

AN ANALYSIS OF INDEX OPTION WRITING WITH MONTHLY AND WEEKLY ROLLOVER

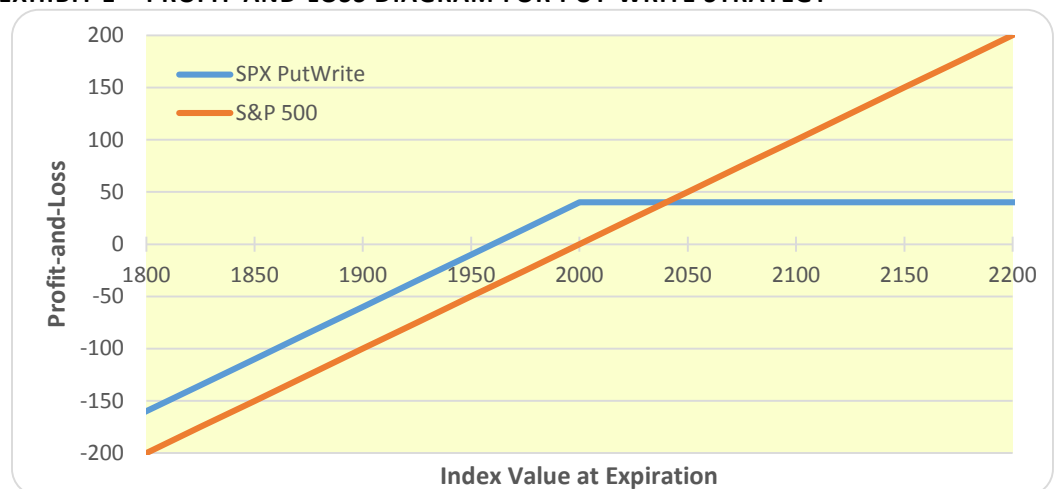
INTRODUCTION AND EXECUTIVE SUMMARY

We analyzed the performance of two put writing indices, the CBOE S&P 500 PutWrite Index (PUTSM Index) and the CBOE S&P 500 One-Week PutWrite Index (WPUTSM Index), and compared it to the performance of traditional benchmarks, such as the S&P 500[®], Russell 2000[®], MSCI[®] World, and Citigroup 30-year Treasury indices. Highlights of our findings are the following:

- ▶ **Long-term performance.** Over an almost 30 year period, the PUT Index outperformed the traditional indices on a risk-adjusted basis. The annual compound return of the PUT Index is 10.13%, compared to 9.85% for the S&P 500 index. However, the standard deviation of the PUT Index is substantially lower, 10.16% versus 15.26%. As a result, the annualized Sharpe ratio is 0.67 for the PUT Index and 0.47 for the S&P 500.
- ▶ **WPUT Index and PUT Index over recent history.** The data history for the WPUT Index begins in January 2006. Over the last 10 years, the PUT and WPUT indices delivered similar risk-adjusted performance and both outperformed the S&P 500 index and other benchmarks. The annual compound return is 6.59% (PUT), 5.61% (WPUT), and 7.09% (S&P 500). The annualized Sharpe ratio is 0.52 (PUT), 0.50 (WPUT), and 0.46 (S&P 500).
- ▶ **Lower risk.** Relative to the PUT and S&P 500 indices, over the last 10 years, the WPUT Index has lower standard deviation, beta with respect to the market, and maximum drawdown. In particular, the standard deviation is 11.51% (PUT), 9.85% (WPUT), and 15.11% (S&P 500). The maximum drawdown is -32.7% (PUT), -24.2% (WPUT), and -50.9% (S&P 500). The longest drawdown is 29, 19, and 52 months, respectively.
- ▶ **Annual premium income.** From 2006 to 2015, the average annual gross premium collected is 24.1% for PUT and 39.3% for WPUT. Premiums for WPUT are smaller, but collected weekly instead of monthly, which results in higher aggregate premiums.
- ▶ **Liquidity.** Trading volume in Weekly S&P 500 options has increased dramatically over the last 5 years. In 2015, on average it was about 340 thousand contracts per day, representing 36% of all CBOE S&P 500 options.

PUT AND WPUT INDICES

EXHIBIT 1 – PROFIT-AND-LOSS DIAGRAM FOR PUT-WRITE STRATEGY



WHAT IS A PUT-WRITE STRATEGY?

- ▶ A cash-secured put-write strategy systematically sells options collateralized by risk-free investment.
- ▶ The CBOE PUT and WPUT Indices are designed to track the performance of a hypothetical passive strategy that collects option premiums from at-the-money (ATM) options on S&P 500 Index, and holds a rolling money account invested in Treasury bills.
- ▶ Both strategies attempt to profit from high premiums of Index options.
- ▶ The WPUT Index, which was launched in 2015, extends the PUT strategy to weekly S&P 500 options. Option premiums are collected weekly, instead of monthly.

EXHIBIT 2 – PUT AND WPUT INDEXES

Index	Ticker	Strategy	Rollover	Year Launched	Price History Begins
CBOE S&P 500 PutWrite Index	PUT	Short one-month ATM put options on S&P 500 Index, long Treasury bills	Monthly (typically, the 3rd Friday of each month)	2007	June 30, 1986
CBOE S&P 500 One-Week PutWrite Index	WPUT	Short one-week ATM put options on S&P 500 Index, long Treasury bills	Weekly (typically every Friday)	2015	Jan 31, 2006

HISTORICAL PERFORMANCE

EXHIBIT 3 – GROWTH OF BENCHMARK INDICES SINCE JAN 31, 2006



The value of \$1 invested in PUT, WPUT, S&P 500 TR, and 30-day Tbill. The period is from Jan 31, 2006 to Dec 31, 2015.

