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Strength in Numbers

The current environment of high asset valuations, rising interest rates, increasing volatility and tighter traditional-asset correlations presents a number of challenges to investors. In this paper we highlight three quantitative approaches to help address these challenges: Collateralized equity index put writing as a way to maintain equity exposure at lower volatility without adding significant interest rate risk; Long-short risk premia investing for its low correlation with equities and bonds; and a risk-parity approach to investing to promote genuine diversification among traditional asset classes.

The volatility in equity markets since October 2018 reflected concern with respect to equity market valuations that had been building for some time. Earnings remain strong, but as this exceptionally long business cycle matures, the tension is palpable between these positive fundamentals and the potentially disruptive forces of trade conflict, geopolitics, the return of inflation and the withdrawal of ultra-loose monetary policy.

Nowadays, most individual and institutional investors diversify their assets in a portfolio of equities and bonds with a sleeve of alternative strategies. In the past, if you thought the business cycle was mature and equities looked expensive relative to the yields you could get from bonds, you could adjust your portfolio allocations from stocks to fixed income. However, after a post-crisis decade of below-trend growth and quantitative easing, bond yields today remain low in many developed markets outside the U.S., and even within the U.S. they appear low relative to where we are in the cycle.

Are we in the mature part of the cycle? That's a semantic debate. What is clear is that we already see market phenomena that have been associated with a maturing cycle in the past, such as high asset valuations, rising rates, increasing volatility and tighter traditional-asset correlations. How can investors prepare for these conditions?

We highlight three liquid and cost-effective ideas for consideration:

- Collateralized equity index put writing as a way to maintain equity exposure at lower volatility without adding significant interest rate risk
- Long-short risk premia investing for its low correlation with equities and bonds
- A risk-parity approach to investing to promote genuine diversification among traditional asset classes

We think these quantitative investment strategies can be very powerful at all times in a cycle—but they have a particularly interesting role to play in the currently emerging conditions.

Index Put Writing: Lower-Volatility Equity without Adding Significant Interest Rate Risk

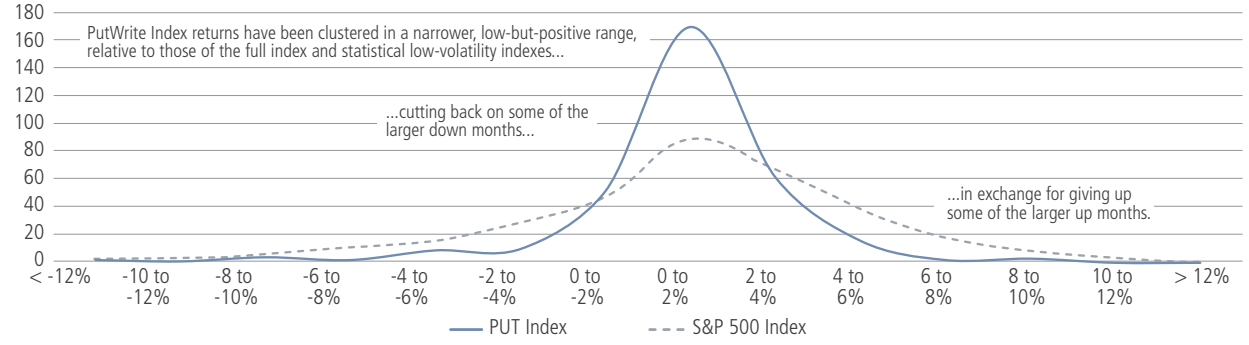
Selling (or "writing") equity index put options, backed by collateral held in high-quality short-term fixed income, is a way to maintain equity exposure that has historically exhibited lower volatility than the underlying equity index itself.

An index put option is a financial contract. It enables the buyer to sell an equity index at a certain price at any point until the contract's expiration. As such, it is like an insurance contract, bought by investors to protect their portfolios from steep equity market drawdowns. Like all insurance, it commands a premium, which generates an excess return for the writers of the put options.

