GLOBAL VOLATILITY SUMMIT

FEBRUARY 2016 NEWSLETTER

Dear Investor,

The Global Volatility Summit ("GVS") brings together volatility and tail hedge managers, institutional investors, thought-provoking speakers, and other industry experts to discuss the volatility markets and the roles volatility strategies can play in institutional investment portfolios. The GVS aims to keep investors updated on the volatility markets throughout the year, and educated on innovations within the space.

The Seventh Annual GVS is just over a month away! If you have not done so already, please register for the event on the website: www.globalvolatilitysummit.com. Space is limited.

Credit Suisse Asset Management has provided the latest piece in the GVS newsletter series enclosed.

Cheers,
Global Volatility Summit

2016 EVENT

The 2016 Global Volatility Summit is coming up on March 16, 2016 at Pier Sixty in New York City. Registration is now open and the agenda has been posted.

2016 MANAGER PARTICIPANTS

Argentière Capital
BlueMountain Capital
Capstone Investment Advisors
Capula Investment Management
Ionic Capital Management
Man AHL
Parallax Volatility Advisors
PIMCO
Pine River Capital Management
True Partner Capital

KEYNOTE AND GUEST SPEAKERS

The 2016 keynote speakers are Barney Frank and Marcus Luttrell. Barney Frank served as a US Congressman for over 30 years and most recently as the Chairman of the House Financial Services Committee from 2007 through 2011. He was a key author of the Dodd-Frank Wall Street Reform and Consumer Protection Act. Marcus Luttrell is a decorated Navy Seal and best-selling author of Lone Survivor. You can access their biographies and more information about the event on the website: www.globalvolatilitysummit.com.

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Manna or Mirage?
An Allocator's Perspective on Volatility Trading Strategies

Yung-Shin Kung
Head of Portfolio Management – Americas and Head of Relative Value Strategies, Alternative Funds Solutions

Executive Summary

After several years of subdued volatility, the recent spike in the VIX index (to a multi-year high of 53.29 on August 24th) was surprisingly abrupt, raising questions about current market structure as well as the features of products and strategies employed within the volatility market by its primary participants.

We approach the volatility market as an advisor to alternative investment portfolios seeking to generate attractive risk-adjusted returns through actively investing in hedge funds as well as more liquid products, such as algorithms created by banks or broker-dealers, which can provide efficient exposure to a variety of risk premiums traditionally associated with hedge fund strategies. Many of these investments trade volatility. In our view, the volatility market and the scope of products encompassed by it has evolved meaningfully since the Global Financial Crisis of 2008 (GFC). One unfortunate consequence of this change is that volatility trading strategies are poorly understood today, and a variety of misconceptions have limited the extent to which volatility trading is successfully integrated into investor portfolios. Defining volatility is a critical starting point in exploring its behavior and its potential uses.

In option pricing models, two variables are unknown: the implied volatility of the underlying asset and the option's price. Investors can deduce implied volatilities from market observable option prices and frequently interpret implied volatilities as measures of the expected price stability of underlying assets. Premised on the belief that periods of asset price decline are generally associated with price instability, investors have embraced the notion that owning implied volatility ought to hedge portfolios against asset price declines. A natural consequence of the use of implied volatility as financial market insurance is the economic necessity that, most of the time, implied volatilities overestimate assets' true price risk. This provides volatility sellers an insurance or risk premium as compensation for bearing exposure to unexpected asset price instability.

In this paper, we explore the evolution of the volatility market, highlighting how new products such as broker-dealer algorithms and exchange-traded products linked to implied volatility have achieved acceptance alongside more traditional volatility-centric instruments such as options and structured products. We discuss the motivations and tendencies of various participants and describe how they lead to exploitable patterns in pricing. One of the most widely noted post-GFC market reforms has been the de-risking of broker-dealers, which is visible in the contraction of their balance sheet exposures. With broker-dealers implicitly marginalized, hedge funds are now the volatility market-makers of last resort. In this context, we suggest why August's volatility spike was a classical short squeeze.

We provide a general assessment of the primary classes of investment strategies designed to trade implied volatility, including volatility premium capture, relative value trading, and hedging, and we examine key issues investors ought to consider in allocating to them. Ultimately, value can be extracted from volatility trading strategies if they are both well understood and thoughtfully integrated into broader investment portfolios.

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Black-Scholes Options Pricing Model

$$C(S,t) = N(d_1)S - N(d_2)Ke^{-r(T-t)}$$

$$d_1 = \frac{1}{\sigma\sqrt{T-t}}\left[\ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)(T-t)\right]$$

$$d_2 = \frac{1}{\sigma\sqrt{T-t}}\left[\ln\left(\frac{S}{K}\right) + \left(r - \frac{\sigma^2}{2}\right)(T-t)\right] = d_1 - \sigma\sqrt{T-t}$$

Where

S is the price of the stock;

$C(S,t)$ is the price of a European call option;

K is the strike price of the option;

r is the annualized risk-free interest rate, continuously compounded;

σ is the expected standard deviation of the stock's returns;

t is a time in years (now=0 and expiry=T); and

$N(x)$ denotes the standard normal cumulative distribution function:

$$N(x) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{x} e^{-\frac{z^2}{2}}\,dz$$

Defining Implied and Realized Volatility

Implied volatilities are input variables specified in options pricing models, the most fundamental of which is the Black-Scholes formula. It states the value of a call option for a non-dividend-paying underlying stock in terms of a set of parameters – current underlying stock price, option strike price, time until option expiration, implied volatility of the underlying stock, and the risk-free interest rate.

The term volatility or, more precisely, implied volatility has a specific, technical definition. An implied volatility is an assessment of the variability of an asset's price over some future period of time. Option pricing models such as the Black-Scholes formula set forth a functional relationship between price and, among other variables, implied volatility. For an option with a market observable price (e.g., a listed option) the underlying asset's implied volatility (σ) is thus a simple model output. However, because implied volatilities are in this fashion model-derived, they also reflect model deficiencies and must be carefully interpreted. For example, most option pricing models, including the Black-Scholes framework, require that an underlying asset's price follow a stationary log-normal process.[1] In reality, asset prices do not behave in strict accordance with rigid model assumptions, and a variety of price-influencing factors such as liquidity conditions and supply-demand dynamics – which are left undefined in pricing models – are consequently reflected in implied volatilities.[2]

The most commonly referenced measure of implied volatility is the CBOE Volatility Index (VIX), which is calculated as 100 times the square root of the expected 30-day variance of the S&P 500 rate of return. Since 30-day options are usually not available, the expected variance is derived from weekly or monthly S&P 500 options expiring in approximately 30 days. Volatility and variance are closely related, and market participants seeking to express precise views on the prospective price variability of an asset or index often prefer to use variance swaps rather than options.[3] A variance swap is a cash-settled over-the-counter (OTC) derivative in which the long leg receives an amount based on the realized price variance of an underlying asset minus a fixed variance strike agreed upon at the time the swap is executed. If the realized variance is less than the strike, then the short leg receives the difference. Realized variance, like realized volatility, is a calculated measure of an asset's price variability or dispersion over a fixed historical time period derived from a series of historical prices. It quantifies the magnitude of price fluctuation (or risk) experienced by an asset holder. Importantly, variance swaps can be perfectly statically replicated with put options and call options, but do not actually provide direct exposure to an underlying asset (and are thus delta and gamma neutral instruments; see Appendix).[4]

It's useful to contrast realized volatility (or variance) which is historical and backward looking with implied volatility (or variance) which is forward looking. As described above, implied volatility and implied variance are forecasts of an asset's price uncertainty over a specific future period and are deduced from derivative prices. Realized volatility and realized variance are calculated from historical asset price time series. Both must be interpreted with reference to a specific timeframe to be meaningful.

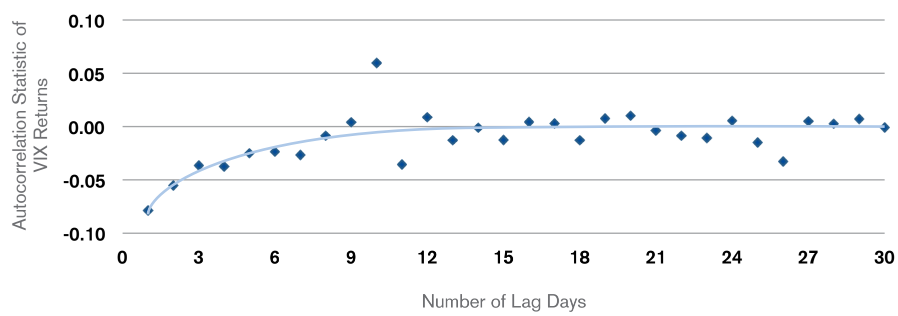
Properties of Implied Volatility

Implied volatility tends to exhibit certain exploitable tendencies which to varying degrees form the *raison d'être* of many volatility trading strategies.

