INVESTMENT INSIGHTS
JUNE 2013 | VOLUME 16, ISSUE 2

BLACKROCK®

VIX YOUR PORTFOLIO

Selling Volatility to Improve Performance

BY THOMAS McFARREN

Author

INVESTMENT INSIGHTS
THE INVESTMENT RESEARCH JOURNAL FROM BLACKROCK

Volume 16, Issue 2
June 2013

THOMAS McFARREN, CFA

Thomas McFarren, CFA, Vice President, is a member of BlackRock's Global Market Strategies Group. His responsibilities include portfolio construction and asset allocation strategies.

Mr. McFarren's service with the firm dates back to 2007, including his years with Barclays Global Investors (BGI), which merged with BlackRock in 2009. At BGI, his role involved researching and building investment solutions within the Client Solutions group.

Mr. McFarren earned a BS degree, summa cum laude, in physiology and an MS degree in finance from the University of Arizona in 2006 and 2007, respectively.

EXECUTIVE EDITORS
Ronald N. Kahn
ron.kahn@blackrock.com

Russ Koesterich
russ.koesterich@blackrock.com

EDITOR
Marcia Roitberg
marcia.roitberg@blackrock.com

The author gratefully acknowledges insights provided by BlackRock colleagues Marcia Roitberg, Dan Veiner, Philip Hodges, Vincent de Martel, John Scruggs, and three anonymous reviewers.

Contents

JUNE 2013

Executive summary

How can investors generate the income and returns required to meet their spending needs or liabilities? Economies are deleveraging, growth may continue to disappoint, and yields have been destructively low. Traditional assets (equities and bonds) may not generate the income or returns that investors seek. One way to address the uncertainty of future market environments is to build portfolios with many engines of return.

Selling volatility is a return engine that does not rely on interest rates, dividends, or price appreciation, making it particularly attractive for investors seeking other sources of returns. Historically, we find that the strategy of selling volatility has generated higher returns with smaller losses, compared with traditional equity portfolios.

Selling volatility on a broad equity index has a positive expected return premium over time, as the seller effectively provides insurance to the buyer of volatility. In fact, the returns distribution of volatility is so unattractive to some investors that the return premium has been higher than that of other common assets, such as equities. Investors who are able to tolerate infrequent, sharp losses in exchange for regular, but limited, short-term gains have the potential to capture outsized returns over long horizons with smaller drawdowns.

Three primary instruments for implementing this strategy are options, variance swaps, and VIX futures. These instruments have notable differences, yet history shows attractive returns to each. This paper highlights VIX futures, as they are exchange-traded, liquid, transparently priced, and operationally simple, and they provide clean volatility exposure.

Risk management is crucial to implementing the strategy successfully. A key component of this is consideration of potential extreme scenarios when sizing positions, in order to minimize negative surprises.

Allocating to a short-volatility strategy as an equity substitute would have improved portfolio performance even during the financial crisis. This makes it a particularly compelling strategy, especially for investors seeking to diversify their portfolio's return engines.

Introduction

Since the financial crisis began to unfold, investors have taken a variety of approaches to improve performance. Some have focused on increasing returns, such as considering less-constrained strategies, shifting to more active exposures, or adding new asset classes. Others have focused on decreasing risk, including adopting a risk-factor approach, shifting to index exposures, or diversifying across more asset classes. Another perspective is to use risk—or more specifically, market uncertainty—to create an opportunity.

Investors can use market uncertainty to their advantage for the simple reason that market participants often pay high fees for insurance, to cover short equity positions or to minimize the impact of equity market downturns. It is this demand for protection that leads to a premium, which can be captured by investors who see the potential to use volatility as a return driver.

This paper provides a framework to sell volatility on a broad equity index (specifically, US large-capitalization stocks) in order to increase risk-adjusted returns, including:

1. Why there is a positive expected return for selling volatility,
2. Implementation approaches available (options, swaps and futures),
3. What the returns have looked like historically,
4. The risks involved, and
5. How to allocate to a short-volatility strategy in a way that mirrors equity allocation.

Even though there has been more asymmetry of returns to selling volatility, this strategy may offer both smaller drawdowns and higher realized returns over long horizons, as compared with investing directly in equities.

Why is there a positive risk premium to selling volatility?

A strategy that systematically sells volatility on a diversified equity index should capture a positive risk premium over long horizons because it is similar to selling insurance. When equity investments decline in value, volatility typically rises. Exhibit 1 shows the historical evidence for the negative correlation of traditional portfolios with implied volatility.[1] An equity investor who is long volatility realizes a gain that offsets negative equity returns; that is, the investor benefits from holding this insurance. The volatility seller—or, the insurance seller—bears this downside risk and, therefore, earns a long-term risk premium.

If there weren't a positive risk premium for selling volatility, then more investors would buy volatility for its insurance-like properties. Such buying pressure would increase the price of volatility-sensitive derivatives and options contracts until their expected returns became significantly negative for long positions (and therefore positive for short positions). A significant negative return expectation is needed to dissuade some investors from being long volatility, as even negative-returning strategies can increase the expected Sharpe ratio of a portfolio when they have a negative correlation with the rest of the portfolio.

Added to this is the fact that investors care about return asymmetry or "skewness" on top of their Sharpe ratio objectives and, as such, should further increase buying pressure and the return incentive needed for being short volatility. Also, many investors are constrained against taking short positions. This means that the market can have more buying potential versus selling potential at any given price level. With the financial crisis still fresh in investors' memories, the demand for protection is likely high.

Global investors are net long risky assets. Insurance for these assets should come at a price. Volatility sellers need a sufficient incentive in the form of a positive expected return that competes with other risky asset expected returns, in order to provide this protection to hedgers.

EXHIBIT 1: VOLATILITY HAS A NEGATIVE CORRELATION WITH COMMON PORTFOLIOS

	Correlation with VIX Index (changes) (1/90–12/12)	Correlation with VIX futures (long position) (4/04–12/12)
S&P 500	–70%	–78%
60/40 Equity / Bond	–69%	–78%
25/75 Equity / Bond	–58%	–69%
Barclays US Aggregate	–8%	–10%

Sources: BlackRock and Bloomberg, as of 12/31/12. Correlation is calculated with monthly data.

A history of negative correlation between volatility and portfolios with equities indicates the insurance that a buyer receives from the seller of volatility.

