“USE OF OPTION STRATEGIES TO IMPROVE RISK-ADJUSTED RETURNS ON A 60/40 INVESTMENT PORTFOLIO.”

Carlos Chujoy\(^1\) \hspace{1cm} Joy Seth\(^2\) \hspace{1cm} Satitpong Chantarajirawong\(^3\)

July 2016

ABSTRACT

Improvement of risk-adjusted returns is one of many goals that pension plans seek to achieve. Many plans that follow a Traditional 60/40 dollar allocation to stocks and bonds end up exhibiting a large concentration of risk to stocks given their higher volatility characteristic. The study aims to explore a variety of strategies that incorporate options as a way to improve a plan’s returns/risk outcomes. In doing so, it also aims to provide a general view of how these strategies perform during the different stages of the business cycle and volatility regimes when they are used in combination with a plan’s stock/bond allocation.

ACKNOWLEDGEMENTS: The authors would like to thank the following people for their contribution and valuable input: Michael Warsh, Paul Stephens, Matt Moran from the Chicago Board Options Exchange, the executive office and Stuart Williams from the Employees Retirement System of Texas for their support and Yu Tang, intern from the University of Washington. All errors and omissions remain the responsibilities of the authors.

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Introduction

Public pension plans in the US have traditionally held an investment allocation of 60% of its assets to equities and 40% to fixed income. This dollar allocation stems from the fact that pension plans need to grow their assets as well as shield their investments from the erosion of purchasing power over time. At the same time, one of their main goals is to generate investment returns that are commensurate with the amount of risk incurred.

Exhibit 1 below, shows the cumulative performance for stocks, bonds and a typical 60/40 plan. For purposes of this exercise, we have used the Vanguard S&P 500 Index Fund (VFINX) from the Yahoo Financial database to represent domestic equities, and for fixed income we have used the BofA Merrill Lynch US Corp Master Total Return Index Value from the Federal Reserve Bank of St. Louis database. At first glance, one can notice how closely related equity returns are to a typical 60/40 allocation. One can also notice that the growth trajectory of plan assets comes in at the expense of increased volatility due to market corrections. Market corrections that exert amongst other things, the decline of a plans’ market value, the liquidation of assets at the wrong time to meet internal obligations, the compromise of the overall soundness of the plan and sometimes its viability as an on-going concern.

The need to diversify market risk has been a very important one and one that plans have sought in order to improve their risk-adjusted returns. Over the years, plans have relied on diversifying their investments into non-traditional asset classes, and more recently in framing their investment opportunities in terms of risk premia as opposed to asset classes to increase a plan’s portfolio diversification.
In terms of risk, Exhibit 2, provides a graphical representation of the evolution of portfolio drawdowns. As noted earlier, a Traditional 60/40 plan as represented by the black line will have its performance results be heavily influenced by the returns of the equity asset class.

Exhibit 3, summarizes the results of the past 25 years. It shows that Equities have delivered strong returns at high levels of risk and large drawdowns.

At the same time, it shows that US Bonds have delivered lower returns relative to stocks but have attained them with a lower amount of risk. Lastly, the Traditional 60/40 plan’s return and risk metrics fall right in the middle of the aforementioned asset classes. It is clear that a 60/40 plan’s statistics are heavily influenced by the equity asset class; a tilt that a plan relies to achieve the growth of its assets throughout time.

**EXHIBIT 3**

**Table of Performance and Risk Measures over the Period May 1990 to Mar 2015**

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Annualized Return</th>
<th>Annualized Risk</th>
<th>Skew</th>
<th>Excess Kurtosis</th>
<th>Sharpe</th>
<th>Drawdown</th>
<th>Sortino</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P500</td>
<td>9.62%</td>
<td>16.18%</td>
<td>-1.04</td>
<td>4.13</td>
<td>0.40</td>
<td>47.91%</td>
<td>0.27</td>
</tr>
<tr>
<td>US Bonds</td>
<td>7.41%</td>
<td>5.3%</td>
<td>-1.05</td>
<td>5.62</td>
<td>0.82</td>
<td>15.32%</td>
<td>0.67</td>
</tr>
<tr>
<td>Traditional 60/40</td>
<td>9.08%</td>
<td>10.29%</td>
<td>-1.23</td>
<td>6.50</td>
<td>0.58</td>
<td>33.15%</td>
<td>0.39</td>
</tr>
</tbody>
</table>

Source: Federal Reserve Bank of St. Louis, Yahoo Finance
A final observation is that all portfolios exhibit fat tails (excess kurtosis is positive) and long left tail (negative skew) in their return distributions.\(^4\)

To further support the thesis of high equity concentration of risk, Exhibit 4 shows that a 60/40 dollar allocation translates to a risk allocation of approximately 92/8 percent. The higher amount of volatility of the equity asset class returns, affects its percent contribution to total portfolio risk more than proportionately.