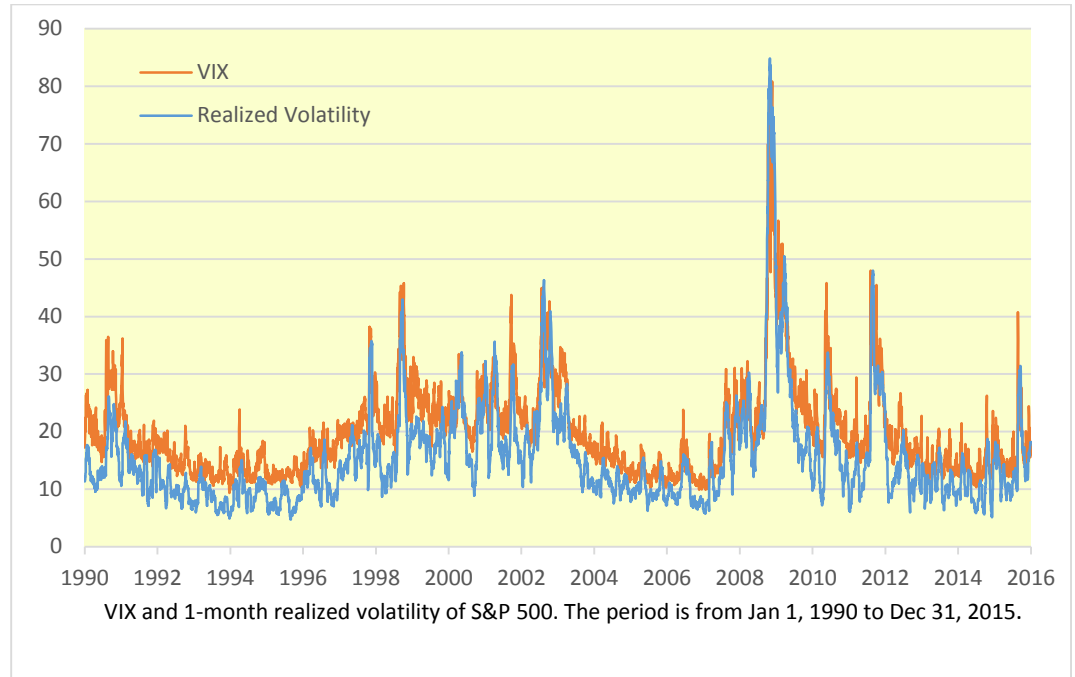
Historically, the option implied volatility has considerably exceeded the realized volatility of the S&P 500 index.

From 1990 to 2015, the average implied volatility, as measured by the CBOE Volatility Index® (VIX® Index) is 19.8%, while the average realized volatility is 15.5%, implying the difference of 4.3%.

High volatility premium indicates that the index options are richly priced. As a result, put writing strategies have historically delivered attractive risk-adjusted performance.

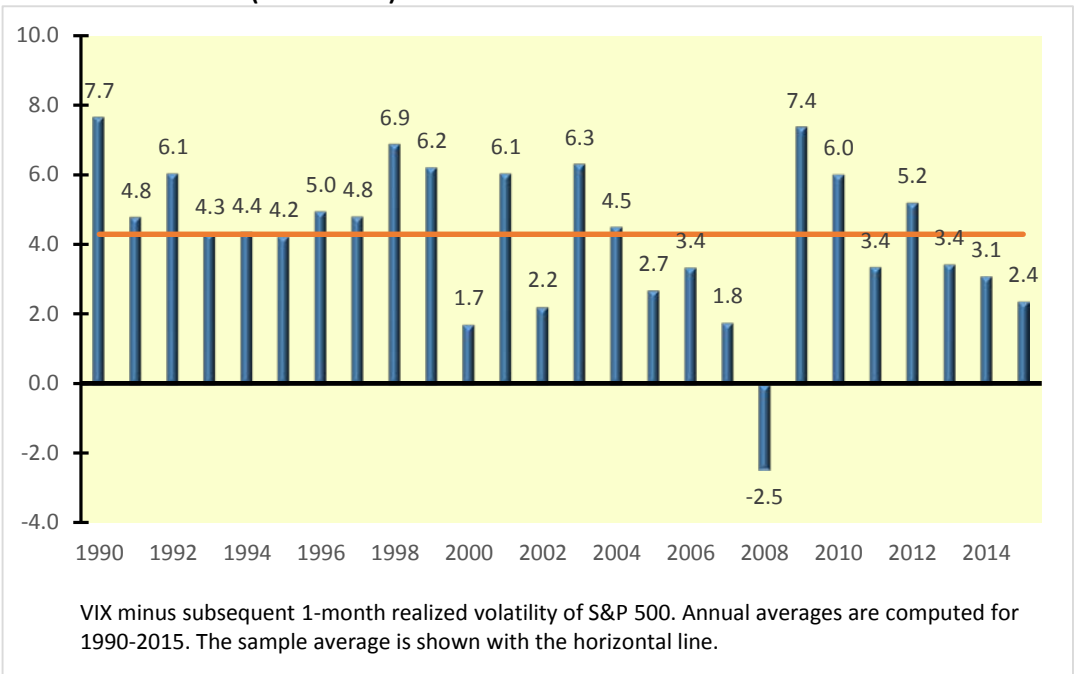
IMPLIED VERSUS REALIZED VOLATILITY – RICHLY PRICED INDEX OPTIONS

EXHIBIT 4 – VIX INDEX MINUS SUBSEQUENT S&P 500 1-MONTH REALIZED VOLATILITY (1990-2015)



