VIX Futures and Options – A Case Study of Portfolio Diversification During the 2008 Financial Crisis.

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INTRODUCTION

In 2008, the S&P 500 experienced a drawdown of about 50% from peak to trough. Many assets which are typically considered effective equity diversifiers also faced precipitous losses. Most hedge fund strategies and commodity indices were not immune from declining. For example, the HFRX Global Hedge Fund Index had a maximum drawdown of approximately 25% of its value in 2008, with some of its sub-indexes dropping almost 60%. The drop in commodities was even more significant. The S&P GSCI commodity index experienced a maximum drawdown of about 2/3 of its value in 2008. In stark contrast, volatility levels as measured by VIX experienced significant increases and in 2008 repeatedly set new highs not seen since the crash of 1987[2]. The rapid rise of VIX futures in the end of 2008 strongly contrasted with the precipitous drop in almost all the other asset classes (managed futures was an obvious exception). This anecdotal evidence leads one to wonder if some degree of long VIX exposure would have provided effective diversification during the market meltdown in which the standard diversifiers mentioned above failed to provide their expected diversification benefits.

Prior to the financial crisis of 2008, correlations between equities, bonds and alternative assets tended to be relatively low. However, in 2007 and 2008 the correlations for many asset classes rose significantly as a variety of assets dropped in value alongside the drop in equities. As a result, many investors discovered that portfolios which they believed to be well diversified based on historical data, were effectively not diversified at all. Exhibit 1 provides an illustration of this phenomenon. The correlations with equity were often dramatically higher in the 2007 to

[2] The 1987 peak of 150.2 was based on the old methodology of VIX. Additional details of VIX methodology are provided later in the paper.

2008 period than in the 2004 to 2006 period. With the exception of managed futures, all correlations were at least moderately higher in the latter period.

Exhibit 1: Asset Class Correlations of 2004 to 2006 (2007 to 2008 in Parenthesis)

	Equity	Bonds	High Yield Bonds	Hedge Funds	Managed Futures	Commodity	Private Equity	Real Estate
Equity	1.00 (1.00)							
Bonds	0.02 (0.22)	1.00 (1.00)						
High Yield Bonds	0.51 (0.87)	0.39 (0.4)	1.00 (1.00)					
Hedge Funds	0.77 (0.8)	-0.01 (0.18)	0.54 (0.74)	1.00 (1.00)				
Managed Futures	0.52 (-0.22)	0 (-0.19)	0.27 (-0.24)	0.61 (0.13)	1.00 (1.00)			
Commodity	-0.22 (0.52)	-0.06 (0)	-0.07 (0.55)	0.06 (0.8)	0.13 (0.03)	1.00 (1.00)		
Private Equity	0.77 (0.84)	0.28 (-0.01)	0.61 (0.8)	0.77 (0.75)	0.48 (-0.23)	-0.23 (0.65)	1.00 (1.00)	
Real Estate	0.56 (0.85)	0.46 (0.31)	0.44 (0.91)	0.47 (0.63)	0.34 (-0.29)	-0.19 (0.44)	0.61 (0.85)	1.00 (1.00)

MOTIVATION

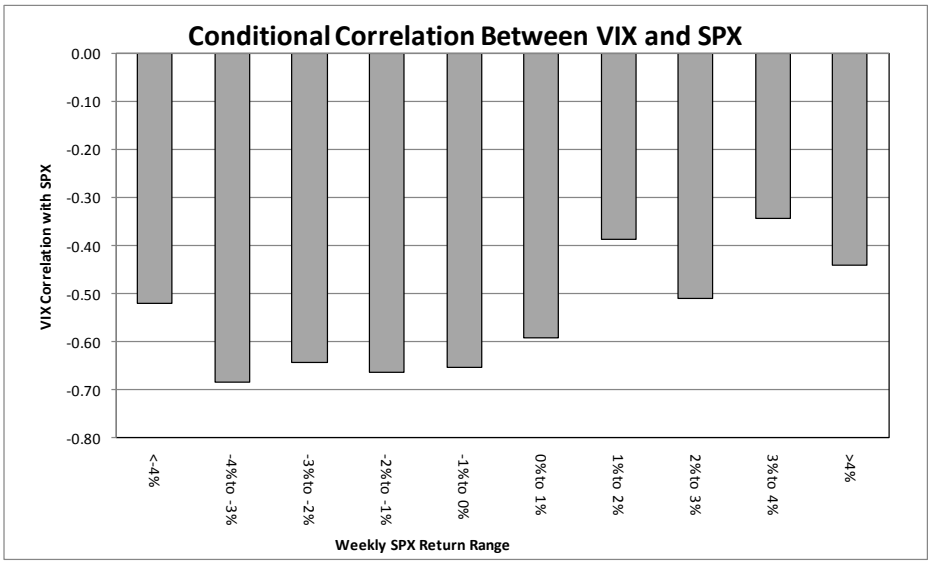
These observations lead to the question which motivates this study: "What could have been done to ensure that the effectiveness of a portfolio's diversification survived in such an environment?" This study assesses the impact of a long VIX investment as a diversifier for a typical institutional investment portfolio during the 2008 credit crisis. The analysis covers the period of March 2006 to December 2008 (beginning shortly after the introduction of VIX options in February of 2006[3]) with a focus on the latter part of 2008 (from August to the end of December).

Great care should be taken in interpreting and applying the results of this analysis. It is important to note that the long VIX exposure is considered as a portfolio diversifier, not as a

[3] The first expiration of VIX futures were excluded for liquidity reasons.

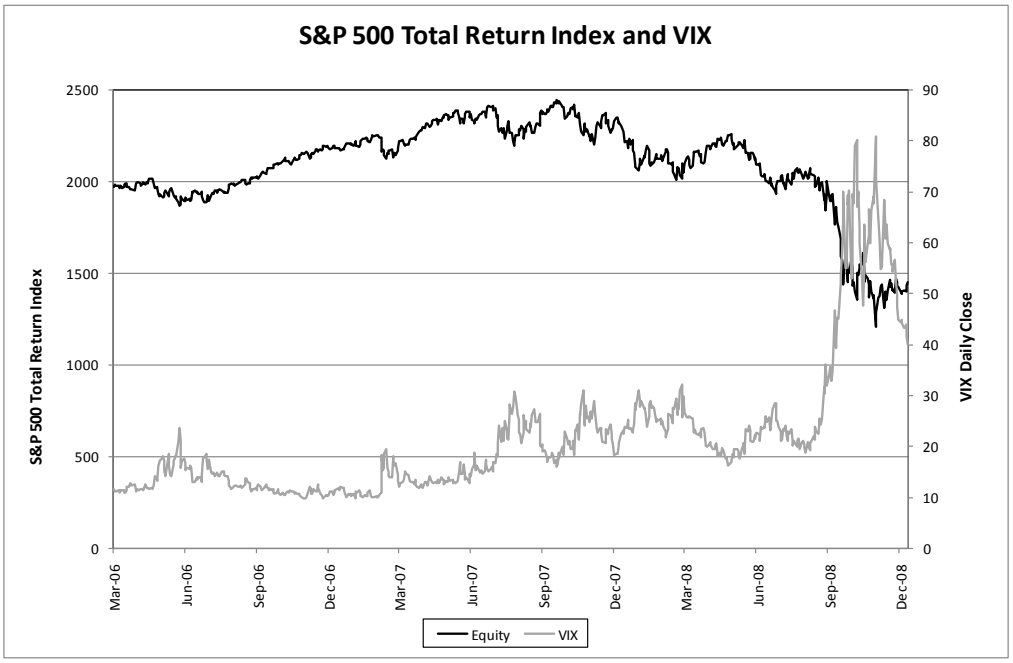
long equity hedge. While VIX often shows a strong negative correlation with S&P 500 returns, this relationship is extremely dynamic as illustrated in Exhibit 2.

Exhibit 2: Conditional Correlation Between VIX and SPX March 2006 to Dec. 2008



The exhibit suggests that the negative correlation between S&P 500 and VIX was particularly strong when the S&P 500 experienced large drops, such as the significant drop at the end of 2008. The fact that the correlation between the S&P 500 and VIX is conditional and time varying suggests that the use of hard and fast rules for hedging equity positions with VIX exposure may be ineffectual or at least challenging. However, the conditional nature of the correlation may result in an actively implemented long VIX position being a particularly effective diversifier in major down moves such as in the recent crisis. Even a cursory glance at Exhibit 3 suggests that VIX may spike upwards as the S&P 500 experiences large drops, leading one to believe that a long VIX position could provide significant diversification benefits to an equity portfolio.

Exhibit 3: S&P 500 Total Return Index and Spot VIX March 2006 to Dec. 2008



A review of recent literature further reinforces this belief. A number of studies have considered the potential diversification benefits of spot VIX exposure to equity portfolios. Daigler and Rossi [2006] find that the strong negative correlation between spot VIX and the S&P 500 results in significant diversification benefits from adding a long spot VIX position to an S&P 500 portfolio. Spot VIX can also provide benefits to portfolios containing alternative investments. Dash and Moran [2005] illustrate the potential diversification benefits of adding spot VIX exposure to hedge fund portfolios. In addition to the diversification benefits of spot VIX, Black [2006] suggests that the skew and excess kurtosis of many hedge fund strategies can be eliminated by a small long exposure to spot VIX. Since spot VIX is not directly investable, this analysis will consider the benefits of a long exposure to VIX futures and call options.

A 2007 paper by Grant, Gregory and Lui of Goldman Sachs[4] considers the payout ratios of VIX calls and SPX puts across all strikes and expirations in the period of July to August 2007. The results suggest that VIX calls have the potential to provide particularly effective diversification of equity risk, exhibiting far higher payouts per dollar then S&P 500 puts over the period of the study. In fact, 9 out of the top 10 payout ratios came from OTM VIX calls.