Exhibit 4: Dollar and Risk Allocation

Based on these results, can risk-adjusted returns be improved for a Traditional 60/40 portfolio, and if so, how? Over the years, some have suggested the higher level of dispersion of returns in the equity asset class provides a window of opportunity for option-based strategies to assist 60/40 plans achieve their risk-adjust return goals. In fact, academics and practitioners\(^5\) have generally come to consensus that the incorporation of option strategies can help with the goal of tail risk mitigation, improvement of total risk levels, increase of total returns and overall improvement of risk-adjusted returns. The main subject of this study examines if equity concentration risk can be mitigated by using option-based strategies.

The following section provides an overview of selected option-based strategies that investors might consider as part of their investment program. We note that option-based strategies are being used for purposes of protection against downside risk, as well as for total return enhancement. We expect that the use of option-based strategies would help to answer these questions.

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\(^4\) Please refer to Appendix A where we use QQ plots to compare the shape of the distributions (location, scale and skewness) between two sets of data. The QQ plot provides a graphical visualization of the quantiles of the probability distribution of a strategy to the theoretical normal distribution.

\(^5\) As noted by Schneeweis and Spurgin on “The Benefits of Index Option-Based Strategies for Institutional Portfolios,” and Asset Consulting Group in “An Analysis of Index option Writing for Liquid Enhanced Risk-Adjusted Returns”
Historical Returns of Option-Based Strategies

Below is a list of 11 option-based strategies that have been grouped into 2 categories; first, those that help with downside protection, in other words, these are strategies that help to mitigate portfolio risk during market downturns, and second, those that that provide income enhancement, which are strategies that seek to improve the total return of a portfolio by expanding its yield via options. When confronted with strategies that exhibit similar pay-offs, we selected the one that provided either the least cost or yielded a positive premium. An example of this is the case of a bearish spread. This spread can be implemented either through puts or calls. Since implementing the bearish spread through puts is more costly than one with calls as the Bear Put Spread requires a cash outlay for establishing the position, we considered the spread that uses call options for purposes of conducting the research. It is also worth noting that the option-based strategies selected have been done on an arbitrary basis and are intended to illustrate the notion of downside protection and income enhancement.

Downside Protection Option-Based strategies

- **Bear-Call Spread** – Sell an ATM strike Call option and purchase a 104% OTM strike Call option.
- **Short Risk Reversal** – Sell a 102% OTM Call option and purchase a 96% OTM Put option.
- **Long Iron Condor** – Sell a 96% OTM Put and 104% OTM Call (4% OTM Strangle) and purchase a 98% OTM Put and a 102% OTM Call (2% OTM Strangle)
- **Long Put** – Purchase a 96% OTM Put
- **Long Strangle** – Purchase a 104% OTM Call and a 96% OTM Put.
- **Put Spread Collar** – Sell a 102% OTM Call, purchase an ATM Put and sell a 96% OTM Put

Income Enhancement Option-Based strategies

- **Short Straddle** – Sell an ATM Call and sell an ATM Put
- **Bull Put Spread** – Purchase a lower 96% OTM Put strike and sell a higher ATM Put strike
- **Short Call** – Sell a 102% OTM Call
- **Short Put** – Sell a 96% OTM Put
- **Short Iron Condor** – Purchase a 96% OTM Put and 104% OTM Call (4% OTM Strangle) and sell a 98% OTM Put and a 102% OTM Call (2% OTM Strangle)
Exhibit 5 shows cumulative returns for the 11 option-based strategies under study including the Traditional 60/40 portfolio. Monthly data from the Chicago Board Options Exchange were used to calculate the returns for the various option-based strategies under study. In the context of this study, the option-based strategies are treated as overlay portfolios and assume a notional of 25% of the total assets of the Traditional 60/40 portfolio. Moreover, the dollars invested in the options overlay represent a fraction of the 60/40 and include the premium and margin required to establish the position. This calculation is explained in more detail in the portfolio construction process of this paper as well as in appendix B. Exhibit 5 shows the cumulative returns of the combined returns.

We then look at how each strategy performed during different market cycles. In Exhibit 6, we show the results of the option-based strategies used for downside protection. We used the period of August 2000 through September 2002 to depict a down market. The results show that from a total return standpoint, all of the downside protection strategies selected performed better than having been invested in either the S&P500 or the Traditional 60/40.

