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Global Equity Derivatives & Delta One Strategy
12 January 2012

Cross-Asset Hedging with VIX

Tools for Trading VIX Options and Futures

Summary

- **Cross-asset hedging:** Over the past five years, investors have witnessed a rise in cross-asset correlations, with high macroeconomic volatility a key driver. When prices move together, investors can hedge one asset with tradeable instruments from another asset class. This cross-asset hedging can be optimal if the proxy hedge is more liquid, costs less, or provides a better entry point compared to a direct hedge. Against these benefits, investors should consider tracking risk that can come from correlation breakdown, or asset trending. However, the cross-asset tracking risk can benefit investors by avoiding the negative impact of 'crowded hedge' unwinds, and providing better entry points due to lead/lag relationships between different assets.
- **VIX:** Given macro volatility drives the performance and correlation of various assets, one can use volatility itself as a hedge against adverse asset moves. The VIX index, which represents short-term implied volatility of the S&P 500, is highly correlated with Credit, Rates, Equities, FX, and Commodities. For this reason, VIX-based products can be used for cross-asset hedging. Over the past three years, liquidity of VIX futures and options increased significantly due to growth in VIX-based structured products, ETFs, and ETNs.
- **Equities:** With almost $2T of notional options open interest, the S&P 500 is the most actively hedged index globally. Given the VIX measures volatility of the S&P 500, hedging S&P 500 with VIX is the most logical cross-asset hedge. Hedging S&P 500 with VIX options makes sense if the VIX hedge is cheaper than the S&P 500 option hedge. Given the different properties of VIX and S&P 500 index options, we propose a simple framework for comparing prices of VIX call spreads to S&P 500 put spreads. In addition to comparison of option prices, investors should look for divergences between VIX and S&P 500 to identify attractive entry levels.
- **Credit and other asset classes:** Investors may find it fascinating that VIX futures currently have higher correlation to US and European Credit spreads than to the S&P 500 itself. Aside from hedging Credit, VIX can be used to hedge Commodities, Interest Rates, and Currencies. To set up a cross-asset hedge, an investor needs to determine cross-asset 'beta' and matching notional exposures. The investor can then look at the levels and changes in cross-asset performance to determine whether the entry point is attractive and compare the cost of hedges. J.P. Morgan Derivatives Strategy team regularly calculates cross-asset Z-score matrices.
- **Which 'VIX' contract to use:** When designing a cross-asset VIX hedge, an investor needs to choose the maturity of VIX future or option. Holding a long position in VIX futures or call options in an upward-sloping term structure results in a negative carry. Shorter-dated VIX futures provide more volatility exposure than longer-dated VIX futures but typically suffer a larger term structure slide. One method is to select the VIX future that offers the highest volatility exposure for the same term structure slide. Flows from VIX structured products, ETFs, and ETNs can result in term structure shifts that favor holding one future over another, and even create long volaltility positive carry opportunities. Our analyses can be readily applied to other index volatility futures such as V2X (EuroStoxx 50), and soon-to-be-launched VXEEM (MSCI EM),VNKY (Nikkei 225), and VHSI (Hang Seng) futures.

Global Equity Derivatives & Delta One Strategy

Marko Kolanovic[AC] (Global Head)
(1-212) 272-1438
mkolanovic@jpmorgan.com
J.P. Morgan Securities LLC

Davide Silvestrini (EMEA)
(44-20) 7777-1018
davide.silvestrini@jpmorgan.com
J.P. Morgan Securities Ltd.

Tony SK Lee (Asia Pacific)
(852) 2800-8857
tony.sk.lee@jpmorgan.com
J.P. Morgan Securities (Asia Pacific) Limited

Michiro Naito (Japan)
(81-3) 6736-1352
michiro.naito@jpmorgan.com
JPMorgan Securities Japan Co., Ltd.

Equity Derivatives Strategy

US

Marko Kolanovic	mkolanovic@jpmorgan.com
Adam Rudd	adam.ch.rudd@jpmorgan.com
Amyn Bharwani	amyn.x.bharwani@jpmorgan.com
Kapil Dhingra	kapil.dhingra@jpmorgan.com
Min Moon	min.k.moon@jpmorgan.com

EMEA

Davide Silvestrini	davide.silvestrini@jpmorgan.com
Bram Kaplan	bram.kaplan@jpmorgan.com
Peng Cheng	peng.cheng@jpmorgan.com

Asia Ex-Japan

Tony Lee	tony.sk.lee@jpmorgan.com
Clara Law	clara.cs.law@jpmorgan.com
Sue Lee	sue.sj.lee@jpmorgan.com

Japan

Michiro Naito	michiro.naito@jpmorgan.com
Hayato Ono	hayato.ono@jpmorgan.com

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Marko Kolanovic
(1-212) 272-1438
MKolanovic@jpmorgan.com

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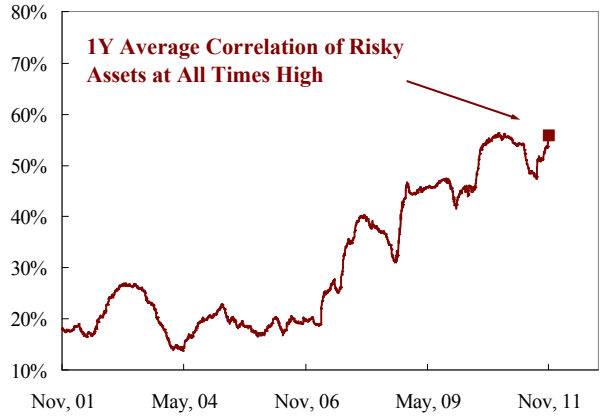
Cross-Asset Hedging with VIX

Over the past five years, investors have witnessed a rise in cross-asset correlations (Figure 1).[1] One of the key drivers of cross-asset correlation has been recently high macroeconomic volatility. When prices move together, investors can hedge one asset with tradable instruments from another asset class. This cross-asset hedging can be optimal if the proxy hedge is more liquid, costs less, or provides better entry point as compared to a direct hedge. Against these benefits, investors should consider tracking risk that can come from correlation breakdown, or asset trending. However, the cross-asset tracking risk can benefit investors by avoiding the negative impact of 'crowded hedge' unwinds, and providing a better entry point due to lead/lag relationships between different assets. These benefits of cross-asset hedging can be called 'hedge diversification'.