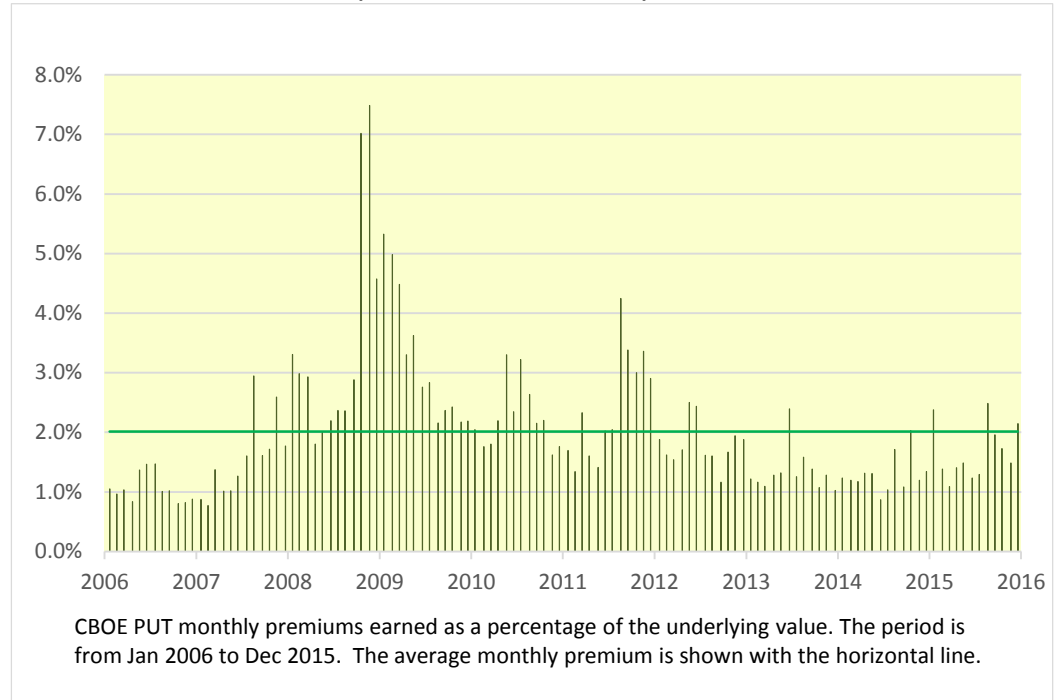
Year	Implied volatility (VIX)	S&P 500 Realized Volatility
1990	23.1	15.4
1991	18.4	13.6
1992	15.5	9.4
1993	12.7	8.3
1994	13.9	9.5
1995	12.4	8.1
1996	16.4	11.5
1997	22.4	17.6
1998	25.6	18.7
1999	24.4	18.1
2000	23.3	21.6
2001	25.7	19.7
2002	27.3	25.1
2003	22.0	15.7
2004	15.5	11.0
2005	12.8	10.1
2006	12.8	9.4
2007	17.5	15.8
2008	32.7	35.2
2009	31.5	24.1
2010	22.5	16.5
2011	24.2	20.8
2012	17.8	12.6
2013	14.2	10.8
2014	14.2	11.1
2015	16.7	14.3
All	19.8	15.5

EXHIBIT 5 – VIX INDEX MINUS SUBSEQUENT S&P 500 1-MONTH REALIZED VOLATILITY ANNUAL AVERAGES (1990-2015)



SOURCES OF RETURN

EXHIBIT 6 – PUT PREMIUMS (JAN 2006 TO DEC 2015)



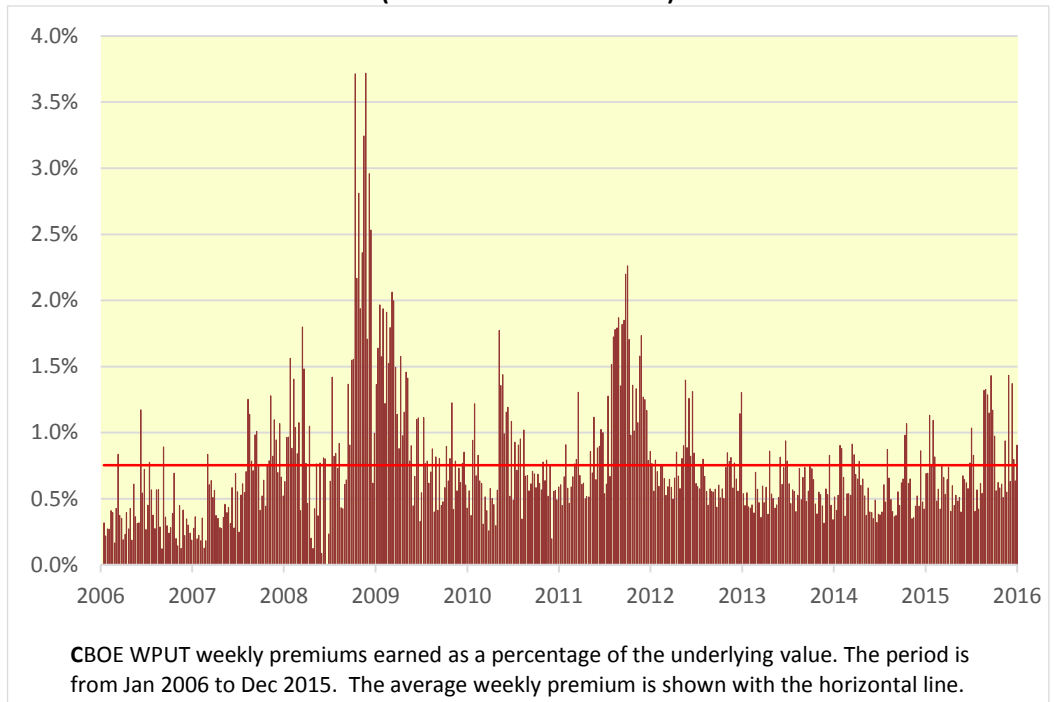
Selling 1-month ATM puts 12 times a year can produce significant income. From 2006 to 2015, the average monthly premium is 2.01%.