Consistent with the results found in Exhibits 2 and 3, a 2004 paper by CSFB[5] suggests that the negative correlation between S&P 500 and implied volatility is strongest in large down moves. The authors argue that short volatility should be characterized as an asset class. They demonstrate that long volatility is associated with a negative risk premium, therefore over extended time periods, long volatility positions tend to underperform the market. This is consistent with a number of studies on option writing strategies that find excess risk-adjusted returns for short volatility positions[6]. They also note that volatility tends to be mean reverting, and tends to cluster.

The characterization of short volatility as an asset class is further supported by a 2007 paper from Goldman Sachs appropriately entitled "Volatility as an Asset". The authors argue that short volatility should be considered an asset class because it offers significant passively generated returns, the returns are large enough to generate a non-trivial allocation and volatility provides diversification benefits in "hostile" markets.

[4] "Considering All Options", M. Grant, K. Gregory and J. Lui, Aug. 14, 2007. Goldman Sachs Global Investment Research.
[5] "Volatility as an Asset?", M. Toikka, E.K. Tom, S. Chadwick, and M. Bolt-Christmas, Feb. 26, 2004. CSFB Equity Derivatives Strategy.
[6] See for example Kapadia and Szado [2007] and Ungar and Moran [2009]

The research outlined above, in combination with the poor performance of "well diversified" portfolios in the crisis of 2008 motivates this study. Research suggests that, over the long term, a long volatility position may result in negative excess returns. However, long volatility may provide significant diversification benefits in large downward moves of the market. Additionally, the conditional nature of the negative correlation between SPX and VIX (as well as the research results which suggest that VIX calls may have higher payouts than SPX puts) suggests that VIX calls may provide more "bang for the buck" than SPX puts in diversifying a typical portfolio. These observations suggest that a long term passive long volatility position may return negative excess returns. However, a selectively applied long volatility position may provide significant diversification benefits, particularly in times when the diversification benefits of other assets break down, such as in the last two quarters of 2008.

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. Since long volatility positions are expected to earn negative excess returns in the long-term, an active approach rather than a passive long volatility exposure may be appropriate.

DATA

This study utilizes daily data for a range of assets from 2004 to the end of 2008. The majority of the analysis is confined to the period since the introduction of VIX options in 2006[7]. The S&P 500 total return index is used to represent returns to stocks. Bonds are represented by the Barclays Capital U.S. Aggregate total return index. A number of additional asset classes are included to provide a well diversified benchmark portfolio to which a long VIX exposure is subsequently added. High yield bonds are represented by the Barclays Capital U.S. High Yield total return index. Hedge funds are represented by the investable HFRX Global Hedge Fund Index, CTAs are represented by the investable Newedge CTA Index, real estate returns are represented by the S&P U.S. REIT Total Return Index, private equity is represented by the S&P Listed Private Equity Index and commodity returns are represented by the S&P GSCI Total Return Index. The investment in VIX futures will be represented by a long position in fully collateralized VIX futures. To create this investment, a long position in the front-month VIX futures contract is fully collateralized by holding the full value of the contract in Treasury bills. Each end of day the positions are rebalanced by marking-to-market and adjusting the Treasury bill position to reflect the cash inflow or outflow generated from marking-to-market. The futures position is rolled into the next front-month contract at the close on the day prior to

[7] While VIX options were introduced in February of 2006, the analysis begins by rolling into a position on the day prior to the March 22, 2006 expiration date of VIX options. This allows us to avoid the first month of trading to avoid liquidity limitations.

expiration. In addition to VIX futures, the analysis also utilizes one month to expiration VIX calls with two different degrees of moneyness (at-the-money, as well as 25% out-of-the-money)[8].

METHODOLOGY

To assess the diversification impacts of VIX exposure during the crisis, the addition of VIX exposure to three different portfolios is considered: Two traditional portfolios (100% stocks and 60% stocks / 40% bonds) as well as a portfolio of traditional and alternative assets (60.5% Stocks / 30.5% Bonds / 1.3% High Yield Bonds / 1.2% Hedge Funds / 0.1% Managed Futures / 0.3% Commodity / 1.6% Private Equity / 4.5% Real Estate)[9]. To these portfolios a 2.5% and 10% long allocation to fully collateralized near-month VIX futures is added. In addition, a 1% and 3% long allocation to one-month VIX ATM and 25% OTM calls is considered. Each month, on the day before the expiration of the options or futures, the options or futures are rolled to the next one-month contract and the portfolio is rebalanced to the target weights[10]. For the sake of consistency, the base portfolios (without VIX exposure) are also rebalanced monthly to the target weights on the day before the options and futures expiration. In this way, daily returns are calculated for each of the potential portfolio strategies[11]. In order to capture transactions

[8] The analysis was performed using at-the-money VIX calls, as well as 5%, 10%, 15%, 20% and 25% out-of-the-money VIX calls, although not all results are provided in the paper for the sake of clarity.
[9] Asset allocation based on Pensions and Investments 2007 average allocation for U.S. Institutional tax-exempt Assets
[10] VIX options settle based on a Special Opening Quotation of VIX on the day of expiration. The calls are rolled out of at the close on the day before expiration. This may induce a slight inaccuracy if the opening quotation differs from the close of the previous night, but it should not impose a systematic bias.
[11] In order to capture transactions costs for VIX calls, the calls are purchased at the ask price, and settle at the intrinsic value.

costs, the long VIX calls are rolled into at the ask price, and rolled out of at expiration at the intrinsic value. Returns for all days between the roll in date and expiration are calculated using the mid-point between the bid and ask prices. It is worth noting that the allocation levels of VIX exposure are largely arbitrary[12]. Due to the dynamic relationship between VIX and the S&P 500, it is not straightforward to establish a hedge ratio or an ideal long-term level of allocation. Such an exercise would be beyond the scope of this paper.

VIX

VIX was originally introduced by Whaley [1993] as an index of implied volatility on the S&P 100. In 2003 the new VIX was introduced which is based on the S&P 500 and is the basis for this paper. VIX is a measure of the implied volatility of 30-day S&P 500 options. Its calculation is not dependent on an option pricing model and is calculated from the prices of the front month and next-to-front month S&P 500 ATM and OTM call and put options. The level of VIX represents a measure of the implied volatilities of the entire smile for a constant 30-day to maturity option chain[13]. Since VIX measures the expected future volatility of the S&P 500, it has drawn a great deal of attention from the main stream media in the past year[14]. VIX is quoted in percentage points (e.g. 25.4 VIX represents an implied volatility of 25.4%).

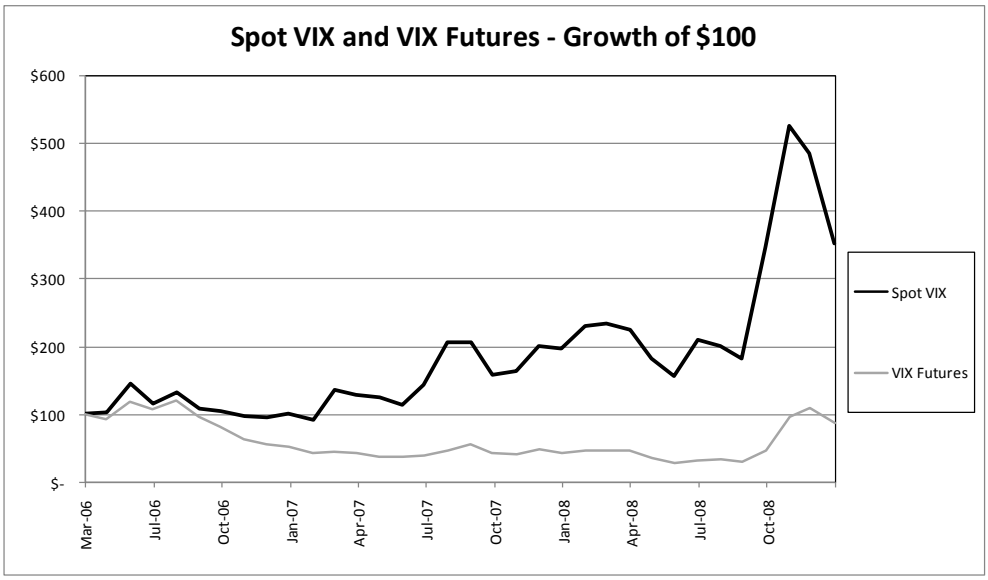
[12] I originally attempted to optimize the portfolio exposures for three different levels of risk aversion, but the superior return characteristics of the VIX futures position over the period of study resulted in a 100% allocation to VIX futures. This allocation is neither realistic nor useful for the purposes of this study.

[13] More information on calculating VIX can be found at http://www.cboe.com/micro/vix/vixwhite.pdf

[14] For example, see “On Wall Street Eyes Turn to The Fear Index.”New York Times Oct. 20, 2008, page B1 New York Edition. Lauricella, Tom and Aaron Lucchetti. "What's Behind the Surge In the VIX 'Fear' Index?" Wall Street Journal

Generally, references to the current level of VIX are based on spot VIX. However, spot VIX is currently not investable. In order to invest in VIX, an investor can take a position in VIX futures or VIX options. While spot VIX represents a measure of the expected volatility of the S&P 500 over the next 30-days, the prices of VIX futures and options are based on the current expectation of what the expected 30-day volatility will be at a particular time in the future (on the expiration date). While VIX futures and options should converge to the spot at expiration, it is possible to have significant disconnects between spot VIX and VIX futures and options prior to expiration. Exhibit 4 illustrates the performance of a theoretical $100 investment in spot VIX versus an investment in a fully collateralized rolling 1-month VIX future. The difference between the two is quite significant.