Mean Reversion

Implied volatilities show mean-reverting behavior.[5] An implied volatility regime can be thought of as a period in which an asset's implied volatilities center on a certain level. When the level is exceeded within a regime, implied volatilities subsequently tend to decline, and vice versa. A time series of the VIX daily percentage returns provides a fitting illustration of the shorter-term negative autocorrelation structure of implied volatility[6,7] *(Display 1).*

Display 1: Daily VIX Percentage Returns Are Negatively Autocorrelated (January 1990 – September 2015)

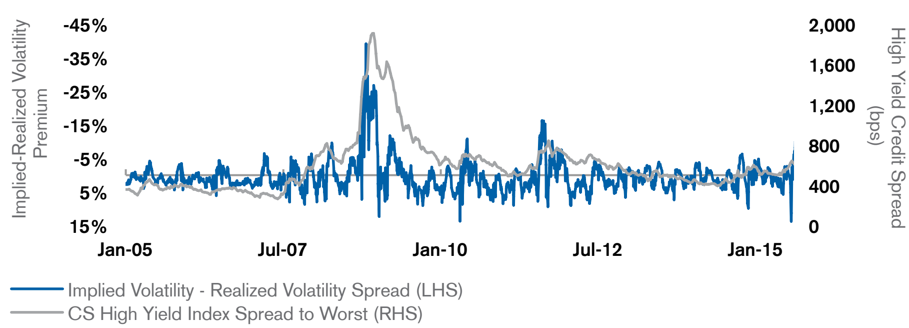


Source: Credit Suisse Asset Management and Bloomberg. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

Implied-Realized Premium

Implied volatilities typically trade at a premium to subsequent realized volatilities. This is the basic, risk-aversion necessitated insurance premium that compensates sellers of implied volatility for their exposure to the risk that realized volatility exceeds expectations, and in particular, to unhedgeable gap moves in the underlying asset.[8,9] This premium varies through time and is influenced by a variety of factors including the prevailing level of risk tolerance in the marketplace.[10] For example, in the years since the GFC, credit spreads and the implied-realized premium have compressed in tandem *(Display 2).*

Display 2: Implied-Realized Premium and High Yield Credit Spreads (January 2005 – August 2015)



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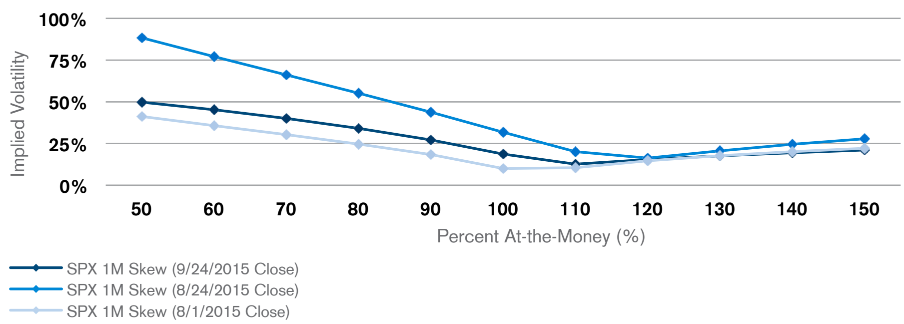
Skews and Smiles

Skew describes the extent to which the implied volatilities of options of different strike prices or levels of moneyness on a given asset of the same tenor differ in value. Implied volatilities in many assets exhibit smiles, whereby out-of-the money options trade at higher implied volatilities than at-the-money options *(Display 3).* This reflects deficiencies in the distributional assumptions regarding underlying asset price processes specified in option pricing models (e.g., underlying asset prices have fatter than assumed tails), varying liquidity across strike prices (e.g., there is generally better liquidity in options that are closer to at-the-money strikes), and structural supply-demand imbalances in out-of-the-money options.[11] Skew often refers to the difference between out-of-the-money put volatility and out-of-the-money call volatility. Indices such as the S&P 500 typically exhibit a large premium of put volatility over call volatility due to the high demand for put protection and the supply of calls from overwriting strategies.

Display 3: S&P 500 1-Month Implied Volatility Skew

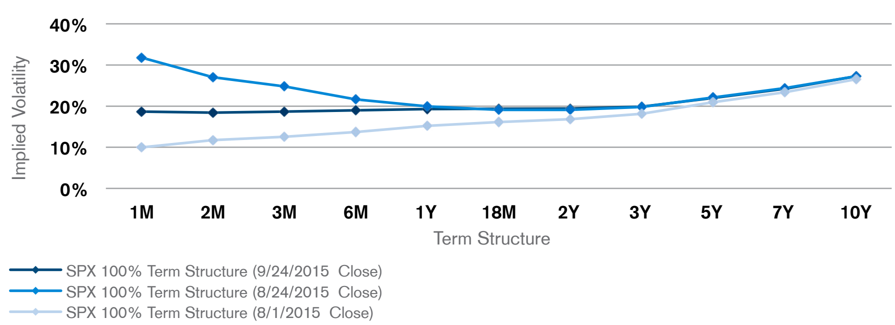


Source: Credit Suisse

Term Structure

Term structure describes the extent to which the implied volatilities of options of differing time to maturity on a given asset that are otherwise identical differ in value. Implied volatilities of many assets ordinarily exhibit upward sloping term structures *(Display 4),* suggesting that asset pricing uncertainty increases with time. Term structure also reflects market participant segmentation. Volatility traders tend to be most active in shorter-term contracts, resulting in spotty liquidity and poor pricing in longer-dated options. While the term structure of the VIX typically reflects these dynamics, risk-off periods often coincide with near-term market concerns in which shorter-dated options are bid up, and in these periods, the VIX term structure can invert and become downward sloping. Single name equities can exhibit somewhat unusual implied volatility term structures, including kinks, or points of higher implied volatility levels, around corporate events such as earnings announcements.

Display 4: S&P 500 At-the-Money Implied Volatility Term Structure



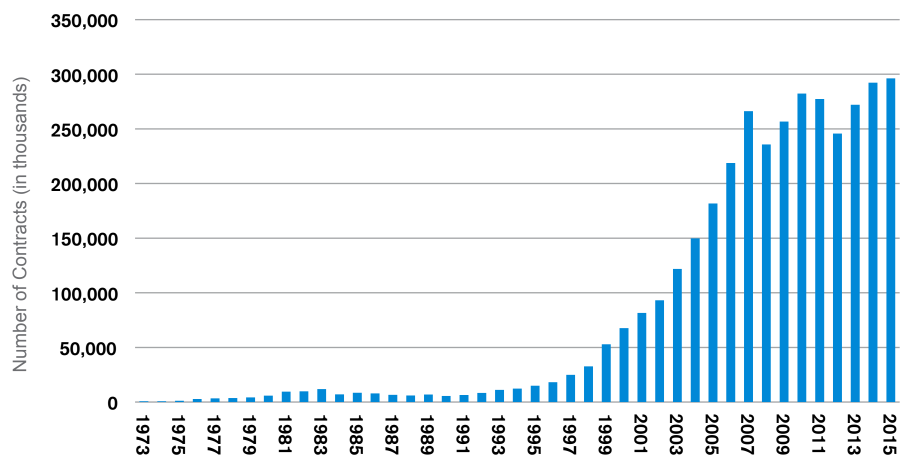
Source: Credit Suisse

Evolution of the Volatility Marketplace

Market Structure

Individuals have employed options as a means of tailoring financial exposures for thousands of years. The Greeks are credited with inventing options contracts in ancient times in order to speculate on olive harvests.[12] However, the market for options truly began to flourish with the establishment of the Chicago Board of Options Exchange (CBOE) in 1973. The CBOE brought increasing standardization to options contracts and provided the security of a guaranteed clearing house. These features have enabled a variety of participants to access the options market and laid a foundation for today's highly diverse, and continually expanding implied volatility market *(Display 5).*

Display 5: The Growth in Equity Options Open Interest Since 1973



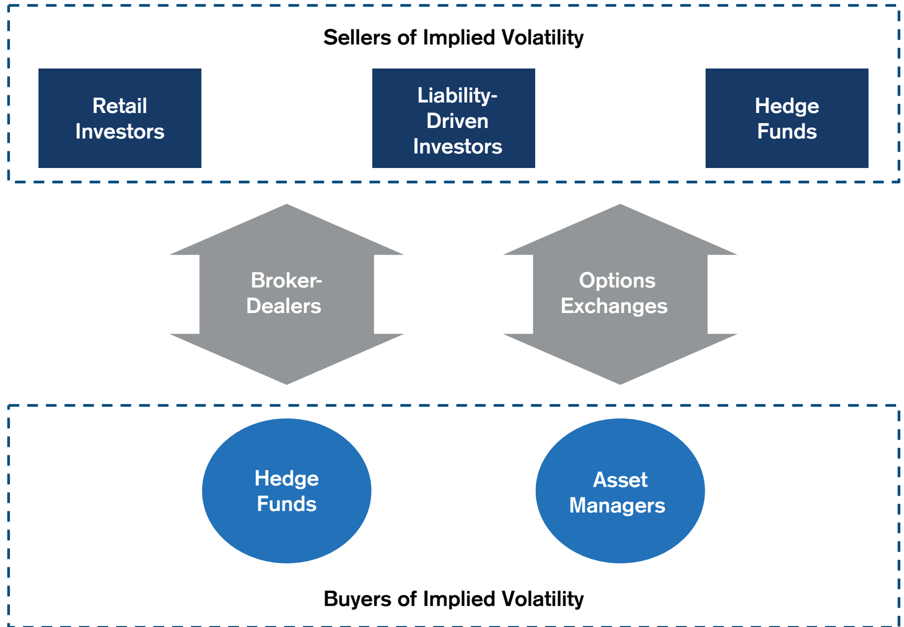
Source: Options Clearing Corporation. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

The complexity and operational burden of trading and managing the risk and liquidity of a portfolio of listed derivatives in order to generate income, hedge, or express investment views is daunting for many market participants. Broker-dealers and large asset managers have recognized that the existence of these implementation hurdles engenders an important business opportunity and they have responded with the creation of a host of more accessible products targeting a wide range of investor needs.