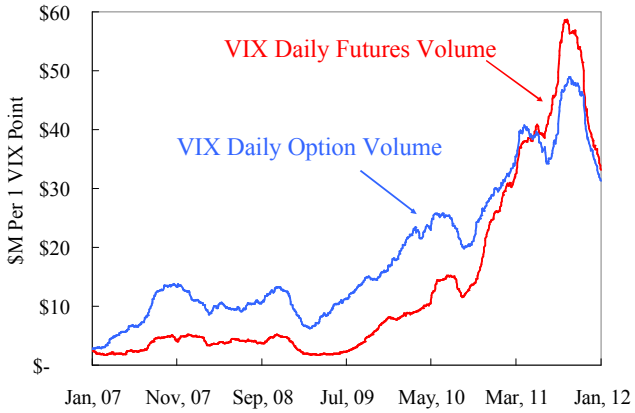
Given that macro volatility drives performance and correlation of various assets, one can use volatility itself as a hedge against adverse asset moves. The VIX index, which represents the short-term implied volatility of the S&P 500, is highly correlated with Credit, Rates, Equities, FX, and Commodities. For this reason, VIX-based products can be used for cross-asset hedging. Over the past three years, liquidity of VIX futures and options increased significantly due to growth in VIX-based structured products, ETFs, and ETNs, and demand from institutional hedgers (Figure 2).

Figure 1: Average Correlation of Equities, Credit, FX, Long-Term Interest Rates, and Commodities



Source: J.P. Morgan Equity Derivatives Strategy.

Figure 2: Three-Month Average Daily Volume of VIX Futures and Options (Expressed in $M per 1 Point in VIX)



Source: J.P. Morgan Equity Derivatives Strategy.

Hedging Equities

With almost $2T of notional options open interest, the S&P 500 is the most actively hedged index globally. Given that the VIX measures volatility of the S&P 500, hedging S&P 500 with VIX is the most logical cross-asset hedge. Similarly, small-cap investors can use VIX to hedge Russell 2000 exposure.

Hedging S&P 500 with VIX options makes sense if the VIX hedge is cheaper than the S&P 500 option hedge. However, a direct comparison of S&P 500 option and VIX option hedges is not easy. Unlike the S&P 500, the VIX is a mean-reverting quantity, and VIX futures of different maturities provide different exposure to spot VIX.[2] The term structure of VIX futures also has its own dynamics that can result in a negative or positive PnL contribution.

An attractive feature of the VIX is that spikes tend to be faster and significantly larger than the corresponding moves in the S&P 500. This 'convexity' makes VIX options and futures an attractive hedge. However, there are also undesirable effects of holding VIX instruments. For instance, term structure slide can create a performance drag, and the mean reversion can make the option payoff sensitive to timing, and hence less certain.

[1] For a review of cross-asset correlations, see our report: Rise of Cross-Asset Correlations: Asset Class Roadmap for Equity Investors.
[2] Note that spot VIX is not tradable. See discussion later in this report and Options on Implied Volatility report.

Marko Kolanovic
(1-212) 272-1438
MKolanovic@jpmorgan.com

Given the significant differences between VIX and S&P 500 index options, we propose a simplified framework for comparing prices of VIX and S&P 500 options-based hedges. To make an unbiased assessment, we compare the price of VIX call spreads to the price of S&P 500 put spreads, thus limiting the payoff of both instruments and eliminating convexity bias. We compare one-month options held to expiry, eliminating issues of different mark-to-market properties of VIX and S&P 500 options. For instance, if the S&P 500 drops 10% in a month (at the expiry), the expected increase of the VIX would be 10 points.[3] Assuming a 'beta' of VIX to S&P 500 of 100 (i.e., a 1% move in the S&P 500 corresponds to a 1 point move in the VIX), we would compare the price of, for example, a 100-90% S&P 500 put spread to an ATM, ATM+10 pts VIX call spread; the price of a 90-80% S&P 500 put spread to an ATM+10, ATM+20 VIX call spread; and so on. Figure 3 below compares the price of one-month S&P 500 Put spreads to one-month VIX Call spreads as of January 10th. Current pricing is fairly in line with VIX call spreads being slightly more expensive than the S&P 500 put spreads. For instance, the VIX ATM+5, ATM+15 call spread costs about 20bps more than the 95-85% S&P 500 put spread.[4] Historically, pricing of VIX call spreads has been fairly in line with pricing of S&P 500 put spreads. Figure 4 shows an example of a one-month 95-85% S&P 500 put spread and the price of an ATM+5, ATM+15 VIX call spread. While the pricing was in line on average, there have been times when VIX call spreads appeared cheaper or richer than the S&P 500 put spreads.

Figure 3: Comparison of S&P 500 Put Spread Prices to VIX Call Spread Prices (Table Shows Price Difference)

Cost of SPX Puts (Mid)

Put	Strike	Cost
SPX 100P	1295	2.43%
SPX 95P	1230	1.00%
SPX 90P	1165	0.40%
SPX 85P	1100	0.19%
SPX 80P	1035	0.12%

Cost of VIX Calls (Mid)

Call	Strike	Cost
VIX 100C	20.0	4.22
VIX +'5' C	25.0	1.99
VIX +'10' C	30.0	1.15
VIX +'15' C	35.0	0.65
VIX +'20' C	40.0	0.41

Cost VIX C. Spreads - Cost of SPX P. Spreads

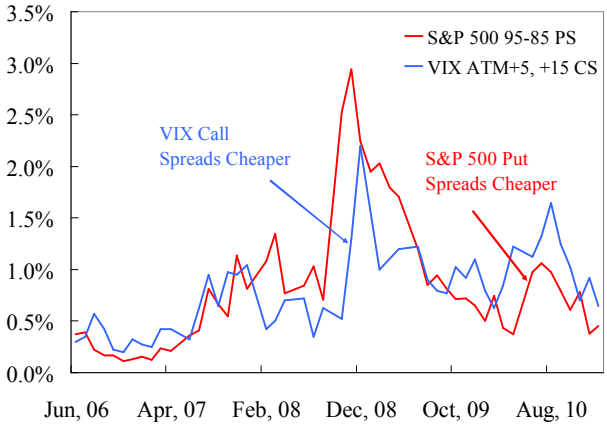
SPX	ATM	+5%	+10%	+15%	+20%
ATM	1.7%	0.7%	0.9%	1.2%	1.4%
+5%	--	1.0%	0.2%	0.5%	0.7%
+10%	--	--	0.7%	0.3%	0.5%
+15%	--	--	--	0.5%	0.2%
+20%	--	--	--	--	0.3%

Option Expiry / Days

SPX	Feb, 18	39
VIX	Feb, 15	36

Source: J.P. Morgan Equity Derivatives Strategy.

Figure 4: Historical Comparison of S&P 500 95-85% Put Spread Price (% of Notional) to ATM+5, ATM+15 VIX Call Spread Price (1% = 1 VIX Point)



Source: J.P. Morgan Equity Derivatives Strategy.