1 Implied volatility is the volatility of the price of the underlying security that is implied by the price of the derivative when using a certain pricing model (e.g., the Black-Scholes model).

How can we sell volatility?

EXHIBIT 2: VIX FUTURES OFFER PURE VEGA EXPOSURE… WITH PRICE TRANSPARENCY

Delta	Exposure to value of underlying asset
Vega	Exposure to volatility of underlying asset
Options	Delta and vega
Variance swaps	Vega
VIX futures	Vega

The three most common instruments for getting volatility exposure are options, variance swaps, and VIX futures. The choice of instrument depends on the investor's:

1. Ability to short securities,
2. Desired pureness of volatility exposure,
3. Portfolio management tools for various derivatives,
4. Counterparty risk tolerance, and
5. Desire for price transparency.

For unconstrained investors, VIX futures may be preferable because they offer clean volatility exposure, less management complexity, and the benefits of exchange trading. Variance swaps also have pure volatility exposure, but they are traded over-the-counter and have counterparty risk. While options are exchange traded and transparent, they are exposed both to the value of the underlying asset and to the volatility of the underlying asset. These two types of exposure are called delta and vega, respectively (Exhibit 2).

To compare these three approaches to selling volatility, we can examine the implementation details of each, starting with options.

1. OPTIONS APPROACH

The most widely used and long-established instrument for getting exposure to the volatility risk premium is an option contract. Options prices are influenced by volatility, as volatility affects the probability and the degree to which an option can be valuable (or "in the money") at expiration. Other things held constant, an increase in the implied volatility will make an option more valuable and expensive. It is important to keep in mind that the prices of other volatility derivatives are largely influenced by options prices, as options can be used to hedge other volatility derivatives.

Selling volatility with options involves short positions with puts and/or calls. One basic strategy, called a "short straddle," combines a short put and short call position of equal strike price, maturity, and number of contracts. Even more simply, one can just sell puts or calls alone to get short volatility exposure. Selling cash-secured puts or covered calls involves limited losses and is, therefore, the easiest and most accepted way to sell volatility.

A disadvantage of these simple options strategies is that their valuations are more influenced by the price changes of the underlying asset once that asset's price has moved away from the strike price(s) of the option structure. One way to offset this exposure is to take an opposing position in the underlying asset sized by an amount equal to the exposure of the option structure to changes in the underlying asset price. This practice, known as delta-hedging, can be operationally complex, as the delta exposure changes and is subject to price-gap risk (the risk that the price of the underlying asset jumps without making a smooth and continuous transition). Thus, delta-hedging of options is not always worth its benefits.

Another slight disadvantage of simple options strategies is that the vega notional exposure changes as the underlying asset price changes. Vega notional is the profit exposure of an instrument to a change in the volatility priced by the instrument. Specifically, the vega notional equals the dollar profit realized if the implied volatility—as priced by the instrument—were to increase by one volatility point. For example, if an instrument's implied volatility goes from 23 to 20, then a position with a vega notional of –5 would have a profit of $15.[2]

While the details are beyond the scope of this paper, it is important to note that by adding more short options positions of different notionals across various strike prices, one can reduce the sensitivity to changes in vega notional and the underlying asset price. This creates an exposure that becomes similar to a variance swap.

2. VARIANCE SWAPS APPROACH

A variance swap is one of the purest forms of exposure; its profit is simply determined by the difference between the square of realized volatility and the square of implied volatility. This instrument will create a profit for a short position (i.e., negative notional) when realized volatility over the life of the swap is lower than the strike implied volatility at the opening of the swap position.

$$profitAtMaturity = varianceNotional \times (realizedVolatility^2 - strikeVolatility^2)$$

A variance swap can be replicated very well by a static portfolio of options contracts of the same maturity and a position in the underlying asset that requires some dynamic adjustment of the position.[3] This is less onerous and risky than the adjustments needed for delta-hedging options straddles. Unlike options, however, the vega notional exposure for a variance swap will not change due to a change in the underlying asset price. Still, the vega notional of a variance swap will change with large changes in the implied volatility, because variance equals the square of volatility. This feature leads to even more skewness of returns, compared with VIX futures.

The squaring feature also creates asymmetry of returns, such that a given increase in implied volatility leads to a larger return impact compared with a decrease in implied volatility of the same magnitude. This asymmetry—also known as convexity or "negative convexity" in the case of a short position—is beneficial to long positions but unfavorable for short positions if large changes in volatility occur.[4] These charac-

2 For some instruments, the vega notional changes as implied volatility changes. In this simple example, the vega notional is assumed to be constant and we have: profit = –5 * (20 – 23) = 15.

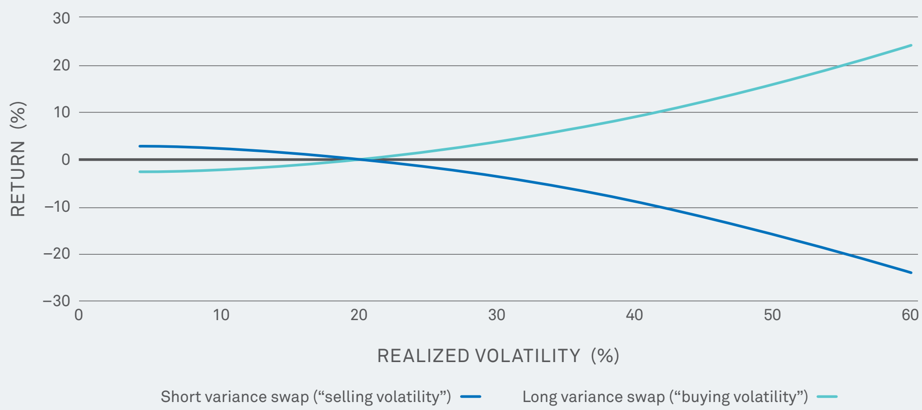
3 See Peter Carr and Liuren Wu, "A Tale of Two Indices," *The Journal of Derivatives* 13, no. 3 (Spring 2006).

4 However, when large changes in volatility don't occur, this feature should lead to better returns for short variance swap positions, compared with short VIX futures positions, as market prices should not allow the payoff profile of one instrument to dominate another in every possible case.

teristics can be seen by the curvature in Exhibit 3, which graphs the return payoff of an example variance swap as a function of realized volatility.