Broker-dealers generate an important supply of implied volatility through structuring and marketing income generative products to retail clients, liability-driven investors, and to a lesser extent, hedge funds in the form of structured products, ETPs, listed options, and OTC derivatives[13] *(Display 6).*

Broker-dealers generally seek to manage the risk these activities produce by actively hedging out unwanted Greek exposures, primarily delta (see Appendix) and by unloading theta (time decay) and vega (the profit/loss associated with a marginal increase/decrease in the level of implied volatility). Risk reduction is effectuated via options exchanges, through the creation of long volatility products such as certain ETPs, or through bilateral OTC transactions. Broadly speaking, asset managers and hedge funds represent the bulk of long vega demand.

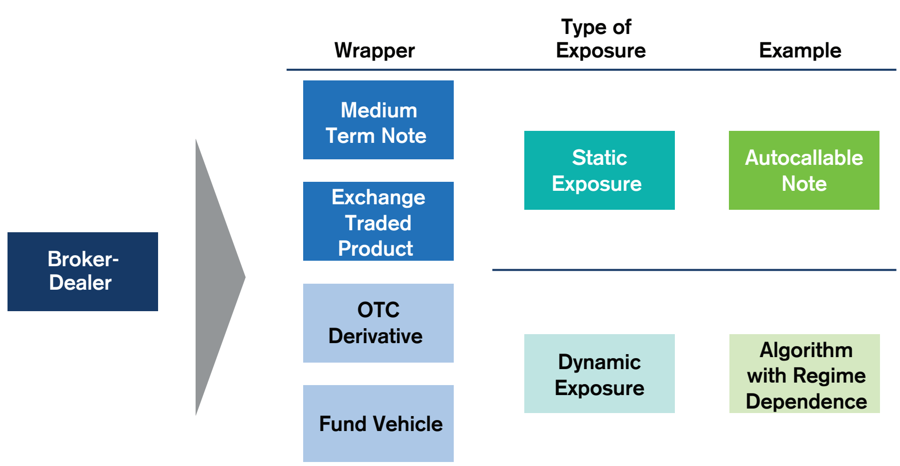
Display 6: Participants in the Volatility Market



Source: Credit Suisse Asset Management. For illustrative purposes only.

Broker-dealers offer market participants two sets of products providing exposure to implied volatility: (i) static products which offer no embedded mechanism to time the market and (ii) dynamic products which offer embedded market timing through a systematic trading strategy or "algorithm". These products are packaged in a variety of wrappers to meet the needs of investors *(Display 7).*

Display 7: An Array of Products Are Available Providing Either Static or Dynamic Exposure to Implied Volatility

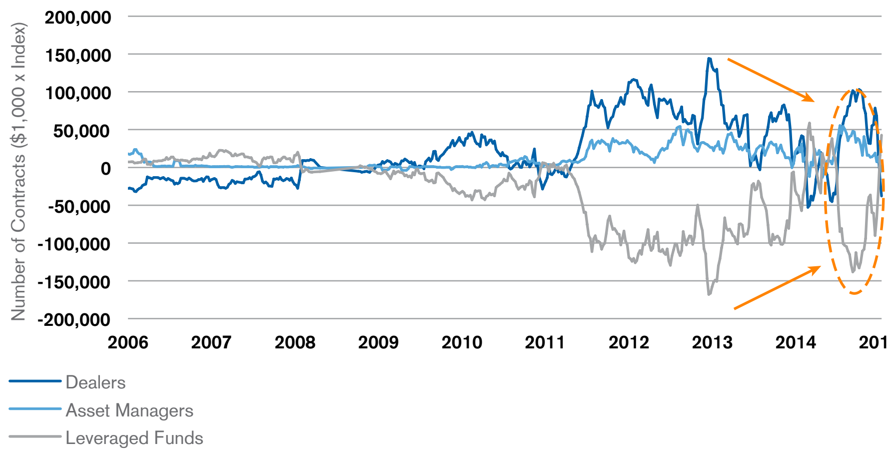


Source: Credit Suisse Asset Management. For illustrative purposes only.

In many cases, these products are liquid, transparent and low-cost. They enable investors to express directional views on implied volatility and to generate market timing alpha either by actively trading the products or through the strategies employed by the products themselves.

The GFC catalyzed meaningful structural change within the markets as regulators sought to reduce systemic risk through the introduction of a host of micro- and macro-prudential measures. This change has directly impacted the implied volatility market, which had traditionally relied heavily on broker-dealers for risk capital. As broker-dealers have adapted to new regulatory constraints and grown less willing or unable to warehouse risk, they have become increasingly dependent upon hedge funds, which are typically highly mark-to-market and liquidity sensitive, to price and warehouse unwanted vega supply and to meet unexpected vega demand. The zero-sum nature of broker-dealer and hedge fund net positioning in the VIX futures markets *(Display 8)* illustrates the nature of this complex relationship. Importantly, because they are relatively balance sheet constrained, and because they operate with a high cost of capital and a high sensitivity to mark-to-market losses, hedge funds, to their investors' benefit, are naturally ephemeral market makers of last resort.

Display 8: The Symbiotic Relationship between Broker-Dealers and Hedge Funds is Evidenced in Their Inversely Related Net Positioning in the VIX Futures Market[14]

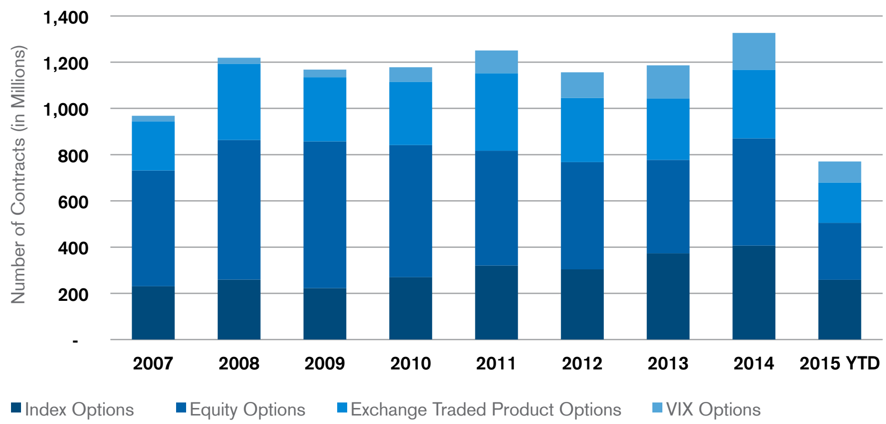


Source: CFTC. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

New Products

The GFC also witnessed the VIX hitting an all-time intraday high of 89.53 on October 24, 2008, which provoked a tremendous amount of interest in VIX products and their potential applications in portfolio hedging. Investors continue to view owning implied volatility as a form of financial market insurance. Consequently, while the trading of single-name equity calls and puts has declined over the last several years, the market has experienced growth in index option trading which has coincided with the adoption of more complex instruments such as VIX options and futures *(Display 9)*. As noted above, broker-dealers remain active in structuring and marketing a variety of products in ETPs, algorithms, and structured notes.

Display 9: VIX Options Trading Continues to Grow (as of August 2015)



Source: CBOE. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

VIX ETPs allow investors to express a long or short view on volatility and are often available in levered formats. One of most recognized is the iPath S&P 500 VIX Short-Term Futures ETN (Bloomberg ticker: VXX), which is an unlevered product designed to provide investors with exposure to the two nearest to expiration VIX futures contracts. VXX currently has approximately $1.0 billion in assets (as of September 2015), down from a peak of almost $2.4 billion five years ago. VelocityShares Daily Inverse VIX Short Term ETN (Bloomberg ticker: XIV), which has almost $1.4 billion in assets, provides investors with short volatility exposure. Our group tracks over 15 VIX ETPs that differ from one another in their long or short, levered or unlevered, and passive or dynamic exposures, and we estimate that the assets invested in these products exceed $5 billion. Of the 15 VIX ETP names we track, roughly 60% by number are long implied volatility biased, 30% are short implied volatility biased, and 10% are dynamically managed such that directional exposure is signal dependent.

Similarly, there has been considerable growth in algorithms focused on trading implied volatility developed and marketed by broker-dealers. We currently track more than 90 such strategies which operate in one or more of a range of asset classes including equities, fixed income, commodities, and currencies, and we invest in a small handful that we believe are suitable for our clients. Algorithms are frequently accessed via OTC derivatives (primarily swaps) which provide users the benefit of being able to structurally leverage their exposures in a manner consistent with their risk tolerances. Of the algorithms we track, approximately 70% by number are short implied volatility biased and 30% are long implied volatility biased.

Structured products provide a popular means for retail investors to express investment views often through the sale of implied volatility. They are typically debt instruments with embedded options linked to the performance of an underlying asset or index and frequently offer attractive conditional yields relative to risk-free rates. When investors in these products are short implied volatility (as is often the case), the issuer normally assumes a long volatility position and may seek to offload the associated vega and theta exposure into the market. These hedging flows flatten skew. Such income-generative instruments have been popular in low interest rate countries such as Japan, where 10-year government bonds are trading at an annual yield of approximately 0.32% (as of September 2015). There, Uridashi bonds, which may be linked to the Nikkei 225 stock index, have experienced $129 billion of new issuance over the last five years.[15] Similarly, record-low bond yields in Europe have been a boon to the autocallable note industry which has issued an estimated $150 billion notional in product over same period.[16] The tremendous supply of implied volatility in these markets has pressured volatility levels downward.