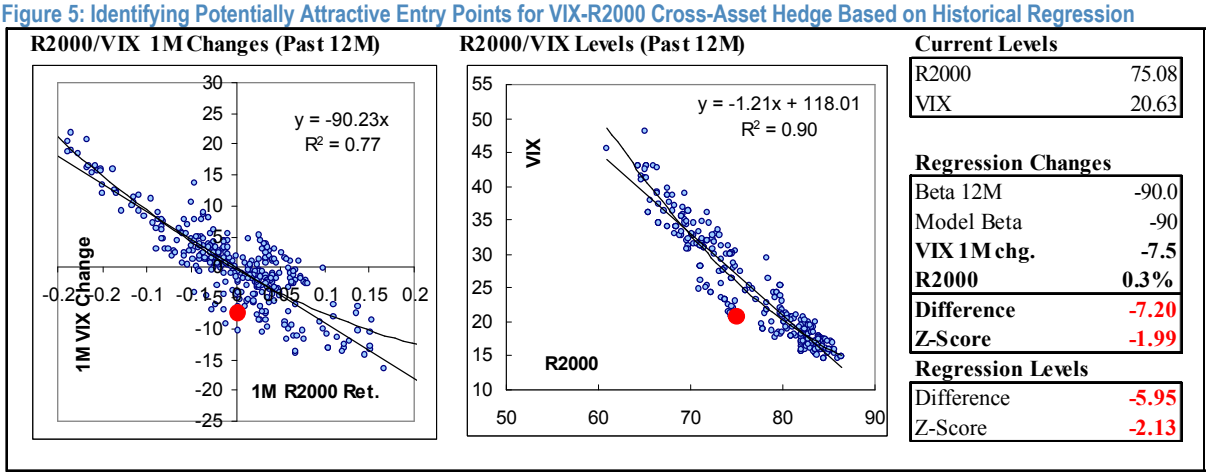
The entry level for the VIX cross-asset hedge is perhaps more important than the price differential between S&P 500 and VIX options. Investors should look for divergences between the VIX and S&P 500 that could provide lower VIX entry levels. For example, buying VIX calls can be attractive when the VIX declines more than what is expected based on the S&P 500 move. To assess the entry level, investors should look at both the levels and recent changes relative to S&P 500. A comparison is performed in the framework of historical time-series regression that produces 'Z-scores', i.e., the number of standard deviations that the current level (or change) diverges from the historical regression. Figure 5 below shows such analysis for the Russell 2000 against the VIX (as of January 9th). Based on the historical regression, the VIX dropped two standard deviations (Z-score -1.99) relative to the Russell 2000 in the past month, and its level is more than ~2 standard deviations below what would be expected based on the historical regression. This would indicate that the VIX level currently provides a good entry point for hedging the Russell 2000 index.

[3] This would correspond to long-term historical VIX 'beta' of 100 with respect to S&P 500. In our models, VIX beta is an input parameter, and investors can compare VIX and S&P 500 hedges under different VIX beta assumptions. For instance, most recently, VIX beta was 125.

[4] Assuming a higher (more recent) beta of VIX would make VIX options look cheaper.

Marko Kolanovic
(1-212) 272-1438
MKolanovic@jpmorgan.com

Figure 5: Identifying Potentially Attractive Entry Points for VIX-R2000 Cross-Asset Hedge Based on Historical Regression

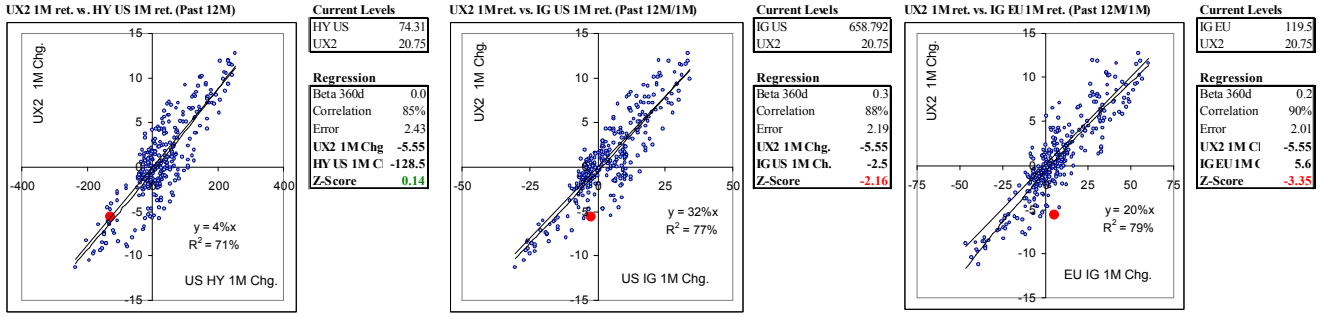


Source: J.P. Morgan Equity Derivatives Strategy.

Hedging Credit and Other Asset Classes

Investors may find it fascinating that the VIX futures currently have higher correlation to US and European Investment Grade (IG) and High Yield (HY) Credit spreads than to the S&P 500 itself.[5] The strong correlation of VIX to credit is a result of the current risk-on/off macro environment but also reflects active cross-asset hedging and arbitrage activity. As discussed in Equity-VIX hedging, investors should look for cross-asset divergences that point to attractive entry levels for VIX-based credit hedges. This can be accomplished by comparing levels and changes of VIX against credit spreads. Figure 6 below shows the regression analysis of second-month VIX future against US HY Credit, IG Credit, and European IG Credit. While the past-month change of the VIX future appears to be in line with the move in US HY spreads, the VIX future has dropped significantly more relative to the US IG spread, resulting in a divergence of ~2.2 standard deviations. This would suggest that hedging the US IG spread with second-month VIX futures is attractive at this point. An even larger divergence is found between the VIX and European IG spread (Z-score of ~3.4) creating a cross-asset, cross-regional hedging opportunity.

Figure 6: Regression Analysis of Second-Month VIX Future to US HY (5Y CDX HY), US IG (5Y CDX IG), and European IG Credit Spreads (5Y ITRX EUR) – One-Month Changes



Source: J.P. Morgan Equity Derivatives Strategy.

[5] Over the past year, correlation of second-month VIX Futures to S&P 500 was 84%, and to US HY, US IG, EU IG, and EU HY credit spreads 85%, 88%, 90%, and 87%, respectively.

To set up a cross-asset hedge, an investor first needs to determine a cross-asset 'beta'. This 'beta' is used to determine matching notional exposures of hedged and hedging assets. For instance, the second-month VIX future has generally increased ~3.2 points for every 10bps increase in credit spreads. This represents a beta of 0.32 (see Figure 6, Middle). To hedge US IG exposure of $100K per bp, an investor would need to acquire ~$300K per point exposure in VIX. Exposure of $300K per point would correspond to 300 second-month VIX futures or 3,000 second-month VIX option contracts.

After establishing 'beta' and matching exposures, an investor can then look at the levels and changes in cross-asset performance to determine if the entry point is attractive. Finally, one needs to compare the cost of hedges. In the example above, the second-month VIX future appears to be more than 5 points lower than US IG spread, based on historical regression analysis (Z-score of 2.16).