The size of option premiums—and therefore the performance of the put writing strategy—is related to the volatility of the underlying index. The CBOE S&P 500 PutWrite Index (PUT), which replicates a systematic collateralized put-writing strategy, has historically outperformed the underlying S&P 500 Index when the S&P 500 Index itself has exhibited higher volatility—reflecting the fact that put option writers are paid to insure against drawdowns. At the same time, however, its performance has been less volatile than that of the S&P 500; since 1990 its annualized return has been almost exactly the same, at 10%, but it has achieved that with just over two-thirds of the annualized volatility (see Figure 1).

FIGURE 1. AN EQUITY-INDEX PUT-WRITING STRATEGY CAN "CUT THE TAILS" OFF OF THE UNDERLYING INDEX AND LOWER VOLATILITY

Number of months exhibiting a given range of return, time period: December 1990 to October 2018



Source: Bloomberg. The CBOE S&P 500 PutWrite Index was introduced in 2007 by the Chicago Board Options Exchange, and tracks a hypothetical portfolio that every month sells one-month "at the money" put options on the S&P 500 Index, fully backed by short-term U.S. Treasuries as collateral; the index sells another put when the prior put expires; the initial investment amount and all net premiums are invested in short-term U.S. Treasuries. Indexes are unmanaged and are not available for direct investment. Investing entails risks, including possible loss of principal. **Past performance is no guarantee of future results.**

RETURN & RISK STATISTICS
December 1990 – July 2018

	CBOE S&P 500 PutWrite (PUT)	S&P 500 Index (SPX)
Annual Return (%)	9.85	10.42
Volatility (%)	9.52	13.97
Risk-Adj. Ret.	1.04	0.75
Beta (S&P 500)	0.56	1.00
Max DrawDown (%)	-32.7	-50.9
Up-Mkt. Cap. (%)	63	100
Down-Mkt. Cap (%)	41	100

Source: Bloomberg. The CBOE S&P 500 PutWrite Index was introduced in 2007 by the Chicago Board Options Exchange, and tracks a hypothetical portfolio that every month sells one-month "at the money" put options on the S&P 500 Index, fully backed by short-term U.S. Treasuries as collateral; the index sells another put when the prior put expires; the initial investment amount and all net premiums are invested in short-term U.S. Treasuries. Indexes are unmanaged and are not available for direct investment. Investing entails risks, including possible loss of principal. **Past performance is no guarantee of future results.**

Why not simply invest in defensive equities or one of the many low-volatility equity products on the market? Low-vol stock portfolios typically tend to be biased toward larger index constituents in sectors that tend to have steadier earnings streams and pay higher dividends. For example, they are usually substantially overweight utilities and consumer staples. Historically, such approaches—as represented by the S&P 500 Low Volatility Index and MSCI USA Minimum Volatility Index, for example—have been very sensitive to changes in interest rates, generally outperforming the S&P 500 Index when interest rates were falling, and lagging when rates were on the rise.

