Trading Volatility: *At What Cost?*

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Volatility trading is in vogue. Launched in January 2009, exchange-traded products (ETPs) linked to the CBOE Market Volatility Index (VIX) have enamored no small number of traders. More than 30 VIX ETPs are now listed with an aggregate market investment value of nearly $4 billion, generating a daily trading volume in excess of $800 million. Unlike other securities traded on stock exchanges, however, these securities are not suitable buy-and-hold investments and are virtually guaranteed to lose money through time. Indeed, the March 23, 2012, prospectus of VelocityShares, the exchange-traded notes issued by Credit Suisse AG says

> The long term expected value of your ETNs is zero. If you hold your ETNs as a long-term investment, it is likely that you will lose all or a substantial portion of your investment. (pp. 27-28).

What, then, is the attraction of VIX ETPs? Unfortunately, it seems that many investors believe that they are buying the CBOE's popular market volatility index, VIX. Launched in 1993, VIX has become a popular measure of investor anxiety, spiking upward at times of political and economic turmoil and hovering at low levels during times of calm. (See Whaley [1993, 2009].) But alas, they are not. VIX is not a traded security. VIX ETPs, on the other hand, are traded securities created from complicated VIX futures trading strategies. These strategies demand daily rebalancing and are subject to a host of management fees and expenses, including futures commissions and trading fees, licensing fees, and (in some cases) forgone interest income.

Even in the absence of fees and expenses, the strategies these products follow are destined to lose money from a contango trap, in which VIX futures prices are systematically drawn downward toward the level of the VIX. What is equally surprising is that most VIX ETP investors cannot gauge the magnitude of the losses they will incur, since they do not have access to real-time (or, in many cases, end-of-day) VIX futures prices. Amazingly, in spite of the fact that holders of ETPs linked to the S&P 500 VIX futures short-term indices have chalked up more than $4 billion in losses since product inception, the market continues to grow.

This article provides an appraisal of VIX ETPs as buy-and-hold investments. First, we explain the motives for trading volatility. Second, we describe the first generation of VIX products—VIX futures and options. These contracts were launched in March 2004 and February 2006, respectively, and experienced modest success. VIX derivatives, however, cannot completely satiate investor

demand for trading volatility, due to restrictions. Many institutions, such as pension funds and endowments, for example, are barred by charter from buying futures and option contracts. In addition, many retail customers are simply too small to trade in the derivatives market or lack the necessary trading sophistication. Third, we show how VIX ETPs have filled the void by providing access to volatility trading through the stock market. We explain how the VIX ETPs are created and show why they generally lose money through time. Finally, we estimate the losses incurred by VIX ETP holders over the past few years.

WHY TRADE VOLATILITY?

Trading arises from the active management of expected return and risk. Some trading is risk-enhancing. Based upon fundamental economic analysis or historical price patterns, traders speculate on the direction of prices or interest rates. Other trading is risk-reducing. Airlines, for example, may hedge the price risk of their fuel costs by buying petroleum futures or call options. Diversification is also risk-reducing. Because the returns of different asset classes are less than perfectly positively correlated, combining asset classes may reduce risk. Traditionally, asset classes included only such staples as stocks, bonds, and money market instruments; however, the opportunity set has been augmented in recent years to include absolute return or alternative investments such as hedge funds and commodity-linked exchange-traded products.

The motives for trading volatility are no different. The VIX tends to spike around major world crises and market events. Someone closely monitoring geopolitical events may speculate on the direction of short-term expected future volatility by buying or selling VIX products. Others may speculate based on technical analysis. Some technical traders believe volatility follows a mean-reverting process and buy and sell depending on the current VIX level, relative to its historical average. Others may trade on the difference between VIX and the realized volatility of the S&P 500. Volatility risk-management strategies are also commonplace. Fearing that volatility may spike in the near term, some institutions hedge by buying VIX call options or VIX futures as tail-risk insurance. Other institutional investors treat volatility as an asset class and buy it to diversify their investment portfolio holdings.[1]

VOLATILITY TRADING OPPORTUNITIES

The first generation of exchange-traded volatility products traded in the U.S. were futures and option contracts written on the VIX. VIX futures contracts were launched by the CBOE Futures Exchange (CFE) on March 26, 2004, and VIX options were launched by the CBOE on February 24, 2006. VIX ETPs, the second generation of volatility products, were introduced in 2009. The first launch was on January 29, 2009, by Barclays Bank PLC, which issued notes on the S&P 500 VIX Short-Term (ticker symbol: VXX) and Mid-Term (ticker symbol: VXZ) total return futures indices. The novelty and widespread interest of these products spawned competition. Twenty-eight more VIX ETPs have been introduced in the U.S. within a span of only three years. Fueling the growth were institutions, hedge funds, and retail customers who do not or cannot trade in derivatives markets. The public access provided by stock markets is estimated to be 100 times larger than that of futures markets.

Exchange-traded products are structured and managed in different ways. The term "exchange-traded product" refers to a security that is designed to provide a price exposure that investors may find difficult to obtain on their own. The price exposure is defined in terms of a readily identifiable benchmark (e.g., the S&P 500 or the price of crude oil). Within the family of ETPs are exchange-traded funds (ETFs) and exchange-traded notes (ETNs). The main distinction between the two products is that ETFs are transparent and specify exactly what instruments are used to generate the benchmark index return. They also provide the owner with a direct claim on the underlying portfolio's assets. ETNs, on the other hand, are notes that promise the benchmark return over their stated maturity. They have no coupons and are secured, not by the assets used to generate the benchmark index return, but rather by the issuer's good faith and collateral. The closing indicative value, the price at which the shares can be redeemed in cash at the end of the day, is updated daily based on the index return.

ETFs are either asset based or futures based. Asset-based ETFs own the shares of the portfolio of stocks that comprise the benchmark. SPY, for example, is a portfolio of the 500 stocks that make up the S&P 500 portfolio. Creation/redemption arbitrage ensures the ETF's price per share equals the fund's net asset value

(NAV) per share at the end of each day. A creation is an in-kind transaction in which a market maker delivers the shares underlying the ETF basket and receives new units of the ETF. A redemption works in the opposite way: A market maker delivers existing units of the ETF and receives the shares of the underlying ETF basket. Futures-based ETFs do not hold securities but rather mimic the benchmark index returns by holding cash (i.e., short-term money market instruments) and futures, usually in a third-party custodian account. The fund's specific holdings are published each day, so the benchmark-mimicking portfolio may be replicated. The creation/redemption process works the same as for asset-based ETFs, except that the in-kind transaction is in cash. For both asset-based and futures-based ETFs, shares outstanding vary on a daily basis as a result of ongoing creations and redemptions. Finally, as noted earlier, ETNs are unsecured notes that promise the daily rate of return of a benchmark index and can be redeemed in cash each day at closing indicative value. This means less tracking error. At the same time, the ETN holder does not have direct claim on the assets underlying the portfolio. Exactly how a bank generates the futures index return exposure need not be disclosed and is usually accomplished using a variety of hedge instruments.