Similarly, VIX futures and options can be used to hedge Commodities, Interest Rates, and Currencies, as well as volatility of these asset classes. The J.P. Morgan Derivatives Strategy team regularly calculates cross-asset correlation levels, and Z-score matrices for relative asset level and changes. These tools can be used to assess attractive entry points for cross-asset hedging. Examples of a cross-asset correlation matrix and cross-asset Z-score matrix are shown in Appendix I. Please contact us for updated levels and opportunity assessments.

Which VIX Contract to Use?

When designing a cross-asset VIX hedge, an investor needs to choose the maturity of the VIX future or option. Holding a long position in VIX futures or call options in an upward-sloping term structure environment results in a negative carry. As the contract matures, its value is reduced because of the term structure slide.[6] Over the past 20 years, the VIX term structure was upward sloping 80% of the time. Carrying a long volatility exposure (long VIX beta) would have resulted in a significant cost most of the time. One can think of this negative carry as an implicit cost of the protection provided by the long volatility exposure.

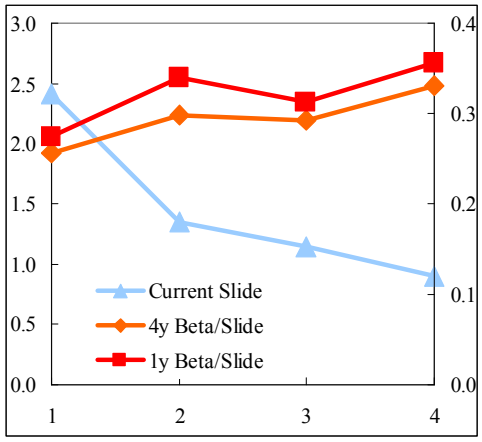
Shorter-dated VIX futures provide more volatility exposure (i.e., have higher 'beta' to VIX) than longer-dated VIX futures. However, shorter-dated VIX futures typically suffer a larger term structure slide as well. Figure 7 shows a snapshot of VIX term structure (as of January 6th) as well as the term structure slide and beta/slide ratio for every point of the curve.

In an environment in which the term structure is expected to be stable, a long volatility investor should select the VIX future that offers the highest volatility exposure (VIX beta) for the same term structure slide. For instance, the second-month future has a one-year beta of 0.46 and term structure slide of 1.35 points. The front-month future has a beta of 0.67 but a much higher slide of 2.42 points. Taking the ratio of beta to slide, the second-month future looks more attractive (0.34) than the front-month future (0.28). The reason for the difference is the structural impact of VIX ETFs and ETNs that currently sell the second-month future and buy the first-month future thus distorting the VIX term structure.7 Supply/demand forces can occasionally create long volatility and positive carry opportunities. These opportunities are not without risk, as an investor is exposed to quick changes in term structure.

[6] This term structure slide is also called 'contango roll', 'term structure carry', etc. Cost is incurred as the future contract converges towards VIX spot level trading below the future contract.
[7] For more details on structural VIX flows and their impact on term structure see: VIX Term Structure Analysis and Impact of VXX US Hedging.

Figure 7: Term Structure Slide and Beta for 1st-, 2nd-, 3rd-, and 4th-Month VIX Futures (Data as of January 6th) – The 1st-Month Future Has the Highest Term Structure Slide (2.42 Points) and the Highest Beta to VIX (0.67); The 2nd- and 4th-Month Futures Have Higher Beta/Slide Ratio, as Compared to the 1st- and 3rd-Month Futures

VIX Futures Slide (left) and Beta/Slide (right)



VIX Term Structure, Changes, and Futures Slide

Future	Level	Change		Slide (and %-tile)		
	Curr.	1D	1W	Curr.	4Y%	1Y%
VIX Spot	**20.63**	-0.85	-2.77	--	--	--
UX1	**23.05**	-0.70	-3.65	**2.42**	88%	85%
UX2	**24.40**	-0.50	-2.75	**1.35**	53%	19%
UX3	**25.55**	-0.45	-2.20	**1.15**	79%	47%
UX4	**26.45**	-0.35	-1.95	**0.90**	89%	70%

Futures Beta to VIX, Beta/Slide

Future	Beta to VIX				Beta/slide	
	4Y	2Y	1Y	6M	4Y	1Y
UX1	0.62	0.65	**0.67**	0.68	0.26	**0.28**
UX2	0.40	0.47	**0.46**	0.45	0.30	**0.34**
UX3	0.34	0.38	**0.36**	0.35	0.29	**0.31**
UX4	0.30	0.34	**0.32**	0.31	0.33	**0.36**

Source: J.P. Morgan Equity Derivatives Strategy.

Our VIX analytics tools introduced in this report can be readily applied to other index volatility futures such as EuroStoxx 50 V2X futures, and soon-to-be-launched MSCI EM: VXEEM, Nikkei 225: VNKY, and Hang Seng: VHSI futures.[8,9]

[8] For more details of V2X options, see Options on Implied Volatility.
[9] For details of VNKY and VHSI futures, see HSI Volatility Index Futures.

Marko Kolanovic
(1-212) 272-1438
MKolanovic@jpmorgan.com

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Appendix I: Cross-Asset Correlation Matrix, 1-M Changes Z-Score Matrix