FIGURE 2. AN EQUITY-INDEX PUT-WRITING STRATEGY HAS OUTPERFORMED EQUITIES IN BOTH RISING AND DECLINING RATE ENVIRONMENTS

	Cumulative Change 3-mo U.S. T-Bill Rate (bps)	S&P 500 Index Total Return	CBOE S&P 500 PutWrite Index Total Return	PutWrite Excess Return over S&P 500 Index	S&P 500 Low Volatility Index	S&P 500 Low Vol Excess Return over S&P 500 Index	MSCI USA Minimum Volatility Index	MSCI USA Min Vol Excess Return over S&P 500 Index
Increasing Rates								
Oct 2015 to Aug 2018	202	14.81%	8.66%	-6.15%	12.28%	-2.53%	13.54%	-1.27%
Jan 1994 to Jan 1995	297	0.51%	7.32%	6.81%	-1.26%	-1.77%	-0.09%	-0.61%
Sep 1998 to Oct 2000	203	19.15%	21.94%	2.79%	7.15%	-12.00%	12.67%	-6.48%
Apr 2004 to Jul 2006	411	8.47%	9.67%	1.21%	10.54%	2.07%	10.78%	2.31%
Average				**1.16%**		**-3.56%**		**-1.51%**
Decreasing Rates								
Jan 1991 to Sep 1992	-364	16.00%	16.15%	0.15%	14.64%	-1.36%	16.28%	0.28%
Oct 2000 to May 2003	-511	-12.98%	-5.02%	7.96%	6.66%	19.64%	-6.47%	6.52%
Jan 2007 to Dec 2008	-503	-19.79%	-11.77%	8.01%	-12.01%	7.78%	-13.20%	6.58%
Average				**5.38%**		**8.69%**		**4.46%**
Flat Rates								
Sep 1992 to Jan 1994	29	14.28%	14.28%	0.00%	12.39%	-1.89%	15.15%	0.87%
Jan 1996 to Aug 1998	-22	19.33%	15.54%	-3.78%	13.55%	-5.77%	15.64%	-3.69%
Dec 2008 to Oct 2015	2	15.41%	11.37%	-4.03%	14.79%	-0.62%	15.14%	-0.27%
Average				**-2.60%**		**-2.76%**		**-1.03%**

Source: Bloomberg. The CBOE S&P 500 PutWrite Index (PUT) launched in June 2007 with backtested data available from June 30, 1986. Time periods not covered were characterized by relatively short periods without any clear trend in interest rates.

As Figure 2 shows, the PUT Index, in contrast, has demonstrated the ability to outperform in both rising- and falling-rate scenarios. This is most likely because periods of adjustment in the interest-rate regime, in either direction, have tended to be associated with a less directional but higher-volatility equity market, which has often meant higher premiums for put option sellers. The PUT Index's collateral portfolio of cash and short-term U.S. Treasuries, meanwhile, can get a boost from rising rates.

This is why we believe there are benefits associated with a diversified approach to low-volatility equity investing that include collateralized put option writing alongside traditional defensive strategies, particularly in an environment with more upside interest rate risk than downside.

Alternative Risk Premia: A Source of Uncorrelated Returns

If you consider the return from a U.S. Treasury to be "risk free," the extra return you can get from equities is the "equity risk premium," while the extra return you can get from corporate bonds is the "credit risk premium." These are traditional market risk premia.

Volatility—which as we mentioned is one of the sources of return to an index put writing strategy—is typically known as an "alternative" risk premium. There are many others, and they are extracted using long-short investment strategies. Some come from "factors" such as value (securities with lower valuations tend to deliver higher long-term returns than those with higher valuations) and momentum (securities whose price has gone up recently tend to continue going up, and vice versa). Others are harvested using systematic investment strategies such as put writing (for the volatility risk premium) or selling an acquiring company while holding the target in an acquisition (for the merger risk premium).

Because strategies designed to access alternative risk premia tend to take a long-short approach, they have typically exhibited market-neutral returns. Moreover, different alternative risk premia have exhibited low or negative correlation with one another—even those extracted from the same asset class—amplifying the potential diversification benefits that can be generated by a thoughtfully constructed portfolio of alternative risk premia exposures.

Let's look at momentum as an example. The basic idea that securities whose prices have gone up recently tend to continue going up, and vice versa, is usually implemented as an investment strategy in two distinct ways: "Absolute" momentum strategies bet on the simple persistence of directional trends, measured in various ways over various time horizons ("trend following"); "Relative" momentum strategies bet that winners will continue to outperform losers within a given universe ("cross-sectional momentum").