Short Squeeze

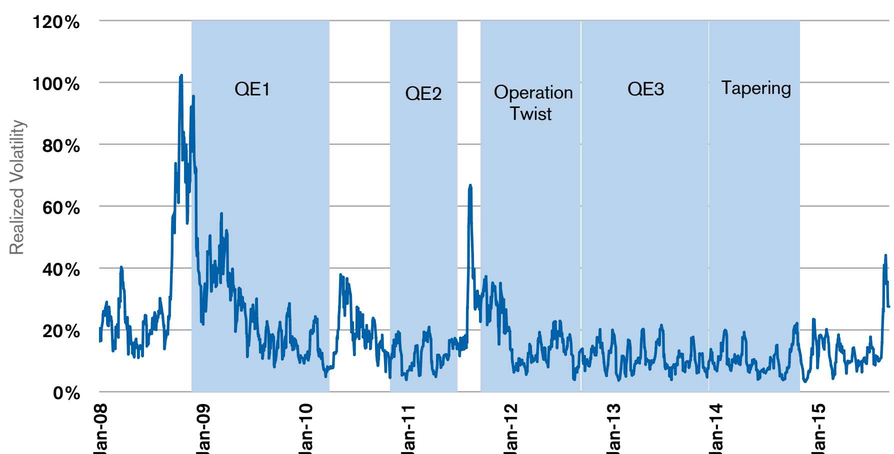
A situation in which a heavily shorted stock or commodity moves sharply higher, forcing more short sellers to close out their short positions and adding upward pressure on the stock. A short squeeze implies that short sellers are being squeezed out of their short positions, usually at a loss. A short squeeze is generally triggered by a positive development that suggests the stock may be embarking on a turnaround. Although the turnaround in the stock's fortune may only prove to be temporary, few short sellers can afford to risk runaway losses on their short positions and may prefer to close them out even if it means taking a substantial loss.[17]

The Recent Behavior of Implied Volatility

We suspect that the implied volatility spike in August 2015 was a classical short squeeze ostensibly triggered by global growth worries linked to China and facilitated by today's brittle market structure, which we see as an unintended but lasting consequence of the post-GFC regulatory framework. A fitting conceptual model for the behavior of VIX in August is a short squeeze.

We believe that post-GFC quantitative easing (QE) undertaken by G3 central banks has engendered a meaningful short interest in implied volatility.[18] As we've detailed in a past paper, the objective of QE and zero-interest rate policy has been to stimulate economic activity by incentivizing risk-taking through two mutually-reinforcing mechanisms: (i) offering investors an unacceptably low inflation-adjusted return on less risky assets and (ii) reassuring investors that the central banks would actively calm markets through their operations and thereby reduce the risk associated with holding traditionally riskier assets.[19] QE has functioned along both of these two dimensions in constraining implied volatility. First, it made asset prices more stable, literally reducing realized volatility which naturally flowed through to implied volatility levels *(Display 10).* Second, it incentivized investors to sell implied volatility as a means of enhancing unacceptably low yields.[20]

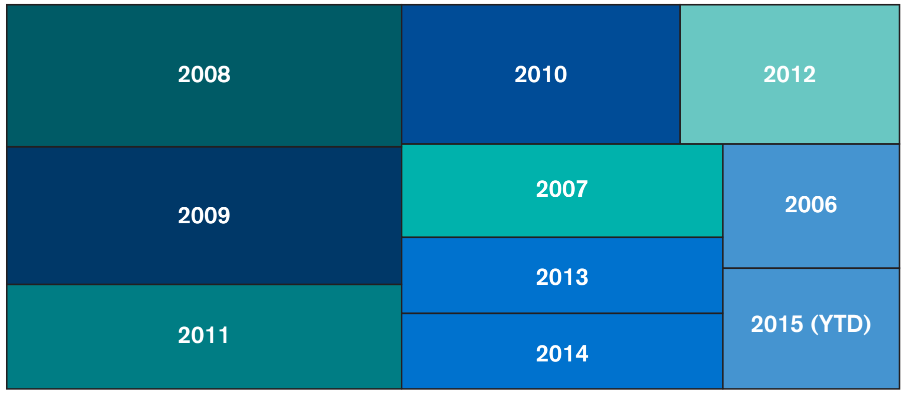
Display 10: S&P 500 Realized Volatility (10 Day) Declined During QE Periods



Source: Credit Suisse Asset Management, Federal Reserve, and Bloomberg. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

As described in the previous section, broker-dealers and large asset managers have addressed market demand for yield generative investment instruments and provided access to short implied volatility strategies through a variety of highly liquid structures like ETPs and OTC derivatives. Such product development has coincided with the increasingly widespread institutional investor adoption of budgeting portfolio capital (or risk) to "alternative risk premiums," such as the spread between implied and realized volatility, as a means of generating improved risk-adjusted portfolio returns.[21] Similar to structured products, these instruments have effectively lowered implied volatility levels and introduced a host of higher order technical dynamics to the implied volatility market *(Display 11).*

Display 11[22]: Treemap of Year Sized by Implied Volatility (as of September 30, 2015)



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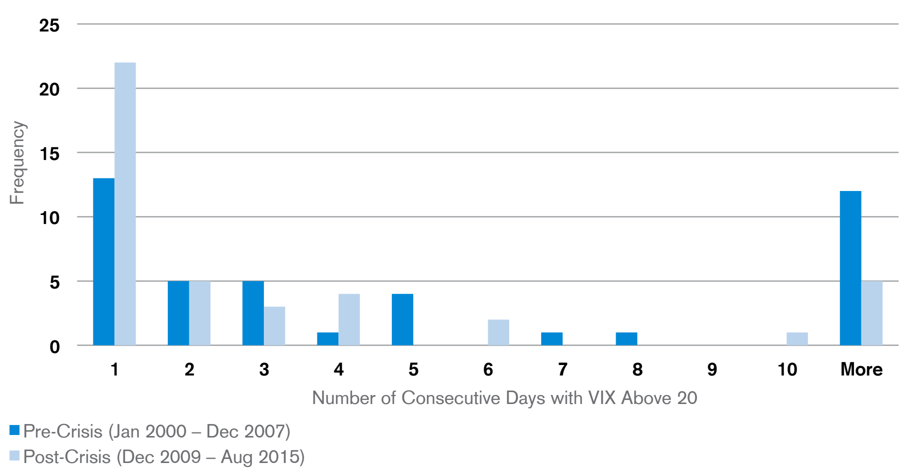
Prior to August's VIX move, several market practitioners had suggested to us that equity implied volatility seemed to exhibit a more muted sensitivity to market shocks in the post-GFC environment than it had before; that is, relative to investor expectations, it seemed to underreact to news. Episodes of higher volatility were brief, with implied and realized escalating and then quickly reverting back down to lower levels. One means of contrasting the behavior of implied volatility pre-crisis versus post-crisis is through a comparison of the frequency and persistence of "risk-off" periods, measured as the number of consecutive days in which the VIX closed above 20, in each timeframe *(Display 12).* Pre-GFC, bouts of high implied volatility tended to vary in length, with many quite sustained. After the GFC, these periods have tended to be short-lived. We view this as congruent with our interpretation that over the past several years, the markets have been in a regime characterized by coordinated risk suppression in which equity implied volatility has (until August 2015) grown commensurately desensitized to negative market surprises.

Display 12: Post-GFC, Episodes of High Volatility Have Been Short-Lived



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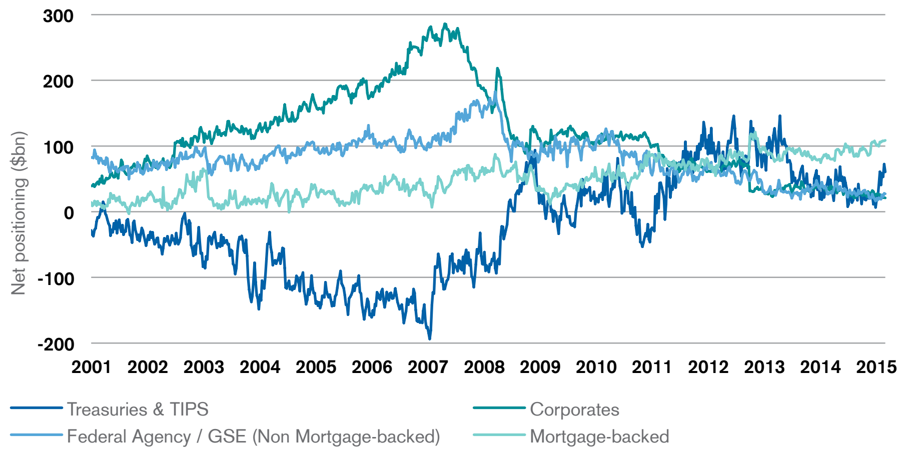
The dramatic reduction in the scope of broker-dealer market-making activities called for by regulatory measures introduced in the aftermath of the GFC has left the market with little flexibility to absorb large fluctuations in the demand for vega *(Display 13).*[23] Today, broker-dealers attempt to outsource their back-book balance sheet needs to hedge funds and, for longer-dated risk, insurance companies who together act as the market's marginal vega suppliers. Hedge funds carry a high cost-of-capital and are almost uniformly liquidity and mark-to-market sensitive, making them finicky counterparties in tumultuous markets. In August, as implied volatility levels expanded and market participants sought to close out shorts and establish tactical long implied volatility positions, there was no counterparty ready and willing to sell incremental vega, and levels spiked. In fact, VIX futures positioning suggests that hedge funds covered their short volatility exposure and bid up implied volatility in August precisely when the market was most in need of an offer *(Display 8).*[24]