Figure 8: Cross-Asset Correlation Matrix

	S&P 500	R2000	VIX	UX1	UX2	UX3	R2000 Vol	NDX Vol	EM Vol	SX5E Vol	DAX Vol	HSI Vol	NKY Vol	KOSPI Vol	Correlation	HY US	IG US	IG EU	HY EU	20y TSY	1y IR Vol	10y IR Vol	Eur Vol	Yen Vol	Euro	Oil	Oil Vol	Copper	GDX Vol	GLD Vol
S&P 500	--	98%	-95%	-94%	-91%	-87%	-94%	-94%	-92%	-92%	-92%	-89%	-52%	-89%	-68%	-84%	-85%	-84%	-84%	-78%	-61%	-65%	-76%	-21%	38%	83%	-81%	65%	-84%	-88%
R2000	98%	--	-94%	-95%	-94%	-92%	-96%	-92%	-94%	-92%	-94%	-91%	-44%	-91%	-75%	-89%	-88%	-89%	-90%	-84%	-65%	-68%	-80%	-12%	48%	83%	-82%	74%	-87%	-90%
VIX	-95%	-94%	--	98%	93%	90%	99%	99%	96%	97%	96%	94%	58%	94%	67%	84%	84%	83%	83%	77%	62%	73%	81%	30%	-28%	-80%	89%	-64%	90%	92%
UX1	-94%	-95%	98%	--	97%	95%	99%	96%	97%	97%	98%	95%	54%	95%	74%	89%	91%	90%	90%	84%	67%	73%	82%	19%	-38%	-78%	88%	-72%	89%	95%
UX2	-91%	-94%	93%	97%	--	99%	96%	91%	95%	94%	96%	92%	47%	92%	82%	94%	95%	95%	94%	90%	71%	68%	82%	7%	-48%	-71%	83%	-80%	85%	93%
UX3	-87%	-92%	90%	95%	99%	--	94%	88%	93%	92%	95%	91%	42%	90%	87%	95%	96%	96%	96%	92%	73%	68%	83%	0%	-52%	-67%	80%	-83%	83%	91%
R2000 Vol	-94%	-96%	99%	99%	96%	94%	--	98%	98%	97%	97%	95%	52%	95%	72%	87%	88%	88%	88%	82%	66%	76%	83%	21%	-38%	-80%	89%	-71%	92%	95%
NDX Vol	-94%	-92%	99%	96%	91%	88%	98%	--	95%	95%	93%	93%	61%	92%	63%	81%	82%	80%	79%	73%	61%	73%	78%	33%	-26%	-80%	89%	-61%	90%	90%
EM Vol	-92%	-94%	96%	97%	95%	93%	98%	95%	--	95%	96%	95%	45%	94%	70%	88%	90%	87%	86%	81%	70%	82%	86%	17%	-53%	-81%	91%	-72%	93%	93%
SX5E Vol	-92%	-92%	97%	97%	94%	92%	97%	95%	95%	--	99%	95%	55%	95%	72%	87%	88%	89%	88%	82%	64%	72%	85%	22%	-34%	-79%	86%	-68%	86%	93%
DAX Vol	-92%	-94%	96%	98%	96%	95%	97%	93%	96%	99%	--	96%	52%	97%	76%	91%	92%	92%	91%	87%	62%	67%	87%	17%	-38%	-78%	87%	-75%	88%	95%
HSI Vol	-89%	-91%	94%	95%	92%	91%	95%	93%	95%	95%	96%	--	56%	97%	71%	87%	88%	87%	87%	82%	66%	74%	83%	23%	-33%	-78%	86%	-73%	90%	92%
NKY Vol	-52%	-44%	58%	54%	47%	42%	52%	61%	45%	55%	52%	56%	--	52%	16%	33%	38%	30%	28%	25%	13%	40%	29%	70%	15%	-33%	59%	-20%	43%	46%
KOSPI Vol	-89%	-91%	94%	95%	92%	90%	95%	92%	94%	95%	97%	97%	52%	--	70%	87%	88%	88%	87%	83%	63%	68%	84%	22%	-32%	-78%	86%	-73%	90%	94%
Correlation	-68%	-75%	67%	74%	82%	87%	72%	63%	70%	72%	76%	71%	16%	70%	--	91%	89%	92%	91%	94%	66%	40%	73%	-33%	-63%	-48%	56%	-89%	61%	69%
HY US	-84%	-89%	84%	89%	94%	95%	87%	81%	88%	87%	91%	87%	33%	87%	91%	--	98%	98%	97%	97%	70%	53%	83%	-13%	-51%	-65%	73%	-88%	80%	85%
IG US	-85%	-88%	84%	91%	95%	96%	88%	82%	90%	88%	92%	88%	38%	88%	89%	98%	--	98%	96%	96%	69%	54%	84%	-7%	-47%	-64%	74%	-88%	81%	87%
IG EU	-84%	-89%	83%	90%	95%	96%	88%	80%	87%	89%	92%	87%	30%	88%	92%	98%	98%	--	99%	98%	73%	58%	84%	-15%	-58%	-66%	72%	-87%	76%	87%
HY EU	-84%	-90%	83%	90%	94%	96%	88%	79%	86%	88%	91%	87%	28%	87%	91%	97%	96%	99%	--	97%	74%	59%	81%	-16%	-62%	-67%	71%	-87%	77%	86%
20y TSY	-78%	-84%	77%	84%	90%	92%	82%	73%	81%	82%	87%	82%	25%	83%	94%	97%	96%	98%	97%	--	65%	46%	81%	-21%	-59%	-60%	68%	-92%	74%	81%
1y IR Vol	-61%	-65%	62%	67%	71%	73%	66%	61%	70%	64%	62%	66%	13%	63%	66%	70%	69%	73%	74%	65%	--	69%	62%	-20%	-56%	-52%	46%	-56%	56%	59%
10y IR Vol	-65%	-68%	73%	73%	68%	68%	76%	73%	82%	72%	67%	74%	40%	68%	40%	53%	54%	58%	59%	46%	69%	--	59%	26%	-32%	-67%	64%	-37%	74%	70%
Eur Vol	-76%	-80%	81%	82%	82%	83%	83%	78%	86%	85%	87%	83%	29%	84%	73%	83%	84%	84%	81%	81%	62%	59%	--	5%	-38%	-76%	69%	-75%	82%	85%
Yen Vol	-21%	-12%	30%	19%	7%	0%	21%	33%	17%	22%	17%	23%	70%	22%	-33%	-13%	-7%	-15%	-16%	-21%	-20%	26%	5%	--	45%	-17%	30%	26%	23%	21%
Euro	38%	48%	-28%	-38%	-48%	-52%	-38%	-26%	-53%	-34%	-38%	-33%	15%	-32%	-63%	-51%	-47%	-58%	-62%	-59%	-56%	-32%	-38%	45%	--	31%	-24%	61%	-46%	-34%
Oil	83%	83%	-80%	-78%	-71%	-67%	-80%	-80%	-81%	-79%	-78%	-78%	-33%	-78%	-48%	-65%	-64%	-66%	-67%	-60%	-52%	-67%	-76%	-17%	31%	--	-70%	52%	-81%	-79%
Oil Vol	-81%	-82%	89%	88%	83%	80%	89%	89%	91%	86%	87%	86%	59%	86%	56%	73%	74%	72%	71%	68%	46%	64%	69%	30%	-24%	-70%	--	-63%	91%	84%
Copper	65%	74%	-64%	-72%	-80%	-83%	-71%	-61%	-72%	-68%	-75%	-73%	-20%	-73%	-89%	-88%	-88%	-87%	-87%	-92%	-56%	-37%	-75%	26%	61%	52%	-63%	--	-72%	-72%
GDX Vol	-84%	-87%	90%	89%	85%	83%	92%	90%	93%	86%	88%	90%	43%	90%	61%	80%	81%	76%	77%	74%	56%	74%	82%	23%	-46%	-81%	91%	-72%	--	91%
GLD Vol	-88%	-90%	92%	95%	93%	91%	95%	90%	93%	93%	95%	92%	46%	94%	69%	85%	87%	87%	86%	81%	59%	70%	85%	21%	-34%	-79%	84%	-72%	91%	--

Source: J.P. Morgan Equity Derivatives Strategy.