The curvature shows the convexity (or, asymmetry) of the payoff profile for a long or short variance swap position. When large changes in volatility occur, this feature is beneficial for long positions but unfavorable for short positions. Both the long and short positions in this example are for a variance swap with a strike implied volatility of 20 and a position size of +/−0.003 vega notional per dollar of total portfolio capital.

EXHIBIT 3: THE PAYOFF PROFILES OF VARIANCE SWAPS ARE CURVED, OR CONVEX



Source: BlackRock.

A convenient feature of a 30-day maturity variance swap on the S&P 500 is that its fair strike volatility is a very close approximation of the VIX index. Also, the options used in the replicating portfolio of this 30-day variance swap can be the same as the options used for the calculation of the VIX index.[5] It is important to note, however, that an investor cannot buy or sell the VIX index itself.[6] The closest thing is a *VIX futures contract*, which is investable.

3. VIX FUTURES APPROACH

VIX futures provide clean exposure to future implied volatility of the S&P 500. When held to expiration, their profit is determined by the difference between the spot VIX index at the expiration date and the price of the future at the trade open date, which is influenced by the market’s expectation of the future spot VIX index. Thus, the price of a VIX futures contract is the market’s price of forward implied volatility over the period beginning on the expiration date and ending 30 days after expiration.[7] Each contract provides a vega notional equal to the contract multiplier, which is 1,000 for the primarily traded VIX futures.[8]

5 Peter Carr and Liuren Wu, “A Tale of Two Indices,” *The Journal of Derivatives* 13, no. 3 (Spring 2006).

6 The simple reason for this is that the VIX index is a flat trend (or, zero trend) series that is negatively correlated with risky assets. Due to its flat trend, there would be a zero expected return if it were investable. This implies that almost no one would be willing to take the short side of a trade because they would not expect a positive return and they would be holding a position with a significant positive correlation with other risky assets.

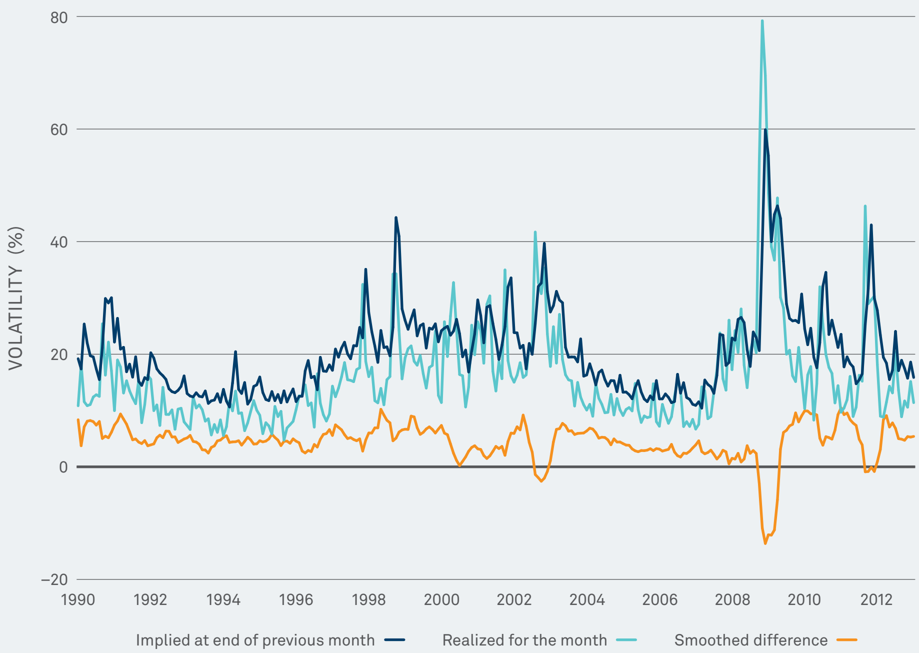
7 The implication of this is that a VIX futures contract is similar to a forward-starting variance swap, which is effectively a calendar spread of variance swaps.

8 The Mini-VIX futures contract has a vega notional of 100 but it currently trades with very little volume compared with the bigger contract.

What has the premium looked like historically?

History strongly suggests that selling volatility on the S&P 500 has a positive risk premium; implied volatility has a significant tendency to be higher than realized volatility. Exhibit 4 compares 30-day implied volatility (as given by the VIX index) at the end of the previous month with the realized volatility for a given month. Notice that the smoothed difference between the two values is predominantly positive. Because of this tendency, we see attractive historic returns to selling options, variance swaps, and VIX futures.

EXHIBIT 4: SHORT-VOLATILITY STRATEGIES HAVE HISTORICALLY PROVIDED A POSITIVE RISK PREMIUM OVERALL



Sources: BlackRock and Bloomberg, 1990–2012. Calculated based on a monthly frequency.

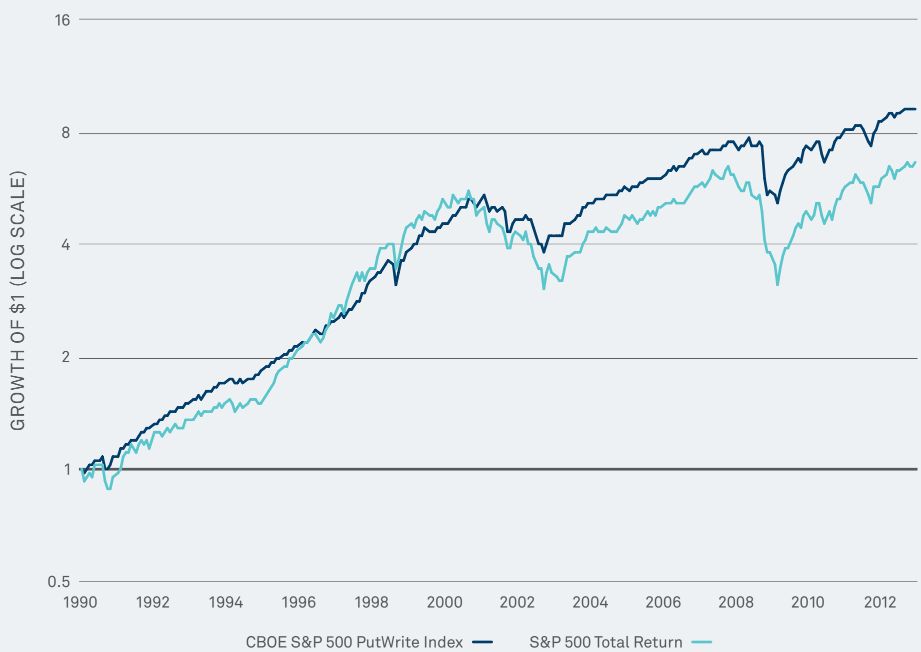
We see a positive risk premium from S&P 500 volatility-related derivatives, as implied volatility of the S&P 500 (measured by the VIX index) has typically been higher than realized volatility.