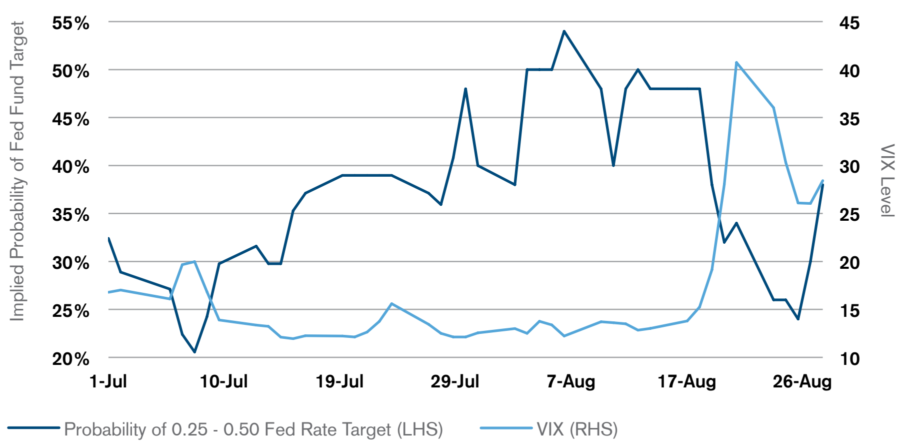
Display 13: Primary Dealer Net Positioning in Major Markets Has Declined Meaningfully Post-GFC



Source: Barclays. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

The challenge of re-introducing conventional monetary policy, particularly in the context of current market structure, was highlighted in August 2015 when the game of chicken between the Fed and risk asset markets ended with the markets blinking first. As risk assets sold off and the VIX spiked, market expectations regarding Fed policy were instantaneously pushed downward and outward, implicitly highlighting the level of asset prices as a critical variable in the Fed's monetary policy reaction function *(Display 14).*

Display 14: August VIX Spike Followed Peak in September Fed Hike Expectations (July 2015 – August 2015)



Source: Credit Suisse Asset Management and Bloomberg. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

What is perhaps most interesting about August's move in the VIX is that, to the extent it was a short squeeze, the "investor fear gauge" as the VIX is widely known, was reflecting a fear that the market's brittle structure was cracking, an endogenous risk, rather than simply the widely cited exogenous macroeconomic risk of spillover effects from China's slowdown and its domestic market turmoil. While beyond the scope of this paper, the contention that August's move was a reaction to a systemic issue appears supported by the poor liquidity and mercurial pricing volatility of a host of ETPs over the course of the month.[25] This episode highlights the value of implied volatility as a hedge against mark-to-market losses and more technically driven sell-offs, particularly those that feature illiquidity and market dysfunctionality. This extends naturally from the calculation of implied volatility which, as we discuss above, inherently results in the inclusion of a variety of liquidity and technical influences one might not ordinarily associate with price uncertainty.

An Allocator's Perspective on Trading Implied Volatility

We believe it is helpful to map implied volatility trading strategies into one of three buckets: (1) volatility premium capture, (2) relative value trading, or (3) hedging. These strategies may be managed discretionarily or systematically. Systematic implementations either seek to provide investors with consistent, static exposures, or they are constructed to generate market timing alpha and offer signal-driven dynamic exposures. These strategies may be accessed by investors through hedge funds, ETPs, OTC derivatives, or structured products. Generally, each exploits one or more of the characteristics of implied volatility discussed in the Properties of Implied Volatility section above.

Volatility Premium Capture

Institutional investors such as pension funds are embracing volatility markets as a channel through which to obtain exposure to attractive risk premiums, either alongside their existing long risk portfolios or as partial equity replacements. For example, PKA, the administrator of five large Danish pension funds with an aggregate €26.1 billion in assets under management, adopted a strategy designed to capture risk premiums and other "market effects" in equities three years ago.[26] In 2014, this program was expanded to other asset classes, including commodities and FX.

The most basic risk premium accessible in the implied volatility market is the positive spread that exists between implied volatility and subsequent realized volatility. Its existence is well documented across a range of underlying asset types. In the case of an equity option, the spread serves to compensate an option seller for bearing the risk that the underlying stock's price gaps upward or downward in a manner incongruent with expectations.[27] The seller is effectively capturing an insurance premium in exchange for assuming this risk.

Likewise, liquidity premiums are prevalent in the implied volatility market. These are visible both in implied volatility smiles and skews and in certain implied volatility term structures. In longer-dated options, bid-ask spreads tend to increase along with the absolute levels of implied volatility as sellers and market makers demand compensation for thin trading volumes and the inherently greater uncertainty that exists further out in time. For options with strikes away from the money, a similar dynamic exists where market depth is thin and sellers demand additional compensation as a means of protection against informational asymmetries and the highly adverse pay-off profile of these options.

Volatility premium capture strategies tend to be short-biased; they generate returns by selling implied volatility. The majority of these strategies target equity implied volatility, but several focus on other asset classes, such as interest rates, commodities, and FX, are available. In addition, some seek to capture risk premiums in multiple markets. Substantial historical data is available to research and back-test implied volatility capture strategies, and investors can easily access them through hedge funds, ETPs, OTC derivatives, or structured products.

The return profiles of these strategies tend to exhibit certain attributes. Because they are short volatility biased, these strategies broadly draw down when asset prices move sharply, and like most underlying asset classes, their return distributions exhibit a negative skew. In other words, the magnitude of losses may be larger than gains. However, their return distributions are also generally leptokurtic, meaning that most of the time, their results are more consistent and clustered around the mean than they would be if they were normally distributed. Importantly, volatility premium capture strategies typically correlate with risk assets, particularly on the downside, and thus many provide little marginal diversification benefit from a portfolio construction standpoint.

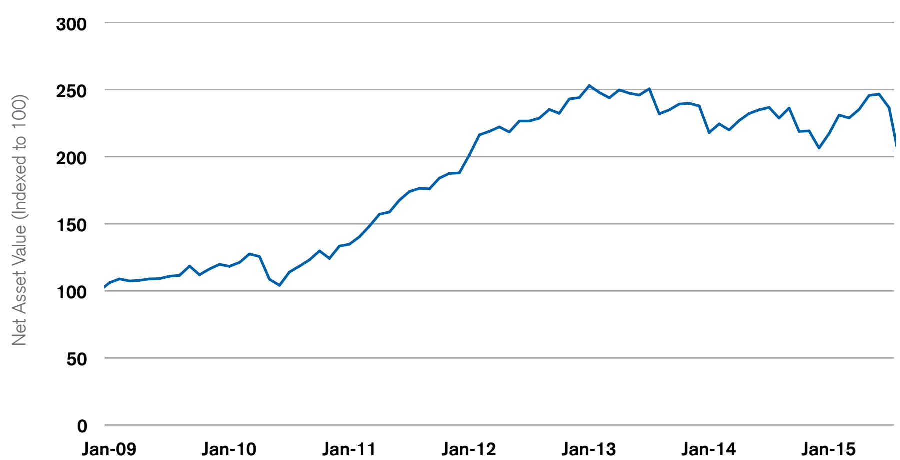
The efficacy of volatility capture strategies varies by asset class and over time. We believe that investors can maximize the benefits of volatility capture strategies in their portfolios by focusing on broader implementations or on those operating in less correlated asset classes and by considering how they are timing their exposures.

Example: Credit Suisse Global Carry Selector I Index

Credit Suisse Global Carry Selector I Index (GCS I) *(Display 15),* is a dynamic broker-dealer algorithm generally accessed via swap (OTC derivative). The strategy seeks to harvest volatility risk premiums in the G3 markets by taking long and short variance swap positions on four equity indices (S&P 500, DAX, Euro Stoxx 50, and Nikkei 225). The strategy relies upon volatility momentum and a term structure indicator to time its exposures. Consistent with most volatility premium capture strategies, GCS I exhibits negative skew *(Display 16)* and relatively high correlation with equity indices *(Display 17).*

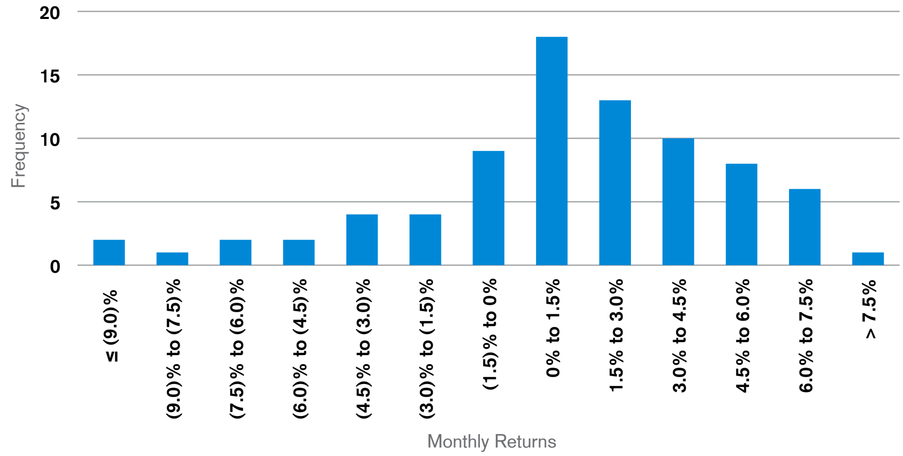
Both in its back-tested and in its live results, GCS I has been effective at capturing the volatility risk premium while limiting severe losses. Its noteworthy drawdowns occurred in May 2010 and August 2015, months that featured heightened investor risk aversion in which equity markets suffered large losses. May 2010 witnessed the Flash Crash and the beginnings of the European Crisis and in August 2015, there was market turmoil in China and the prospect of a move away from zero-interest rate policy in the US. Both episodes raised systemic concerns, which were manifested in spiking risk premiums globally.