The SG Trend Index of large trend-following hedge funds can be used as a measure of absolute momentum, while the performance of relative momentum can be proxied with the Fama-French Global Momentum Factor—an equal-weighted average of the returns of the winner's portfolio minus the average return of the loser's portfolio.[1]

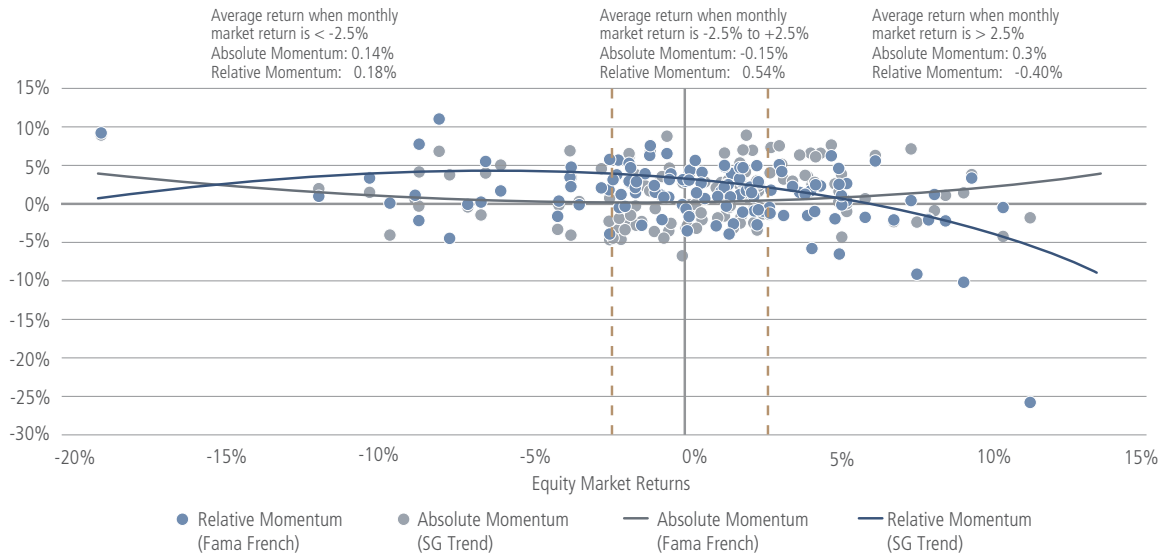
Looking at monthly returns over the decade between 2007 and 2017, absolute momentum has exhibited zero correlation with the MSCI World Index and with the 60/40 portfolio (consisting of 60% MSCI World Index and 40% Bloomberg Barclays Global Aggregate Index, rebalanced monthly); and correlation of just 0.15 with the Bloomberg Barclays Global Aggregate Index. Relative momentum has been slightly negatively correlated with all three of those benchmarks.

Just as interesting is the fact that the two different types of momentum have exhibited correlation of just 0.33 with one another. Whereas an absolute momentum strategy may be market-neutral at certain times, it has been more likely to have a pronounced directional bias long or short. By contrast, a relative momentum strategy is market-neutral by design. As such, absolute momentum has tended to perform best when there are pronounced market-wide trends, either up or down, and has tended to outperform indices the most during extreme and prolonged bear markets. In range-bound markets it has tended to exhibit flat or marginally negative performance. Relative momentum has tended to perform best when there has been high dispersion of returns between individual securities in its universe, and has been prone to deep reversals when there has been a pronounced rotation in market leadership.

[1]The data series for this factor can be accessed at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

FIGURE 3. THE DIVERSIFICATION BENEFITS OF MOMENTUM STRATEGIES

Performance of momentum strategies across equity market environments, monthly returns 2007 – 2017



Source: Bloomberg; Dartmouth College.

Figure 3 shows how a combination of the two strategies can deliver two different—indeed, opposing—types of diversification across a range of equity market environments. One characteristic of current conditions is the tension in markets between the potential for bullish, late-cycle inflationary growth and the bearish anticipation of a coming turn in the cycle sometime further into the future. Combining the two momentum strategies can generate exposure to both scenarios while mitigating downside risk.