Comparing the results to the Traditional 60/40 stock/bond allocation, all of the option-based strategies produced lower risk and better drawdown. Total risk ranged from as low as 8.24% for the Short Risk Reversal and as high as 14.06% for the Long Iron Condor. In terms of

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6 Please refer to Appendix B for further reference in the return calculation used for the option-based strategies
7 To depict a down market, we arbitrarily selected one of the periods used in the April 2016, CBOE presentation titled New Studies on Uses of Options – Protection, and Enhancing Income and Risk-Adjusted Returns by Matt Moran. P1.
drawdowns, they ranged from as low as 11.66% for the Put Spread Collar (making it the best drawdown mitigating strategy) to as high as 20.45% for the Long Iron Condor respectively.

EXHIBIT 6
Table of Performance and Risk Measures for Downside Protection over the Period Aug 2000 to Sep 2002

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Annualized Return</th>
<th>Annualized Risk</th>
<th>Skew</th>
<th>Excess Kurtosis</th>
<th>Sharpe</th>
<th>Drawdown</th>
<th>Sortino</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P500</td>
<td>-19.03%</td>
<td>24.21%</td>
<td>-0.24</td>
<td>-0.39</td>
<td>-0.90</td>
<td>41.83%</td>
<td>-0.26</td>
</tr>
<tr>
<td>US Bonds</td>
<td>9.13%</td>
<td>4.12%</td>
<td>-0.13</td>
<td>-1.09</td>
<td>1.35</td>
<td>1.59%</td>
<td>1.63</td>
</tr>
<tr>
<td>Traditional 60/40</td>
<td>-7.94%</td>
<td>14.13%</td>
<td>-0.36</td>
<td>0.01</td>
<td>-0.78</td>
<td>21.18%</td>
<td>-0.18</td>
</tr>
<tr>
<td>Bear Call Spread</td>
<td>-6.43%</td>
<td>12.89%</td>
<td>-0.55</td>
<td>0.32</td>
<td>-0.74</td>
<td>18.12%</td>
<td>-0.16</td>
</tr>
<tr>
<td>Short Risk Reversal</td>
<td>-4.27%</td>
<td>8.24%</td>
<td>-0.14</td>
<td>-0.44</td>
<td>0.00</td>
<td>12.25%</td>
<td>-0.18</td>
</tr>
<tr>
<td>Long Iron Condor</td>
<td>-7.49%</td>
<td>14.00%</td>
<td>-0.28</td>
<td>0.00</td>
<td>-0.75</td>
<td>20.45%</td>
<td>-0.18</td>
</tr>
<tr>
<td>Long Put</td>
<td>-6.4%</td>
<td>11.4%</td>
<td>0.15</td>
<td>-0.35</td>
<td>-0.84</td>
<td>17.7%</td>
<td>-0.20</td>
</tr>
<tr>
<td>Long Straddle</td>
<td>-6.67%</td>
<td>12.23%</td>
<td>0.35</td>
<td>-0.17</td>
<td>-0.81</td>
<td>19.06%</td>
<td>-0.20</td>
</tr>
<tr>
<td>Put Spread Collar</td>
<td>-3.32%</td>
<td>9.94%</td>
<td>-0.92</td>
<td>0.77</td>
<td>-0.65</td>
<td>11.66%</td>
<td>-0.10</td>
</tr>
</tbody>
</table>

Source: CBOE, Federal Reserve Bank of St. Louis, Yahoo Finance

Exhibit 7 shows the results for the option-based strategies used for income enhancement. The strategies selected were the Short Iron Condor, Bull Put Spread, Short Put, Short Straddle and Short Call. We used the period of December 2003 through December 2004 to depict a range bound to flat market. In this case, we can observe that the three best option-based performing strategies were the Short Put, the Bull Put Spread and the Short Straddle in that order. Additionally, the risk-adjusted returns for the Short Straddle, Short Call, Short Put and Bull Put Spread were higher than for the Traditional 60/40, indicating that it would be to the advantage of a 60/40 plan to incorporate these strategies as part of its portfolio mix.

EXHIBIT 7
Table of Performance and Risk Measures for Income Enhancement over the Period Dec 2003 to Dec 2004

