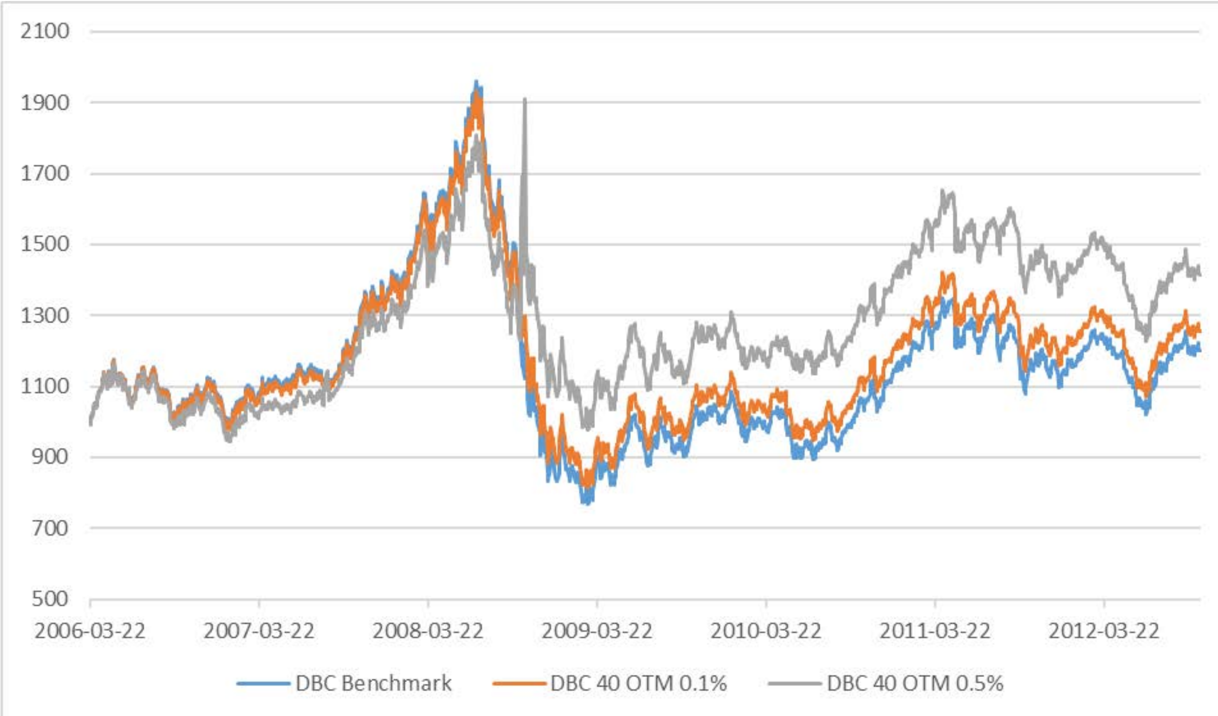

Figure 13 - DBC Portfolio Values for the period 2006-2013

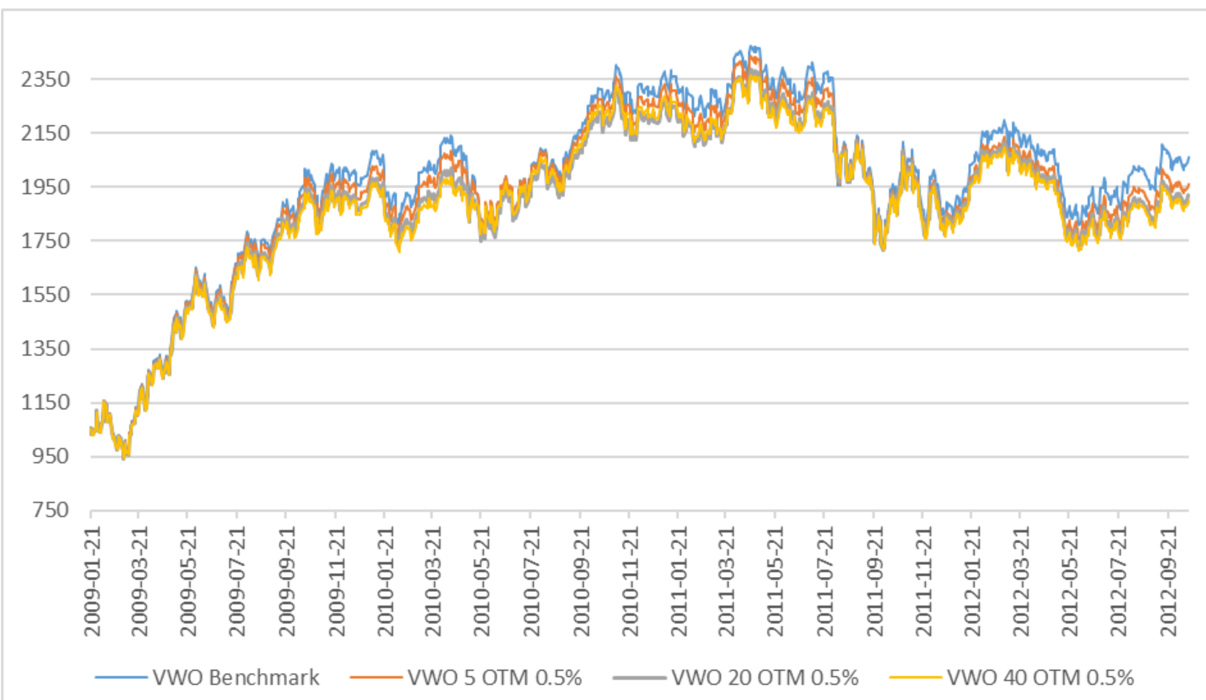