1. OPTIONS PERFORMANCE

When using options to sell volatility, one of the simplest strategies is shorting put options while holding cash to collateralize potential losses. To understand how this basic strategy has performed historically, we can look at the CBOE S&P 500 PutWrite Index, which measures the performance of a hypothetical portfolio that sells one-month, at-the-money, S&P 500 puts and holds Treasury bills to fully collateralize possible losses. Exhibit 5 shows how this put selling strategy has historically outperformed the S&P 500 with less volatility and smaller drawdowns. Also notice in the chart how this strategy tends to outperform equities when equity prices are either flat or falling, while it underperforms equities only when equity prices rise quickly.

Over long horizons, selling options has provided attractive returns compared with the S&P 500. Buyers of options, on the other hand, must pay away a significant premium.

EXHIBIT 5: OPTIONS SELLING HAD HIGHER RETURNS, LESS VOLATILITY AND SMALLER DRAWDOWNS, RELATIVE TO THE S&P 500

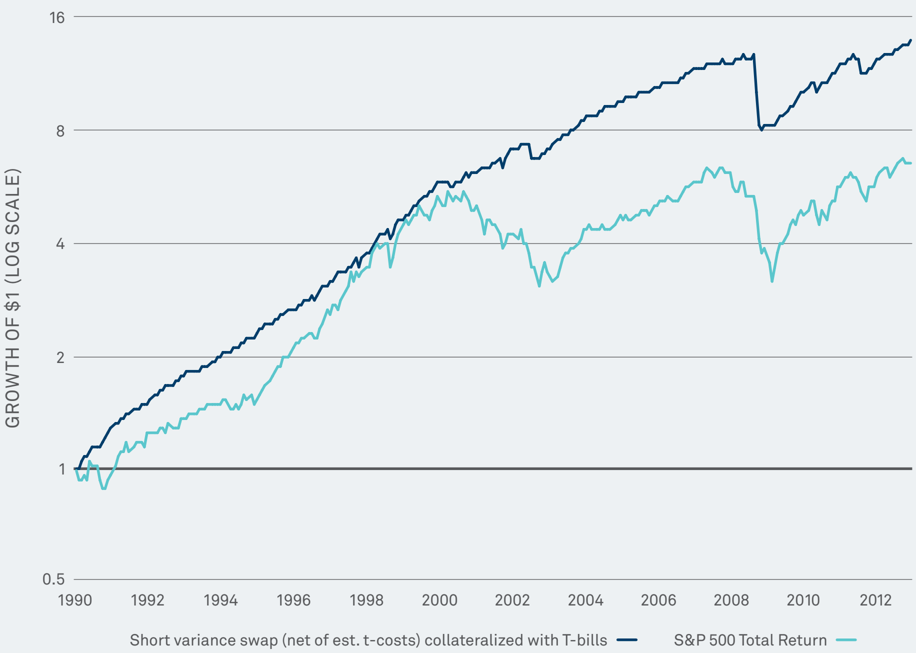


Sources: BlackRock and Bloomberg, 1990–2012.

2. VARIANCE SWAPS PERFORMANCE

We can simulate the performance of a one-month variance swap selling strategy since 1990, by using the data from Exhibit 4 in combination with Appendix C–Equation (3) and the fact that the VIX Index is calculated to approximate the implied volatility or fair strike volatility for a 30-day variance swap. Exhibit 6 shows the cumulative return series for a Treasury bill collateralized strategy using end-of-month rebalancing to target –30 basis points of vega notional per dollar of capital and assuming 1 volatility point of transaction costs per month (which reduces the strike by 1 volatility point for a short position). This exhibit clearly shows that while the variance swap return series is more skewed than that of the S&P 500, it has had a much higher return per unit of realized risk with a smaller maximum drawdown, even including the extreme volatility seen in 2008.

EXHIBIT 6: VARIANCE SWAPS PROVIDED HIGHER RISK-ADJUSTED RETURNS THAN THE S&P 500, WITH SMALLER DRAWDOWNS



Sources: BlackRock and Bloomberg, 1990–2012.

Variance swaps outperformed the S&P 500 with smaller drawdowns, including approximate transaction costs.

3. VIX FUTURES PERFORMANCE

Lastly, we can also look at VIX futures to see how they have performed since their inception in 2004. For this simulation, we can simply rebalance the strategy at the end of each month such that we sell to open the second-month contract and then buy to close that position at the end of the next month; that same contract becomes the first-month contract after one month has passed.[9] We can size this VIX futures strategy to have equity-like volatility using –90 basis points of vega notional per dollar of capital. Because VIX futures have a vega notional of 1,000 for each contract, this is equivalent to –9 contracts for every $1,000,000 of capital. Assuming 0.1 volatility points of transaction costs per month while investing cash in Treasury bills, we get the following cumulative return series in Exhibit 7a. Again, we find a historically higher returning strategy with a smaller drawdown, compared with buying equities.

VIX futures also outperformed the S&P 500 with a smaller maximum drawdown, including approximate transaction costs.

EXHIBIT 7A: VIX FUTURES PROVIDED HIGHER RISK-ADJUSTED RETURNS WITH SMALLER MAXIMUM DRAWDOWN

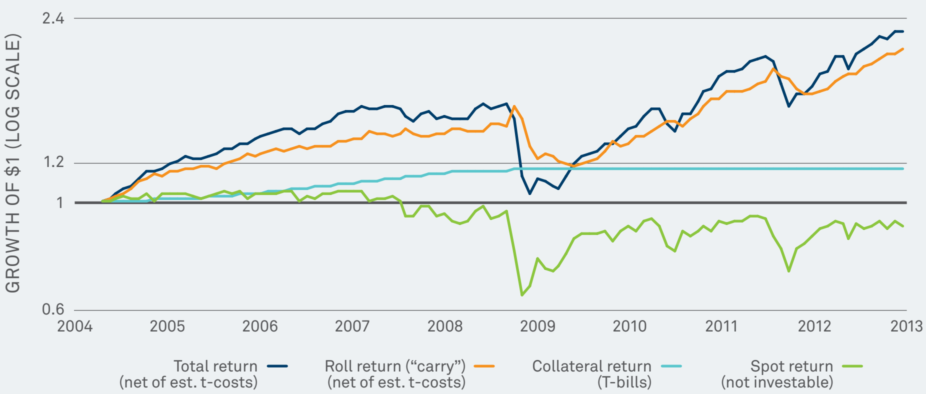
Sources: BlackRock and Bloomberg, 04/04–12/12.