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Annualized Return</th>
<th>Annualized Risk</th>
<th>Skew</th>
<th>Excess Kurtosis</th>
<th>Sharpe</th>
<th>Drawdown</th>
<th>Sortino</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P500</td>
<td>14.83%</td>
<td>11.78%</td>
<td>-0.06</td>
<td>-1.73</td>
<td>1.14</td>
<td>4.04%</td>
<td>0.75</td>
</tr>
<tr>
<td>US Bonds</td>
<td>5.11%</td>
<td>4.95%</td>
<td>-0.89</td>
<td>-0.46</td>
<td>0.76</td>
<td>4.59%</td>
<td>0.45</td>
</tr>
<tr>
<td>Traditional 60/40</td>
<td>11.05%</td>
<td>7.31%</td>
<td>-0.14</td>
<td>-1.38</td>
<td>1.32</td>
<td>3.32%</td>
<td>0.95</td>
</tr>
<tr>
<td>Short Iron Condor</td>
<td>10.37%</td>
<td>6.69%</td>
<td>-0.22</td>
<td>-1.29</td>
<td>1.31</td>
<td>3.48%</td>
<td>0.91</td>
</tr>
<tr>
<td>Bull Put Spread</td>
<td>11.69%</td>
<td>7.9%</td>
<td>-0.09</td>
<td>-1.54</td>
<td>1.33</td>
<td>3.52%</td>
<td>0.96</td>
</tr>
<tr>
<td>Short Put</td>
<td>11.91%</td>
<td>7.21%</td>
<td>-0.14</td>
<td>-1.37</td>
<td>1.46</td>
<td>3.34%</td>
<td>1.07</td>
</tr>
<tr>
<td>Short Straddle</td>
<td>11.56%</td>
<td>5.89%</td>
<td>-0.11</td>
<td>-1.84</td>
<td>1.73</td>
<td>2.24%</td>
<td>1.48</td>
</tr>
<tr>
<td>Short Call</td>
<td>10%</td>
<td>5.31%</td>
<td>-0.04</td>
<td>-1.62</td>
<td>1.57</td>
<td>2.2%</td>
<td>1.39</td>
</tr>
</tbody>
</table>

Source: CBOE, Federal Reserve Bank of St. Louis, Yahoo Finance

In a similar fashion, we also conducted the same type analysis during a strong market cycle. We noticed that the income enhancement strategies did particularly well in this instance and we summarized the results in Appendix D.
Exhibits 8a and 8b illustrate the evolution of drawdowns for all strategies (downside protection and income enhancement) over the past 25 years ending March 2015.

- The strategies with the least drawdowns were the Short Risk Reversal, Put Spread Collar and Long Put.

- While strategies with the largest drawdowns included the Short Put, Bull Put Spread and the Short Straddle. A common characteristic amongst them all was that the drawdowns took place almost at the same time and with similar levels of intensity.
Diversification Analysis

The results shown in the preceding section suggest that a Traditional 60/40 plan can benefit from the use of option-based strategies to enhance its risk-adjusted returns. The study now turns to an analysis of correlations for all strategies to ascertain if diversification of total portfolio risk is a possibility.

Exhibit 9 shows the correlation level of excess returns for the option-based strategies during a market downturn (August 2000-September 2002). The correlation plot provides a clear view that the correlation for most of the option strategies across groups (downside protection and income enhancement) is negative; and another where the correlations intra group is high. For example across groups, the most negatively correlated strategies can be found between the Short Put vs. Long a Put and Long a Strangle; and within each group, the highest correlated strategies were found to be in the Long Put vs. the Risk Reversal, and the Long Put vs. the Long Strangle.
While Exhibit 9 provided a snapshot of correlations for a given time period, Exhibits 10a and 10b show how correlations evolved over the past 25 years. A close look at the chart reveals the behavior of three major trends; strategies that show correlation levels north of 0.5, strategies that show correlations less than -0.5 and those in between -0.5 and 0.5. Option strategies with correlations less than -0.5 have shown to display a pretty stable pattern over time, suggesting they could be good candidates for portfolio diversification. These strategies were the Short Risk Reversal, the Put Spread Collar, the Short Call and the Bear Call Spread. The only option strategy that showed a persistent correlation of +0.5 to a 60/40 was the Bull Put Spread.
Exhibit 11 shows a scatter plot of returns/risk for all strategies over the past 25 years through March 2015.

From the Exhibit above we note that:

- All 11 overlay option-based strategies produced positive returns.
- The best performing strategies included the Bull Put Spread, Short Put and Short Straddle. The higher returns also came with a slightly higher degree of risk relative to the Traditional 60/40 portfolio.
- The Short Risk Reversal produced the least amount of performance but it also incurred the least amount of total risk.
- The Long Iron Condor and Short Iron Condor generated returns and risk levels that were very similar to a Traditional 60/40 portfolio.

Up to this point, the research focused on the need to diversify portfolio risk to the Traditional 60/40 portfolio. The equity asset class was identified to be the largest contributor to total portfolio risk and selected option-based strategies were analyzed to determine if they could improve risk-adjusted returns. We found that investors utilize options in a couple of ways: to protect portfolio returns during market downturns and to enhance portfolio income. Two distinct groups of option strategies were created to address these needs and they were analyzed under a market period of duress and during a market period of range bound to flat returns. The key takeaways of the study suggested that:
1. During stressful markets, in general the downside protection option-based strategies delivered better performance, lower risk and better drawdowns relative to the Traditional 60/40 portfolio.

2. During range-bound to flat markets, the income enhancing option-based strategies also delivered better relative performance and risk metrics.