Selling 1-week ATM puts 52 times a year can produce even higher income, but please note that transaction costs can be higher with more frequent trades. From 2006 to 2015, the average weekly premium is 0.75%. Although smaller, the premium is collected more frequently.

Intuitively, the premium of the ATM put increases as the square root of maturity. This means that a one-week tenor option rolled over four times per month will approximately generate 2.0x the premium of a one-month tenor option rolled over once per month (i.e., 1/2 premium times 4).

Furthermore, put-write strategies using shorter maturity options can benefit from more frequent resets, which help keep up with market price and changes in volatility. This allows the strategy to better capture the volatility risk-premium.

EXHIBIT 7 – WPUT PREMIUMS (JAN 2006 TO DEC 2015)



Year	PUT	WPUT
2006	12.7%	19.8%
2007	18.6%	30.3%
2008	41.9%	61.6%
2009	38.6%	53.1%
2010	27.0%	36.8%
2011	29.3%	55.7%
2012	21.6%	37.5%
2013	16.1%	28.9%
2014	15.5%	29.3%
2015	20.1%	39.9%
Average	24.1%	39.3%

From 2006 to 2015, the average annual premium for PUT is 24.1% and for WPUT is 39.3%. The difference between the two is 15.2% annually.

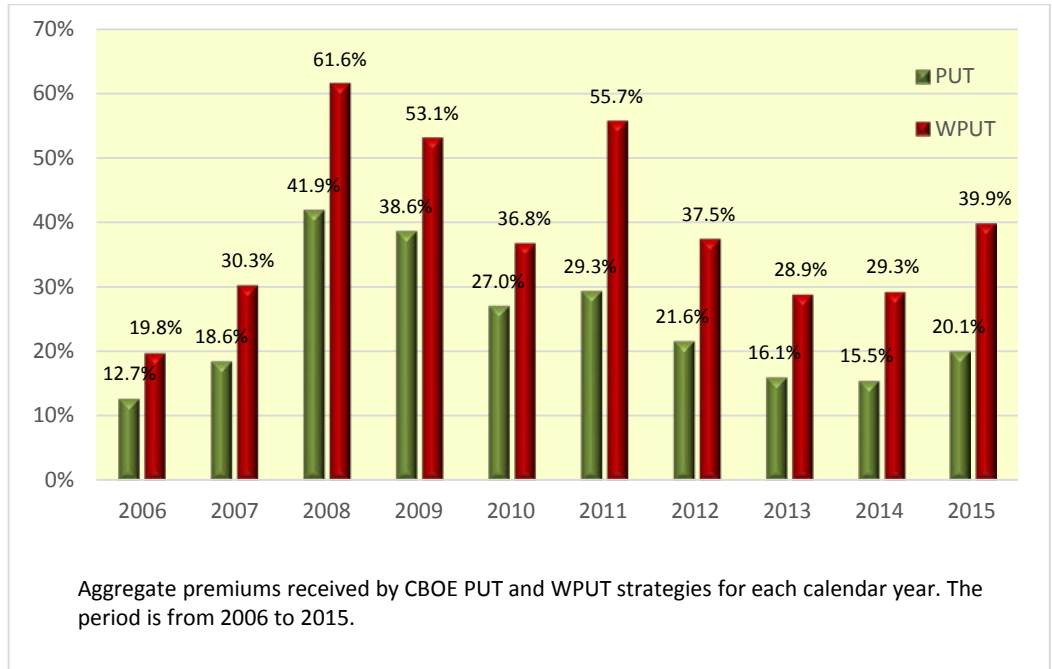
Note: While the gross premiums collected are always positive, the cash-secured put-writing strategy does have downside risk and its net returns can be negative.

Trading volume in SPX WeeklysSM (SPXW) options has increased more than 20 times over the last 5 years. In 2015, the average daily volume was about 340,000 contracts, which constituted 36% of volume of all SPX options.

In 2015, the notional value of the average daily volume for S&P 500 options exceeded \$190 billion.