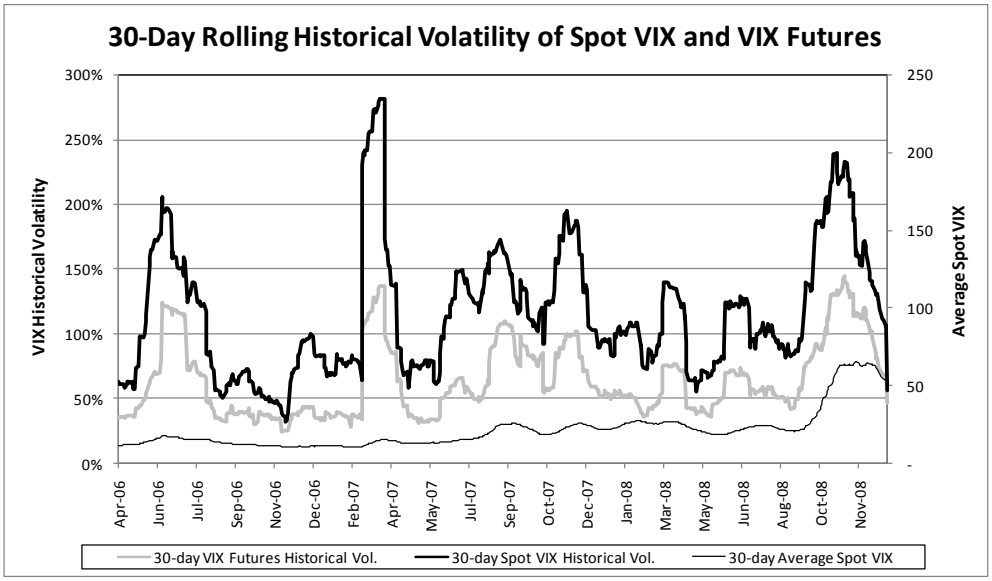
Exhibit 4: Theoretical Investment in Spot VIX versus VIX Futures March 2006 to Dec. 2008



(Oct 23, 2008) pg. C1., Tracy, Tennille. "Index of Volatility Reflects Traders' Continued Caution." Wall Street Journal. Oct 15, 2008. pg. C6., and Tracy, Tennille. "Trading Soars on Financials As Volatility Index Hits Record." Wall Street Journal. (Sep 30, 2008) pg. C6.

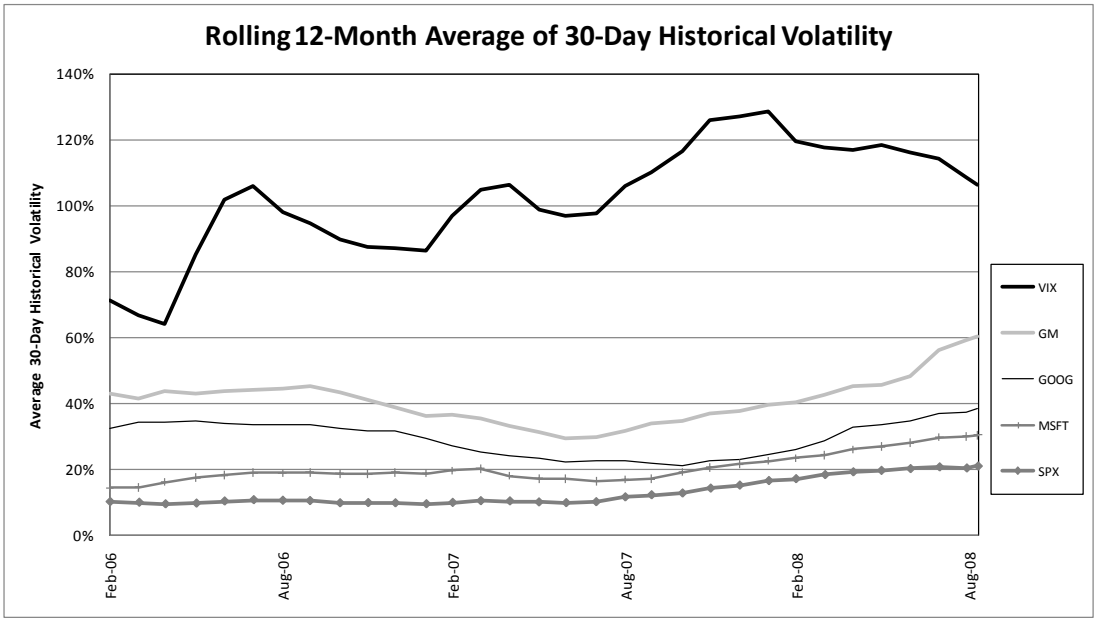
VIX futures have a number of unique characteristics when compared with many other financial futures contracts. As previously mentioned, theoretical spot VIX returns are driven by changes in the level of implied volatilities. In contrast, the returns to the VIX futures are driven by changes in expectations of implied volatilities. The relationship between spot and futures VIX prices is further complicated by the fact that it cannot be characterized by a typical cost of carry model, since there is no inherent cost of carry arbitrage between them. In addition, the relationship is further complicated by the fact that volatility tends to follow a mean reverting process. At least partially due to the mean reverting nature of volatility, VIX futures tend to exhibit significantly lower volatility than spot VIX. The rolling 30-day historical volatilities of spot VIX and 1-month VIX futures returns are shown in Exhibit 5. The difference between the volatilities of the two measures of VIX returns is striking. What is even more striking is the level of VIX volatility, with spot VIX historical volatility significantly exceeding 200% at times.

Exhibit 5: 30-Day Rolling Historical Volatility of VIX, March 2006 to Dec. 2008



VIX options also have unique characteristics which distinguish them from most index options. They tend to exhibit extremely high implied volatilities, in keeping with the high volatility of volatility mentioned earlier. As illustrated in Exhibit 6, the volatility of VIX tends to be extremely high relative to equity index volatility (or even many individual equities). In addition, VIX options must be priced in a manner which reflects the mean reverting nature of volatility.

Exhibit 6: Rolling 12-month Average of 30-day Historical Volatility

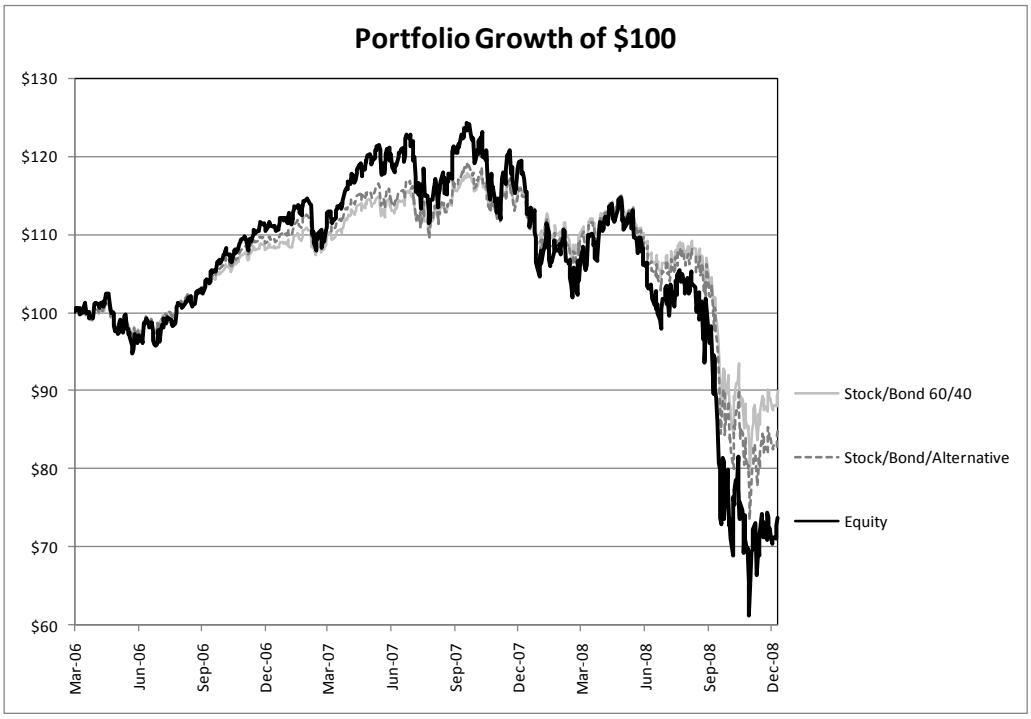


RESULTS

The performance of the three base portfolios is illustrated graphically in Exhibit 7. While the diversification benefits of adding bonds and alternative assets are evident, the benefits appear to be minimal, particularly in the latter half of 2008. Exhibit 8 provides summary statistics for

each of the assets on a standalone basis from March 2006 to December 2008 and from August 2008 to December 2008[15].

Exhibit 7: Base Portfolio Performance March 2006 to Dec. 2008



It is clear that, with the exception of bonds and managed futures, all of the components of the base portfolios performed quite poorly (in a similar fashion to equities) over both the entire period, and the late 2008 period. In contrast, the strong performance of VIX futures suggests that there may be diversification benefits from adding VIX futures to the base portfolios.

[15] Many of the return distributions presented here are highly non-normal. Care should be taken in interpreting results based only on the first two moments. See, for example Arditti [1967].