Figure 9: Cross-Asset 1-M Changes Z-Score Matrix

	S&P 500	R2000	VIX	UX1	UX2	UX3	R2000 Vol	NDX Vol	EM Vol	SX5E Vol	DAX Vol	HSI Vol	NKY Vol	KOSPI Vol	Correlation	HY US	IG US	IG EU	HY EU	20y TSY	1y IR Vol	10y IR Vol	Eur Vol	Yen Vol	Euro	Oil	Oil Vol	Copper	GDX Vol	GLD Vol
S&P 500	--	-1.2	-1.5	-1.1	-1.7	-1.7	-1.3	-1.4	-1.2	-0.9	-0.8	-0.5	0.0	0.0	**-2.0**	**-2.3**	0.1	0.8	**1.0**	0.9	-1.0	-1.2	-0.9	-0.1	-1.7	-0.3	0.2	-0.7	-0.9	-0.4
R2000	**1.2**	--	-1.9	-1.6	**-2.0**	**-2.0**	-2.0	-1.9	-1.7	-1.3	-1.2	-0.9	-0.2	-0.2	**-2.2**	**-2.6**	-0.2	0.5	0.7	0.6	-1.0	-1.3	-1.0	-0.3	-1.7	-0.1	0.0	-0.6	-1.3	-0.6
VIX	-1.1	-1.7	--	0.3	-0.7	-0.9	0.2	-0.1	-0.2	0.2	0.4	0.4	0.6	**1.1**	-1.8	-1.2	0.7	**1.4**	**1.5**	**1.5**	-0.8	-0.8	-0.5	0.5	-1.7	-0.7	**1.3**	-0.9	-0.3	0.4
UX1	-0.8	-1.3	-0.6	--	-1.2	-1.4	-0.5	-0.6	-0.5	-0.2	0.1	0.2	0.4	0.9	-1.8	-1.4	0.8	**1.6**	**1.8**	**1.5**	-0.8	-0.9	-0.6	0.2	-1.8	-0.6	1.0	-0.9	-0.5	0.4
UX2	-1.2	-1.6	0.1	0.8	--	-0.7	0.3	0.1	0.1	0.3	0.8	0.5	0.6	**1.1**	-1.6	-0.9	**1.8**	**3.1**	**2.8**	**2.3**	-0.6	-0.7	-0.4	0.3	**-2.0**	-0.7	1.0	-1.1	-0.2	0.8
UX3	-1.2	-1.5	0.3	0.9	0.4	--	0.5	0.2	0.3	0.5	0.9	0.6	0.7	**1.1**	-1.5	-0.7	**1.8**	**3.1**	**2.6**	**2.1**	-0.5	-0.6	-0.3	0.4	-1.9	-0.6	**1.0**	-1.1	-0.2	0.9
R2000 Vol	-1.0	-1.7	-0.4	0.2	-0.8	-1.1	--	-0.4	-0.3	0.1	0.3	0.4	0.5	**1.1**	-1.8	-1.2	0.7	**1.5**	**1.6**	**1.6**	-0.8	-0.8	-0.5	0.3	-1.8	-0.8	**1.2**	-1.0	-0.3	0.5
NDX Vol	-1.1	-1.6	0.0	0.3	-0.7	-0.9	0.1	--	-0.1	0.1	0.3	0.4	0.7	1.0	-1.7	-1.2	0.8	**1.4**	**1.5**	**1.4**	-0.7	-0.8	-0.5	0.4	-1.8	-0.7	**1.3**	-1.0	-0.3	0.4
EM Vol	-0.9	-1.5	-0.1	0.2	-0.6	-0.9	0.0	-0.2	--	0.0	0.3	0.5	0.7	**1.1**	-2.0	-1.1	**1.0**	**1.5**	**1.7**	**1.6**	-0.7	-0.8	-0.4	0.4	-1.9	-0.7	**1.2**	-1.2	-0.2	0.4
SX5E Vol	-0.6	-0.9	-0.5	-0.2	-0.9	-1.2	-0.4	-0.5	-0.5	--	0.3	0.2	0.5	0.9	-1.8	-1.3	0.5	**1.4**	**1.4**	**1.2**	-0.8	-0.9	-0.6	0.3	-1.8	-0.6	0.9	-0.8	-0.5	0.3
DAX Vol	-0.5	-1.0	-0.7	-0.4	-1.2	-1.4	-0.7	-0.7	-0.7	-0.5	--	0.0	0.3	0.9	-1.9	-1.4	0.6	**1.6**	**1.7**	**1.5**	-0.9	-1.0	-0.7	0.2	-1.8	-0.6	0.8	-0.9	-0.6	0.3
HSI Vol	-0.2	-0.6	-0.9	-0.6	-1.1	-1.3	-0.8	-0.9	-0.9	-0.6	-0.4	--	0.3	0.9	-1.9	-1.5	0.3	0.9	**1.0**	0.9	-0.9	-1.1	-0.8	0.1	-1.6	-0.5	0.6	-0.9	-0.7	-0.1
NKY Vol	0.3	0.0	-1.1	-0.9	-1.3	-1.5	-1.0	-1.2	-1.1	-0.9	-0.8	-0.6	--	-0.1	**-2.0**	-1.6	-0.1	0.4	0.5	0.4	-1.0	-1.3	-0.9	-0.2	-1.6	-0.1	0.1	-0.5	-0.9	-0.5
KOSPI Vol	0.3	-0.1	-1.4	-1.2	-1.6	-1.7	-1.4	-1.4	-1.4	-1.2	-1.1	-1.0	-0.1	--	-2.0	-1.8	-0.1	0.6	0.7	0.6	-1.0	-1.3	-1.0	-0.2	-1.7	-0.2	0.1	-0.6	-1.2	-0.5
Correlation	-0.6	-0.8	-0.2	0.0	-0.2	-0.2	-0.1	-0.2	0.1	-0.1	0.1	-0.1	0.3	0.2	--	-0.7	0.7	**1.6**	**1.5**	**1.6**	-0.5	-0.9	-0.2	-0.1	**-2.6**	-0.4	0.4	-1.4	-0.2	0.3
HY US	-1.8	**-2.2**	0.2	0.6	0.1	-0.2	0.4	0.3	0.4	0.2	0.5	0.6	0.5	**1.1**	-1.5	--	**2.4**	**2.4**	**2.7**	**2.1**	-0.5	-0.8	-0.4	0.2	**-2.0**	-0.9	0.9	-1.5	0.0	0.6
IG US	0.3	-0.1	-1.2	-1.1	**-2.2**	**-2.2**	-1.2	-1.2	-1.3	-0.9	-0.9	-0.6	-0.1	-0.1	**-2.1**	**-2.8**	--	1.0	**1.0**	0.7	-1.0	-1.2	-1.0	-0.2	-1.8	-0.1	0.0	-0.7	-1.0	-0.5
IG EU	0.8	0.4	-1.7	-1.8	**-3.4**	**-3.4**	-1.7	-1.6	-1.8	-1.6	-1.8	-1.0	-0.3	-0.6	**-2.5**	**-2.8**	-1.0	--	0.3	0.1	-1.2	-1.5	-1.4	-0.4	-1.7	0.1	-0.2	-0.3	-1.2	-1.2
HY EU	**1.0**	0.6	-1.8	-1.9	**-3.0**	**-2.9**	-1.9	-1.7	-1.9	-1.6	-1.8	-1.1	-0.3	-0.7	**-2.5**	**-3.0**	-1.0	-0.2	--	0.0	-1.2	-1.5	-1.3	-0.4	-1.7	0.2	-0.3	-0.3	-1.3	-1.3
20y TSY	0.9	0.5	-1.7	-1.7	**-2.6**	**-2.5**	-1.8	-1.7	-1.8	-1.4	-1.7	-1.0	-0.3	-0.6	**-2.5**	**-2.5**	-0.7	0.1	0.2	--	-1.0	-1.4	-1.4	-0.4	-1.7	0.2	-0.3	-0.3	-1.5	-1.2
1y IR Vol	0.1	-0.1	-0.7	-0.6	-0.9	-1.0	-0.7	-0.7	-0.6	-0.6	-0.6	-0.4	-0.1	0.0	-1.8	-1.2	0.2	0.7	0.8	0.4	--	-0.9	-0.7	-0.3	-1.9	-0.1	0.0	-0.5	-0.8	-0.3
10y IR Vol	-0.1	-0.4	-0.3	-0.2	-0.7	-0.8	-0.2	-0.4	-0.4	-0.1	-0.1	0.2	0.4	0.5	-1.8	-1.2	0.2	0.9	0.9	0.7	-0.5	--	-0.5	0.2	-1.6	-0.5	0.6	-0.6	-0.5	0.1
Eur Vol	-0.1	-0.4	-0.6	-0.4	-0.8	-1.0	-0.5	-0.6	-0.4	-0.3	-0.2	-0.2	0.0	0.3	-1.8	-1.2	0.3	**1.1**	0.9	**1.1**	-0.7	-0.9	--	0.1	**-2.2**	-0.5	0.4	-1.1	-0.4	0.2
Yen Vol	0.2	-0.1	-1.0	-0.8	-1.2	-1.3	-0.9	-1.0	-0.9	-0.8	-0.7	-0.5	0.1	0.0	-2.0	-1.5	-0.1	0.4	0.5	0.4	-1.0	-1.2	-0.9	--	-1.6	-0.1	0.1	-0.5	-0.9	-0.4
Euro	0.6	0.4	-1.1	-1.1	-1.7	-1.7	-1.1	-1.2	-1.3	-1.0	-1.0	-0.6	0.0	-0.4	**-2.8**	-1.9	-0.6	-0.5	-0.4	-0.5	-1.4	-1.1	-1.7	0.1	--	0.6	-0.2	0.2	-1.1	-0.7
Oil	0.4	0.1	-1.2	-1.0	-1.4	-1.5	-1.2	-1.2	-1.2	-1.0	-0.9	-0.8	-0.2	-0.3	**-2.0**	-1.7	-0.2	0.3	0.4	0.3	-1.0	-1.3	-1.1	-0.3	-1.7	--	-0.1	-0.5	-1.3	-0.6
Oil Vol	0.4	0.0	-1.6	-1.3	-1.5	-1.7	-1.5	-1.6	-1.5	-1.2	-1.1	-0.9	-0.2	-0.2	**-2.0**	-1.7	-0.2	0.4	0.5	0.4	-1.0	-1.4	-1.0	-0.3	-1.7	-0.1	--	-0.6	-1.5	-0.6
Copper	0.6	0.4	-1.3	-1.2	-1.6	-1.7	-1.3	-1.3	-1.4	-1.0	-1.1	-1.0	-0.3	-0.5	**-2.4**	**-2.1**	-0.5	0.1	0.2	0.0	-1.0	-1.3	-1.4	-0.4	-1.6	0.3	-0.3	--	-1.8	-0.8
GDX Vol	-0.4	-0.9	-0.3	-0.2	-0.7	-0.9	-0.2	-0.3	-0.3	-0.2	-0.1	0.2	0.4	0.8	-2.0	-1.0	0.5	0.8	**1.0**	**1.2**	-0.8	-0.9	-0.5	0.3	-1.8	-0.9	**1.2**	-1.6	--	0.3
GLD Vol	0.0	-0.4	-0.9	-0.8	-1.3	-1.5	-0.9	-0.9	-0.9	-0.7	-0.6	-0.4	0.0	0.3	-2.0	-1.5	0.2	**1.1**	**1.2**	**1.1**	-0.9	-1.1	-0.8	0.0	-1.7	-0.4	0.4	-0.8	-0.8	--