Risk Parity: Genuine Diversification of Traditional Market Risks

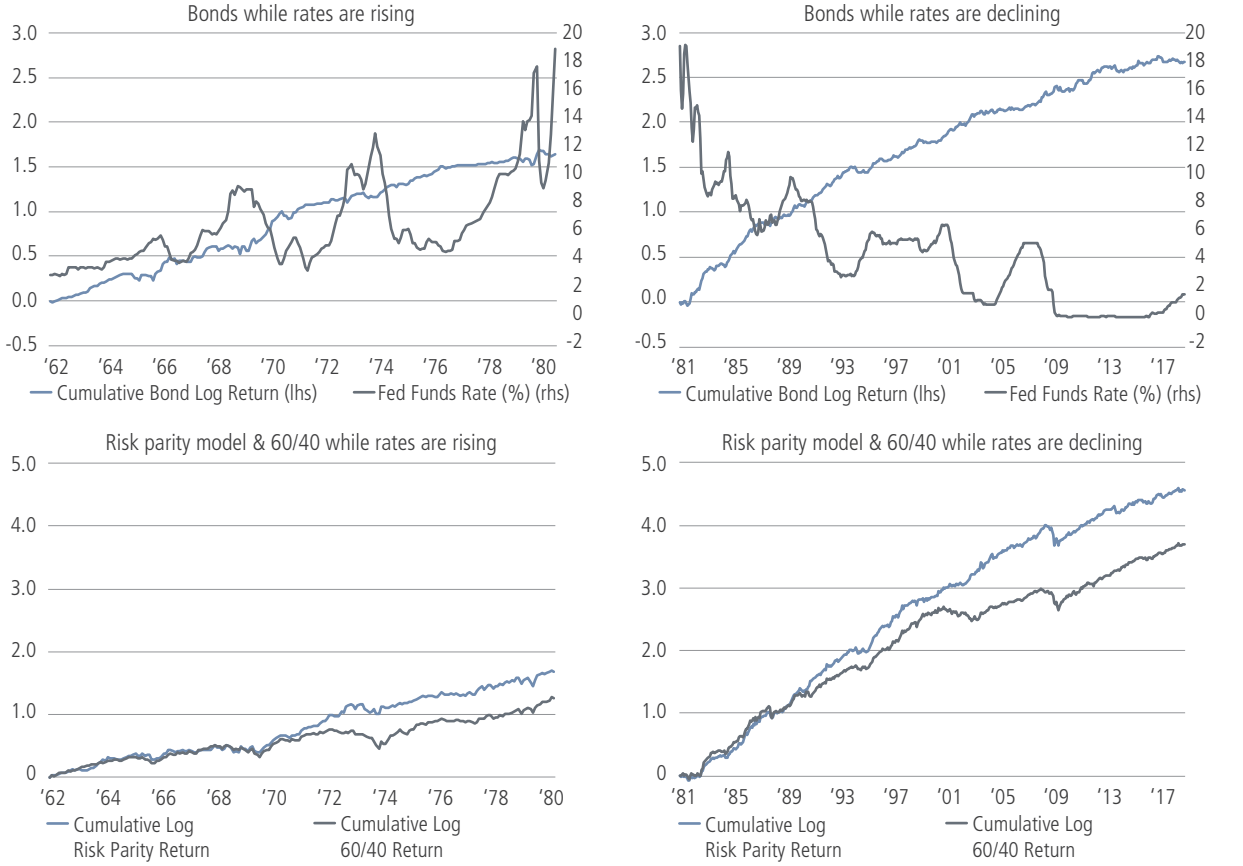
Having diversified by using alternative risk premia, we can still improve diversification between the traditional market risk premia by using the risk parity approach.

Because equities tend to be riskier than bonds, in a capital allocation split equally between both, the bond characteristics will be largely drowned out by the equity risk. To get the most efficient benefit from bonds, an investor could weight bonds until their risk contribution is equal to that of the equities. To do that without compromising the return profile, you would need to apply some leverage to the resulting portfolio. That is risk parity, in a nutshell.

Many will have heard risk parity characterized as "leveraged bonds"—which causes concern in an environment where yields are rising. However, a hypothetical backtest of a simple model risk parity portfolio of equities, bonds and commodities shows that it would have generated positive returns, and outperformed a 60/40 portfolio, not only after 1980 with declining rates, but also with rising rates during the 1960s and 70s—despite higher interest rate exposure and less equity exposure (Figure 4).