Data for VIX ETPs were gathered from ETF Data Base (i.e., http://etfdb.com/etfdb-category/volatility/) and Bloomberg. Exhibit 1 summarizes selected attributes of the eight most active VIX ETPs in the U.S. as of March 30, 2012. While the total number of VIX ETPs is 30, the average daily trading volume over the past three months of all 22 products not reported in the exhibit is only about seven thousand shares. In contrast, the average daily trading volume of the products included in the exhibit is about seven million shares each. Not surprisingly, the most active VIX ETP is VXX. It and VXZ were the first VIX ETPs launched and have enjoyed a first-mover advantage. VXX traded more than 32 million shares a day during January through March 2012 and had a market capitalization exceeding $1.86 billion on March 30, 2012. To place this in context, VXX's trading volume is about the same as Ford shares, when measured as dollar volume, and the market cap is about the same as that of the smallest stocks in the S&P 500.

EXHIBIT 1

Attributes of the Eight Largest VIX ETPs Traded in the U.S. as of March 30, 2012

Symbol	Name	Average Volume	Asset Value in USD Millions	Date of Inception	Yearly Fee	Benchmark		Muliplier
						ST/MT	TR/ER	
VXX	iPath S&P 500 VIX Short Term Futures ETN	32,104,131	1,864.6	20090129	0.89%	ST	TR	1
TVIX	VelocityShares Daily 2x VIX Short-Term ETN	13,344,642	355.7	20101129	1.65%	ST	ER	2
XIV	VelocityShares Daily Inverse VIX Short-Term ETN	7,739,089	446.9	20101129	1.35%	ST	ER	–1
UVXY	Proshares Ultra VIX Short-Term Futures ETF	1,478,367	125.4	20111004	0.95%	ST	ER	2
VXZ	iPath S&P 500 VIX Mid-Term Futures ETN	467,066	320.1	20090129	0.89%	MT	TR	1
VIXY	ProShares VIX Short-Term Futures ETF	273,392	127.9	20110103	0.85%	ST	ER	1
SVXY	Proshares Short VIX Short-Term Futures ETF	111,773	29.1	20111004	0.95%	ST	ER	–1
VIIX	VelocityShares VIX Short-Term ETN	91,465	35.0	20101129	0.89%	ST	ER	1

VXX is benchmarked to the S&P 500 VIX short-term (ST) total return (TR) futures index. VXX has a multiplier of one, which means that the ETN promises one times the daily index return (less management fees and expenses). The second most active VIX ETP is TVIX, which is benchmarked to the S&P 500 VIX ST excess return (ER) futures index. It has a multiplier of two, which means that it promises two times the daily return of the benchmark index. The third is XIV, which is benchmarked also to S&P 500 VIX ST ER futures index, but promises –1 times the daily futures index return. Note that five of the eight products listed in the exhibit are ETNs. VIX ETFs were introduced by ProShares in January 2011, nearly two years after the introduction of the VIX ETNs. They are slowly gaining traction in terms of trading volume and market capitalization, probably due to the reduced credit risk of the ETF structure. Finally, the exhibit shows that yearly management fees range from 0.85% to 1.65% annually. The fees are charged on a daily basis.

All of the ETPs listed in Exhibit 1 are benchmarked to S&P 500 VIX futures indices. The difference between the total return and excess return index benchmarks is subtle, but important. ETPs benchmarked only to excess return futures indices implicitly embed an additional management fee. To see this, assume an investor creates a fully collateralized volatility investment by buying the VIX futures and depositing the notional amount of the futures in money market instruments. Investment return will come in two parts: interest income on the money market instruments (i.e., the risk-free interest rate), and price appreciation on the futures contract (i.e., the risk premium or excess return). But certain participants cannot trade in the futures market. ETP issuers step in, create fully collateralized volatility investments on the investor's behalf, and charge a management fee for their service. In the case of VIX ETPs benchmarked to TR futures indices, the promised return structure should be identical to the fully collateralized investment described previously. VXX, for example, is benchmarked to the VIX ST TR futures index and promises the return on a 91-day T-bill (i.e., the risk-free rate) plus the rate of price appreciation on the VIX ST ER index (i.e., the risk premium). On the other hand, the VIX ETPs introduced since VXX and VXZ are generally benchmarked to excess return futures indices. Some of these products promise the daily return (i.e., price appreciation) on an excess return futures index, plus a daily interest accrual. VIIX, for example, is an ETN linked to the return of VIX ST ER index and also has a daily interest accrual based on the 91-day T-bill rate. Others do not. VIXY, for example, is an ETF that seeks only to match the performance of VIX ST ER. This means that the investor is implicitly forfeiting the interest income she should be earning on the cash invested in the ETP and is thereby paying an additional (albeit implicit) management fee. The difference between TR and ER futures indices is seemingly innocuous at current short-term interest rate levels, however, it will undoubtedly grow as the economy recovers.

The VIX futures indices are intended to mimic the behavior of dynamic futures trading strategies that involve rolling VIX futures in a manner that maintains a constant futures maturity. The exact methodologies used to compute each of the futures volatility indices are provided in S&P Indices [2012]. (See http://us.spindices.com/indices/strategy/sp-500-vix-short-term-index-mcap). The VIX ST ER futures index, for example, holds long positions in the nearby and second nearby futures in proportions that create an average time to maturity of one month (approximately 30 days). The position is held for one day, recognizing any gains or losses, and then rebalanced or rolled to move the weighted average maturity from 29 days back to 30 (i.e., selling some of the nearby contracts and buying more of the second nearby contracts). The MT ER futures index is similarly rebalanced daily to maintain five-month constant maturity. It uses the fourth, fifth, sixth, and seventh futures contracts. The futures trading strategies underlying the TR indices are the same as the ER indices.

VIX ETP PERFORMANCE

In assessing the viability of buying volatility as tail-risk insurance or an asset class, we need a sense of expected performance. Typically, expected performance is projected on the basis of historical performance. In this case, historical performance has two dimensions. First, how well does a typical VIX ETP track its benchmark index? Second, how well does the benchmark perform as an asset class? We address each question in turn.