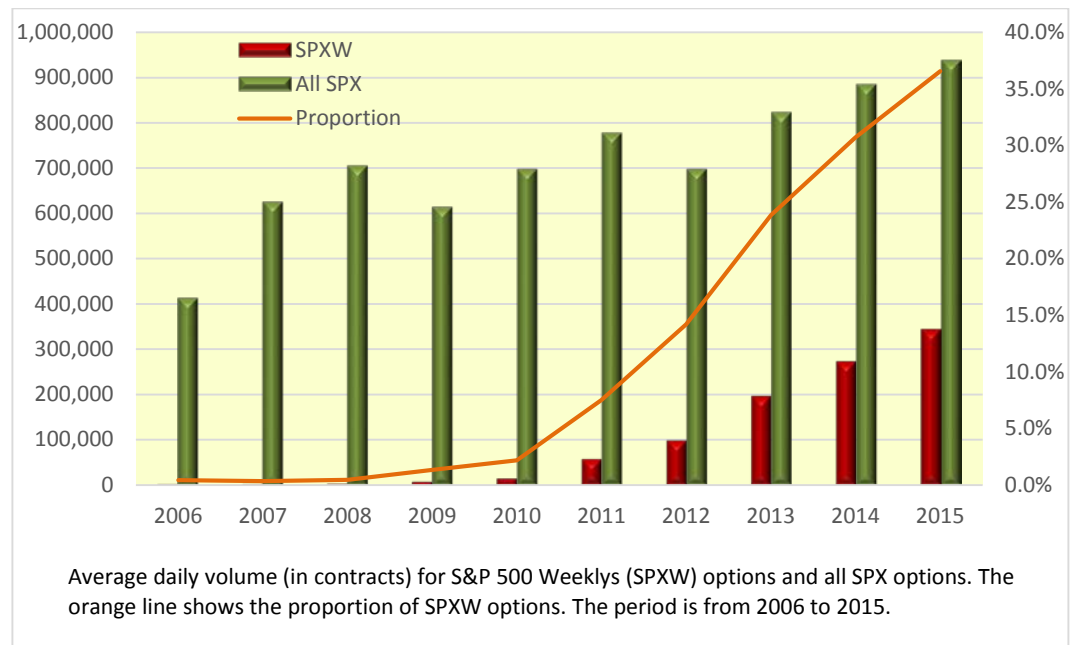
ANNUAL PREMIUMS

EXHIBIT 8 – PUT AND WPUT AGGREGATE GROSS PREMIUMS RECEIVED FOR EACH CALENDAR YEAR (2006 TO 2015)



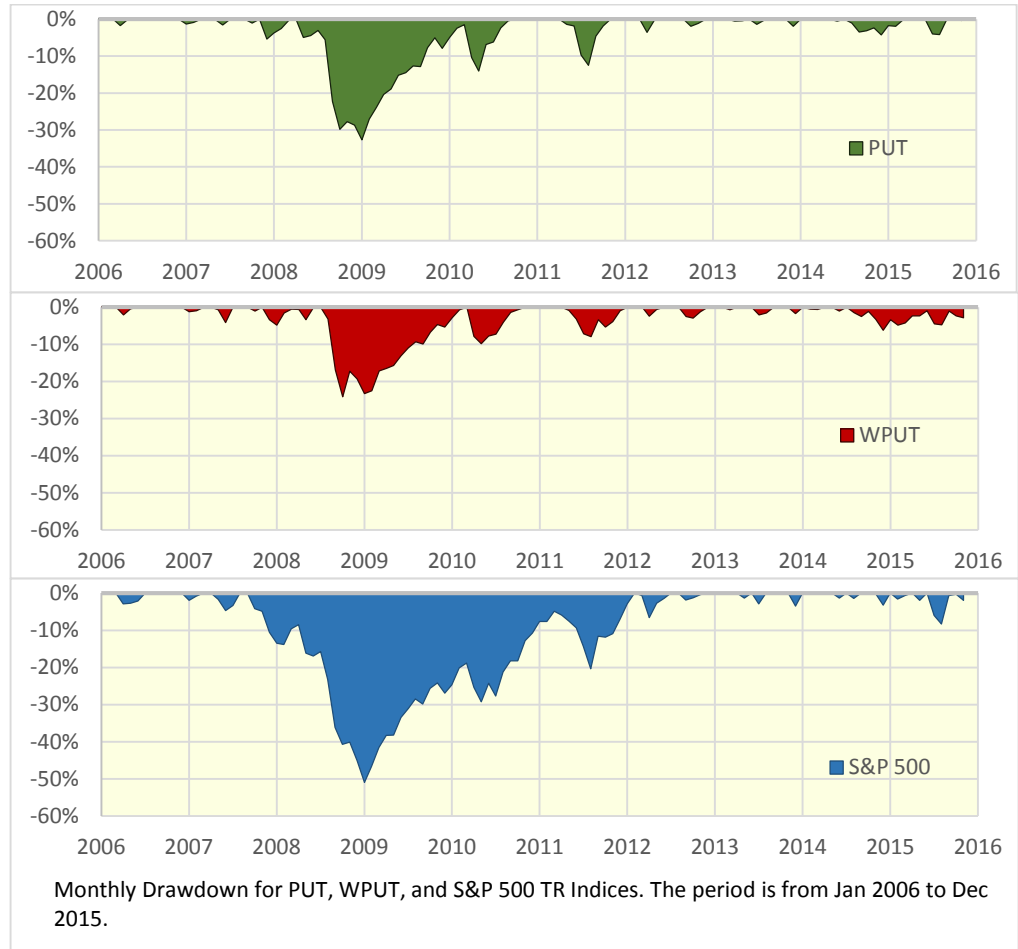
LIQUIDITY

EXHIBIT 9 – SPX AND SPXW AVERAGE DAILY VOLUME FOR EACH CALENDAR YEAR (2006 TO 2015)



DRAWDOWN

EXHIBIT 10 – MONTHLY DRAWDOWN FOR PUT, WPUT, AND S&P 500 (2006 TO 2015)



From 2006 to 2015, the maximum drawdown (MDD) for WPUT is -24.2%, as compared to -32.7% for PUT and -50.9% for SPTR.