Display 15: GCS I Live Performance (January 2009 – August 2015)



Source: Credit Suisse Asset Management and Bloomberg. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

Display 16: GCS I Monthly Returns Exhibit a Negative Skew (January 2009 – August 2015)



Source: Credit Suisse Asset Management and Bloomberg. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

Display 17: GCS I Key Performance Statistics (January 2009 – August 2015)

	CS GCS I
Annualized Return	10.92%
Annualized Volatility	15.11%
Sharpe Ratio	0.72
Maximum Drawdown	-21.17%
Skew	-1.25
Kurtosis	2.91
Correlation with MSCI World	0.44

Source: Credit Suisse Asset Management

Relative Value Trading

Relative value trading encompasses a set of volatility trading strategies which focus on one or more of the following areas: exploiting the mean-reversionary behavior of implied volatility, trading implied volatility spreads on an inter-regional or inter-market basis, or taking directional views on implied correlations which are derived by comparing the implied volatility of an index versus those of its constituents.

Provisioning liquidity to the market in order to exploit the mean reversionary tendency of implied volatility is central to relative value trading. A simple strategy might involve comparing a prevailing implied volatility level to an historical average and establishing a vega position (long or short) based upon the sign and magnitude of the differential. A more sophisticated implementation might account for recent realized volatility levels and condition on the prevailing skew and term structure of implied volatility.

Some relative value trading strategies express views on differences in the levels of implied volatility on an inter-regional basis. These are also inherently liquidity provisioning strategies given the differences are typically seen as a function of market idiosyncrasies such as structural supply-demand imbalances. For example, implied volatility has tended to trade at relatively low levels in Japan, which many attribute to the selling of implied volatility by retail investors seeking incremental yield (e.g., Uridashi bonds). In contrast, S&P 500 implied volatility trades relatively rich, particularly in near-dated options, given index hedging demand. Relative value trading strategies may also seek to take advantage of pricing discrepancies in the implied volatility surfaces of similar indices, such as those of the S&P 500 and the Russell 2000. Another common relative value trading strategy is the expression of directional views on prevailing implied correlation levels either via correlation swaps or through the much more operationally intensive trading of options on index constituents versus options on an index.

Executing relative value strategies is generally complicated given the factors that must be accounted for in implementation. These include both timing and sizing decisions, as well as the output of a continual analysis of market technicals. These strategies are usually accessed through discretionary hedge fund managers, many of whom are reluctant to discuss their investment methodologies. Recently, a small set of hedge funds and broker-dealers have sought to build dynamic algorithms focused on the relative value trading space that broadly target sophisticated institutional investors.

There may be notable contrasts in the risk and return profiles of relative value funds, related to strategy objective and implementation differences. Generally speaking, relative value trading strategies exhibit lower Greek exposures (e.g., lower vega) than volatility premium capture or hedging strategies, which may allow them to withstand large adverse moves in underlying markets and to perform across market cycles. Frequent periods of higher implied volatility or elevated volatility of volatility, provide attractive backdrops for relative value trading strategies.

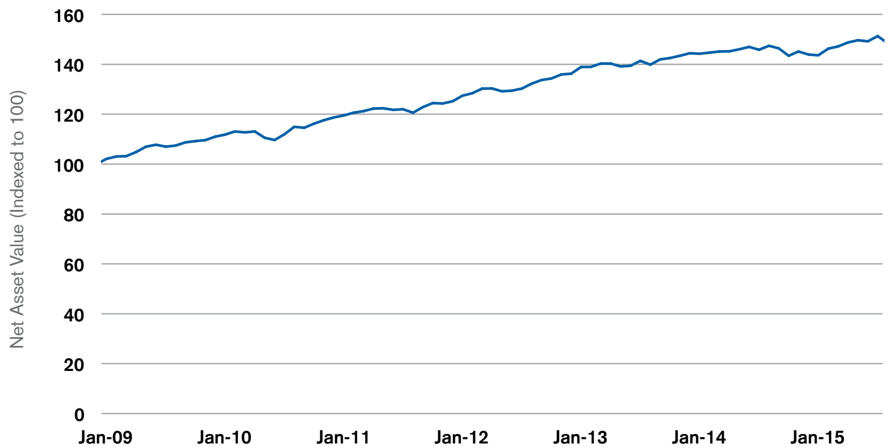
These strategies, if implemented successfully, typically exhibit higher Sharpe ratios and better drawdown profiles than volatility premium capture schemes.[28] In addition, they tend to have lower correlations to risk assets than volatility premium capture strategies, which makes them interesting from a portfolio construction standpoint. Nonetheless, investors are frequently concerned about the higher notional leverage levels involved in relative value trading, as well as the limited scalability of many implementations.

Example: CBOE Eurekahedge Relative Value Volatility Index

The CBOE Eurekahedge Relative Value Volatility Index is an index of 37 equally weighted constituent funds designed to measure opportunistic or relative value volatility trading-oriented hedge fund performance. Managers whose funds are included in the index may express long, short, or neutral views on volatility with a goal of generating positive absolute return.

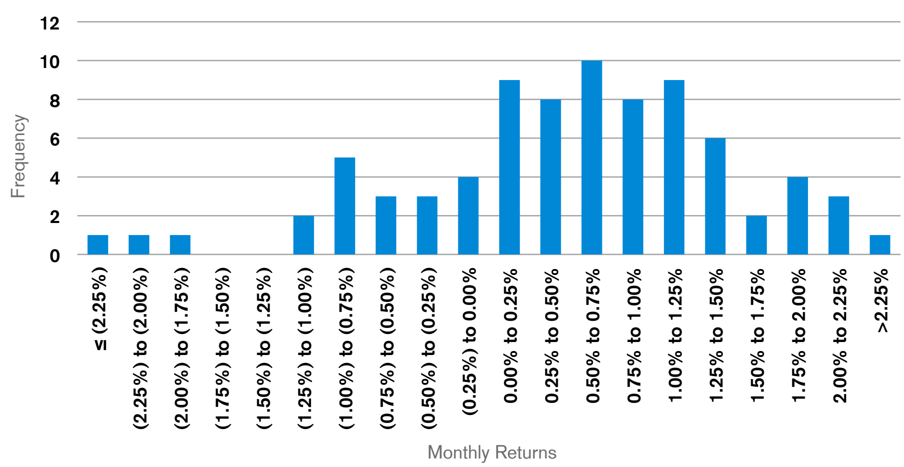
The CBOE Eurekahedge Relative Value Volatility Index has demonstrated steady performance across market cycles with relatively muted volatility *(Display 18).* The index has generally exhibited contained drawdowns, which is a function of index construction methodology, but is also attributable to relative value strategies having lower correlation to broader equity markets than many volatility premium capture strategies *(Display 20).* The index experienced its largest drawdown in the period from May 2010 to June 2010 around the European crisis, but posted its strongest performance in the subsequent two months as market fears were alleviated and implied volatilities normalized.

Display 18: Eurekahedge Relative Value Volatility Index Performance (January 2009 – August 2015)



Source: Credit Suisse Asset Management and Bloomberg. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

Display 19: Eurekahedge Relative Value Volatility Index Monthly Return Distribution (January 2009 – August 2015)



Source: Credit Suisse Asset Management and Bloomberg. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

Display 20: Eurekahedge Relative Value Volatility Index Key Performance Statistics (January 2009 – August 2015)

	Eurekahedge Relative Value Volatility Hedge Fund Index
Annualized Return	6.04%
Annualized Volatility	3.40%
Sharpe Ratio	1.76
Maximum Drawdown	-3.05%
Skew	-0.56
Kurtosis	0.53
Correlation with MSCI World	0.37

Source: Credit Suisse Asset Management

Hedging

Hedging strategies are long implied volatility by nature, and may be implemented within a specific asset class such as equities or across several asset classes. These strategies differ from one another primarily in their approaches to managing option time decay (theta) and in the scale of returns they seek to generate in markets drawdowns (downside or conditional beta). Hedging programs are generally easily adapted to investors' particular circumstances and constraints.

Critical implementation decisions include the set of instruments traded and the maturity profile or tenor of such instruments. These decisions drive much of the differentiation across strategies. Most hedging programs are systematically implemented, which provides users with methodological definition and a high level of certainty regarding return expectations. Methodologies can be quite simple (e.g., periodically spending a fixed amount of capital to buy equity index put options of a set tenor and moneyness) or more sophisticated (e.g., using signals such as the prevailing level of implied volatility to size exposures across a range of asset classes). It is worth noting that given the investor transparency available, rigid implementations may be front-run or otherwise exploited by other market participants.