Tracking Performance

The data for the VIX ETPs and the S&P 500 VIX futures indices were drawn from Bloomberg. One test of

a VIX ETP's performance is to see how well it tracks its benchmark. To evaluate this performance, we regress the daily returns of the eight ETPs listed in Exhibit 1 on the daily returns of their respective benchmarks, that is,

$$R_{i,t} = \alpha_i + \beta_i R_{BM_{i,t}} + \varepsilon_{i,t} \quad (1)$$

where i denotes the i^{th} ETP whose day t return is $R_{i,t}$ and whose day t benchmark return is $R_{BM_{i,t}}$. Each time series begins on the day that the ETP was launched and ends on March 30, 2012. For the levered and inverse products, the underlying index returns are scaled by their respective multipliers. In theory, if the ETP mimics its benchmark exactly, the estimated intercept will be equal to zero and the estimated slope will be equal to one. Consequently, the t-ratios correspond to the null hypotheses that the intercept equals zero and the slope coefficient equals one, respectively. In practice, however, the slope may be less than one due to tracking error, and the intercept should be less than zero due to management fees and other expenses such as licensing fees and trading costs and fees.

The intercept may also reflect an interest component. VIIX, for example, promises the daily return on the VIX ST ER index plus the daily return on a 91-day T-bill, in which case the intercept should include the average daily T-bill return over the estimation period. Since interest rates were negligible over the estimation period, the effect is small.

The performance regression results are reported in Exhibit 2. The adjusted R-squared figures reflect the proportion of the variance of the VIX ETP's return that is explained by the benchmark return. VXX, for example, has an adjusted R-squared of 0.957, which means it tracks the VIX ST TR futures index quite well. The regression coefficients are consistent with expectations. For the most part, the intercept terms are negative, although none of them are significantly different from zero. The slope coefficients are all significantly less than one, although the sizes of the deviations are small from an economic perspective. The last three columns of the exhibit measure tracking error directly. Note that the mean differences (Mean) between the daily returns of the ETPs and their benchmarks are all near zero, while the mean absolute deviation (MAD) and root mean squared deviation (RMSD) are all above zero. This means that, while VIX ETP prices closely track underlying net asset values, the relation is noisy (at least in part) due to the costs of executing creation/redemption arbitrage transactions. In addition, for VIX ETFs, perfect hedging would require that the manager rebalance the VIX futures positions at exactly the prices used by S&P in the computation of its futures indices. As a practical matter that is not possible, since S&P uses settlement prices, which are determined after the market is closed.[2] The VIX ETF manager must rebalance before the close.

As a sidebar, it is worth noting that the performance of TVIX is somewhat anomalous. Its slope coefficient is lowest among all ETPs, and its MAD and RMSD are highest. The reason is that Credit Suisse stopped issuing new shares in the ETN on February 21, 2012, "due to internal limits on the size of ETNs." Without arbitrage between the ETN and its underlying hedged portfolio, the price per share of the ETN can rise well above (or below) the net asset value per share. Indeed, this is exactly what transpired. By March 21, 2012, the price per share of TVIX had an 89% premium

EXHIBIT 2

Summary Results from Regressions of Daily VIX ETP Returns on Benchmark Returns

							Daily Return Deviations		
Ticker	No. of Obs.	Adj. R^2	α	t(α)	β	t(β)	Mean	MAD	RMSD
VXX	799	0.957	–0.0003	–1.09	0.9319	–9.73	–0.0001	0.0062	0.0086
TVIX	336	0.886	–0.0007	–0.42	0.8731	–7.42	–0.0002	0.0182	0.0322
XIV	336	0.951	–0.0001	–0.25	0.8991	–9.03	–0.0003	0.0075	0.0109
UVXY	123	0.957	–0.0026	–1.49	0.8961	–6.01	–0.0010	0.0170	0.0219
VXZ	799	0.930	–0.0001	–0.32	0.9515	–5.25	0.0000	0.0039	0.0054
VIXY	312	0.960	–0.0004	–0.69	0.9050	–9.08	–0.0002	0.0072	0.0101
SVXY	123	0.952	0.0006	0.65	0.9208	–4.24	0.0000	0.0088	0.0111
VIIX	307	0.939	–0.0004	–0.56	0.9019	–7.45	–0.0001	0.0088	0.0123
TVIX	314	0.952	–0.0011	–1.03	0.9104	–7.73	–0.0009	0.0146	0.0215

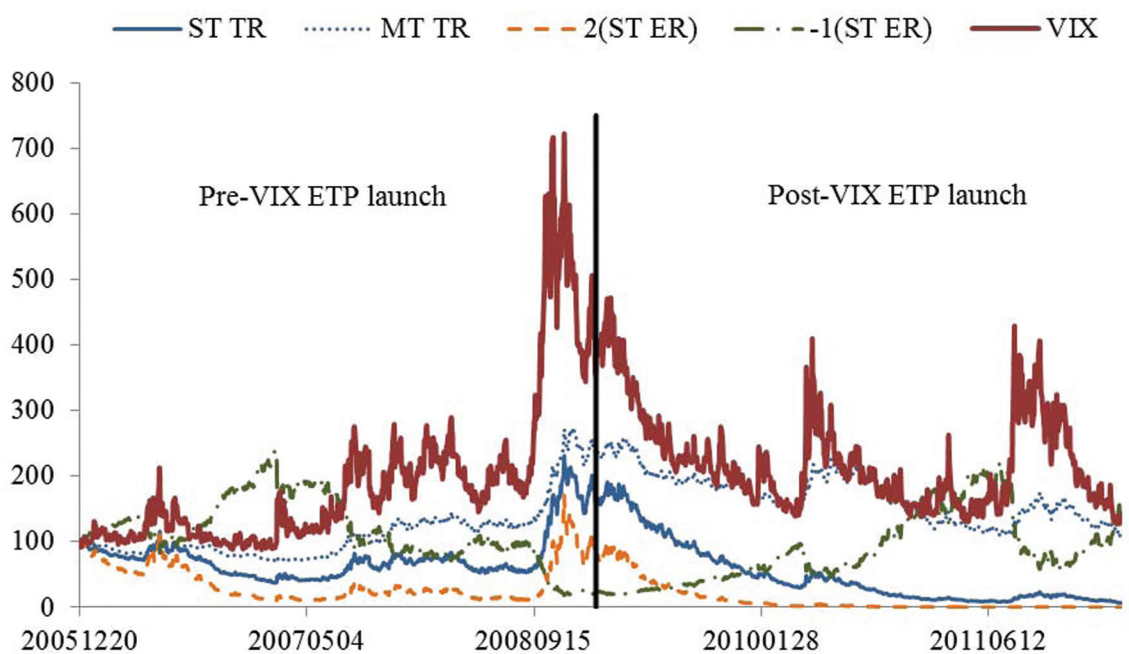
over the indicative value per share. On March 22, 2012, Credit Suisse announced it would again allow for new creation units, albeit on a limited basis. With the creation process back in place, the TVIX price and NAV quickly re-aligned. The final row of Exhibit 2 shows the results for TVIX regression when the daily returns for the subperiod from February 21 through March 22 are eliminated. The slope coefficient estimate rises to 0.9104, and both the MAD and RMSD fall. Clearly the noise introduced by the suspension of the creation process had an effect.