Figure 14 - VWO Portfolio Values for the period 2006-2013

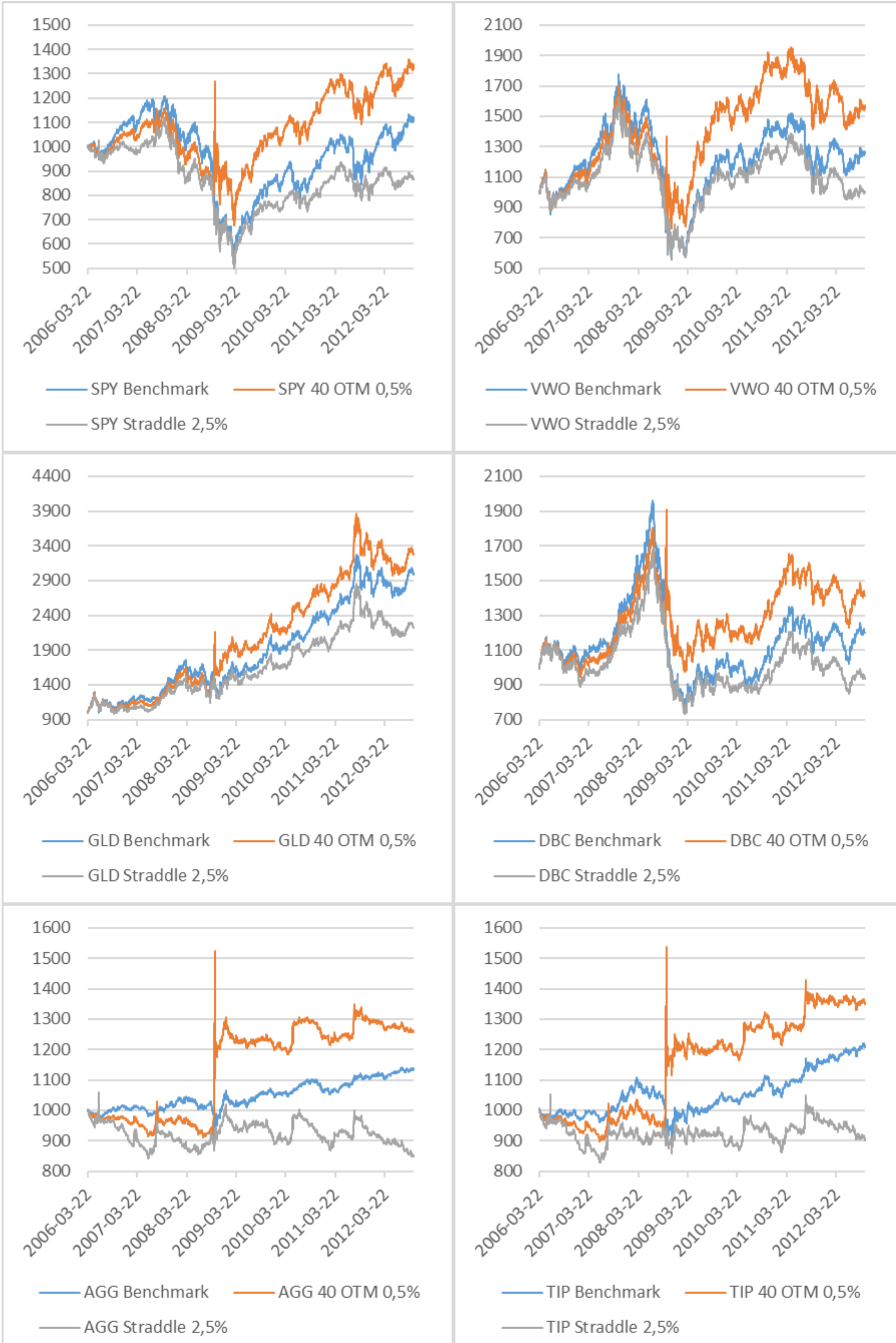

Figure 15 - Portfolio Value for all the assets for the period A