Source: J.P. Morgan Equity Derivatives Strategy.

Appendix II: VIX Futures and Options Contract Specifications

The VIX (CBOE Volatility Index) is a measure of the expected future volatility of the S&P 500 index. The VIX reflects the market expectation for 30-day S&P 500 volatility, based on S&P 500 option prices. Its calculation is not dependent on an option pricing model but is based on the mid-prices of short-dated call and put options across the entire skew surface. Further information on the VIX calculation can be found in the VIX White Paper.[10] A published historical record of VIX prices since 1990 can be found on the CBOE website and is available on Bloomberg.

VIX Futures

It is not practicable to invest directly in the VIX spot price, since replication would require dynamically investing in the full portfolio of options used in the calculation of the VIX. However, VIX Futures and VIX Options can be traded directly. We provide the salient details for the VIX Futures and VIX Options in the following two tables.

Figure 10: VIX Futures Contract Specifications

VIX Futures	
Exchange	CFE (CBOE Futures Exchange)
VIX Futures Tickers	**UX*MY*** Index *M* = Month symbol: F (Jan), G (Feb), H (Mar), J (Apr), K (May), M (Jun), N (Jul), Q (Aug), U (Sep), V (Oct), X (Nov), Z (Dec) *Y* = Calendar year: 2 (2012), 3 (2013) …
Trading Hours	**8:00am - 4:15pm EST (7:00am - 3:15pm CST)** Regular trading hours for VIX futures are 9:30am - 4:15pm EST (8:30am - 3:15pm CST) and extended trading hours are 8:00am EST (7:00am CST) until the regular trading hours begin. On the final settlement date, trading hours for the expiring VIX futures are 8:00am - 9:15am EST (7:00am - 8:15am CST) and the final settlement value is determined afer the market open.
Contract Value	**The contract multiplier for each VIX futures contract is $1000.**
Tick size	**The tick size is 0.05 points, or $50 per contract.** *Spread trades (individual legs and net prices) may be in increments of 0.01 index points, or $10.*
Final Settlement Date	**The Wednesday thirty days prior to the third Friday of the following calendar month.** If that Friday is a holiday, the final settlement date is thirty days prior to the preceding business day. Trading terminates on the final settlement date of the VIX futures contract.
Final Settlement Value	The final settlement value for VIX futures is the Special Opening Quotation (SOQ) calculated from the opening prices of the S&P 500 options used in the VIX index calculation, on the settlement date. The final settlement value is rounded to the nearest $0.01.
Historical Values	**VRO Index** provides the historical monthly VIX settlement values.
Margin Requirements	For outright VIX Futures trades, the Initial Margin required for a speculative position is $8,600 and Maintenance Margin is $6,900. For a calendar spread within a single maturity tier (the two maturity tiers are 1-3 months and 4-14 months) Initial Margin is $625 and Maintenace Margin $500. For a calendar spread across both maturity tiers, Initial Margin is $1,250 and Maintenace Margin $1,000.
Delivery	VIX futures contracts are cash settled. The final mark to market amount, based on the final settlement value of the VIX futures contract and multiplied by $1000, is delivered on the business day immediately following the final settlement date.