S&P 500 VIX Futures Index Return Performance

The results of Exhibit 2 indicate that the VIX ETPs are reasonably good at tracking the return performance of their respective benchmarks. New questions arise: "Are the indices worth tracking, and, if so, in what investment context?" To answer these questions, we rely on the daily returns of a number of indices. Included are the SPY ETF, to proxy for the S&P 500 stock market return (SPY), the VIX, short-term and mid-term VIX TR indices (ST TR and MT TR), the VIX ST ER index (ST ER), two times the VIX ST ER (2(ST ER)) index, and the so-called "inverse" VIX ST ER index (–1(ST ER)). The rationale for performing the computations on the VIX futures index returns, rather than the VIX ETP returns, is twofold. First, the return series is longer. The VIX futures index histories date back to December 20, 2005, whereas the longest VIX ETP history dates to only January 29, 2009. Since we have already established that the VIX ETPs track their respective VIX futures index benchmarks reasonably well, working with the longer history in our return analysis ensures that our sample includes as many volatility cycles as possible. Exhibit 3 shows the different volatility benchmarks since December 20, 2005, with the exhibit divided into pre- and post-VIX ETP launch date periods. The vertical bar separating the two periods is on January 29, 2009. In terms of understanding the return performance of VIX ETPs, the pre-launch date period is particularly important, since the VIX level spiked during the October 2008 financial crisis, a time during which VIX ETPs should have shown particularly strong performance. Second, the return analysis will be free of

EXHIBIT 3

Daily Levels of S&P 500 VIX Futures Return Indices, December 20, 2005 through March 30, 2012, and Normalized to 100 on December 20, 2005



the effects of management fees and expenses and will focus exclusively on the merits of the different futures indices. The specific indices used in the analysis are the most common benchmarks. Recall from Exhibit 1 that VXX and VXZ benchmark to the ST TR and MT TR futures indices, respectively, and TVIX benchmarks to the 2(ST ER) and XIV benchmarks to –1(ST ER).

Exhibit 4 contains summary statistics of the daily returns of the different indices, as well as the correlations between the different return series. The results are interesting in a number of respects. First, the correlation of SPY returns and VIX futures index returns is virtually the same for all VIX futures indices, on an order of –0.78. Holding other factors constant, this means that all of the volatility indices are equally effective at diversifying stock-portfolio risk, at least to the degree that the S&P 500 portfolio reflects traditional portfolio risk. Of course, other factors are not held constant. Return means and standard deviations also weigh in.

Second, note the abysmal performance of the VIX ST TR futures index, which fell by 93.16% since inception or by –34.81% annually, expressed as a compound growth rate (CAGR). Even worse is the return performance of the 2(ST ER) futures index, with a holding period return of –99.96% and a CAGR of –71.69%. This is eerily consistent with the Credit Suisse warning about VelocityShares quoted in our opening paragraph. While TVIX, the Credit Suisse two times VIX ST ER return product, lost only –93.6% since its inception on November 29, 2010, had it had a long history, the story could have been worse.

The culprit is the contango in the VIX futures market. A futures market is said to be in contango when the futures price curve slopes upward. When the futures prices curve slopes downward, the market is in normal backwardation.[3] Exhibit 5 shows the VIX futures price curve on March 14, 2012. The market is in contango. The VIX cash index level is 15.31. The nearby VIX futures contract has seven days remaining to expiration and a price of 17.80, the second nearby futures has 35 days to expiration and a price of 22.10, and so on. Now, suppose this curve (not the dots on the curve) remains the same shape through time. Day by day the dots on the curve (i.e., the futures prices) would march downward to the left along the curve as the VIX futures days to expiration grow short, finally converging at the VIX cash index level on settlement day. This relation is important because, if a futures price curve (in any market) slopes consistently upward through time, a long position in the futures will tend to lose money through time, relative to a long position in the cash index level. Conversely, if the price curve slopes downward, a long futures position will tend to make money, relative to a long position in cash.

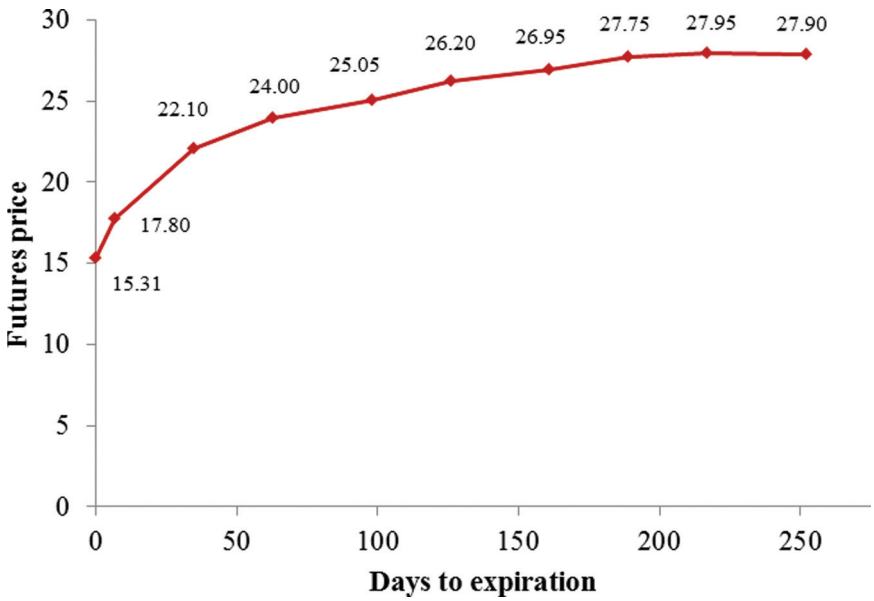
EXHIBIT 4

Summary Statistics of Daily Returns for Stock and Volatility Indices, December 20, 2005 through March 30, 2012

	Daily Returns						
	SPY	**VIX**	**ST TR**	**MT TR**	**ST ER**	**2(ST ER)**	**–1(ST ER)**
Panel A: Summary Statistics							
n	1,580	1,580	1,580	1,580	1,580	1,580	1,580
Mean	0.026%	0.286%	–0.095%	0.024%	–0.102%	–0.204%	0.102%
Standard deviation	1.520%	7.478%	3.911%	2.041%	3.911%	7.822%	3.911%
Annualized standard deviation	24.1%	118.7%	62.1%	32.4%	62.1%	124.2%	62.1%
Holding period return	26.6%	38.5%	–93.2%	5.9%	–93.9%	–100.0%	44.2%
Compound annual growth rate	3.8%	5.3%	–34.8%	0.9%	–36.0%	–71.7%	6.0%
Panel B: Correlation Estimates							
SPY	1	–0.760	–0.782	–0.767	–0.782	–0.782	0.782
VIX	–0.760	1	0.878	0.801	0.878	0.878	–0.878
ST TR	–0.782	0.878	1	0.905	1	1	–1
MT TR	–0.767	0.801	0.905	1	0.905	0.905	–0.905
ST ER	–0.782	0.878	1	0.905	1	1	–1
2(ST ER)	–0.782	0.878	1	0.905	1	1	–1
–1(ST ER)	0.782	–0.878	–1	–0.905	–1	–1	1