9 A strategy where one always holds the first-month contract and necessarily rolls it intra-month but rebalances only at month-end to target the desired vega notional to capital ratio gives very similar risk-adjusted results. The difference is that this strategy will have a more-volatile return per unit of vega notional, because the vega exposure is for a forward volatility that is less forward in time (about 30 days less forward), and because forward volatility is itself less volatile the more forward in time it is. In other words, the first-month VIX future will be more volatile than the second-month contract, which will be more volatile than the third-month contract (and so on). The same effect is true for variance swaps where the returns of longer-dated swaps are less volatile than shorter-dated swap returns.

We can compare performance results for the three strategies, but first consider how returns are achieved through a short-volatility strategy. Exhibit 7b provides a return attribution of this strategy where the roll return, the spot return (due to changes in the VIX index), and the collateral return add up to equal the total return. The roll return is determined by changes in the price of a futures contract, as it rolls down the curve over time toward the spot price. Exhibit 7c shows this and how the VIX futures curve (or "term structure") is typically upward sloping (or in "contango"). The contango and the resulting roll return create the insurance-like premium that is paid by a long position and received by a short position. During periods of extremely high volatility, the term structure can invert ("backwardation") and create a negative roll return for the short position. However, the high probability of volatility falling to more normal levels can offset a temporary negative roll return.

Looking at the period following the financial crisis, the increased roll return is similar to how equities had an increased return; risky assets tend to have their highest returns after a crisis. During calm markets, the roll return is unlikely to be as large as it was following the financial crisis, but the returns of other risk assets, such as equities, are also unlikely to be as large as they were following the crisis.

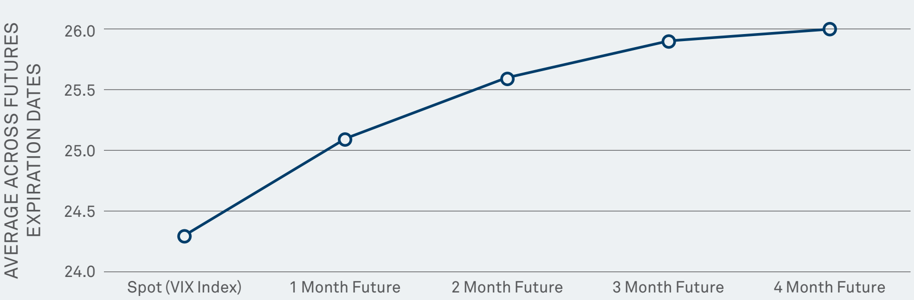
EXHIBIT 7B: ROLL RETURN FROM THE FUTURES CURVE CREATES THE PREMIUM FOR SELLING VIX FUTURES



Sources: BlackRock and Bloomberg, 04/04–12/12.

The roll return comes from the price of a futures contract rolling-down the futures curve over time. In stressed markets, the roll return can be negative, as the futures price rolls up the curve toward the spot price, because the market is expecting a fall in the spot price.

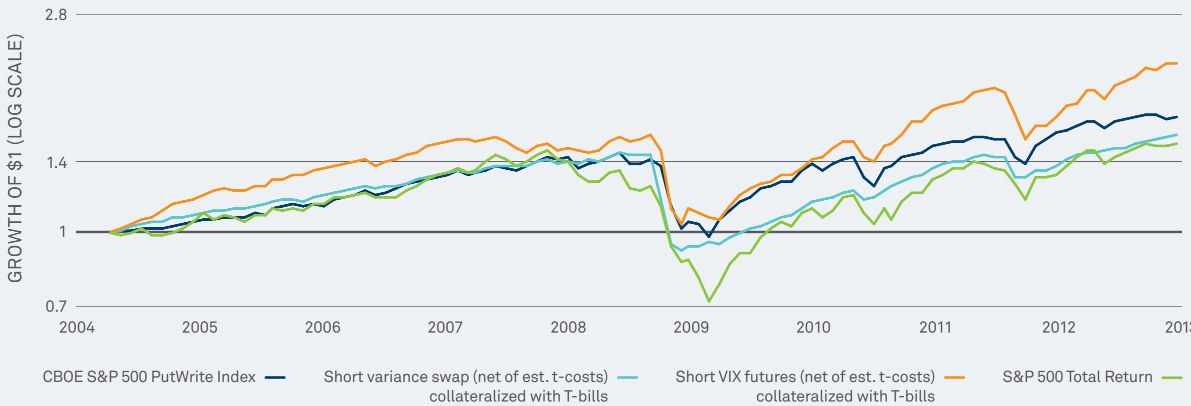
EXHIBIT 7C: TERM STRUCTURE FOR VIX FUTURES IS TYPICALLY UPWARD-SLOPING



Sources: BlackRock and Bloomberg, 2007–2012.

Each day, the futures price moves closer to the spot price; this movement creates a profit during normal market conditions for a short position.

EXHIBIT 8: ALL THREE SHORT-VOLATILITY STRATEGIES HAVE OUTPERFORMED THE S&P 500



	CBOE S&P 500 PutWrite Index	Short variance swap (net of est. t-costs) collateralized w/T-bills	Short VIX futures (net of est. t-costs) collateralized w/T-bills	S&P 500 Total Return
Cumulative return (annualized)	6.4%	5.4%	9.5%	4.9%
Volatility	11.8%	11.0%	14.0%	15.2%
Sharpe ratio	0.39	0.33	0.55	0.20
Max drawdown	−32.7%	−36.8%	−34.2%	−50.9%
VaR 5% (5th percentile downside)	−5.3%	−2.6%	−6.4%	−7.8%
Skewness	−1.9	−4.9	−2.5	−0.8
Excess kurtosis	8.7	27.5	12.8	2.0
Minimum monthly return	−17.7%	−19.4%	−23.7%	−16.8%
Maximum monthly return	9.0%	3.3%	7.8%	10.9%
Correlation with PutWrite Index	100%	65%	82%	87%
Correlation with variance swap	65%	100%	76%	62%
Correlation with VIX futures	82%	76%	100%	79%

Sources: BlackRock and Bloomberg, 04/04–12/12. Calculated with monthly returns.