FIGURE 4. BONDS—AND RISK PARITY—CAN THRIVE WHEN RATES ARE RISING OR FALLING

Hypothetical Backtested Performance



January 1963–December 1980	Model Risk Parity	60/40 Portfolio	Stock	Bond	Commodities
Annual Return (%)	9.80	7.28	8.40	4.96	16.77
Volatility (%)	10.80	9.32	14.45	5.43	20.94
Max DrawDown (%)	-14.0	-26.4	-42.6	-8.9	-37.5
Sharpe Ratio	0.39	0.19	0.24	-0.13	0.57
Annual Return / Max DrawDown	0.70	0.28	0.20	0.56	0.45

January 1981–July 2018	Model Risk Parity	60/40 Portfolio	Stock	Bond	Commodities
Annual Return (%)	12.85	10.30	11.25	8.05	7.22
Volatility (%)	9.80	9.29	14.71	6.56	13.99
Max DrawDown (%)	-27.4	-29.6	-50.9	-8.6	-59.9
Sharpe Ratio	0.87	0.67	0.53	0.60	0.28
Annual Return / Max DrawDown	0.47	0.35	0.22	0.93	0.12

Source: Ibbotson Associates, Federal Reserve Bank of St. Louis (FRED database), Neuberger Berman. The model risk parity portfolio includes bonds, equities and commodities, with volatility contributions equally weighted based on two-year trailing realized volatility, and a target portfolio volatility of 10% annualized; bonds are represented by the Ibbotson U.S. Intermediate-Term Government Bond Index, equities by the S&P 500 Index and commodities by the GSCI Commodity Index after 1970, and commodity futures data from Bloomberg pre-1970. 60/40 portfolio consists of 60% S&P 500 Index and 40% Ibbotson U.S. Intermediate-Term Government Bond Index, rebalanced monthly. Indexes are unmanaged and are not available for direct investment. Investing entails risks, including possible loss of principal. **Please see "Hypothetical Backtested Performance Disclosures" at the end of this material. Past performance is no guarantee of future results.**

One reason for this is that bonds have been surprisingly resilient even when rates were rising. It is intuitive that the price of a bond should decline as interest rates go up. But because a bond generates income, it is still possible for it to deliver a positive total return. In June 2018, for example, market pricing indicated that the 10-year U.S. Treasury yield would need to rise by more than 40–50 basis points before it delivered a negative total return. The question for bond investors is not "Are yields rising?", but rather "Will yields rise faster than the market is currently pricing?"

The other, more powerful reason is the genuine diversification within a risk parity portfolio. When we look at the worst calendar years for stocks, bonds and commodities since 1960, we find that when equities experienced their worst losses (2008, 1974, 2002), bonds posted good positive returns—and sometimes commodities helped, too. When commodities performed most poorly (2008, 2015, 1981), bonds were positive—and sometimes equities helped, too. When bonds struggled the most (2009, 2013, 1994), equities were positive. When equities and bonds both lost money due to a surge in inflation, in 1969, commodities performed extremely strongly. By balancing the risk contributions of all three asset classes, it is possible to get the full benefit of these natural hedges.

To sum up, risk parity can be a way to achieve genuine diversification between traditional market risks when none of them present clear value—and it may perform better than expected in a rising-yield environment.

A Powerful Threefold Response to a Challenging Environment

Investors face a challenge. Inflation and interest rates appear to be rising, traditional asset markets appear close to full valuations, investors are starting to look over the horizon toward the maturing and turning of the current business cycle, and as a result, volatility has risen and asset correlations have tightened.

The threefold approach of put option writing, alternative risk premia and risk parity can help address this challenge by implementing low-volatility, low interest rate risk equity exposure, uncorrelated alternative risks and genuine diversification between traditional market risks.