EXHIBIT 5

VIX Futures Price Curve on March 14, 2012



The VIX futures market is usually in contango.[4] To illustrate, we compute the slope of the term structure at maturities of 30, 60, 90, 120, 150, and 180 days each day since VIX futures were initially listed. VIX futures closing prices were obtained from the CBOE Futures Exchange website. In our analysis, slope is defined as the difference between the prices of the two futures contracts whose expirations straddle the constant maturity (e.g., 30 days), divided by the number of days between the futures expirations. Exhibit 6 contains summary statistics. Panel A of Exhibit 6 shows that the mean slope at 30 days to expiration across all days in the sample is 0.0230. This means that the 30-day futures price is expected to drop by 0.0230 per day, on average. The median slope is 0.0304, which means that on a typical day the

EXHIBIT 6

Average Slope of VIX Futures Prices Curve at Different Times to Expiration Across All Days in the Sample Period, March 26, 2004 through March 30, 2012

	30-day	60-day	90-day	120-day	150-day	180-day	Volatility Spread
Panel A: All observations							
Total days	2,021	2,021	2,021	2,021	2,021	2,021	2,021
Mean	0.0230	0.0124	0.0058	0.0051	0.0041	0.0036	1.73
Standard deviation	0.0737	0.0391	0.0282	0.0216	0.0166	0.0131	5.79
Minimum	–0.7536	–0.3486	–0.1821	–0.1543	–0.0971	–0.0800	–41.44
Median	0.0304	0.0156	0.0105	0.0086	0.0061	0.0043	2.74
Maximum	0.1946	0.1232	0.0857	0.0857	0.0554	0.0589	11.99
Panel B: Slopes greater than or equal to 0.							
Number of days	1,633	1,566	1,507	1,488	1,494	1,502	1,603
Percent of total days	80.8%	77.5%	74.6%	73.6%	73.9%	74.3%	79.3%
Mean	0.0465	0.0273	0.017	0.0139	0.0109	0.0088	3.78
Standard deviation	0.0322	0.0201	0.0126	0.0115	0.0096	0.0087	2.32
Median	0.0393	0.0239	0.0143	0.0113	0.0091	0.0071	3.52
Maximum	0.1946	0.1232	0.0857	0.0857	0.0554	0.0589	11.99
Mean length of run	27.2	27.5	22.8	19.1	18.2	19.3	24.7
Panel C: Slopes less than 0.							
Number of days	388	455	514	533	527	519	418
Percent of total days	19.2%	22.5%	25.4%	26.4%	26.1%	25.7%	20.7%
Mean	–0.0759	–0.0387	–0.0269	–0.0193	–0.0153	–0.0116	–6.13
Standard deviation	0.1087	0.0450	0.0349	0.0244	0.0168	0.0118	7.98
Minimum	–0.7536	–0.3486	–0.1821	–0.1543	–0.0971	–0.0800	–41.44
Median	–0.0376	–0.0196	–0.0132	–0.0120	–0.0086	–0.0075	–3.23
Mean length of run	6.6	8.0	7.8	6.8	6.5	6.7	6.5

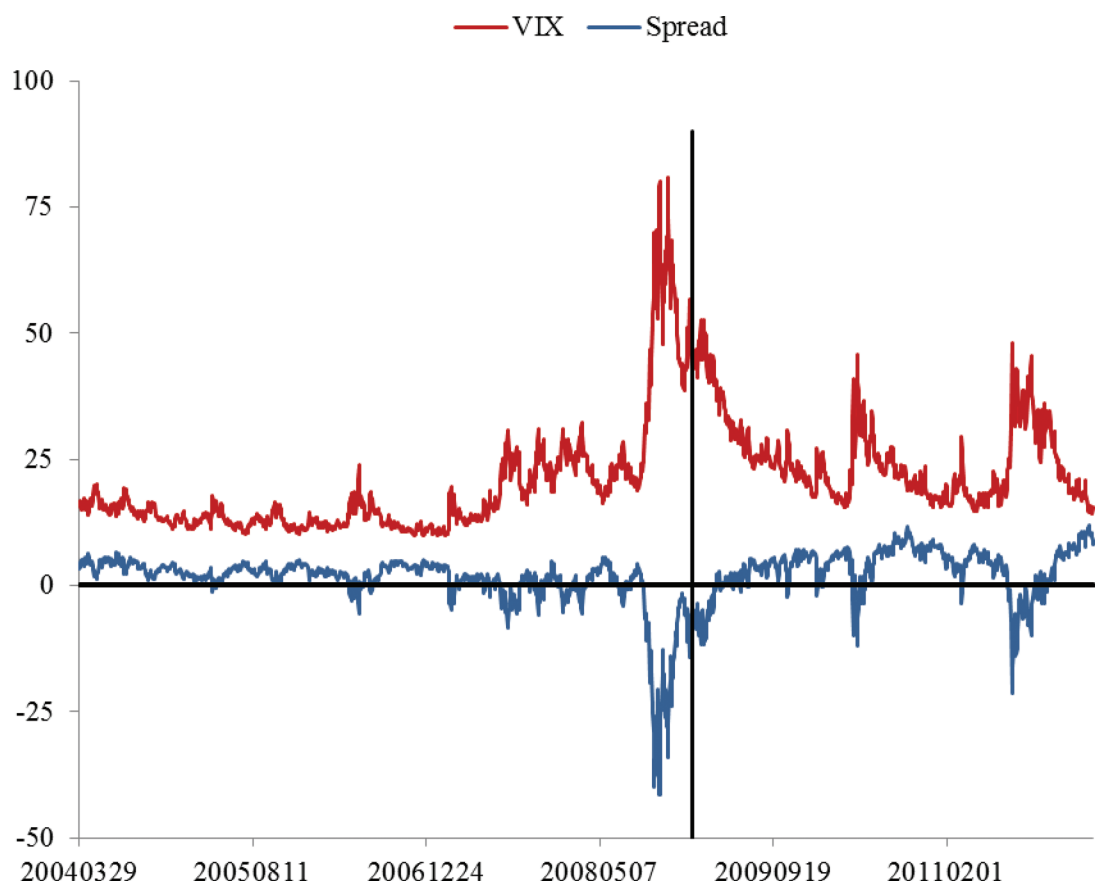
30-day futures are expected to drop by 0.0304. Panel B contains summary statistics for days on which the slope is positive. Note that the term structure slopes upward on 1,633 of the 2,021 trading days of the sample period, nearly 81% of the VIX futures history. When the slope is positive, the mean and median are 0.0465 and 0.0393, respectively. The maximum slope is 0.1946, which occurred only recently, on March 16, 2012. Panel C of Exhibit 6 contains summary statistics for days on which the slope is negative. The slope is negative about 19% of the days in the sample. When it is, we expect the futures price to increase by 0.0759 per day, on average. The typical (median) price increase is 0.0376, which means that the slope distribution contains some unusually large negative values.