The chart and return statistics show superior drawdown and volatility-adjusted returns despite the added skewness (asymmetry) of returns.

Exhibit 8 compares the cumulative returns of the various volatility selling strategies since April 2004. Over this time period, all three of these strategies outperformed equities with smaller drawdowns. While VIX futures outperformed variance swaps over this horizon, it is possible for variance swaps to outperform VIX futures in other market environments.[10]

Knowing that selling volatility can provide attractive risk-adjusted performance, we can now turn to a few key implementation issues, including rebalancing practices, managing negative surprises, and fitting the strategy into a multi-asset portfolio. Addressing these issues upfront can help with allocating to the strategy in a way that mirrors equity allocations.

10 Variance swaps are more exposed to volatility-of-volatility, since their returns are determined by the square of volatility. If volatility-of-volatility declines, then one would expect variance swaps to have higher risk-adjusted returns than VIX futures.

Position rebalancing

Rebalancing and sizing volatility strategies is different from how one typically sizes and rebalances equity index or equity futures exposures. When rebalancing equities, we care about the *dollar notional* exposure as a percentage of total capital. When rebalancing volatility strategies that have minimal *delta exposure* to changes in the underlying price (this excludes basic put selling), we should focus on the *vega notional* exposure as a percentage of total capital. For VIX futures, the vega notional of each contract is equal to the contract multiplier (or 1,000). However, an investor might be tempted to multiply the vega notional of VIX futures by the *price* when sizing a position during a portfolio rebalance. We refer to this product of vega and price as the dollar notional of a VIX futures position.

Using the vega notional to size a short VIX futures position is important for the simple reason that it reduces reversal or whipsaw risk. Having a constant vega notional as a percentage of capital at each rebalancing period reduces the problem of being overexposed to volatility (and selling more contracts) when it is low, relative to being underexposed to volatility (and selling fewer contracts) when it is high and likely to mean revert. Appendix A demonstrates this risk with an example and discusses rebalancing in more detail.

Avoiding blowups

The key to sizing a short-volatility position (especially if using variance swaps) is to remember that even though there may be long periods of time with limited drawdowns, there may occasionally be sharply negative returns. This strategy is not intended for large portfolio allocations, given the risk of capital loss; recall that short positions have theoretically unlimited losses (except for fully collateralized or covered short option positions).

A fairly safe assumption is that the spot VIX index could rise to roughly 100 from a starting point of around 20. For a one-month variance swap sized at –30 basis points of vega notional per unit of capital, this would imply a drawdown of 72% (using Equations (3) and (4) from Appendix C).[11] For a VIX futures position sized at –90 basis points of vega notional per unit of portfolio capital, a move from 20 to 100 for spot VIX would imply a drawdown of at most 72%, because the VIX futures price is unlikely to go as high as spot VIX.[12] The reason for this is that the market typically prices into the futures contract a significant expectation of mean reversion of spot VIX toward more normal levels. This extreme illustration also highlights how the non-constant vega notional exposure of a variance swap implies that one should use a smaller magnitude of vega notional with a variance swap, compared with the vega notional used for a VIX futures position. The payoff of a variance swap is based on volatility squared rather than linear volatility. Appendix B discusses risk management within this context in greater detail.

11 –72% = –0.0030 ⁄ (2 * 20) * (100^2 – 20^2)

12 –72% = –0.0090 * (100 – 20)

Selling volatility in a multi-asset portfolio

To see how selling volatility can influence a multi-asset portfolio, we can compare a traditional 60/40 stock/bond portfolio with a 35/40/25 stock/bond/T-bill portfolio (benchmarked to the S&P 500, Barclays U.S. Aggregate Bond Index and Citigroup 3-Month U.S. Treasury Bill Index) used to collateralize a 25% position in either the variance swap or the VIX futures strategy described above. A 25% position in the above variance swap strategy would lead to a –7.5 basis point vega notional to portfolio capital ratio, while a 25% position in the VIX futures strategy would lead to a –22.5 basis point vega notional to portfolio capital ratio.[13] We have chosen the 25% position sizes for illustration purposes. A reasonable allocation to this strategy for an institutional investor could be roughly 5%, sourced from equities. For large institutions, capacity should be monitored.

Looking at Exhibit 9, we can see that including either of these volatility-selling strategies in a traditional portfolio as an equity substitute has historically led to a similar level of total return but with reduced drawdowns. We have simply replaced a portion of the S&P 500 allocation with a short-volatility strategy.

The concept of selling volatility may be applied to markets beyond the US large-cap sector, where sufficient trading volume exists. Although this is beyond the scope of this paper, preliminary investigation shows potential for the EURO STOXX 50 equity index, which may be the subject for future research in the area of short-volatility strategies.

To some investors, it may seem counterintuitive that selling volatility reduced a portfolio's maximum drawdown from 2007 to 2009 without sacrificing the longer-term absolute return. The reason is simple: fearful market participants rewarded sellers of insurance more than they rewarded buyers of traditional assets, even over a crisis period. Going forward, we should expect some periods when selling volatility generates less-efficient returns compared with equities. But, at a minimum, selling volatility can provide more portfolio diversification, as it is a way to earn differentiated returns.

13 Example with variance swap: –7.5 basis points vega notional ⁄ capital = 25% * –30 basis points vega notional ⁄ capital
Example with VIX futures: –22.5 basis points vega notional ⁄ capital = 25% * –90 basis points vega notional ⁄ capital

EXHIBIT 9: SUBSTITUTING A PORTION OF A MULTI-ASSET PORTFOLIO WITH A SHORT-VOLATILITY STRATEGY LED TO SMALLER DRAWDOWNS WITHOUT SACRIFICING LONG-RUN RETURN

Volatility-selling strategies may improve long-horizon portfolio returns when replacing part of an equity allocation.