Over same period, the longest drawdown for WPUT is much shorter than for PUT and SPTR: 19 months (WPUT), 29 months (PUT), and 52 months (SPTR).

EXHIBIT 11 – MAXIMUM DRAWDOWN (2006 TO 2015)

	PUT	WPUT	S&P 500	Russell 2000	MSCI World	Citigroup Tbond
Max Drawdown	-32.7%	-24.2%	-50.9%	-52.9%	-54.0%	-26.0%
Max Drawdown Month	Jan-09	Oct-08	Jan-09	Jan-09	Jan-09	Feb-10
Longest Drawdown (months)	29	19	52	44	68	32

Sharpe Ratio is defined as the risk-premium per unit of volatility:

$$\text{Sharpe Ratio} = \frac{E[r] - r_f}{\sigma}$$

where $E[r]$ is the expected return, r_f is the risk-free rate, and σ is the standard deviation.

Sortino Ratio is defined as:

$$\text{Sortino Ratio} = \frac{E[r] - r_f}{\sigma_d}$$

where σ_d is the downside semi-deviation. Unlike Sharpe Ratio, Sortino Ratio does not penalize for large positive returns.

Stutzer Index does not assume that returns are normally distributed. It penalizes negative skewness and high kurtosis:

$$\text{Stutzer Index} = \sqrt{2I},$$

$$I = \max\{-\log E[e^{\theta r}]\}$$

When returns are normally distributed, Stutzer Index and Sharpe Ratio coincide.

Over the last 10 years, the PUT and WPUT indices delivered similar risk-adjusted performance and both outperformed the S&P 500 and other benchmarks.

The annual compound return is 6.59% (PUT), 5.61% (WPUT), and 7.09% (S&P 500). The annualized Sharpe ratio is 0.52 (PUT), 0.50 (WPUT), and 0.46 (S&P 500). The Stutzer Index, which accounts for non-normal returns, is 0.50 for PUT, 0.48 for WPUT, and 0.45 for S&P 500.

PERFORMANCE MEASURES

EXHIBIT 12 – SHARPE RATIO, SORTINO RATIO, AND STUTZER INDEX (2006 TO 2015)

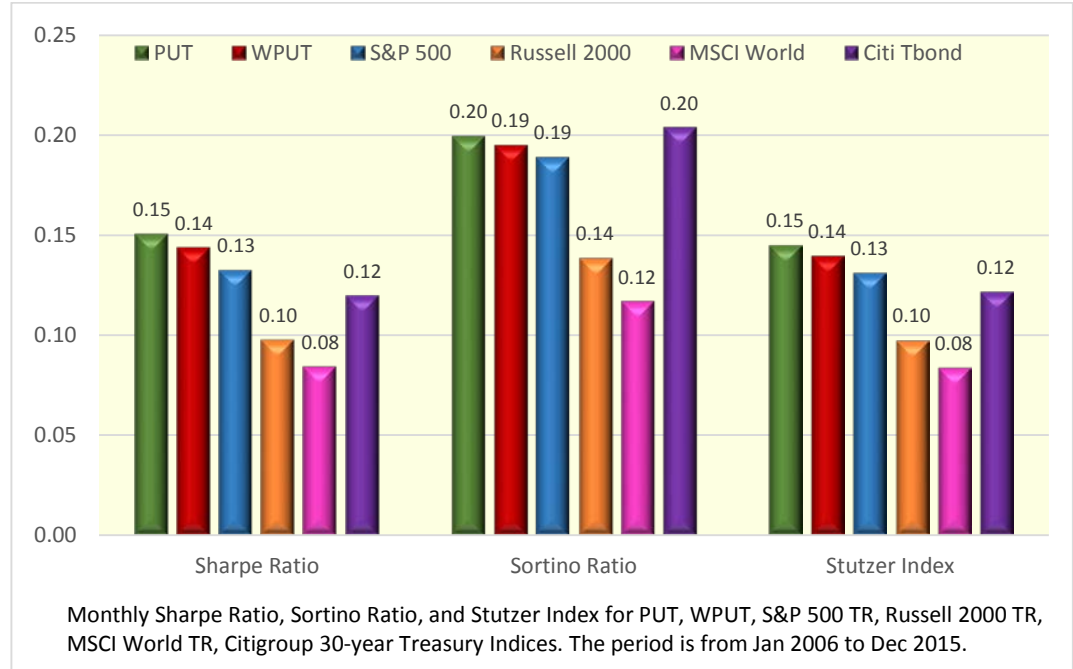


EXHIBIT 13 – MONTHLY STATISTICS (2006 TO 2015)

	PUT	WPUT	S&P 500	Russell 2000	MSCI World	Citigroup Tbond
Mean Return	0.59%	0.50%	0.67%	0.65%	0.49%	0.62%
Compound Return	0.53%	0.46%	0.57%	0.48%	0.37%	0.52%
Min Return	-17.65%	-14.14%	-16.79%	-20.80%	-18.96%	-14.61%
Standard Deviation	3.32%	2.84%	4.36%	5.68%	4.72%	4.42%
Skewness	-1.77	-1.44	-0.75	-0.53	-0.77	0.58
Kurtosis	11.01	9.13	4.66	4.18	4.95	5.54
Alpha	0.12%	0.10%	0.00%	-0.13%	-0.21%	0.72%
Beta	0.66	0.53	1.00	1.19	1.05	-0.33
Sharpe Ratio	0.15	0.14	0.13	0.10	0.08	0.12
Sortino Ratio	0.20	0.19	0.19	0.14	0.12	0.20
Stutzer Index	0.15	0.14	0.13	0.10	0.08	0.12
M-squared	0.75%	0.72%	0.67%	0.52%	0.46%	0.61%