Exhibit 8: Base Asset Summary Statistics March 2006 to Dec. 2008 and Aug. 2008 to Dec. 2008

3/22/2006 to 12/31/2008	Equity	Bonds	High Yield Bonds	Hedge Funds	Managed Futures	Commodity	Private Equity	Real Estate	VIX Futures
Annualized Daily Return	-10.30%	5.97%	-6.92%	-5.73%	9.31%	-14.68%	-29.10%	-15.98%	-5.98%
Annualized Std Deviation	26.85%	4.35%	6.94%	5.66%	7.60%	29.09%	29.92%	48.29%	70.75%
Maximum Drawdown	-50.71%	-5.08%	-35.34%	-26.30%	-9.13%	-67.59%	-74.28%	-70.86%	-82.02%
Annual Sharpe Ratio	-0.42	1.16	-1.13	-1.18	1.10	-0.54	-1.00	-0.35	-0.10
Skew	0.05	-0.11	-2.96	-0.97	-0.62	-0.15	-0.24	0.23	0.52
Kurtosis	10.47	1.92	25.56	4.87	2.04	2.65	8.54	10.28	5.07
%Up days	54%	54%	58%	55%	58%	51%	48%	49%	45%
% Down Days	46%	46%	42%	45%	42%	49%	52%	51%	55%
Return over the period	-26.26%	17.64%	-18.22%	-15.26%	28.35%	-35.94%	-61.87%	-38.62%	-15.87%
8/1/2008 to 12/31/2008	**Equity**	**Bonds**	**High Yield Bonds**	**Hedge Funds**	**Managed Futures**	**Commodity**	**Private Equity**	**Real Estate**	**VIX Futures**
Period Return	-27.87%	4.15%	-24.17%	-20.20%	7.33%	-56.89%	-57.38%	-37.88%	159.52%
Period Std Deviation	37.73%	4.04%	10.17%	5.51%	5.09%	33.84%	40.21%	69.53%	62.88%
Maximum Drawdown	-41.92%	-5.08%	-32.12%	-20.20%	-3.09%	-62.00%	-62.70%	-63.33%	-35.31%
Period Sharpe Ratio	-0.75	0.93	-2.41	-3.73	1.36	-1.69	-1.44	-0.55	2.53
Skew	0.21	-0.11	-1.04	-0.15	-0.21	0.36	0.24	0.20	0.31
Kurtosis	1.13	1.48	3.28	3.80	3.60	0.13	1.13	0.68	0.20
%Up days	54%	54%	58%	55%	58%	51%	48%	49%	45%
% Down Days	46%	46%	42%	45%	42%	49%	52%	51%	55%

VIX Futures

The upper panel of Exhibit 9 provides performance measures over the entire period for the addition of 2.5% and 10% VIX futures to the base portfolios[16]. The Exhibit shows that for all three base portfolios, the addition of a 2.5% allocation to VIX futures both increases returns and reduces the standard deviation of returns. It is also interesting to note that when comparing only the base portfolios with no VIX allocation, the addition of alternative assets to the stock/bond portfolio results in a decrease in returns and an increase in standard deviation.

[16] While these allocations may seem quite high, there are two factors that mitigate this concern. First, the allocations are deliberately high to aid in the clear illustration of the impact of VIX inclusion in the portfolios. Secondly, the allocation represents a fully-collateralized futures position which implies that the dollar amount of the allocation is held in Treasury Bills, eliminating the high degree of leverage which may occur with futures positions.

This suggests that the addition of alternative assets was ineffectual in providing diversification benefits in this time period.

Exhibit 9: Summary Statistics with VIX Futures Mar. 2006 to Dec. 2008 and Aug. 2008 to Dec. 2008

Mar. 21, 2006 to Dec. 31, 2008	100% Equity	97.5% Equity / 2.5% VIX Futures	90% Equity / 10% VIX Futures	60% Equity / 40% Bonds	58.5% Equity / 39% Bonds / 2.5% VIX Futures	54% Equity / 36% Bonds / 10% VIX Futures	100% E/B/A Portfolio	97.5% E/B/A Portfolio / 2.5% VIX Futures	90% E/B/A Portfolio / 10% VIX Futures
Annualized Daily Return	-10.30%	-9.13%	-6.01%	-3.66%	-2.78%	-0.47%	-5.56%	-4.59%	-2.05%
Annualized Std Deviation	26.85%	24.38%	18.22%	15.39%	13.41%	9.47%	17.86%	15.80%	11.34%
Maximum Drawdown	-50.71%	-47.04%	-35.14%	-32.88%	-28.77%	-16.33%	-38.32%	-34.32%	-21.65%
Annual Sharpe Ratio	-0.47	-0.47	-0.46	-0.39	-0.39	-0.30	-0.45	-0.44	-0.39
Skew	0.05	0.07	0.23	-0.15	-0.07	0.30	-0.21	-0.15	0.15
Kurtosis	10.47	10.39	10.94	9.53	9.91	11.59	9.37	9.71	11.04
%Up days	54%	53%	50%	54%	52%	49%	54%	53%	50%
% Down Days	46%	47%	50%	46%	48%	51%	46%	47%	50%
Return over the 2 3/4 year period	-26.26%	-23.54%	-15.94%	-9.94%	-7.59%	-1.30%	-14.82%	-12.35%	-5.63%
Daily Stutzer Index	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Leland Beta	1.00	0.91	0.64	0.57	0.49	0.27	0.66	0.58	0.35
Leland Daily Alpha	0.000%	-0.001%	-0.003%	0.002%	0.002%	0.001%	-0.001%	-0.001%	-0.002%
Aug. 1, 2008 to Dec. 31, 2008	**100% Equity**	**97.5% Equity / 2.5% VIX Futures**	**90% Equity / 10% VIX Futures**	**60% Equity / 40% Bonds**	**58.5% Equity / 39% Bonds / 2.5% VIX Futures**	**54% Equity / 36% Bonds / 10% VIX Futures**	**100% E/B/A Portfolio**	**97.5% E/B/A Portfolio / 2.5% VIX Futures**	**90% E/B/A Portfolio / 10% VIX Futures**
Period Return	-27.87%	-24.03%	-12.12%	-15.87%	-12.06%	-0.33%	-19.68%	-15.85%	-4.02%
Period Std Deviation	37.73%	34.51%	26.24%	21.65%	19.15%	13.28%	25.25%	22.65%	16.33%
Maximum Drawdown	-41.92%	-37.69%	-23.82%	-27.59%	-22.97%	-9.04%	-32.17%	-27.72%	-14.00%
Period Sharpe Ratio	-0.74	-0.70	-0.47	-0.74	-0.64	-0.04	-0.79	-0.71	-0.26
Skew	0.21	0.21	0.23	0.08	0.10	0.27	0.05	0.07	0.17
Kurtosis	1.13	0.99	0.88	0.79	0.70	1.12	0.65	0.58	0.77
%Up days	48%	48%	49%	48%	47%	48%	49%	48%	47%
% Down Days	52%	52%	51%	52%	53%	52%	51%	52%	53%
Daily Stutzer Index	-0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leland Beta	1.00	1.83	1.41	3.25	3.07	-0.21	2.99	2.92	1.12
Leland Daily Alpha	0.000%	0.017%	0.071%	-0.004%	0.017%	0.079%	-0.017%	0.004%	0.067%

At this point in the analysis, it is important to clarify a number of points. First, it should be noted that negative Sharpe ratios provide little useful information. The calculation of the Sharpe ratio is based on expected returns. Certainly, if one expected returns to be negative, all wealth would be allocated to cash for the period. Even when returns are positive, one should be wary of employing traditional risk-adjusted performance measures, such as the Sharpe ratio and Jensen's alpha. This is particularly the case for portfolios that include option trading or other strategies which may potentially generate skewed or kurtotic return distributions. These

measures assume that returns are normally distributed[17]. Arditti [1967] shows that investors that exhibit non-increasing absolute risk aversion prefer positive skewness. Therefore negatively skewed return distributions should exhibit higher expected returns than positively skewed distributions, all else being equal. Since many of the return distributions presented here are highly non-normal, measures which are robust to non-normality such as the Stutzer index and Leland's alpha[18] are provided in the exhibits.

The lower panel of Exhibit 9 provides even stronger evidence of the benefits of the addition of VIX exposure to the base portfolios. The panel provides summary statistics for August to December 2008. In this period of extreme negative returns, the 2.5 % VIX futures exposure results in significantly reduced losses, at far lower standard deviations. For example, for the Stock/Bond/Alternatives portfolio, period returns are improved from -20% to -16% by adding 2.5% VIX futures and further improved to -4% by adding 10% VIX futures. Standard deviations are also reduced significantly (from 25% to 23% and 16%, respectively). Thus, the addition of 10% VIX futures cuts the losses to about 1/5 their initial level while reducing standard deviation by 1/3. Similarly, maximum drawdown for the portfolios is significantly improved by the addition of VIX futures. For example, for the Stock/Bond/Alternatives portfolio maximum drawdown is reduced from -32% to -27% and then to -14%. Similarly, the Leland daily alpha of the portfolio is improved from -1.7 basis points to 0.4 bps and then to 6.7 bps (for the 0%, 2.5% and 10% VIX futures allocations). A graphic illustration is provided in Exhibit 11.

[17] The Sharpe ratio may also be easily manipulated. For example, see Spurgin [2001].
[18] See Appendix A for further details regarding these measures. Despite its limitations, the Sharpe ratio is included for the sake of convention.

Exhibit 10 illustrates the efficient frontier that is possible from the addition of VIX futures to a Stock/Bond/Alternatives portfolio. Once again, the diversification benefits of VIX futures are clearly evident. The addition of up to 10% VIX futures reduces standard deviation in the overall period by more than a half while improving returns by cutting the losses in half[19].