	35/40/25 with VIX future	35/40/25 with variance swap	60/40
Cumulative return (annualized)	6.5%	5.4%	5.3%
Volatility	8.6%	7.6%	9.3%
Sharpe ratio	0.54	0.48	0.38
Max drawdown	–26.0%	–26.9%	–32.5%
VaR 5% (5th percentile downside)	–3.8%	–3.3%	–4.3%
Skewness	–1.7	–2.2	–0.9
Excess kurtosis	7.3	9.8	2.9
Minimum monthly return	–12.7%	–11.5%	–11.0%
Maximum monthly return	5.6%	4.7%	6.6%

Sources: BlackRock and Bloomberg, 04/04–12/12. Summary statistics calculated with monthly returns.

Volatility: The newest asset class

Maximizing risk-adjusted returns has never been more difficult—nor more critical. Investors must challenge their preconceived ideas of investing and look at markets differently, even seeing volatility itself as an investment opportunity.

This paper demonstrates that selling volatility on the S&P 500 may generate attractive risk-adjusted returns. The three approaches to this strategy—options, variance swaps, and VIX futures—have notable differences, with VIX futures being the most effective approach on a historical basis. Several implementation issues should be considered, including rebalancing the portfolio based on vega notional as a percentage of portfolio capital, and sizing positions given the potential for extreme market scenarios.

Overall, despite the added skewness and kurtosis of returns, this strategy may lead to both smaller drawdowns and higher realized returns, compared with equities. That gives investors an opportunity to make volatility a return generator.

Appendix A: Position rebalancing example

Vega notional sizing for rebalancing is intended to reduce reversal or whipsaw risk, as we can see from an example. Suppose we have two periods of time and that we rebalance our position between the two periods to target the same notional to capital percentage as the starting position size. Assume that during the first period volatility goes from 20 to 45, and then, during period two, volatility goes from 45 back to 20. Thus, we are rebalancing when volatility is at 45. If we use vega notional sizing, the percentage returns of the two periods will be equal in magnitude but opposite in direction, because the magnitude of the change in volatility is 25 for both periods. If, instead, we were targeting a constant dollar notional as a percentage of our capital at each rebalancing period, we would have returns that are not equal in magnitude. For a short position, we would have a larger loss in the first period compared with the gain in the second period, because the percentage change in volatility from 20 to 45 is larger than the percentage change in volatility from 45 to 20. Exhibits A-1 and A-2 outline the numbers and compare these two approaches for rebalancing.

EXHIBIT A-1: USING A CONSTANT VEGA NOTIONAL WHEN REBALANCING WITH VIX FUTURES

Period	Volatility at beginning of period	Volatility at end of period	Capital at beginning of period	Vega notional at beginning of period	Vega notional to capital ratio at beginning of period	Dollar notional at beginning of period	Dollar notional to capital ratio at beginning of period	Profit for the period	Capital at end of period	Return
0	—	20	—	—	—	—	—	—	$1,000,000	
1	20	45	$1,000,000	−9,000	**−0.90%**	−$180,000	−18.00%	−$225,000	$775,000	−22.50%
2	45	20	$775,000	−6,975	**−0.90%**	−$313,875	−40.50%	$174,375	$949,375	22.50%

Cumulative return: −5.06%

Source: BlackRock.

EXHIBIT A-2: USING A CONSTANT DOLLAR NOTIONAL WHEN REBALANCING WITH VIX FUTURES

Period	Volatility at beginning of period	Volatility at end of period	Capital at beginning of period	Vega notional at beginning of period	Vega notional to capital ratio at beginning of period	Dollar notional at beginning of period	Dollar notional to capital ratio at beginning of period	Profit for the period	Capital at end of period	Return
0	—	20	—	—	—	—	—	—	$1,000,000	
1	20	45	$1,000,000	−9,000	−0.90%	−$180,000	**−18.00%**	−$225,000	$775,000	−22.50%
2	45	20	$775,000	−3,100	−0.40%	−$139,500	**−18.00%**	$77,500	$852,500	10.00%

Cumulative return: −14.75%

Source: BlackRock.

Notice that rebalancing was harmful to both approaches because the overall returns were negative in both cases, even though volatility started at 20 and ended at 20. However, the constant dollar notional sizing approach did not regain as much of its first-period losses during the second period. This is due to how this dollar notional approach rebalanced to a smaller vega notional to capital ratio before volatility reverted back to its starting level. If, instead, volatility had gone from 45 to 20 and then back to 45, the dollar notional approach would have also underperformed, as it would have had more vega notional exposure after rebalancing with volatility at 20 just before volatility went back to 45.

While vega notional sizing for selling VIX futures has this advantage, it isn't necessarily the case that when buying VIX futures investors would want to systematically use constant dollar notional to capital sizing in order to buy more when spot VIX is low and then rebalance to fewer contracts when spot VIX is high. The reason for this is that the negative carry with long positions in VIX futures (caused by the usually upward-sloping futures curve) tends to be much larger when spot VIX is relatively low, which is when an investor would be buying relatively more contracts in order to get to a targeted dollar notional to capital ratio. However, if spot VIX were investable, then an investor would always want to be long using dollar notional to capital sizing; but that would be too good to be true, because the market eventually prices things to either eliminate or substantially reduce low-risk profits. Thus, the VIX index is not investable, and the VIX futures curve is normally upward-sloping to provide compensation for a short position.

Appendix B: More on risk management

Extreme market scenarios must be considered while sizing short-volatility positions. When using a historically derived risk model to determine the position size, drastic volatility events should be a part of the history used to generate the risk estimate. Either actual crisis periods can be used, or an estimated crisis period can be added to the calculation roughly every 10 years surrounding the actual history of returns.

For a history of simulated returns for a one-month variance swap, we can use the historical spot VIX values from Exhibit 4. For VIX futures, the historic returns before 2004 would be harder to simulate; however, we can instead simulate the volatility of one-month VIX futures returns by creating a proxy return series that rebalances to a certain target vega notional-to-capital ratio each period (e.g., monthly) using changes in the spot VIX index. This may even be a bit conservative, as the returns to actual VIX futures have been less volatile and are expected to be less volatile than such simulated returns of this non-investable proxy using spot VIX.