between 2006 and 2013.

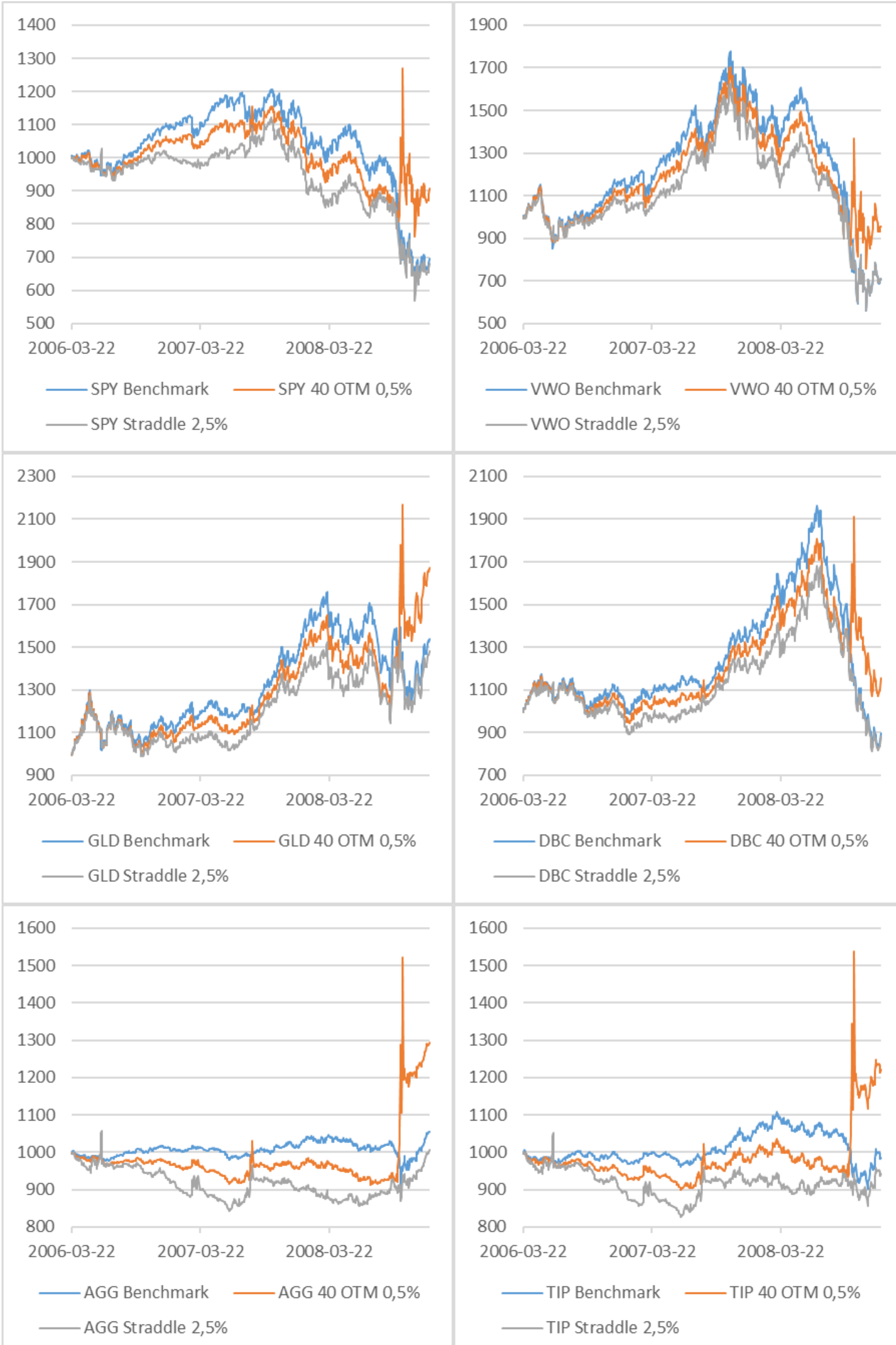

Figure 16 - Portfolio Value for all the assets for the period A between 2006 and 2009.