Source: J.P. Morgan Equity Derivatives Strategy, CBOE.

[10] http://www.cboe.com/micro/vix/vixwhite.pdf.

VIX Options

Figure 11: VIX Options Contract Specifications

VIX Options	
Exchange	CBOE
Trading Hours	**9:30am - 4:15pm EST (8:30am - 3:15pm CST)** VIX options do not begin trading until the S&P 500 opening rotation is completed.
Contract Value	**The contract multiplier for each VIX option contract is $100.**
Tick Size	Option premiums are quoted in points and fractions where one point has a value of $100. The minimum tick for options trading below $3 is 0.05 ($5 value) and above $3 is 0.10 ($10 value).
Strike Price Intervals	The intervals between strike prices for VIX options are not less than $1 and vary by strike price. Currently strike price intervals are $5 for strikes <= $15, intervals are $1 for strikes between $15 and $30, intervals are $2.50 for strikes from $30 to $50 and intervals are $5 for strikes >= $50.
Expiry Date	**The Wednesday thirty days prior to the third Friday of the following calendar month.** If that Friday is a holiday, the settlement date is thirty days prior to the preceding business day. The VIX option expiry date is the same as the final settlement date for the VIX Future.
Last Trading Day	The Last Trading Day is the business day prior to the Expiry Date.
Option Expiry Style	**European** - VIX options may be exercised only on the expiration date.
Exercise-Settlement Value	The exercise-settlement value that dictates a VIX option payoff is the Special Opening Quotation (SOQ) calculated from the opening prices of the S&P 500 options used in the VIX index calculation, on the settlement date. The final settlement value is rounded to the nearest $0.01.
Historical Values	**VRO Index** provides historical monthly VIX exercise-settlement values.
Margin Requirements	Generally, buyers of options must pay the premium in full. Sellers of uncovered puts or calls require margin equal to the option value plus 15% of the current index level minus the amount by which the option is out-of-the-money, if any, subject to a minimum for calls of option value plus 10% of the index value and a minimum for puts of option value plus 10% of the strike price.
Delivery	VIX option contracts are cash settled. The exercise-settlement amount, equal to the difference between the exercise-settlement value and the exercise price of the option and multiplied by $100, is delivered on the business day immediately following expiration.

Source: J.P. Morgan Equity Derivatives Strategy, CBOE.

For further research on VIX Futures and Options, please see our recent publications: Global Derivatives Themes – 2012 Outlook for Equity Derivatives; VIX Term Structure Analysis, Impact of VXX Hedging, and Options on Implied Volatility.

Risks of Common Option Strategies

Risks to Strategies: Not all option strategies are suitable for investors; certain strategies may expose investors to significant potential losses. We have summarized the risks of selected derivative strategies. For additional risk information, please call your sales representative for a copy of "Characteristics and Risks of Standardized Options." We advise investors to consult their tax advisors and legal counsel about the tax implications of these strategies. Please also refer to option risk disclosure documents.

Put Sale. Investors who sell put options will own the underlying asset if the asset's price falls below the strike price of the put option. Investors, therefore, will be exposed to any decline in the underlying asset's price below the strike potentially to zero, and they will not participate in any price appreciation in the underlying asset if the option expires unexercised.

Call Sale. Investors who sell uncovered call options have exposure on the upside that is theoretically unlimited.

Call Overwrite or Buywrite. Investors who sell call options against a long position in the underlying asset give up any appreciation in the underlying asset's price above the strike price of the call option, and they remain exposed to the downside of the underlying asset in the return for the receipt of the option premium.

Booster. In a sell-off, the maximum realized downside potential of a double-up booster is the net premium paid. In a rally, option losses are potentially unlimited as the investor is net short a call. When overlaid onto a long position in the underlying asset, upside losses are capped (as for a covered call), but downside losses are not.

Collar. Locks in the amount that can be realized at maturity to a range defined by the put and call strike. If the collar is not costless, investors risk losing 100% of the premium paid. Since investors are selling a call option, they give up any price appreciation in the underlying asset above the strike price of the call option.

Call Purchase. Options are a decaying asset, and investors risk losing 100% of the premium paid if the underlying asset's price is below the strike price of the call option.

Put Purchase. Options are a decaying asset, and investors risk losing 100% of the premium paid if the underlying asset's price is above the strike price of the put option.

Straddle or Strangle. The seller of a straddle or strangle is exposed to increases in the underlying asset's price above the call strike and declines in the underlying asset's price below the put strike. Since exposure on the upside is theoretically unlimited, investors who also own the underlying asset would have limited losses should the underlying asset rally. Covered writers are exposed to declines in the underlying asset position as well as any additional exposure should the underlying asset decline below the strike price of the put option. Having sold a covered call option, the investor gives up all appreciation in the underlying asset above the strike price of the call option.

Put Spread. The buyer of a put spread risks losing 100% of the premium paid. The buyer of higher-ratio put spread has unlimited downside below the lower strike (down to zero), dependent on the number of lower-struck puts sold. The maximum gain is limited to the spread between the two put strikes, when the underlying is at the lower strike. Investors who own the underlying asset will have downside protection between the higher-strike put and the lower-strike put. However, should the underlying asset's price fall below the strike price of the lower-strike put, investors regain exposure to the underlying asset, and this exposure is multiplied by the number of puts sold.

Call Spread. The buyer risks losing 100% of the premium paid. The gain is limited to the spread between the two strike prices. The seller of a call spread risks losing an amount equal to the spread between the two call strikes less the net premium received. By selling a covered call spread, the investor remains exposed to the downside of the underlying asset and gives up the spread between the two call strikes should the underlying asset rally.

Butterfly Spread. A butterfly spread consists of two spreads established simultaneously – one a bull spread and the other a bear spread. The resulting position is neutral, that is, the investor will profit if the underlying is stable. Butterfly spreads are established at a net debit. The maximum profit will occur at the middle strike price; the maximum loss is the net debit.

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