Exhibit 10: Addition of VIX futures to Stock/Bond/Alternatives March 2006 to Dec. 2008

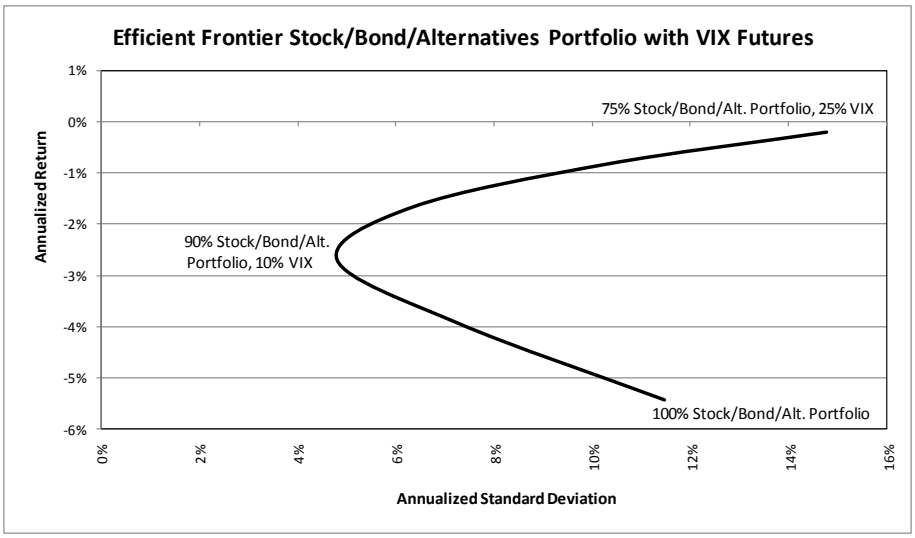
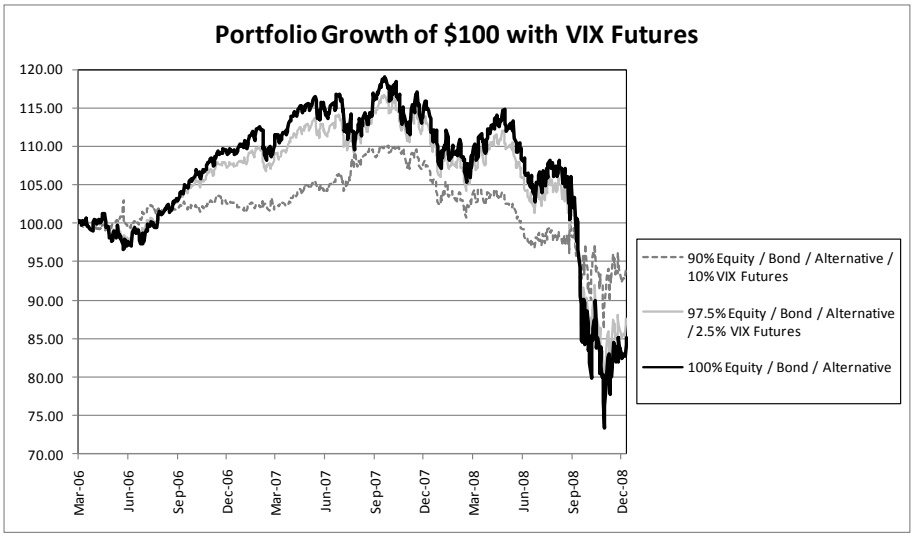


Exhibit 11: Portfolio Performance with VIX Futures March 2006 to Dec. 2008



[19] Of course, if an investor had predicted the negative returns, he would be fully in cash and achieve higher returns than available at any point on the provided frontier.

ATM VIX Calls

The section considers the addition of VIX calls to the base portfolios. The base portfolios are combined with a 1% or 3% allocation of ATM VIX 1-month calls or 25% OTM VIX 1-month calls.

Exhibit 12: Summary Statistics with ATM VIX Calls Mar. 2006 to Dec. 2008 and Aug. 2008 to Dec. 2008

Mar. 21, 2006 to Dec. 31, 2008	100% Equity	99% Equity / 1% ATM VIX Calls	97% Equity / 3% ATM VIX Calls	60% Equity / 40% Bonds	59.4% Equity / 39.6% Bonds / 1% ATM VIX Calls	58.2% Equity / 38.8% Bonds / 3% ATM VIX Calls	100% E/B/A Portfolio	99% E/B/A Portfolio / 1% ATM VIX Calls	97% E/B/A Portfolio / 3% ATM VIX Calls
Annualized Daily Return	-10.30%	-8.42%	-6.61%	-3.66%	-2.27%	-1.34%	-5.56%	-4.03%	-2.84%
Annualized Std Deviation	26.85%	22.24%	21.86%	15.39%	12.22%	18.13%	17.86%	14.41%	18.76%
Maximum Drawdown	-50.71%	-43.12%	-35.60%	-32.88%	-23.79%	-31.51%	-38.32%	-29.64%	-31.98%
Annual Sharpe Ratio	-0.47	-0.49	-0.41	-0.39	-0.38	-0.21	-0.45	-0.45	-0.28
Skew	0.05	0.26	0.08	-0.15	0.33	-0.31	-0.21	0.19	-0.31
Kurtosis	10.47	10.22	14.21	9.53	10.61	23.24	9.37	10.29	20.67
%Up days	54%	51%	47%	54%	50%	43%	54%	50%	44%
% Down Days	46%	49%	53%	46%	50%	57%	46%	50%	56%
Return over the 2 3/4 year period	-26.26%	-21.85%	-17.44%	-9.94%	-6.24%	-3.72%	-14.82%	-10.88%	-7.76%
Daily Stutzer Index	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.02	-0.02	-0.01
Leland Beta	1.00	0.78	0.40	0.57	0.37	0.02	0.66	0.46	0.10
Leland Daily Alpha	0.000%	-0.005%	-0.012%	0.002%	-0.001%	-0.007%	-0.001%	-0.004%	-0.010%
Aug. 1, 2008 to Dec. 31, 2008	**100% Equity**	**99% Equity / 1% ATM VIX Calls**	**97% Equity / 3% ATM VIX Calls**	**60% Equity / 40% Bonds**	**59.4% Equity / 39.6% Bonds / 1% ATM VIX Calls**	**58.2% Equity / 38.8% Bonds / 3% ATM VIX Calls**	**100% E/B/A Portfolio**	**99% E/B/A Portfolio / 1% ATM VIX Calls**	**97% E/B/A Portfolio / 3% ATM VIX Calls**
Period Return	-27.87%	-15.44%	11.04%	-15.87%	-2.68%	25.24%	-19.68%	-6.72%	20.78%
Period Std Deviation	37.73%	31.52%	27.55%	21.65%	17.04%	19.24%	25.25%	20.48%	21.08%
Maximum Drawdown	-41.92%	-29.76%	-20.49%	-27.59%	-13.58%	-12.37%	-32.17%	-18.82%	-15.41%
Period Sharpe Ratio	-0.74	-0.50	0.39	-0.74	-0.17	1.30	-0.79	-0.34	0.98
Skew	0.21	0.26	0.11	0.08	0.25	-0.23	0.05	0.18	-0.22
Kurtosis	1.13	0.92	2.55	0.79	1.11	8.61	0.65	0.84	6.13
%Up days	48%	50%	55%	48%	48%	56%	49%	50%	52%
% Down Days	52%	50%	45%	52%	52%	44%	51%	50%	48%
Daily Stutzer Index	-0.07	-0.04	0.05	-0.07	-0.01	0.12	-0.07	-0.02	0.10
Leland Beta	1.00	0.80	0.47	0.57	0.40	0.11	0.67	0.49	0.19
Leland Daily Alpha	0.000%	0.081%	0.248%	-0.004%	0.084%	0.255%	-0.017%	0.071%	0.245%

Exhibit 12 provides the summary statistics for the resulting portfolios. The addition of ATM VIX calls provides largely similar results to the addition of VIX futures. While ATM VIX calls reduce losses for all three portfolios in the March 2006 to December 2008 period, the effect on standard deviation is mixed. The addition of a 1% allocation to ATM calls reduces the standard deviation, but the greater 3% allocation increases standard deviation for all but the 100% stock portfolio. Maximum drawdown suggests a similar pattern. For example, for the stock/bond/alternatives portfolio in the overall period, annualized daily returns are -6%, -4% and -3% respectively, while standard deviations are 18%, 14% and 19% and maximum

drawdowns are -38%, -30% and -32% respectively. The Leland alphas suggest a slight underperformance from the addition of ATM VIX calls in the 2006 to 2008 period.

As with VIX futures, the impact of ATM VIX calls is more significant in the latter half of 2008. While the standard deviation reduction is generally not very large, the return improvements are impressive. In the case of the stock/bond/alternatives portfolio, period returns are increased from -20% to +21%, while period standard deviation is reduced from 25% to 21%, and maximum drawdown is cut in half from -32% to -15%. Exhibit 13 illustrates the diversification benefits of ATM VIX calls in an efficient frontier context. An allocation to ATM VIX calls of up to 1% in a well diversified portfolio can cut losses by 1/5 while reducing standard deviation by 1/5. Exhibit 14 graphically illustrates the same results as Exhibit 12. The reduced portfolio returns in up markets and the loss reduction/return enhancement in down markets are clearly evident in Exhibit 14.