3. Correlation levels were negative amongst these two groups suggesting that their inclusion in a portfolio would tend to diversify portfolio risk. This was shown by static and rolling correlation analysis. Likewise the rolling correlation levels for the downside protection strategies relative to the Traditional 60/40 portfolio were found to be stable over time, further reinforcing the idea that these strategies could be considered as part of the Traditional 60/40 portfolio mix to improve risk-adjusted returns.

In addition to stressful and range-bound to flat markets, the research study covered a period of strong market returns; the results of which can be found in Appendix D. During a bullish market, we observed that all of the income enhancement strategies produced returns above and beyond those attained by a Traditional 60/40 portfolio. Moreover, we found that the risk-adjusted returns were generally better. Downside protection strategies did not do as well during this period as they are generally designed to perform during stressful markets.

With these results in hand, the study now aims to explore the use of economic data and volatility regimes that in conjunction with the option-based strategies may help the returns of a Traditional 60/40 portfolio.

Portfolio Construction using Option-Based Strategies under a Regime-Based Approach

Portfolio construction can be approached in a variety of ways. For example, an investor might choose to use a bottoms-up analysis, a systematic process or a top-down approach when constructing portfolios. In our case, we decided to apply a systematic, top-down portfolio construction process; whereby the top-down view is expressed through the use of economic data such as an economic indicator and a volatility index. To complement this process, we use a set of rules to select option strategies that vary based on current economic regimes. We then apply these set of rules on a systematic basis over the entire investment period.
Exhibit 12 shows the Conference Board Leading Economic Indicator® (LEI)\(^8\). An indicator that is used as a proxy for the business cycle. A reading above 1 indicates that the economy is growing while a reading below 1 indicates that the economy is contracting. The different shades of colors in the Exhibit represent the different stages of the business cycle. Green depicts expansion, yellow represents slowdown, red defines contraction and blue characterizes recovery.

The VIX\(^9\) is used as a proxy for expected volatility. A high volatility regime is defined as one where the VIX is trading above its long-term mean whereas a low volatility regime is defined as one where the VIX is trading below that mean. The red shade in Exhibit 13 highlights a regime of high volatility whereas a green shade depicts a low volatility regime.

A regime signal is created using current data. For instance, when the LEI is trending above 1 with an upward trend, we characterize this regime as an economic expansion. When we combine the expansionary phase with a VIX reading that is below its long-term mean, in other words when the volatility environment is low, the regime is defined as expansion plus low volatility. We repeat this process to characterize all possible combination of regimes and

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\(^8\) The Conference Board Leading Economic Indicator® (LEI) is a registered trademark of The Conference Board, Inc. This indicator is used to reveal common turning point patterns in economic data.

\(^9\) VIX\(^®\) is a registered trademark of the Chicago Board Options Exchange, Incorporated (CBOE). The VIX is used as a measure of the market’s expectation about the stock’s market volatility over the next 30-day period.
compute a series of statistics such as the annualized excess returns, hit rates\textsuperscript{10} and information ratios for all strategies within each regime environment.

Exhibit 13 below summarizes the results of the regime-based analysis\textsuperscript{11}. For example, under an economic slowdown and high market volatility, one can observe that the income enhancement strategies have done well over time.

The preceding results lead us to determine if a combination of regimes such as the one described above and the use of option-based strategies helped to improve the outcomes of a Traditional 60/40 portfolio. This is the area of focus for the next section of the study.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{VIX.png}
\caption{VIX\textsuperscript{©}}
\end{figure}

Source: Federal Reserve Bank - St. Louis

\textsuperscript{10} We calculate the hit rate as the percentage of times a strategy outperforms the Traditional 60/40 portfolio.

\textsuperscript{11} Please refer to Appendix C for hit rates and information ratios.
Portfolio Construction

We construct two model portfolios; one that incorporates the regime-based signal applied to the 60/40 portfolio and a second one that adds option-based strategies in its composition.

The regime-based portfolio with option-based strategies is constructed as follows

1. Rank the selected option-based strategies based on annualized excess return, information ratio and hit rates,
2. Select the best two option-based strategies from step 1,
3. Set 25% notional of the fund’s AUM, and divide equally between the strategies from step 2,
4. Calculate the number of contracts based on notional and spot,
5. Calculate margin requirements for each strategy as per CBOE guidelines,
6. Calculate premium amount for each strategy,
7. Calculate dollar allocation to Traditional 60/40 by netting out the margin and premium from the current AUM,
8. Calculate the payoff for each option-based strategy as per the Formula Definition table in Appendix B, and
9. Compute the returns based on the changes in the AUM (refer to Appendix B).

Exhibit 15 shows an out-of-sample backtest of how the modeled portfolios have performed relative to a Traditional 60/40 stock/bond portfolio. The backtest period starts May 1990 and ends March 2015. A one-month ahead forecast was applied to determine the regime environment and portfolios were rebalanced when the forecast signal changed.
The graph provides evidence that the combination of economic data with volatility regimes and option-based strategies can add incremental value in the portfolio construction process.