Panels B and C also show that the 30-day slope tends to be positive and stable for long periods of time, and turns negative and erratic for short periods of time. When the slope is positive, for example, its standard deviation is 0.0322. When the slope is negative, it is more than three times higher, at 0.1087. When the slope is positive, it stays positive for 27.2 days on average; when the slope is negative, it stays negative for only 6.6 days. The volatility spread reported in the last column of Exhibit 6 is defined as the difference between the 150-day VIX futures price and the VIX cash index level. On average, the 150-day futures are 173 basis points higher than the VIX cash index level. The median is 274 basis points. The lowest value is −41.44 on October 24, 2008, the height of the 2008 financial crisis.

Exhibit 7 shows the VIX level and the volatility spread over the history of the VIX futures contract. Two observations are particularly noteworthy. First, the volatility spread has been consistently positive over the full sample period. Occasionally it goes negative when VIX spikes, but then quickly reverts back to being

EXHIBIT 7

Daily Levels of VIX and Volatility Spread, March 26, 2004 through March 30, 2012



positive, as documented in Exhibit 6. Second, the size of the volatility spread has increased on average since the launch of VIX ETPs on January 29, 2009 (denoted by the dark vertical bar in the center of the exhibit). The mean daily volatility spread in the period before and including January 29, 2009, is 0.63, significantly different from 0 at the 5% probability level. The mean daily volatility spread in the period after January 29, 2009, is 3.40, significantly greater than that in the pre-ETP period. The slope of the term structure has increased significantly since the advent of VIX ETPs.

Returning to the results of Exhibit 4, it is not immediately obvious that the VIX futures indices, like the ST index, will lose money due to contango, since they maintain a constant maturity. But, alas, they do not. While the ST index may have 30 days to expiration at the close today, it will have 29 days to expiration tomorrow, when the futures index portfolio is rebalanced. In the interim the futures index, which is a weighted average of the nearby and second nearby VIX futures contract prices, has slid down toward the VIX cash index level.

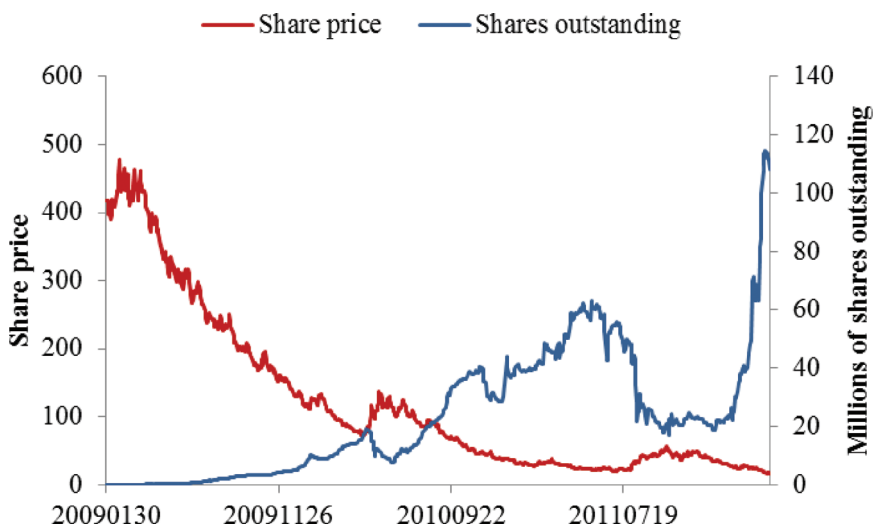
The CAGR for the VIX MT TR futures index, 0.9%, is dramatically higher than that of the VIX ST TR futures index. For the mid-term futures index, the contango effect is much lower. While the VIX futures term structure is typically upward sloping, it is much more steeply sloped for shorter maturities than for longer maturities. Recall that in panel A of Exhibit 8, the slope of the VIX term structure was 0.0230 at 30 days to expiration, nearly six times higher than the 0.0041 at 150 days to expiration. Not only is the mean return higher for the VIX MT TR futures index (0.9% versus –34.8%), its annualized volatility rate is lower (32.4% versus 62.1%). From a practical standpoint, this means that VIX ETPs based on the mid-term VIX futures index strictly dominate those based on the short-term index in terms of providing diversification, if historical performance is a reliable indicator of future performance.[5] This result is helpful in the sense that perhaps an argument can be made for considering volatility as an asset class. At the same time, it is curious. The strongest interest in VIX ETPs remains in those benchmarked to the VIX ST indices. Of the $3.3 billion in VIX ETPs shown in Exhibit 1, 75.9% are in direct ETPs ($L = 1$ and $L = 2$) benchmarked to the VIX ST indices, 14.4% is in inverse ETPs ($L = -1$) benchmarked to the VIX ST indices, and only 9.7% is benchmarked to VIX MT indices. VXX alone accounts for 56.4%. But consider VXX's record, as shown in Exhibit 8. Although VXX has lost 93.6% of its value since it was launched, shares outstanding are at unprecedented levels.

With the evidence clearly suggesting that buyers of ST volatility index futures are looking for a substitute for the VIX cash index, we perform a final analysis of VIX futures index returns to demonstrate that VIX futures indices (and consequently VIX ETPs) are watered down and noisy versions of VIX and that VIX futures index returns are predictable, based on the slope on the VIX futures price curve yesterday.

On a given day, the VIX futures index moves for at least two reasons. The first is the innovation to true short-term market volatility, presumably resulting from new information disseminating into the marketplace. To proxy for this volatility shock, we use the daily percentage change in the VIX cash index level, $R_{VIX,t}$. The second is the deterministic and typically downward pull of the VIX futures index toward the VIX cash index level. To proxy for this return, we use minus the slopes of the VIX futures price term structure at 30 and 150 days, divided by the constant-maturity VIX

EXHIBIT 8

Daily Share Price and Daily Shares Outstanding of VXX since Product Inception on January 29, 2009 through March 30, 2012



futures prices at 30 and 150 days for the short-term and mid-term total return indices, respectively. It is important to note that this variable, $R_{slope,t-1}$, is measured on the day before the futures index return and is therefore predictive in nature. The regression equation is

$$R_{FI,t} = \beta_0 + \beta_1 R_{VIX,t} + \beta_2 R_{slope,t-1} + \varepsilon_t \qquad (2)$$

and the regression is performed for both the VIX ST TR and VIX MT TR futures indices.