We believe these solutions are useful in themselves. In combination, we think they can be very powerful at any time—but particularly in the current conditions.

Hypothetical Backtested Performance Disclosures

The hypothetical performance results included in this material are for a backtested model portfolio and are shown for illustrative purposes only. Neuberger Berman calculated the hypothetical results by running a model portfolio on a backtested basis using the methodology described herein. The results do not represent the performance of any Neuberger Berman managed account or product and do not reflect the fees and expenses associated with managing a portfolio.

The model risk parity portfolio includes bonds, equities and commodities, with volatility contributions equally weighted based on two-year trailing realized volatility, and a target portfolio volatility of 10% annualized; bonds are represented by the Ibbotson U.S. Intermediate-Term Government Bond Index, equities by the S&P 500 Index, commodities by the GSCI Commodity Index after 1970 and commodity futures data from Bloomberg pre-1970. 60/40 portfolio consists of 60% S&P 500 Index and 40% Ibbotson U.S. Intermediate-Term Government Bond Index, rebalanced monthly. The results assume a minimum investment of $10 million, monthly rebalancing, no cash allocation, no withdrawals and reinvestment of any dividends and distribution. Model performance figures referenced are shown gross of fees, which do not reflect the deduction of investment advisory fees and other expenses. If such fees and expenses were reflected, returns referenced would be lower.

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Options involve investment strategies and risks different from those associated with ordinary portfolio securities transactions. By writing put options, an investor assumes the risk of declines in the value of the underlying instrument and the risk that it must purchase the underlying instrument at an exercise price that may be higher than the market price of the instrument, including the possibility of a loss up to the entire strike price of each option it sells but without the corresponding opportunity to benefit from potential increases in the value of the underlying instrument. The investor will receive a premium from writing options, but the premium received may not be sufficient to offset any losses sustained from exercised put options.

The **S&P 500** consists of 500 stocks chosen for market size, liquidity and industry group representation. It is a market value weighted index (stock price times number of shares outstanding), with each stock's weight in the Index proportionate to its market value. The "500" is one of the most widely used benchmarks of U.S. equity performance. As of September 16, 2005, S&P switched to a float-adjusted format, which weights only those shares that are available to investors, not all of a company's outstanding shares. The value of the index now reflects the value available in the public markets.

The **CBOE S&P 500 PutWrite Index (PUT)** is designed to track the performance of an index option put writing strategy that sells a sequence of one-month, at-the-money, S&P 500 Index puts and invest cash at one- and three-month Treasury Bill rates. The number of puts sold varies from month to month, but is limited so that the amount held in Treasury Bills can finance the maximum possible loss from final settlement of the SPX puts, i.e., put options are fully collateralized.

The **S&P 500® Low Volatility Index** measures performance of the 100 least volatile stocks in the S&P 500. The index benchmarks low volatility or low variance strategies for the U.S. stock market. Constituents are weighted relative to the inverse of their corresponding volatility, with the least volatile stocks receiving the highest weights.

The **GSCI Commodity Index**, published by Standard & Poor's, is a world production-weighted index of the most liquid futures contracts in 24 commodity sectors.

The **Bloomberg Barclays Global Aggregate Index** is an index of global investment grade debt from 24 developed and emerging local currency markets, including government, corporate and securitized fixed-rate bonds.

Ibbotson U.S. Intermediate-Term Government Bond Index is a one-bond index that tracks the total return of the shortest non-callable bond with a maturity of not less than five years for one calendar year, before choosing a new bond on the same criteria.

The **MSCI USA Minimum Volatility (USD) Index** aims to reflect the performance characteristics of a minimum variance strategy applied to the large and mid cap USA equity universe. The index is calculated by optimizing the MSCI USA Index, its parent index, in USD for the lowest absolute risk (within a given set of constraints). Historically, the index has shown lower beta and volatility characteristics relative to the MSCI USA Index.

The **SG Trend Index** is a cross-asset indicator and is an equal-weighted index track the largest trend-following hedge fund strategies. The index is published by SG Prime Services.

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