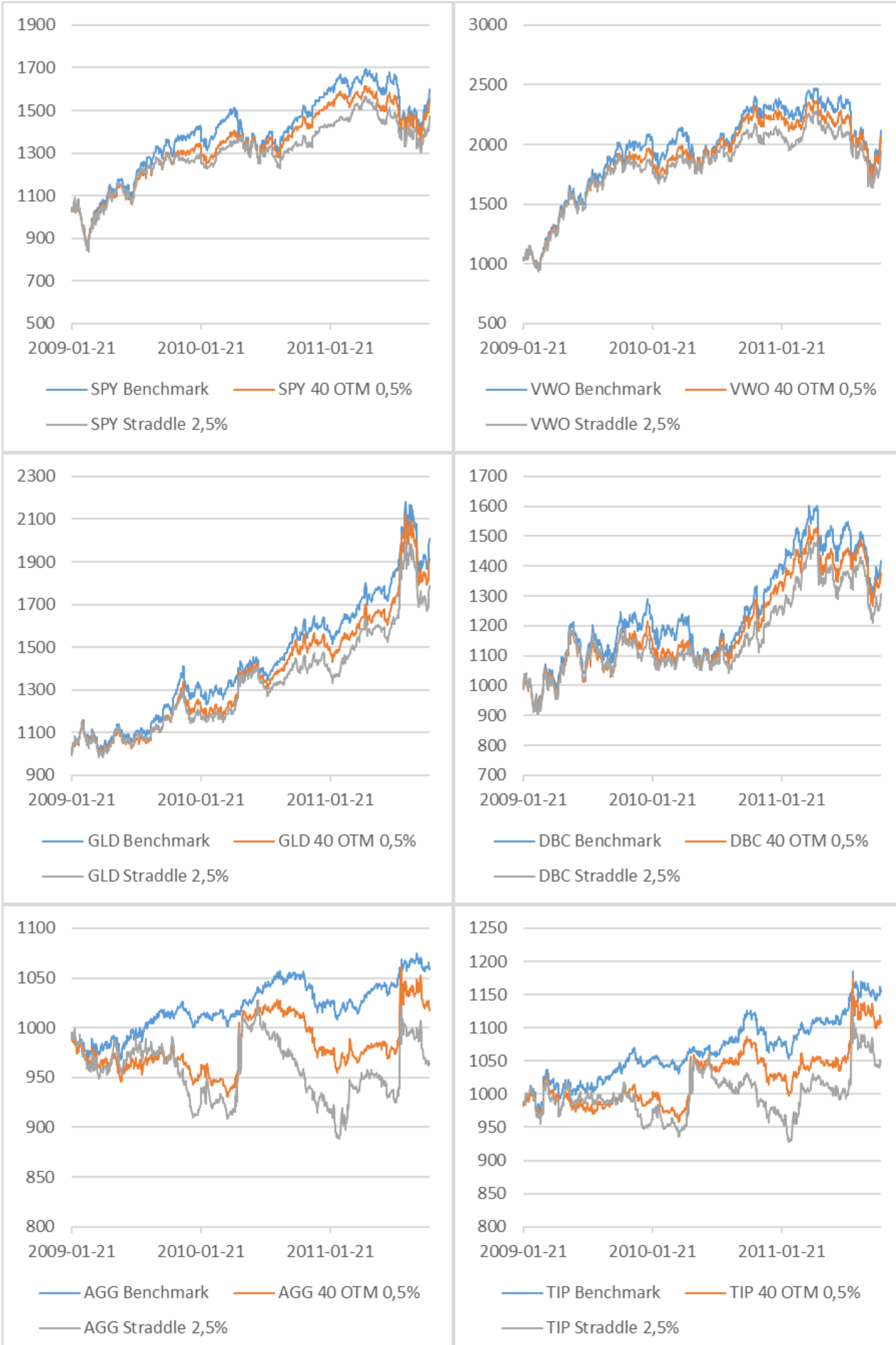

Figure 17 - Portfolio Value for all the assets for the period A between 2009 and 2013.