The regression results are reported in Exhibit 9. The VIX short-term futures index has a β_1 coefficient estimate of 0.4629. This means that if VIX moves upward by 1% on a given day, the VIX short-term futures will rise by slightly less than a half a percent. Similarly, the β_1 coefficient estimate of the VIX mid-term futures index is only 0.2200, which means that it responds by about one-quarter of 1% to a 1% movement in VIX. The VIX futures indices upon which the VIX ETPs are based are muted versions of an investment in the VIX. Positions in the ST and MT futures indices would need to be levered upward by factors of two and four, respectively, to achieve the same price action as VIX.[6] This is consistent with Exhibit 4, where we show that the return volatilities of the ST and MT indices are about one-half and one-quarter the return volatility of the VIX, respectively. But beware. The adjusted R-squared values are far below one, which means that movements in the value of these levered positions may deviate substantially from movements in the VIX. In levering the indices, the effects of contango are also being levered.

Note that the estimates of the coefficient β_2 for the ST and MT indices in Exhibit 9 are positive and significantly different from zero at the 5% probability level. To interpret these coefficient magnitudes, consider the fact that, due to the persistent contango in the VIX futures market, the mean value of $R_{slope,t-1}$ in the VIX ST futures index return regression is –0.133%. Multiplying by the coefficient estimate, a VIX ETP based on a VIX ST futures index is expected to fall by 0.286% a day, on average and without leverage. Assuming 22 trading days in a month, this means losing more than 6% a month on average with a buy-and-hold strategy based on the index. Recall that the direct VIX ETPs based on the VIX ST futures indices are by far the most popular, based on their market capitalization and trading volume.

The return performance of the short-term VIX futures indices provides compelling evidence that VIX ETPs based on the VIX short-term indices are not suitable as buy-and-hold investments. But someone is holding them. Otherwise, the number of shares outstanding would fall to zero. To illustrate how out of hand the situation has gotten, we assess the amount of money lost by investors, presumably unsophisticated investors, as a result of holding VIX ETPs benchmarked to the VIX ST futures indices.

The methodology is straightforward. The dollar amount of VIX derivatives that is required to hedge the short volatility exposure of a VIX ETP at the close of trading on a given day t is

$$DH_t = n_t S_t L \qquad (3)$$

where n_t is the number of shares outstanding, S_t is the net asset value per share of the ETP, and L is the leverage factor. Where L is 2, the index exposure is twice the level of total net asset value, because of the index's 200% promised return. Where L is –1, the promised return is –100% of the index return. Based on Equation (3), the change in the value of this futures hedge from day $t-1$ to day t is

$$DH_{t-1}R_t = n_{t-1}S_{t-1}LR_t \qquad (4)$$

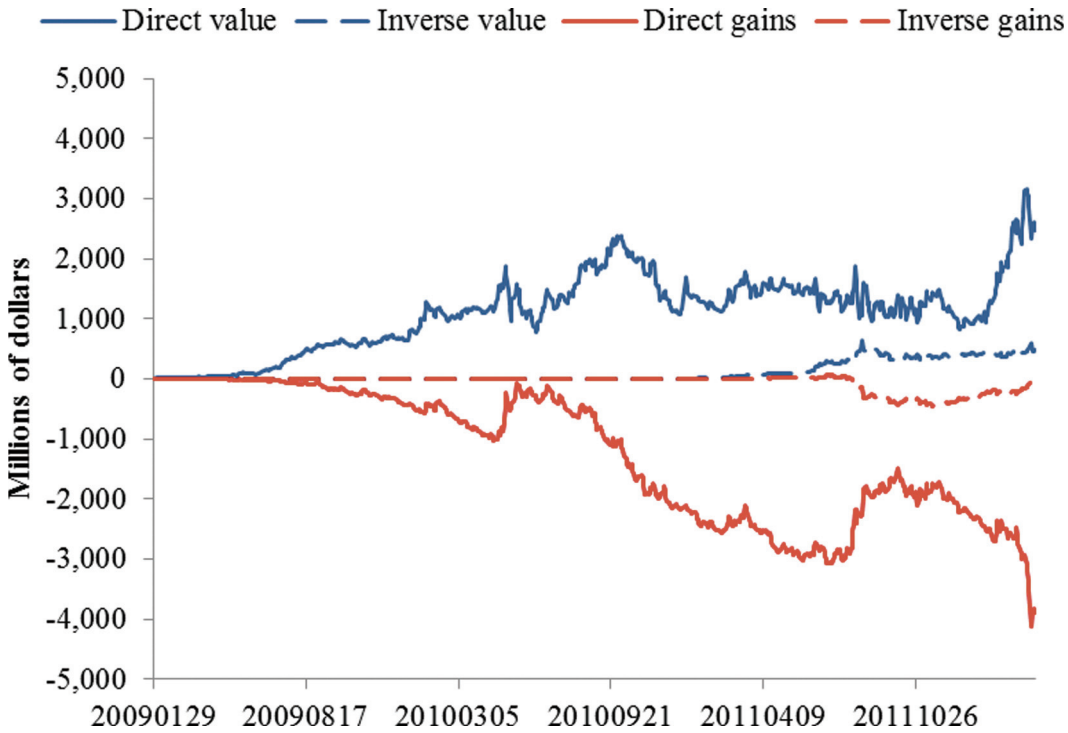
EXHIBIT 9

Summary of Results from Regressing VIX Short-Term Total Return (ST TR) and Mid-Term Total Return (MT TR) Futures Index Returns on VIX Returns and Previous Day's Term Structure Predicted Return, December 20, 2005, through March 30, 2012

Index	No. of obs.	Adj. R^2	β_0	$t(\beta_0)$	β_1	$t(\beta_1)$	β_2	$t(\beta_2)$
ST TR	1,580	0.7919	0.0006	1.18	0.4629	77.01	2.1489	12.61
MT TR	1,580	0.6468	0.0001	0.33	0.2200	53.76	2.4911	5.31

EXHIBIT 10

Total Market Value and Cumulative Gains of Direct and Inverse ETPs Benchmarked to VIX Short-Term Futures Indices, December 20, 2005 through March 30, 2012



where R_t is the VIX futures index return on day t. Finding cumulative dollar losses for all VIX ETPs involves summing the values of Equation (4) for each VIX ETP each day, then summing through time. Note that in this computation, the gains of direct ETPs are offset by the losses of inverse ETPs, and vice versa.