Exhibit 13: Efficient Frontier with ATM VIX Calls Mar. 2006 to Dec. 2008

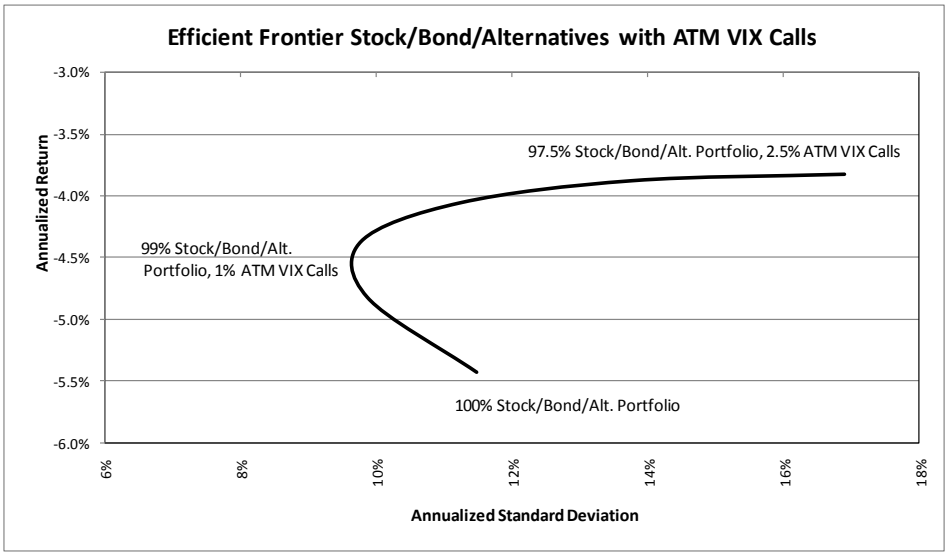
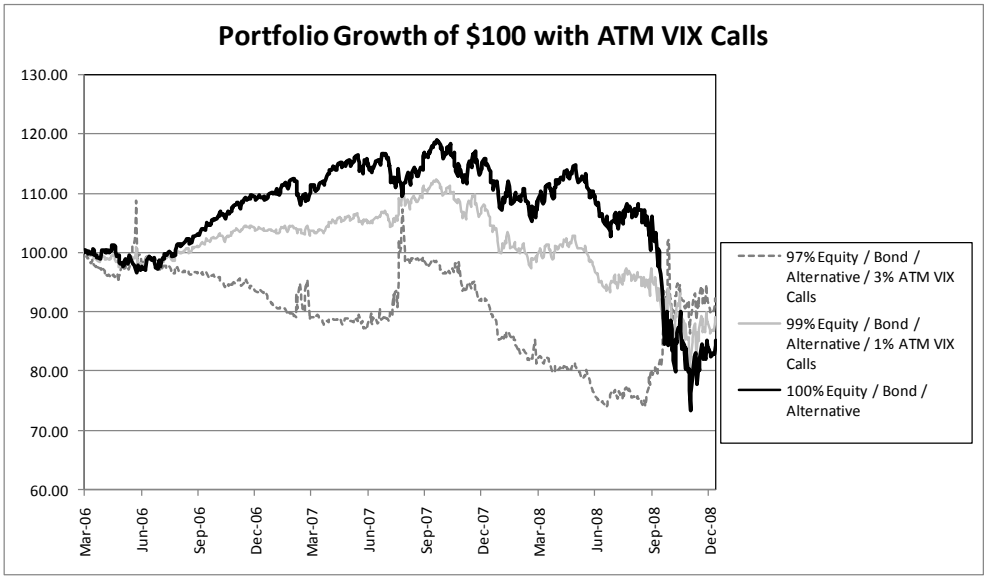


Exhibit 14: Portfolio Performance with ATM VIX Calls March 2006 to Dec. 2008



25% OTM VIX Calls

This section considers the addition of deep out-of-the-money (25% OTM) VIX calls to the base portfolios. As with the ATM calls, an allocation of 1% and 3% to the 25% OTM calls is considered. Not surprisingly, the results for the 25% OTM calls are more extreme than for the ATM calls. The extra leverage provided by the deep OTM calls results in greater return benefits in market drops, but with a corresponding increase in standard deviation.

This is evident in both time periods, but is particularly pronounced in the latter 2008 period. For example, for the stock/bond/alternatives portfolio in the lower panel of Exhibit 15, period returns increase from -20% to +18% and then to +97% with the addition of 1% and 3% OTM VIX calls, respectively. Meanwhile, the period standard deviation increases from 25% to 29% and to 52%. On the other hand, maximum drawdown does not exhibit as significant of a change (-32%,

-24% and -27%). The improvements in risk-adjusted returns are also evident in the Stutzer index and Leland alpha. The Stutzer index improves from -0.07 to 0.07 and then 0.15, while the Leland daily alpha increases from -1.7 bps to 24.7 bps and finally 69.1 bps. The results for the overall period exhibit a similar pattern, although to a somewhat lesser degree.

Exhibit 15: Summary Statistics with 25% OTM VIX Calls Mar. 2006 to Dec. 2008 and Aug. 2008 to Dec. 2008

Mar. 21, 2006 to Dec. 31, 2008	100% Equity	99% Equity / 1% 25% OTM VIX Calls	97% Equity / 3% 25% OTM VIX Calls	60% Equity / 40% Bonds	59.4% Equity / 39.6% Bonds / 1% 25% OTM VIX Calls	58.2% Equity / 38.8% Bonds / 3% 25% OTM VIX Calls	100% E/B/A Portfolio	99% E/B/A Portfolio / 1% 25% OTM VIX Calls	97% E/B/A Portfolio / 3% 25% OTM VIX Calls
Annualized Daily Return	-10.30%	-3.29%	1.24%	-3.66%	2.64%	6.17%	-5.56%	0.96%	4.79%
Annualized Std Deviation	26.85%	24.86%	39.99%	15.39%	18.67%	38.92%	17.86%	19.95%	39.14%
Maximum Drawdown	-50.71%	-30.86%	-53.10%	-32.88%	-21.46%	-51.05%	-38.32%	-24.37%	-51.45%
Annual Sharpe Ratio	-0.47	-0.23	-0.03	-0.39	0.01	0.10	-0.45	-0.07	0.06
Skew	0.05	0.04	0.88	-0.15	-0.27	1.08	-0.21	-0.29	1.01
Kurtosis	10.47	16.89	37.21	9.53	41.33	43.32	9.37	33.26	42.38
%Up days	54%	50%	46%	54%	49%	43%	54%	50%	44%
% Down Days	46%	50%	54%	46%	51%	57%	46%	50%	56%
Return over the 2 3/4 year period	-26.26%	-8.95%	3.51%	-9.94%	7.59%	18.27%	-14.82%	2.71%	14.01%
Daily Stutzer Index	-0.02	-0.01	0.01	-0.02	0.01	0.02	-0.02	0.00	0.02
Leland Beta	1.00	0.57	-0.01	0.57	0.18	-0.36	0.66	0.26	-0.28
Leland Daily Alpha	0.000%	0.011%	0.027%	0.002%	0.015%	0.031%	-0.001%	0.013%	0.029%
Aug. 1, 2008 to Dec. 31, 2008	**100% Equity**	**99% Equity / 1% 25% OTM VIX Calls**	**97% Equity / 3% 25% OTM VIX Calls**	**60% Equity / 40% Bonds**	**59.4% Equity / 39.6% Bonds / 1% 25% OTM VIX Calls**	**58.2% Equity / 38.8% Bonds / 3% 25% OTM VIX Calls**	**100% E/B/A Portfolio**	**99% E/B/A Portfolio / 1% 25% OTM VIX Calls**	**97% E/B/A Portfolio / 3% 25% OTM VIX Calls**
Period Return	-27.87%	7.95%	84.41%	-15.87%	22.22%	103.02%	-19.68%	17.70%	97.18%
Period Std Deviation	37.73%	34.96%	53.38%	21.65%	26.77%	51.31%	25.25%	28.70%	51.86%
Maximum Drawdown	-41.92%	-29.24%	-31.90%	-27.59%	-21.46%	-25.60%	-32.17%	-24.37%	-27.40%
Period Sharpe Ratio	-0.74	0.22	1.58	-0.74	0.82	2.00	-0.79	0.61	1.87
Skew	0.21	-0.04	0.51	0.08	-0.29	0.66	0.05	-0.28	0.60
Kurtosis	1.13	3.00	9.40	0.79	9.34	11.85	0.65	7.02	11.34
%Up days	48%	54%	55%	48%	54%	58%	49%	55%	54%
% Down Days	52%	46%	45%	52%	46%	42%	51%	45%	46%
Daily Stutzer Index	-0.07	0.04	0.14	-0.07	0.09	0.16	-0.07	0.07	0.15
Leland Beta	1.00	0.51	-0.06	0.57	0.15	-0.38	0.67	0.23	-0.31
Leland Daily Alpha	0.000%	0.252%	0.694%	-0.004%	0.257%	0.698%	-0.017%	0.247%	0.691%

The results of the 25% OTM VIX call allocation are illustrated graphically in Exhibits 16 and 17. The addition of VIX calls to the portfolios significantly increases the volatility of returns. However, the benefits are also quite clear. The additional leverage of the deep OTM calls provides a strong upward spike in portfolio returns in down markets.

Exhibit 16: Efficient Frontier with 25% OTM VIX Calls Mar. 2006 to Dec. 2008

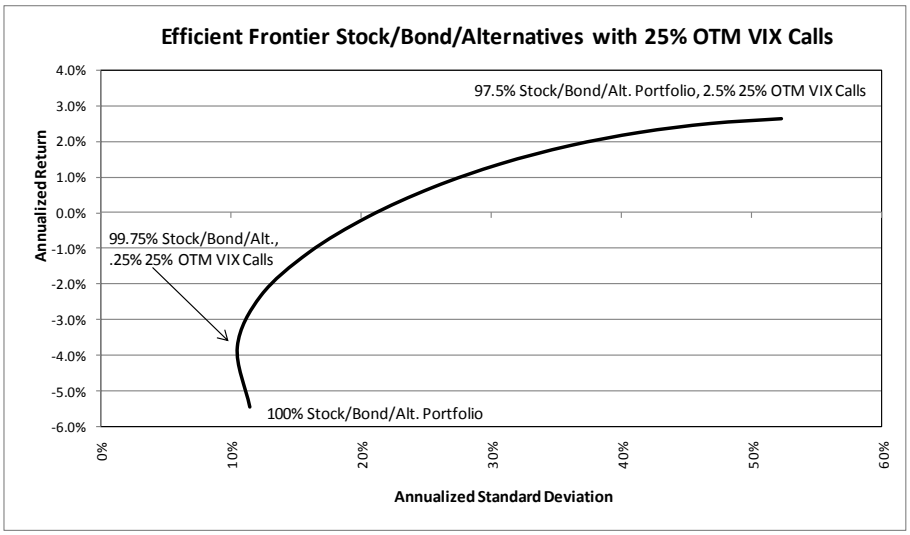
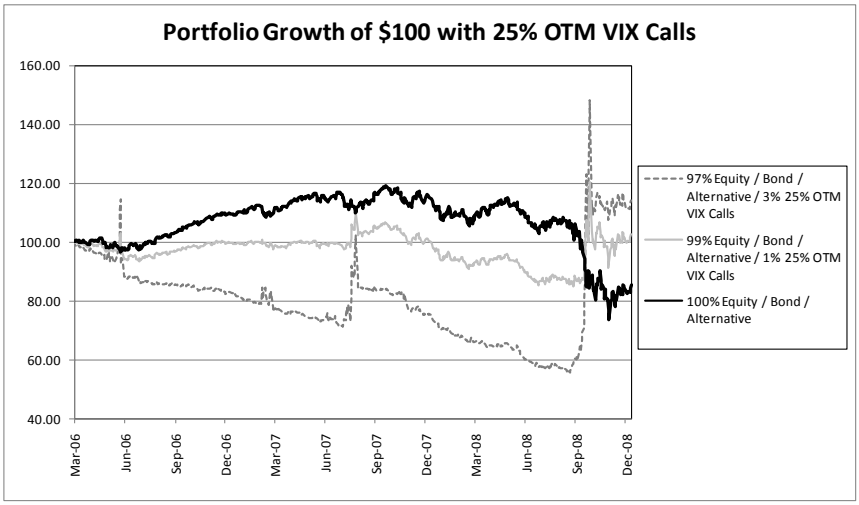