Hedging strategies may be accessed through a variety of highly liquid wrappers including listed options, ETPs, broker-dealer algorithms, and OTC derivatives. In addition, a handful of large, established hedge fund managers offer commingled "tail risk" funds and customized hedging solutions to a primarily institutional client base.

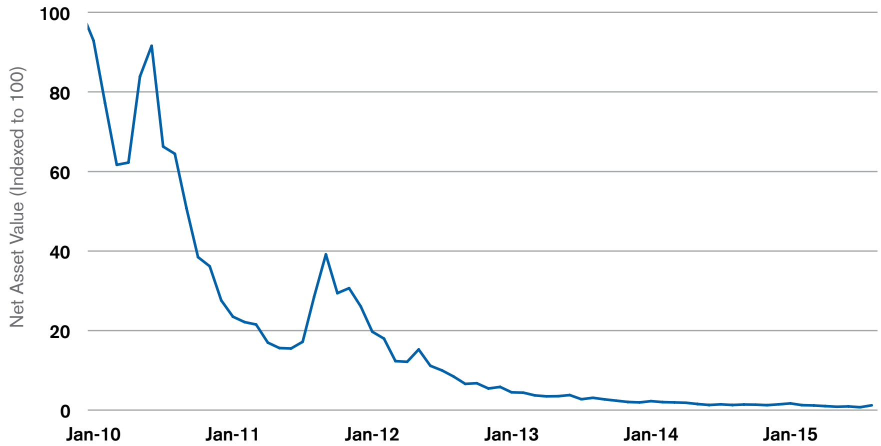
The return profile of hedging strategies tends to be the mirror image of that of volatility premium capture strategies. That is, they consistently bleed small losses as a result of option time decay, but they typically generate outsized positive returns when risk assets sell-off, particularly in periods characterized by heightened systemic risk. It is this negative correlation to risk assets and positive skew that makes hedging strategies attractive in a portfolio context in spite of their tendency to generate negative returns over time, as a result of, among other things, paying the implied-realized volatility premium.

Example: iPath S&P 500 VIX Short-Term Futures ETN

The iPath S&P 500 VIX Short-Term Futures ETN (Bloomberg Ticker: VXX) provides investors with exposure to the S&P 500 VIX Short-Term Futures Index. The index is calculated by rolling long positions in the first and second month VIX futures contracts on a daily basis.

VXX deteriorates over time due to high negative theta associated with carrying long implied volatility exposure *(Display 21).* This erosion is periodically interrupted by spikes in implied and realized volatility driven by heightened systemic risks, most recently in August 2015. While VXX exhibits both a poor annualized return and Sharpe ratio, the distribution of returns is positively skewed *(Display 23).* VXX's strong negative correlation to equities and its ability to generate large gains during market turbulence makes the product a useful hedge in certain portfolios.

Display 21: VXX Performance (January 2010 – August 2015)



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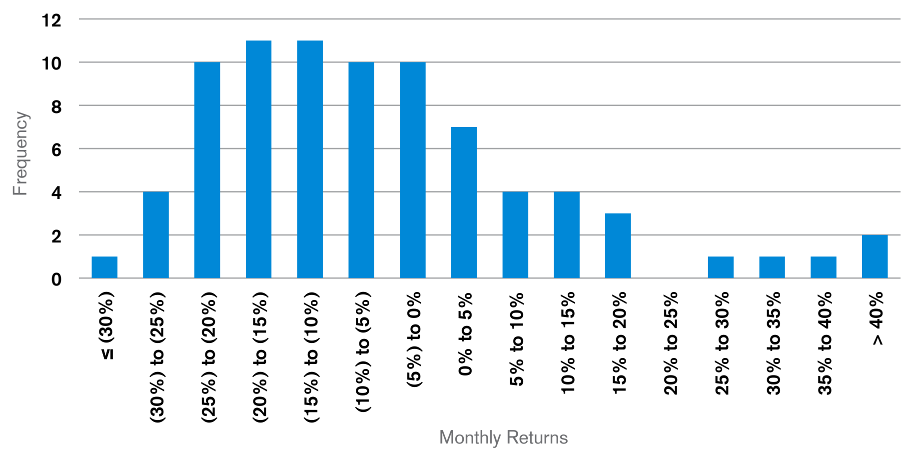
Display 22: VXX Monthly Return Distribution (January 2010 – August 2015)



Source: Credit Suisse Asset Management and Bloomberg. All data was obtained from publicly available information, internally developed data and other third party sources believed to be reliable. Credit Suisse has not sought to independently verify information obtained from public and third party sources and makes no representations or warranties as to accuracy, completeness or reliability of such information.

Display 23: VXX Key Performance Statistics (January 2009 – August 2015)

	iPath S&P 500 VIX Short-Term Futures ETN
Annualized Return	-56.00%
Annualized Volatility	63.05%
Sharpe Ratio	-0.89
Maximum Drawdown	-99.78%
Skew	1.82
Kurtosis	4.90
Correlation with MSCI World	-0.73

Source: Credit Suisse Asset Management

Investment Considerations

Volatility trading strategies are evolving with the volatility market, which itself is experiencing significant regulator-driven structural change and product innovation. Today, a wide range of strategies is available, offering investors several distinct value propositions. We believe that it behooves investors to consider how allocating to volatility strategies may improve the risk-adjusted returns of their portfolios.

This assessment should begin with a careful consideration of the investor's objectives and constraints, as well as a realistic analysis of the resources an investor is willing to deploy around such an allocation. Volatility trading strategies are nuanced, and meaningful work is required to thoughtfully integrate a suitable set of strategies into a portfolio. In addition, many have regime dependencies necessitating ongoing monitoring, particularly against suitable benchmarks. Investors should also consider the extent to which they would like to capture market-timing alpha, either through actively managing their allocations or through allocating to dynamic volatility trading strategies. Clearly, this answer should hinge on an assessment of skill at either level. Many strategies are offered in a variety of wrappers, and optimizing the investment structure may require an assessment of counterparty and operational risk as well as term and contract negotiation.

Investment Analysis

A thorough analysis of volatility trading strategies is both a quantitative and a qualitative undertaking. We see tremendous value in analyzing volatility trading strategies against relevant peer strategies, and we consider a variety of dimensions such as back-tested and live performance results, drawdowns, correlations with broader markets, and scenario analyses in making comparisons within these peer groups. However, a primary consideration is the economic intuition or investment philosophy at the core of the strategy. Our understanding of this helps calibrate our quantitative work in assessing strategy vulnerabilities and key macroeconomic or market regime dependencies. Naturally, our perspectives on market structure and macroeconomic variables such as central bank policy are important considerations in this context.

A thorough investment analysis is not possible without a fundamental understanding of the trading and pricing dynamics of the instruments used in a strategy's implementation, and a careful consideration of the appropriateness of the level of discretion or signal optimization embedded within a strategy.

Market Timing

Market timing can be introduced to volatility trading strategies at one or both of two levels. An investor may utilize the flexible liquidity of many strategy wrappers to actively time portfolio allocations or an investor can select strategies that utilize signals or discretion to time exposures. We call the latter dynamic strategies. Many institutional investors prefer to outsource market timing and elect to invest in dynamic volatility trading strategies such as regime-dependent broker-dealer algorithms or discretionary hedge funds.

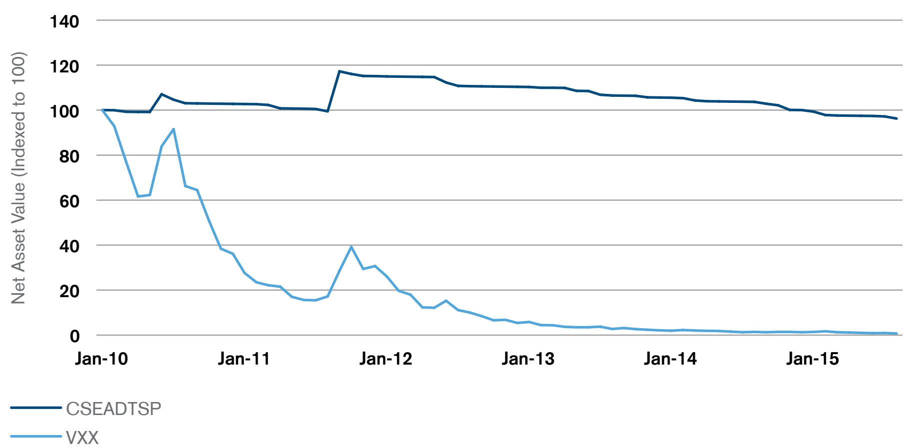
Deciding on an approach to market timing is another critical investment consideration as passive investments in static approaches may provide disappointing risk-adjusted returns for a number of reasons including negative carry and inefficient management of transaction costs. For instance, many hedging ETPs, which have experienced tremendous asset growth and which may be highly profitable portfolio allocations during periods of market dislocation, degrade portfolio returns over time. Indeed, the cost of owning VXX is notable *(Display 21).*

In contrast, some dynamic algorithms may demonstrate an ability to reduce negative carry, while continuing to offer the potential for positive performance in certain risk-off environments. The Credit Suisse Equity Dynamic Tail Hedge SPX Index (Bloomberg ticker: CSEADTSP) was developed with this objective. This product has thus far outperformed VXX by dynamically adjusting its exposure profile on the basis of certain signals *(Display 24).*

Example: Credit Suisse Equity Dynamic Tail Hedge SPX Index

The Credit Suisse Equity Dynamic Tail Hedge SPX Index is a broker-dealer algorithm that seeks to provide equity tail risk protection through exposure to three-month ratio put spreads when indicators such as corporate credit spreads and the level of implied volatility skew in the S&P 500 signal the potential for extreme adverse market moves. Otherwise, it allocates to cash.