Exhibit 10 shows the results. The exhibit contains the total market value of all direct ETPs benchmarked to the VIX ST futures index and the total market value of all inverse ETPs, as well as the cumulative dollar gains in millions of dollars of the direct and inverse ETPs. Only the seven most active VIX ST ETPs listed in Exhibit 1 are used. As the exhibit shows, direct ETPs dominate, in the sense that their market value is five times the market value of inverse ETPs: $2.50 billion versus $48 million as of March 30, 2012. They also dominate in terms of racking up losses. When the gains and losses are summed through time, direct ETPs lose a whopping $3.89 billion, while inverse ETPs lose only $57.4 million. The results are perplexing indeed. In spite of the fact that investors in direct VIX ETPs benchmarked to the short-term futures index lost nearly $4 billion since inception, strong interest in holding them remains.

SUMMARY AND CONCLUSIONS

This article evaluates VIX ETPs as a buy-and-hold investment. The evidence is not good. The nature and performance of VIX ETPs suggest that a significant proportion of holders are either irrational and/or unaware of how these products are structured and perform through time. Among the findings is that VIX ETPs benchmarked to the VIX short-term futures indices are virtually certain to lose money through time. Indeed, over its six-year history, the VIX short-term total return futures index dropped in value by nearly 94%. This completely discounts the notion that this VIX investment can or should be used as a buy-and-hold asset class in the manner of stocks and bonds. While its returns are highly negatively correlated with the returns of traditional asset classes, its poor return performance renders it ineffective. Indeed, over their three-year history, the holders of ETPs bench-

marked to the VIX Short-Term Futures indices have lost nearly $4 billion.

But if the holders of VIX ETPs are losing money, is it possible to make money by being on the other side of the trade? Possibly. These securities are hard to borrow, and rebate rates are often thousands of basis points below the general collateral rate. Another alternative is to buy an inverse ETP. The inverse of the S&P 500 VIX Short-Term Excess Return Futures Index experienced a 6.0% annualized return from December 2005 through March 2012. Perhaps this accounts for the fact that XIV has the highest institutional ownership. The returns of inverse VIX ETPs are highly positively correlated with stock returns, however, and do not provide much diversification power.

For those considering VIX ETPs as long-term holdings, we offer two suggestions. First, buy VIX ETPs that are based on the VIX mid-term, rather than on the VIX short-term futures index. The term structure of VIX futures prices is much flatter in the region at the mid-term index's five-month month maturity than at the short-term index's one month maturity. This means the losses due to the contango trap are considerably lower (i.e., are incurred at a much slower rate). Indeed, over the six-year period in which S&P reported futures index returns, the holding period return of the MT index was 5.9%, compared to the ST index return of –93.9%. At the same time, the MT index returns are almost as negatively correlated with stock returns (–0.77) as the ST index returns (–0.78), so there is no loss in diversification effectiveness.

Second, holding other factors constant, consider only VIX ETPs that provide interest accrual, whether by benchmarking to the total return indices (e.g., VXX and VXY) or promising the return of the excess return indices plus an explicit interest accrual (e.g., VIIX). The risk-free return on the capital tied up in the VIX ETPs properly belongs to the investor and when the economy fully recovers and interest rates return to more normal levels, this income may amount to several hundred basis points a year.

ENDNOTES

This article is based in part on a Keynote Address at the Financial Management Association European Conference in Turin Italy, June 2009, and presentations at the 2012 Berkeley-Haas Finance Conference in Berkeley, CA, March 2012, the Financial Markets Research Center Conference at Vanderbilt University, Nashville, TN, in May 2012, the 9th Annual Rothschild Caesarea Summit, Interdisciplinary Center (IDC), Tel Aviv, Israel, in May 2012, and the Global Derivatives USA Trading and Risk Management conference in Chicago, IL, in November 2012. Discussions with Kate Barraclough, Nick Bollen, Henry Chien, Bernard Dumas, Gary Gastineau, Joanne Hill, Neil Ramsey, Jacob Sagi, Tom Smith, Hans Stoll, and Damon Walvoord and the research assistance of Theodosios Athanasiadis, Hilary Craiglow, and Daejin Kim are gratefully acknowledged.

[1]The debate regarding whether volatility should be considered an asset class is contentious. Szado [2009] is often cited as providing evidence that a long volatility exposure is a good diversification tool. See *Volatility Indexes at CBOE* (http://www.cboe.com/micro/VIX/pdf/VolatilityIndexQRG2012-01-30.pdf). Unfortunately, Szado's evidence is based on a short sample period that includes a market crash. In a more careful systematic framework, Alexander and Korovilas [2011] concluded that, unless one is able to predict market crashes, volatility is a poor diversifier.

[2]Beginning on November 4, 2012, the CBOE instituted trade at settlement (TAS) transactions, whereby market participants can enter orders during the day to trade at the VIX futures settlement price at the end of the day. This new practice should mitigate some of the tracking error, particularly for the VIX ETFs. For more details, see http://ir.cboe.com/releasedetail.cfm?ReleaseID=619298.

[3]Technically, while these definitions are widely used in practice, they are only loosely correct. Contango refers to a market in which futures prices exceed expectations of the futures spot price, and normal backwardation refers to a market in which the opposite holds. See Keynes [1930].

[4]At first blush, the upward-sloping curve may seem counterintuitive. Since the cost of carrying volatility is zero, one might expect the futures price curve to be flat. But the usual cost-of-carry model does not hold here, since buying or selling the VIX cash index is not possible. Hence, the futures price curve is determined largely by hedging demand. In this market, we have the reverse of Keynesian normal backwardation, in that the demand is long (not short) as a result of portfolio insurance buyers.

[5]The summary statistics reported in Exhibit 6 leave open the possibility that the inverse products based on the short-term futures indices may be better diversifiers than the direct mid-term products. Using the parameters of Exhibit 6 as expectations of the mean, standard deviations, and correlations of the future returns and a 0.5% risk-free interest rate, the maximum Sharpe ratio is 0.232 for a risky asset portfolio with fraction 0.6258 invested in SPY and 0.3742 invested in the VIX MT TR futures index. For the inverse index, the maximum Sharpe ratio is 0.1419 for a risky asset portfolio with

fraction 1.1233 invested in SPY and −0.1233 invested in the −(ST ER) futures index. Not only is the Sharpe ratio lower, the optimal risky asset portfolio involves short selling the inverse index. The mid-term index appears to be the strongest diversification prospect of the available VIX ETPs.

[6]The fact that the MT futures index is only half as responsive as the ST futures index has not gone unrecognized. Indeed, Standard and Poor's has already created the S&P 500 VIX Futures Term-Structure Index Excess Return (Bloomberg ticker symbol: SPVXTSER) from taking a 100% long position in the S&P 500 VIX Short-Term Index Excess Return and a 50% short position in the S&P 500 VIX Mid-Term Index Excess Return. It serves as the benchmark for the UBS ETRACS Daily Long-Short VIX ETN, which trades under the ticker symbol XVIX.

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