Exhibit 16 shows the drawdown curves for all portfolios while Exhibit 17 summarizes the results for the backtest. The results show that the regime-based plus option-based strategies provide a superior return profile over the Traditional 60/40, with an increased level of risk-adjusted returns.
EXHIBIT 17
Performance and Risk Measures over the Period May 1990 to Mar 2015

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Annualized Return</th>
<th>Annualized Risk</th>
<th>Sharpe</th>
<th>Drawdown</th>
<th>Sortino</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional 60/40</td>
<td>9.08</td>
<td>10.3%</td>
<td>0.58</td>
<td>33.15%</td>
<td>0.39</td>
</tr>
<tr>
<td>Regime-Based 60/40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option-Based Strategies</td>
<td>10.63</td>
<td>10.24%</td>
<td>0.73</td>
<td>27.55%</td>
<td>0.46</td>
</tr>
</tbody>
</table>

Source: CBOE, Federal Reserve Bank - St. Louis, Yahoo Finance.
Conclusion

The study noted that a Traditional 60/40 plan is prone to high equity concentration of risk. In fact, the research showed that a 60/40 dollar allocation translates to a risk allocation of approximately 92/8 percent. This is evidence that the higher amount of volatility of the equity asset class returns, affects its percent contribution to total portfolio risk more than proportionately.

Investors utilize options in a couple of ways: to protect portfolio returns during market downturns and to enhance portfolio income. Two distinct groups of option strategies were created to address these needs and they were analyzed under a market period of duress and during a market period of range bound to flat returns. The study found that in general option-based strategies delivered better performance, lower risk and better drawdowns relative to the Traditional 60/40 portfolio.

Portfolio construction can be approached in a variety of ways. For example, an investor might choose to use a bottoms-up analysis, a systematic process or a top-down approach when constructing portfolios. The study chose to use the LEI and VIX as the preferred signals to drive economic regimes though it was noted that any other set of drivers could have been used as well. The research showed promising results when using economic data and volatility regimes in combination with option-based strategies to augment the value of a portfolio.
Appendix A – QQ plots

We use QQ plots to compare the shape of the distributions (location, scale and skewness) between two sets of data. The QQ plot provides a graphical visualization of the quantiles of the probability distribution of a strategy to a theoretical distribution. In this case, we are using the normal distribution as our theoretical. A point \((x, y)\) on the plot corresponds to one of the quantiles of the strategy distribution \((y\text{-coordinate})\) plotted against the same quantile of the theoretical normal distribution \((x\text{-coordinate})\).

The light gray line depicts a goodness of fit between the quantiles of the empirical and normal distribution. If the light green points lie on the gray line, the distributions are similar in nature. Fat tails occur when on the extremes the light green dots deviate from the gray line.

![QQ plots for different strategies](image)
Appendix A – QQ plots…*(continued)*

For example the short straddle, exhibits a long thick negative tail.
Appendix B – Calculation of Returns for Option-Based Strategies

To calculate returns for all of the option-based strategies, we referred to the Chicago Board Options Exchange data and used the following steps. No transaction costs were included and have used mid prices for both the long and short transactions.

1. Set notional to 25% of the current assets under management for the Traditional 60/40 portfolio
2. Calculate the number of contracts based on notional and spot
3. Calculate margin requirements as per CBOE guidelines
4. Calculate premium amount
5. Calculate dollar allocation to Traditional 60/40 by netting out the margin and premium from the current AUM
6. Calculate the payoff for the option-based strategy as per the Formula Definition table
7. Calculate returns using the following steps

\[
AUM_{t+1} = AUM_{60/40_t} \times (1 + r) + Options \, PnL + Margin_t \times (1 + rf)
\]

where,

\[
r = 60\% \times \text{Stock return} + 40\% \times \text{Bond return}
\]