EXHIBIT 14 – ANNUALIZED STATISTICS (2006 TO 2015)

	PUT	WPUT	S&P 500	Russell 2000	MSCI World	Citigroup Tbond
Compound Return	6.59%	5.61%	7.09%	5.94%	4.56%	6.46%
Standard Deviation	11.51%	9.85%	15.11%	19.68%	16.36%	15.31%
Sharpe Ratio	0.52	0.50	0.46	0.34	0.29	0.41
Stutzer Index	0.50	0.48	0.45	0.34	0.29	0.42

EXHIBIT 15 – BIG ONE-WEEK MOVES (2004 TO 2015)

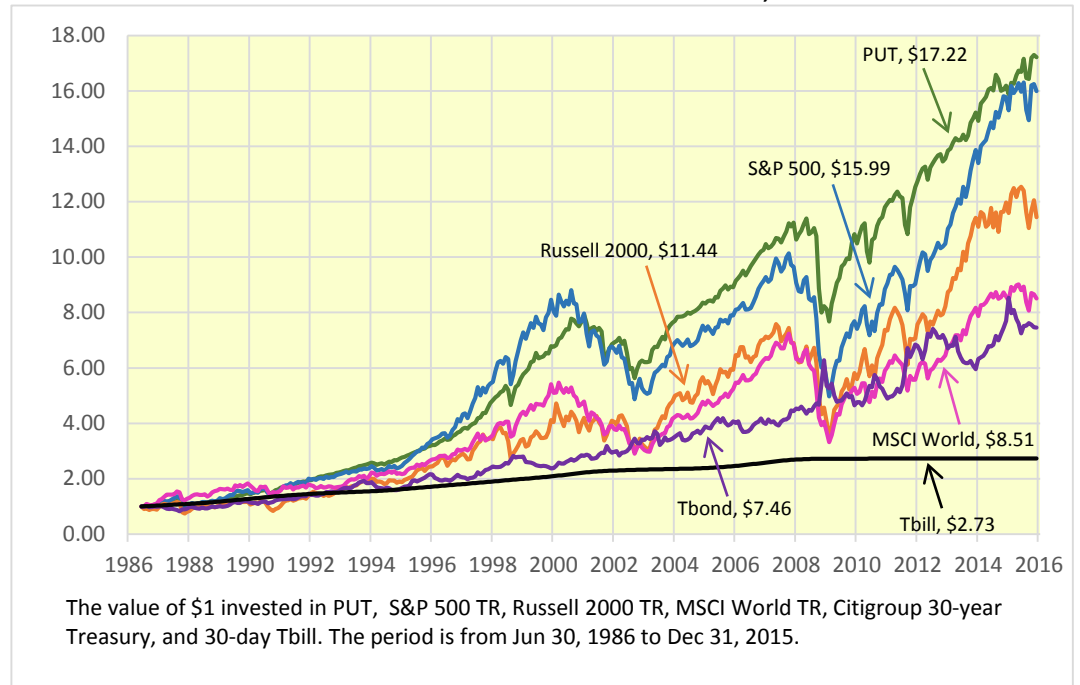
	S&P 500	PUT	WPUT	Russell 2000	MSCI World	Citigroup Tbond	VIX
10-Oct-2008	-18.1%	-17.7%	-15.1%	-15.6%	-20.0%	-0.3%	55.0%
3-Oct-2008	-9.3%	-7.2%	-7.0%	-12.1%	-8.9%	4.1%	29.9%
21-Nov-2008	-8.3%	-9.3%	-7.0%	-10.9%	-9.6%	9.7%	9.6%
5-Aug-2011	-7.2%	-5.7%	-5.7%	-10.3%	-8.5%	5.4%	26.7%
6-Mar-2009	-7.0%	-5.2%	-4.0%	-9.7%	-7.1%	4.1%	6.4%
24-Oct-2008	-6.8%	-4.0%	-0.9%	-10.5%	-8.3%	3.8%	12.5%
20-Feb-2009	-6.8%	-5.6%	-4.9%	-8.3%	-7.6%	1.9%	14.8%
23-Sep-2011	-6.5%	-4.1%	-5.1%	-8.6%	-6.9%	9.1%	33.2%
7-May-2010	-6.3%	-5.3%	-5.1%	-8.9%	-8.1%	4.1%	85.7%
14-Nov-2008	-6.1%	-3.9%	-3.5%	-9.7%	-6.3%	0.6%	18.2%
14-Oct-2011	6.0%	4.4%	1.7%	8.6%	5.4%	-3.5%	-22.0%
27-Mar-2009	6.2%	3.6%	2.7%	7.3%	4.5%	0.8%	-10.6%
2-Jan-2009	6.8%	4.1%	1.2%	6.2%	5.9%	-3.7%	-9.7%
17-Jul-2009	7.0%	5.6%	1.4%	8.0%	6.6%	-5.2%	-16.1%
2-Dec-2011	7.5%	4.6%	1.8%	10.4%	8.2%	-1.9%	-20.2%
31-Oct-2008	10.5%	8.0%	3.5%	14.2%	9.9%	-4.4%	-24.3%
13-Mar-2009	10.8%	9.4%	2.2%	12.1%	8.5%	-2.9%	-14.1%
28-Nov-2008	12.1%	4.0%	1.7%	16.4%	12.4%	3.2%	-23.9%

During the period from 2004 to 2015, there were 18 weeks in which the S&P 500 index rose or fell by more than 6%.