Exhibit 17: Portfolio Performance with 25% OTM VIX Calls March 2006 to Dec. 2008



SPX Protective Puts

Up to this point, the analysis has ignored one of the simplest and most common strategies for protection from equity market downturns, the use of protective puts. While long VIX exposure has been shown to be an effective diversifier, protective puts are a direct hedge for the equity

portion of a portfolio rather than a diversification tool. Carrying a long SPX put position is a very simple way to help mitigate or eliminate portfolio losses due to drops in the equity market. However, there is a great deal of evidence that OTM puts tend to be richly priced[20]. As discussed earlier, the negative correlation between SPX and VIX is conditional in nature and tends to be strongest when diversification benefits are needed the most, in large down moves in SPX. This suggests that the diversification benefits of VIX calls may provide a more efficient alternative to portfolio protection than SPX puts[21]. To evaluate this assertion, the performance of the long VIX enhanced portfolios are compared to that of portfolios which utilize long SPX protective puts. To avoid the issue of determining an appropriate "hedge ratio"[22] and to compare the effectiveness of VIX calls and SPX puts on a dollar-for-dollar basis, the following methodology is utilized:

At each roll date (the day prior to expiration), an SPX put is purchased which is the same price as the VIX call that had been used in the ATM or 25% OTM VIX call strategy. Thus, the SPX strike price varies month-to-month in degree of moneyness and is derived endogenously based on the relative pricing of SPX puts and VIX calls.[23] Due to the high liquidity of SPX options and their overwhelmingly institutional usage, the return calculations assume that the puts are purchased at the mid-point between the bid and ask prices. It is important to note that in the following

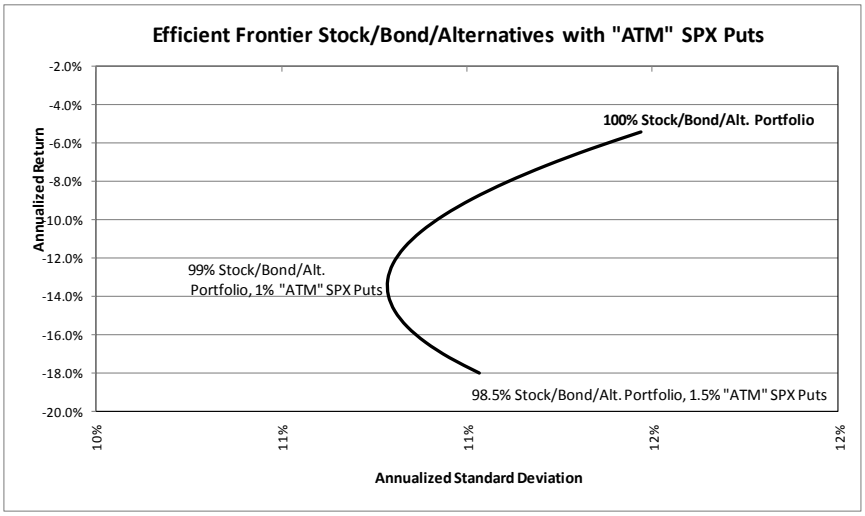
[20] For example, see Ungar and Moran [2009] and Bakshi and Kapadia [2003]
[21] Of course, SPX puts provide a direct hedge so there is no question of their effectiveness. In contrast, the dynamic correlation between the S&P 500 and VIX leaves some uncertainty to the ex ante diversification effectiveness of VIX.
[22] As mentioned earlier, due to the dynamic correlations between VIX and SPX, an appropriate "hedge ratio" is not easily derived.
[23] While this methodology may be criticized for ignoring the relative scaling issues between SPX and VIX, it does provide a dollar for dollar comparison and thus does not rely on an arbitrary hedge ratio.

analysis the term “ATM” SPX put refers not to an actual ATM put, but to an SPX put that is the same price as a corresponding ATM VIX call on the roll date[24].

Exhibit 18: Summary Statistics with “ATM” SPX Puts Mar. 2006 to Dec. 2008 and Aug. 2008 to Dec. 2008

Mar. 21, 2006 to Dec. 31, 2008	100% Equity	99% Equity / 1% SPX Puts matching ATM VIX Calls	97% Equity / 3% SPX Puts matching ATM VIX Calls	60% Equity / 40% Bonds	59.4% Equity / 39.6% Bonds / 1% SPX Puts matching ATM VIX Calls	58.2% Equity / 38.8% Bonds / 3% SPX Puts matching ATM VIX Calls	100% E/B/A Portfolio	99% E/B/A Portfolio / 1% SPX Puts matching ATM VIX Calls	97% E/B/A Portfolio / 3% SPX Puts matching ATM VIX Calls
Annualized Daily Return	-10.30%	-17.41%	-30.85%	-3.37%	-11.30%	-26.09%	-5.20%	-12.91%	-27.33%
Annualized Std Deviation	26.85%	29.23%	62.14%	15.50%	24.95%	60.99%	17.97%	25.94%	61.44%
Maximum Drawdown	-50.71%	-54.58%	-70.75%	-32.64%	-41.00%	-62.33%	-38.01%	-45.52%	-65.13%
Annual Sharpe Ratio	-0.47	-0.67	-0.53	-0.37	-0.55	-0.47	-0.42	-0.59	-0.48
Skew	0.05	-1.42	1.94	-0.12	-2.14	2.25	-0.17	-2.08	2.20
Kurtosis	10.47	32.14	95.70	9.61	79.75	102.38	9.48	67.45	101.63
%Up days	54%	49%	43%	54%	46%	41%	54%	48%	42%
% Down Days	46%	51%	57%	46%	54%	59%	46%	52%	58%
Return over the 2 3/4 year period	-26.26%	-41.51%	-64.46%	-9.17%	-28.56%	-57.17%	-13.91%	-32.12%	-59.14%
Daily Stutzer Index	-0.02	-0.04	-0.02	-0.02	-0.03	-0.01	-0.02	-0.03	-0.02
Leland Beta	1.00	0.41	-0.42	0.57	0.03	-0.76	0.66	0.11	-0.68
Leland Daily Alpha	0.000%	-0.053%	-0.094%	0.004%	-0.043%	-0.084%	0.001%	-0.047%	-0.087%
Aug. 1, 2008 to Dec. 31, 2008	**100% Equity**	**99% Equity / 1% SPX Puts matching ATM VIX Calls**	**97% Equity / 3% SPX Puts matching ATM VIX Calls**	**60% Equity / 40% Bonds**	**59.4% Equity / 39.6% Bonds / 1% SPX Puts matching ATM VIX Calls**	**58.2% Equity / 38.8% Bonds / 3% SPX Puts matching ATM VIX Calls**	**100% E/B/A Portfolio**	**99% E/B/A Portfolio / 1% SPX Puts matching ATM VIX Calls**	**97% E/B/A Portfolio / 3% SPX Puts matching ATM VIX Calls**
Period Return	-27.87%	-23.58%	-16.44%	-15.22%	-10.95%	-3.91%	-18.83%	-14.52%	-7.41%
Period Std Deviation	37.73%	42.54%	91.05%	21.86%	37.33%	88.75%	25.48%	38.79%	89.66%
Maximum Drawdown	-41.92%	-38.09%	-56.34%	-27.31%	-31.24%	-50.67%	-31.77%	-34.13%	-52.86%
Period Sharpe Ratio	-0.74	-0.56	-0.18	-0.70	-0.30	-0.05	-0.75	-0.38	-0.08
Skew	0.21	-0.76	0.97	0.09	-1.17	1.08	0.07	-1.12	1.07
Kurtosis	1.13	6.49	22.77	0.78	17.25	25.05	0.65	14.28	24.59
%Up days	48%	50%	46%	48%	46%	47%	49%	47%	47%
% Down Days	52%	50%	54%	52%	54%	53%	51%	53%	53%
Daily Stutzer Index	-0.07	-0.04	0.03	-0.06	-0.01	0.04	-0.07	-0.02	0.04
Leland Beta	1.00	0.30	-0.60	0.58	-0.06	-0.91	0.67	0.02	-0.83
Leland Daily Alpha	0.000%	-0.095%	0.084%	0.005%	-0.058%	0.120%	-0.005%	-0.071%	0.110%

Exhibit 19: Efficient Frontier with “ATM” SPX Puts Mar. 2006 to Dec. 2008



[24] The average actual moneyness of “ATM” SPX puts was 13% OTM and the range was 7% OTM to 37% OTM, the average actual moneyness of “25% OTM” SPX puts was 19% OTM and the range was 9% OTM to 47% OTM.

Exhibit 18 provides the summary statistics of the "ATM" SPX put portfolios for the overall period and the latter 2008 period. It is immediately clear that the SPX put portfolios do not perform as well as the ATM VIX call portfolios in either period. In the overall period, ATM VIX calls cut losses significantly while having little impact on standard deviations. In contrast, The upper panel of the exhibit indicates that long "ATM" SPX puts drastically increased losses and increased standard deviations in the overall period. Similar results are found when one considers only the August 2008 to December 2008 period. It was noted earlier that Exhibit 12 shows that the addition of ATM VIX calls changes large losses into even larger gains while reducing standard deviations. The addition of "ATM" SPX puts cuts losses, but not as substantially as the VIX call allocation. Furthermore, the return improvements that the "ATM" SPX puts provide come at a cost. The standard deviations increase by as much as a factor of 4.