Options \, PnL = Pay off – Premium

Margin = varies by strategy as per CBOE guidelines

Return = \( \frac{AUM_{t+1}}{AUM_t} - 1 \)
## Formula Definitions

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Payoff</th>
<th>Net Premium</th>
<th>Net PnL</th>
<th>Margin Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Call</td>
<td>- MAX(0, St - K)</td>
<td>C</td>
<td>- MAX(0, St-K) + C</td>
<td>MIN([C + 0.205 - MAX(0, K - S)], (C + 0.105))</td>
</tr>
<tr>
<td>Bull Call Spread</td>
<td>MAX(0, St - K1) - MAX(0, St - K2)</td>
<td>C7 - G1</td>
<td>MAX(0, St-K1) - MAX(0, St-K2) + (G7 - G1)</td>
<td>0</td>
</tr>
<tr>
<td>Bear Call Spread</td>
<td>MAX(0, St - K1) - MAX(0, St - K2)</td>
<td>C2 - C1</td>
<td>MAX(0, St-K1) - MAX(0, St-K2) + (C2 - C1)</td>
<td>K1 - K2</td>
</tr>
<tr>
<td>Risk Reversal</td>
<td>MAX(0, K2 - St) - MAX(0, St - K1)</td>
<td>C - P</td>
<td>MAX(0, K2-St) - MAX(0, St-K1) + (C - P)</td>
<td>50% S</td>
</tr>
<tr>
<td>Long Straddle</td>
<td>MAX(0, St - K) + MAX(0, K - St)</td>
<td>- C - P</td>
<td>MAX(0, St-K) + MAX(0, K- St) - (C + P)</td>
<td>0</td>
</tr>
<tr>
<td>Short Straddle</td>
<td>- MAX(0, St - K) - MAX(0, K - St)</td>
<td>C + P</td>
<td>MAX(0, St-K) - MAX(0, K - St) + (C + P)</td>
<td></td>
</tr>
<tr>
<td>Long Strangle</td>
<td>MAX(0, St - K1) + MAX(0, K2 - St)</td>
<td>- C - P</td>
<td>MAX(0, St-K1) + MAX(0, K2- St) - (C + P)</td>
<td>0</td>
</tr>
<tr>
<td>Short Strangle</td>
<td>- MAX(0, St - K1) - MAX(0, K2 - St)</td>
<td>C + P</td>
<td>MAX(0, St-K1) - MAX(0, K2 - St) + (C + P)</td>
<td></td>
</tr>
<tr>
<td>Bull Put Spread</td>
<td>MAX(0, K1 - St) - MAX(0, K2 - St)</td>
<td>P2 - P1</td>
<td>MAX(0, K1-St) - MAX(0, K2-St) + (P2 - P1)</td>
<td>K2 - K1</td>
</tr>
<tr>
<td>Bear Put Spread</td>
<td>MAX(0, K1 - St) - MAX(0, K2 - St)</td>
<td>P2 - P1</td>
<td>MAX(0, K1-St) - MAX(0, K2-St) + (P2 - P1)</td>
<td>K2 - K1</td>
</tr>
<tr>
<td>Put Spread Collar</td>
<td>- MAX(0, St - K1) + MAX(0, K2 - St) - MAX(0, K3 - St)</td>
<td>C - P1 + P2</td>
<td>MAX(0, St-K1) + MAX(0, K2-St) + (C - P1 + P2)</td>
<td>50% S</td>
</tr>
<tr>
<td>Short Put</td>
<td>- MAX(0, K - St)</td>
<td>P</td>
<td>MAX(0, K - St) + P</td>
<td>MIN([P + 0.205 - MAX(0, S - K)], (P + 0.105))</td>
</tr>
<tr>
<td>Long Put</td>
<td>MAX(0, K - St)</td>
<td>- P</td>
<td>MAX(0, K - St) - P</td>
<td>0</td>
</tr>
<tr>
<td>Long Iron Condor</td>
<td>- MAX(0, K1 - St) + MAX(0, K2 - St) + MAX(0, K3 - K1) - MAX(0, St - K4)</td>
<td>P1 - P2 - C1 + C2</td>
<td>MAX(0, K1-St) + MAX(0, K2-St) + MAX(0, St-K1) - MAX(0, St-K4) + (P1 - P2 - C1 + C2)</td>
<td>0</td>
</tr>
<tr>
<td>Short Iron Condor</td>
<td>MAX(0, K1 - St) - MAX(0, K2 - St) - MAX(0, St - K3) + MAX(0, S - K4)</td>
<td>-P1 + P2 + C1 - C2</td>
<td>MAX(0, K1-St) - MAX(0, K2-St) - MAX(0, St-K3) + MAX(0, S-K4) - (P1 - P2 - C1 + C2)</td>
<td>MAX([K2-K1], [K4-K3])</td>
</tr>
</tbody>
</table>

**Note:**
- S: Spot Today
- St: Spot at Expiration
- C, C1, C2: Call Prices
- P, P1, P2: Put Prices
- K, K1, K2, K3, K4: Strike Prices
Appendix D – Table of Performance and Risk Measures during a Strong Market

The tables below show the performance statistics for the Downside Protection Strategies and the Income Enhancement Strategies during a period of strong market returns.