As expected, big moves in S&P 500 index correspond to big moves of the opposite sign in the VIX Index.

LONG-TERM HISTORICAL PERFORMANCE

EXHIBIT 16 – GROWTH OF BENCHMARK INDICES SINCE JUN 30, 1986



The value of \$1 invested in PUT, S&P 500 TR, Russell 2000 TR, MSCI World TR, Citigroup 30-year Treasury, and 30-day Tbill. The period is from Jun 30, 1986 to Dec 31, 2015.

Over an almost 30-year period, the PUT Index outperformed the traditional indices on a risk-adjusted basis.

The annual compound return is 10.13% for PUT and 9.85% for S&P 500. The annualized Sharpe ratio is 0.67 for PUT and 0.47 for S&P 500. The Stutzer Index is 0.63 for PUT and 0.46 for S&P 500.

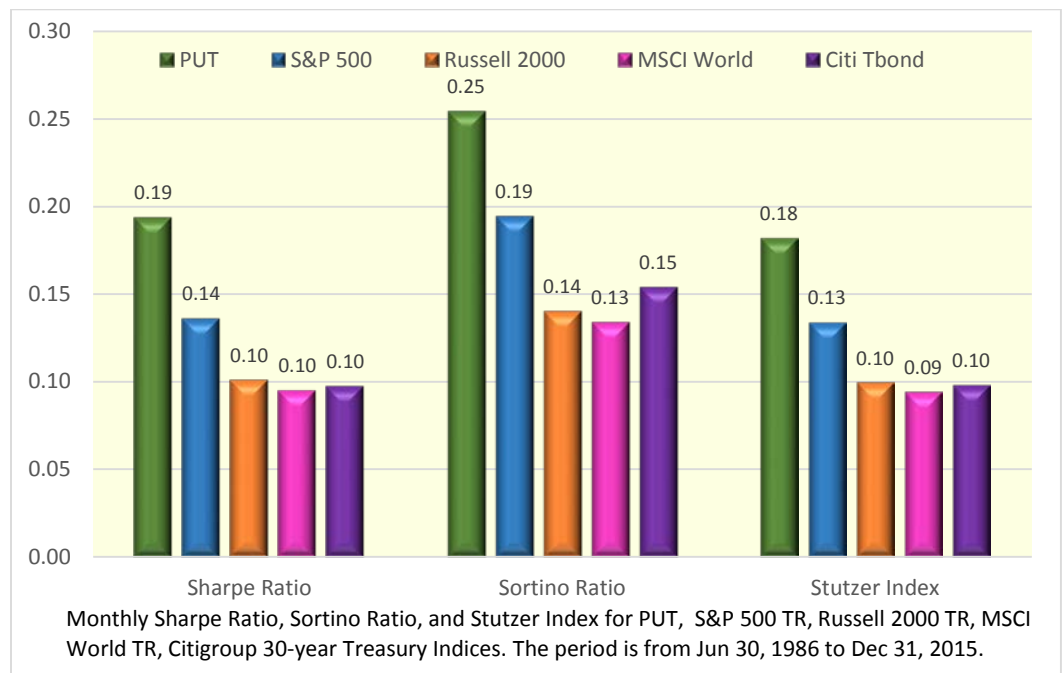
EXHIBIT 17 – MONTHLY STATISTICS (JUN 30, 1986 TO DEC 31, 2015)

	PUT	S&P 500	Russell 2000	MSCI World	Citigroup Tbond
Mean Return	0.85%	0.88%	0.85%	0.71%	0.63%
Compound Return	0.81%	0.79%	0.69%	0.61%	0.57%
Min Return	-17.65%	-21.54%	-30.63%	-18.96%	-14.61%
Standard Deviation	2.93%	4.40%	5.63%	4.42%	3.54%
Skewness	-2.09	-0.79	-0.89	-0.66	0.29
Kurtosis	12.60	5.40	6.08	4.67	5.74
Alpha	0.23%	0.00%	-0.06%	-0.11%	0.39%
Beta	0.56	1.00	1.06	0.89	-0.07
Sharpe Ratio	0.19	0.14	0.10	0.10	0.10
Sortino Ratio	0.25	0.19	0.14	0.13	0.15
Stutzer Index	0.18	0.13	0.10	0.09	0.10
M-squared	1.14%	0.88%	0.73%	0.70%	0.71%

EXHIBIT 18 – ANNUALIZED STATISTICS (JUN 30, 1986 TO DEC 31, 2015)

	PUT	S&P 500	Russell 2000	MSCI World	Citigroup Tbond
Compound Return	10.13%	9.85%	8.61%	7.53%	7.05%
Standard Deviation	10.16%	15.26%	19.49%	15.31%	12.26%
Sharpe Ratio	0.67	0.47	0.35	0.33	0.34
Stutzer Index	0.63	0.46	0.35	0.33	0.34

EXHIBIT 19 – SHARPE RATIO, SORTINO RATIO, AND STUTZER INDEX (JUN 30, 1986 TO DEC 31, 2015)



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