Exhibit 20: VIX and SPX Movement of Underlying Relative to Strike Price Mar. 2006 to Dec. 2008

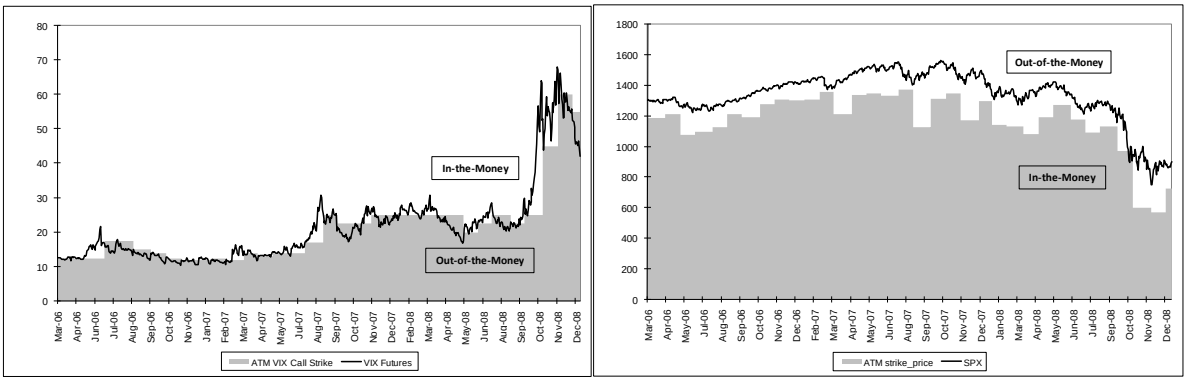


Exhibit 20 provides some insight into what is driving these results. The left panel illustrates the movement of the front-month VIX futures contract relative to the ATM VIX strike prices that are used in the analysis. It is clear that the ATM VIX calls often end up ITM, and occasionally very deep ITM. In contrast, the right panel provides a similar graphic for the SPX puts. The SPX puts only go ITM for a brief period, and even then they do not go very deep ITM. Thus, due to the

relative cost of the SPX puts (compared to VIX calls), and the resulting initial moneyness, the SPX puts end up being a cost for the portfolio while providing very little protection. Similar results for the "25% OTM" SPX puts are provided in Appendix B.

Thus, there clearly seems to be an efficiency to be gained by using VIX calls or VIX futures for portfolio diversification rather than SPX puts.

CONCLUSION

Ultimately, 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 would 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. It is clear from the results of the analysis that, 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.

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APPENDIX A: VIX BASED VOLATILITY INDEXES

CBOE Capped VIX Premium Strategy Index (VPN) (Introduced in November 2007)

Methodology: Sells 1-month VIX futures, capped with long VIX calls struck 25 points higher than the VIX futures price.

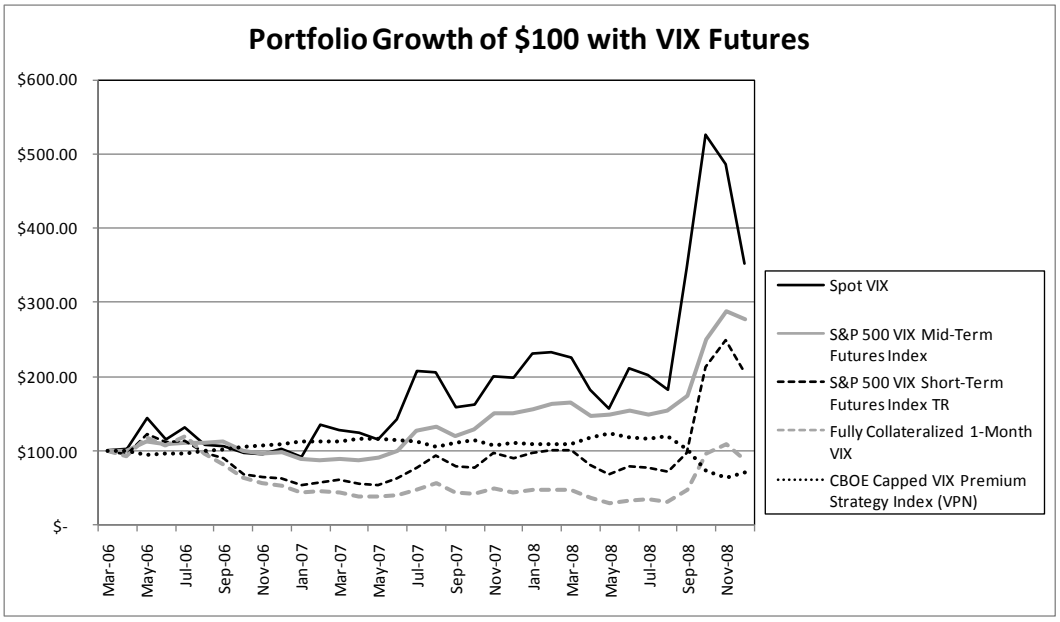
S&P 500 VIX Futures Indices (Introduced January 2009)

The S&P 500 VIX Short-Term Futures Index

Methodology: Long position in the first- and second-month VIX futures, rolled daily to maintain a constant one-month maturity

The S&P 500 VIX Mid-Term Futures Index

Methodology: Long position in the fourth-, fifth-, sixth- and seventh-month VIX futures, rolled daily to maintain a constant five-month maturity



APPENDIX B: "25% OTM" SPX Put Portfolio Performance

Mar. 21, 2006 to Dec. 31, 2008	100% Equity	99% Equity / 1% SPX Puts matching 25% OTM VIX Calls	97% Equity / 3% SPX Puts matching 25% OTM VIX Calls	60% Equity / 40% Bonds	59.4% Equity / 39.6% Bonds / 1% SPX Puts matching 25% OTM VIX Calls	58.2% Equity / 38.8% Bonds / 3% SPX Puts matching 25% OTM VIX Calls	100% E/B/A Portfolio	99% E/B/A Portfolio / 1% SPX Puts matching 25% OTM VIX Calls	97% E/B/A Portfolio / 3% SPX Puts matching 25% OTM VIX Calls
Annualized Daily Return	-10.30%	-20.56%	-37.93%	-3.37%	-14.43%	-33.14%	-5.20%	-16.05%	-34.40%
Annualized Std Deviation	26.85%	28.80%	57.62%	15.50%	23.60%	55.86%	17.97%	24.81%	56.43%
Maximum Drawdown	-50.71%	-59.04%	-78.08%	-32.64%	-46.35%	-71.15%	-38.01%	-50.58%	-73.46%
Annual Sharpe Ratio	-0.47	-0.79	-0.70	-0.37	-0.71	-0.63	-0.42	-0.74	-0.65
Skew	0.05	-2.29	-2.18	-0.12	-4.83	-2.01	-0.17	-4.24	-2.05
Kurtosis	10.47	33.06	77.12	9.61	89.82	86.45	9.48	74.13	84.70
%Up days	54%	49%	44%	54%	47%	43%	54%	48%	44%
% Down Days	46%	51%	56%	46%	53%	57%	46%	52%	56%
Return over the 2 3/4 year period	-26.26%	-47.55%	-73.74%	-9.17%	-35.39%	-67.65%	-13.91%	-38.76%	-69.34%
Daily Stutzer Index	-0.02	-0.05	-0.03	-0.02	-0.04	-0.03	-0.02	-0.04	-0.03
Leland Beta	1.00	0.50	-0.21	0.57	0.11	-0.55	0.66	0.20	-0.48
Leland Daily Alpha	0.000%	-0.065%	-0.133%	0.004%	-0.056%	-0.122%	0.001%	-0.059%	-0.125%

Aug. 1, 2008 to Dec. 31, 2008	100% Equity	99% Equity / 1% SPX Puts matching 25% OTM VIX Calls	97% Equity / 3% SPX Puts matching 25% OTM VIX Calls	60% Equity / 40% Bonds	59.4% Equity / 39.6% Bonds / 1% SPX Puts matching 25% OTM VIX Calls	58.2% Equity / 38.8% Bonds / 3% SPX Puts matching 25% OTM VIX Calls	100% E/B/A Portfolio	99% E/B/A Portfolio / 1% SPX Puts matching 25% OTM VIX Calls	97% E/B/A Portfolio / 3% SPX Puts matching 25% OTM VIX Calls
Period Return	-27.87%	-31.57%	-38.50%	-15.22%	-19.57%	-27.71%	-18.83%	-22.98%	-30.79%
Period Std Deviation	37.73%	40.90%	81.76%	21.86%	34.31%	78.72%	25.48%	36.09%	79.78%
Maximum Drawdown	-41.92%	-43.72%	-66.39%	-27.31%	-36.54%	-61.26%	-31.77%	-39.33%	-63.20%
Period Sharpe Ratio	-0.74	-0.78	-0.47	-0.70	-0.58	-0.35	-0.75	-0.64	-0.39
Skew	0.21	-1.29	-1.47	0.09	-2.77	-1.49	0.07	-2.40	-1.48
Kurtosis	1.13	7.49	20.29	0.78	22.06	23.50	0.65	17.71	22.72
%Up days	48%	51%	42%	48%	46%	44%	49%	50%	44%
% Down Days	52%	49%	58%	52%	54%	56%	51%	50%	56%
Daily Stutzer Index	-0.07	-0.07	-0.01	-0.06	-0.05	0.00	-0.07	-0.05	0.00
Leland Beta	1.00	0.40	-0.38	0.58	0.04	-0.70	0.67	0.12	-0.62
Leland Daily Alpha	0.000%	-0.180%	-0.185%	0.005%	-0.139%	-0.136%	-0.005%	-0.154%	-0.150%