Display 24: Passive Investments in Dynamic Strategies May Be More Attractive Than Passive Investments in Static Strategies Over Long Periods (January 2010 – August 2015)



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A variety of implementations including low cost, static strategies may be appropriate for investors seeking exposure to the volatility capture area. Relative value trading strategies are often quite nuanced and complex, generally requiring active management. Consequently, higher cost hedge funds are frequently the investment vehicle of choice in this space. Hedging strategies entail bleed and may require a high degree of client customization to be effective. Either active management of static strategy allocations or allocations to dynamic strategies may be most appropriate for investors interested in hedging strategies.

Conclusion

The GFC was a watershed event for volatility trading strategies on two levels. First, it witnessed the VIX hitting an all-time high of 89.53, which spawned tremendous interest in implied volatility, particularly from the standpoint of its application to portfolio hedging. Second, the GFC catalyzed lasting policy developments. A set of regulatory measures were introduced that changed the structure of the volatility market and ossified broker-dealer back books which had historically been flexible sources of liquidity critical to the market. Simultaneously, G3 central banks introduced broad-scaled QE programs and zero-interest rate policies, which together have succeeded in dampening volatility and increasing investor risk appetite. In the years since the GFC, and in many cases in response to these dynamics, broker-dealers and large asset managers have introduced a host of new implied volatility products which have gained acceptance in the marketplace. We see these developments as contributing substantially to August 2015's VIX spike.

All the while, volatility trading strategies have evolved along with the volatility market and today offer investors a variety of distinct value propositions. They can generally be mapped into three categories: volatility capture, relative value trading, and hedging. We believe that while these strategies are often misunderstood by investors, when used appropriately, they have the potential to improve the risk-adjusted returns of investor portfolios. In our experience allocating to these strategies, the devil is in the details. The breadth of strategies, wrappers, and underlying instruments traded creates a meaningful barrier to allocation for many prudent, resource conscious investors, making this a potentially appropriate area for outsourced or advised investment management.

Acknowledgements

Production of this white paper could not have been possible without the help of many people. We would like to express gratitude for the excellent and useful suggestions of William Bartlett, Tony Becker, Deepak Gulati, William Lee, Dmitry Novikov, Jordan Sinclair, Barry Thomas, and Nicolas Vanhoutteghem. Please note that all views expressed herein are the authors' and do not necessarily represent the views or opinions of these individuals. Any errors or omissions are exclusively the authors' responsibility.

Appendix[29]

The Black–Scholes Greeks are very useful for derivatives traders, especially those who seek to hedge their portfolios from adverse changes in market conditions. The most common of the Greeks are the first order derivatives: Delta, Vega, Theta, and Rho as well as Gamma, a second-order derivative.

- **Delta:** Delta measures the rate of change of the theoretical option value with respect to changes in the underlying asset's price.
- **Vega:** Vega measures sensitivity to volatility. Vega is the derivative of the option value with respect to the volatility of the underlying asset.
- **Theta:** Theta measures the sensitivity of the value of the derivative to the passage of time: the "time decay."
- **Rho:** Rho measures sensitivity to the interest rate: it is the derivative of the option value with respect to the risk free interest rate (for the relevant outstanding term).
- **Gamma:** Gamma measures the rate of change in the delta with respect to changes in the underlying price. Gamma is the second derivative of the value function with respect to the underlying price.

End Notes

1. Follows a lognormal distribution – that is, the natural log of returns on the underlying are normally distributed; Fisher Black and Myron Scholes, “The Pricing of Options and Corporate Liabilities”, The Journal of Political Economy, Volume 81, Issue 3 (May – June, 1973), 637-654
2. Nicholas Bollen and Robert Whaley, “Does Net Buying Pressure Effect the Shape of Implied Volatility Functions”, Journal of Finance, Volume 59, 711-753
3. Dresimir Demeterfi, et. al., “More Than You Ever Wanted to Know About Volatility Swaps”, Goldman Sachs Quantitative Research Notes, March 1999
4. Sebastien Bossu, et al, “Just What You Need to Know About Variance Swaps”, Equity Derivatives, JP Morgan, February 2005
5. Euan Sinclair, “Volatility Trading”, 2nd Edition, John Wiley & Sons, 2013
6. The Equity Derivatives Strategy team corroborates that autocorrelation of short-term implied volatility suggests mean reversion; “Variance Spreads and the Variance Risk Premium”, Systematic Investment Strategies, Credit Suisse Equity Derivatives Strategy, January 17, 2014
7. Robert Whaley, et. al, “Predicting Stock Market Volatility”, The Journal of Futures Markets, Vol. 15, No. 3, 265-302 (1995)
8. Wei Ge, “Understanding the Sources of the Insurance Risk Premium”, Parametric Portfolio Associates, December 2014, http://www.cboe.com/institutional/pdf/parametric-research-brief--understand-sources-insurance-risk-prem.pdf
9. Wei Ge, “Understanding the Sources of the Insurance Risk Premium”, Parametric Portfolio Associates, December 2014, http://www.cboe.com/institutional/pdf/parametric-research-brief--understand-sources-insurance-risk-prem.pdf
10. Wei Ge, “Understanding the Sources of the Insurance Risk Premium”, Parametric Portfolio Associates, December 2014, http://www.cboe.com/institutional/pdf/parametric-research-brief--understand-sources-insurance-risk-prem.pdf
11. Nicolae Garleanu, et al., “Demand-Based Option Pricing”, Review of Financial Studies, 22: 4259-4299, (2009)
12. Stephan Abraham, “The History of Options Contracts”, http://www.investopedia.com/articles/optioninvestor/10/history-options-futures.asp
13. Structured products are synthetic, market-linked investment instruments that can be created to meet specific needs as a pre-packaged investment strategy based on derivatives. Exchange Traded Products (ETPs) are derivatively-priced securities that trade on national securities exchanges. Over-the-counter (OTC) derivatives is a derivative security that is traded in some other context other than on a formal trade exchange
14. The “Asset Manager” category includes investors such as pension funds, endowments, insurance companies, and mutual funds. Participants labeled “Leveraged Funds” are typically hedge funds. We classify a dealer entity providing VIX futures liquidity in the “Dealer” category and would classify a dealer entity managing a retail product book in the “Asset Manager” category. Source: CFTC
15. Source: Bloomberg
16. “The Mighty European Autocall Market”, European Equity Volatility Outlook, Credit Suisse Equity Derivatives Strategy, November 28, 2014
17. “Short Squeeze”, Investopedia, http://www.investopedia.com/terms/s/shortsqueeze.asp
18. We define the G3 as the world’s top three developed economies: USA, Europe and Japan
19. Yung-Shin Kung, et. al. “Implications of Unconventional Federal Reserve Policy on Fixed Income Arbitrage Strategies”, Credit Suisse Asset Management, White Paper, November 2013
20. “The Mighty European Autocall Market”, European Equity Volatility Outlook, Credit Suisse Equity Derivatives Strategy, November 28, 2014
21. Investors are increasingly expanding into risk-premium strategies. The investor base is increasing from institutional and retail investors to pension funds as well; Martin Steward, “Denmark’s PKA to expand pioneering ‘risk-premia’ strategies”, Investments & Pensions Europe (I&PE), January 16, 2014
22. The Treemap was constructed by taking the sum of the average VIX price for each month of the last ten calendar years. The 2015 sum is a year-to-date representation that is current as of September 30, 2015. The sums were compared in relation to each other to generate a relative sizing for analyzing the proportional amount of implied volatility in the market for the respective year
23. “Opportunities and Challenges for Hedge Funds in the Coming Era of Optimization”, Citi Investor Services, https://www.citibank.com/mss/docs/citi_2014_spring_survey_part_2.pdf
24. Inyoung Hwang, “Hedge Fund VIX Positions Double in Bet Stock Turbulence to Last”, Bloomberg, September 8, 2015. http://www.bloomberg.com/news/articles/2015-09-08/hedge-fund-vix-positions-double-in-bet-stock-turbulence-to-last
25. Corrie Driebusch, et. al, “Wild Trading Exposed Flaws in ETFs”, The Wall Street Journal, September 13, 2015
26. Martin Steward, “Denmark’s PKA to expand pioneering ‘risk-premia’ strategies”, Investments & Pensions Europe (I&PE), January 16, 2014

27. Wei Ge, “Understanding the Sources of the Insurance Risk Premium”, Parametric Portfolio Associates, December 2014, http://www.cboe.com/institutional/pdf/parametric-research-brief--understand-sources-insurance-risk-prem.pdf
28. Donald Chambers, et al, “Alternative Investments: CAIA Level I”, CAIA Association, 3rd Edition, 2015
29. John C. Hull, “Fundamentals of Futures and Options Markets”, Prentice Hall, 8th Edition, 2013

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