The VXO Index (a measure similar to VIX but with more history) had a closing maximum of about 150 during "Black Monday" on October 19, 1987. It is arguable that this level of implied volatility is unlikely to have an impact larger than our "safe assumption" of 100 would have on a VIX futures position, because the futures would price in a very large mean reversion if spot VIX were this high. In other words, if spot VIX were near 150, a one-month VIX futures contract would probably be closer to 100, as an expectation of 150% volatility over a one-month period is very difficult to sustain. Even if the S&P 500 fell 30% in one day, which is approximately the maximum it can fall in one day due to circuit breakers put in place after Black Monday, the next day it would have to fall another 20% in order to get close to 150% realized volatility over a month.[14] For a short variance swap position, a 150 point level on spot VIX could be very painful when marked-to-market. Fortunately, 21-trading-day (about one month) realized volatility has only been above 100 once since 1928, if we include the Great Depression when it reached 105. During October 1987, realized one-month volatility peaked at 100. However, volatility is extremely mean reverting when it gets to these levels. As long as investors can manage the mark-to-market with cash (or other liquid securities) on hand to help collateralize the short position, it is a good idea to maintain the position and not rebalance, as volatility is likely to revert back to more normal levels, even if the S&P 500 Index doesn't rebound.

14 If we assume a 30% decline one day and a 20% decline another day, and then 2% declines every remaining day of the month (19 of the remaining 21 trading days in the month), then we get a realized volatility of 149 using Equation (5) in Appendix C: 149 = 100 * sqrt(252 / 21 * (ln(1 – 0.30)^2 + ln(1 – 0.20)^2 + 19 * ln(1 – 0.02)^2)).

Appendix C: Equations

For a VIX futures position opened on $time = t_0$ and expiring on $time = T$, the profit at $time = t$ is given by:

$$profit_t = vegaNotional_{t_0} \times [vixFuturesPrice_t(T) - vixFuturesPrice_{t_0}(T)] \tag{1}$$

where

$$vegaNotional_t = \frac{\partial(profit_t)}{\partial[vixFuturesPrice_t(T)]}$$

$$vixFuturesPrice_t(T) = \sqrt{(impliedVol_t(T, T+30\ days))^2 - convexAdjust_t(T, T+30\ days)} \tag{2}$$

where

$vegaNotional_t$ for a VIX future equals the number of contracts times the contract multiplier of 1000 (regardless of the price)

$impliedVol_t(T, T+30\ days)$ is the implied volatility priced by a forward-starting variance swap at $time = t$ for the period starting at $time = T$ and ending at $time = T + 30\ days$.

$convexAdjust_t(T, T+30\ days)$ is the convexity adjustment for a forward implied volatility from $time = T$ to $time = T + 30\ days$ priced at $time = t$ by a forward-starting variance swap or an equivalent calendar spread of variance swaps. It explains the difference in pricing between a linear payoff for VIX futures and a quadratic payoff with variance swaps. At $time = T$, $convexityAdjust_t(T) = convexityAdjust_T(T) = 0$.

For a variance swap position opened on $time = t_0$ and expiring on $time = T$, the profit at $time = t$ is given by:

$$profit_t = PV_t(t,T) \times varianceNotional \times \left[\frac{t - t_0}{T - t_0} \times (realizedVol(t_0, t))^2 + \frac{T - t}{T - t_0} \times (impliedVol_t(t,T))^2 - strikeVol^2\right] \tag{3}$$

where

$PV_t(t,T)$ is the present value of a dollar received at $time = T$

$strikeVol = impliedVol_{t_0}(t_0, T)$

$$vegaNotional_t = \frac{\partial(profit_t)}{\partial[impliedVol_t(t,T)]} = PV_t(t,T) \times varianceNotional \times \frac{T - t}{T - t_0} \times 2 \times impliedVol_t(t,T) \tag{4}$$

$$realizedVol = 100 \times \sqrt{\frac{252}{N_{expected}} \times \Sigma_{i=1}^{i=N} \left(\ln\left(\frac{P_i}{P_{i-1}}\right)^2\right)} \tag{5}$$

where

P_i = the price of the underlying index or security at $time = i$

ln is the natural logarithm operator

Variances from non-overlapping consecutive horizons $(t_0 < t < T)$ can be combined to calculate a variance over a longer horizon. The formula is given by:

$$\sigma(t_0, T)^2 = \frac{t - t_0}{T - t_0} \times \sigma(t_0, t)^2 + \frac{T - t}{T - t_0} \times \sigma(t, T)^2 \tag{6}$$

BLACKROCK, INC.
400 Howard Street
San Francisco, CA 94105
www.blackrock.com

For more information on volatility investment strategies, please contact your BlackRock account manager or email investmentinsights@blackrock.com

Investment Insights
Published by BlackRock

Please direct topic ideas, comments, and questions to:

Marcia Roitberg, editor
Telephone 415-509-7042
Facsimile 415-618-1455
marcia.roitberg@blackrock.com

BlackRock, Inc. and its subsidiaries (together, "BlackRock") do not provide investment advice regarding any security, manager or market. This information is for illustrative purposes only and is not intended to provide investment advice. BlackRock does not guarantee the suitability or potential value of any particular investment. Past performance is no guarantee of future results. Index performance is shown for illustrative purposes only. You cannot invest directly in an index. Investing involves risk, including possible loss of principal.

The information included in this material has been taken from trade and other sources we consider to be reliable. We do not represent that this information is accurate and complete, and it should not be relied upon as such. Any opinions expressed in this material reflect our judgment at this date, are subject to change and should not be relied upon as the basis of your investment decisions. No part of this material may be reproduced in any manner without the prior written permission of BlackRock.

In Canada, this material is intended for accredited investors and permitted clients only. In Latin America, this material has been provided by BlackRock in a private and confidential manner to institutional investors upon request. This material is provided for informational purposes only and is not an offer to sell, nor an invitation to apply for any particular product or service in any jurisdiction.

In Latin America, this material is intended for institutional and professional investors only. This material is solely for educational purposes and does not constitute investment advice, or an offer or a solicitation to sell or a solicitation of an offer to buy any shares of any funds (nor shall any such shares be offered or sold to any person) in any jurisdiction within Latin America in which such an offer, solicitation, purchase or sale would be unlawful under the securities laws of that jurisdiction. If any funds are mentioned or inferred to in this material, it is possible that some or all of the funds have not been registered with the securities regulator of Brazil, Chile, Colombia, Mexico, Peru or any other securities regulator in any Latin American country, and thus, might not be publicly offered within any such country. The securities regulators of such countries have not confirmed the accuracy of any information contained herein. No information discussed herein can be provided to the general public in Latin America.

©2013 BlackRock, Inc. All rights reserved. **BLACKROCK** is a registered trademark of BlackRock, Inc.

BLK-0782 5567-03-PRD_v03HK_7/13

FOR INSTITUTIONAL USE ONLY