EXHIBIT D1
Table of Performance and Risk Measures for Downside Protection
over the Period Jan 2009 to Dec 2010

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Annualized Return</th>
<th>Annualized Risk</th>
<th>Skew</th>
<th>Excess Kurtosis</th>
<th>Sharpe</th>
<th>Drawdown</th>
<th>Sortino</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P500</td>
<td>21%</td>
<td>17.15%</td>
<td>-0.24</td>
<td>0.46</td>
<td>1.22</td>
<td>12.71%</td>
<td>0.66</td>
</tr>
<tr>
<td>US Bonds</td>
<td>14.55%</td>
<td>6.06%</td>
<td>-0.15</td>
<td>-1.02</td>
<td>2.27</td>
<td>3.64%</td>
<td>1.74</td>
</tr>
<tr>
<td>Traditional 60/40</td>
<td>18.75%</td>
<td>11.22%</td>
<td>-0.19</td>
<td>0.51</td>
<td>1.05</td>
<td>8.13%</td>
<td>0.88</td>
</tr>
<tr>
<td>Bear Call Spread</td>
<td>17.22%</td>
<td>10.05%</td>
<td>-0.15</td>
<td>0.89</td>
<td>1.70</td>
<td>6.78%</td>
<td>0.91</td>
</tr>
<tr>
<td>Short Risk</td>
<td>13.73%</td>
<td>7.34%</td>
<td>-0.50</td>
<td>-0.04</td>
<td>1.85</td>
<td>5.57%</td>
<td>0.99</td>
</tr>
<tr>
<td>Reversal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Iron Condor</td>
<td>18.38%</td>
<td>11.29%</td>
<td>-0.04</td>
<td>0.26</td>
<td>1.61</td>
<td>8.23%</td>
<td>0.90</td>
</tr>
<tr>
<td>Long Put</td>
<td>14.92%</td>
<td>10.43%</td>
<td>-0.04</td>
<td>0.20</td>
<td>1.42</td>
<td>9.09%</td>
<td>0.77</td>
</tr>
<tr>
<td>Long Strangle</td>
<td>13.51%</td>
<td>11.71%</td>
<td>0.28</td>
<td>0.62</td>
<td>1.14</td>
<td>10.93%</td>
<td>0.63</td>
</tr>
<tr>
<td>Put Spread Collar</td>
<td>15.78%</td>
<td>7.14%</td>
<td>-0.50</td>
<td>0.61</td>
<td>2.19</td>
<td>3.89%</td>
<td>1.21</td>
</tr>
</tbody>
</table>

Source: CBOT, Federal Reserve Bank of St. Louis, Yahoo Finance

EXHIBIT D2
Table of Performance and Risk Measures for Income Enhancement
over the Period Jan 2009 to Dec 2010

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Annualized Return</th>
<th>Annualized Risk</th>
<th>Skew</th>
<th>Excess Kurtosis</th>
<th>Sharpe</th>
<th>Drawdown</th>
<th>Sortino</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P500</td>
<td>21%</td>
<td>17.15%</td>
<td>-0.24</td>
<td>0.46</td>
<td>1.22</td>
<td>12.71%</td>
<td>0.60</td>
</tr>
<tr>
<td>US Bonds</td>
<td>14.55%</td>
<td>6.06%</td>
<td>-0.15</td>
<td>-1.02</td>
<td>2.37</td>
<td>3.84%</td>
<td>1.74</td>
</tr>
<tr>
<td>Traditional 60/40</td>
<td>18.75%</td>
<td>11.22%</td>
<td>-0.10</td>
<td>0.51</td>
<td>1.65</td>
<td>8.15%</td>
<td>0.88</td>
</tr>
<tr>
<td>Short Iron Condor</td>
<td>18.68%</td>
<td>11.09%</td>
<td>-0.34</td>
<td>0.63</td>
<td>1.69</td>
<td>7.95%</td>
<td>0.87</td>
</tr>
<tr>
<td>Bull Put Spread</td>
<td>20.31%</td>
<td>12.23%</td>
<td>-0.37</td>
<td>0.38</td>
<td>1.65</td>
<td>9.04%</td>
<td>0.84</td>
</tr>
<tr>
<td>Short Put</td>
<td>21.8%</td>
<td>11.6%</td>
<td>-0.37</td>
<td>0.83</td>
<td>1.86</td>
<td>6.83%</td>
<td>0.96</td>
</tr>
<tr>
<td>Short Straddle</td>
<td>23.56%</td>
<td>10.67%</td>
<td>-0.94</td>
<td>1.00</td>
<td>2.19</td>
<td>6.04%</td>
<td>1.05</td>
</tr>
<tr>
<td>Short Call</td>
<td>19.04%</td>
<td>9.04%</td>
<td>-0.66</td>
<td>0.50</td>
<td>2.09</td>
<td>5.28%</td>
<td>1.08</td>
</tr>
</tbody>
</table>

Source: CBOT, Federal Reserve Bank of St. Louis, Yahoo Finance
References


Yang, George. Buy-Write or Put-Write: An Active Index Writing Portfolio to Strike it Right. Available at SSRN 1827363 (2011)