CBOE HOLDINGS℠

EXECUTE SUCCESS℠

Contract Design & Trading of VIX® and Other Listed Volatility Derivatives

CBOE RMC Europe Conference
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Topics

- **Update:** CBOE Short Term Volatility Index (VXST^{SM})

- **Re-Launch:** S&P 500® Variance Futures

- **Enhancement**: VIX® Index… *now with SPX Weeklys^{SM}*

- **Deep Dive:** VIX® Settlement Process

- **Coming soon:** CBOE/CBOT 10-year US Treasury Note Volatility Index Futures

- **Questions**

Update: CBOE Short Term Volatility Index (VXST^{SM} Index)

- Measures 9-day expected volatility of S&P 500® Index

- First volatility index to use SPX Weeklys^{SM} options

- VXST futures & options used for:

  - Trading around events
  - Term structure plays
  - Risk premium capture

- Particularly responsive to SPX moves; almost twice the volatility of the VIX® Index

- VXST futures launched February 13, 2014; options launched April 10, 2014.
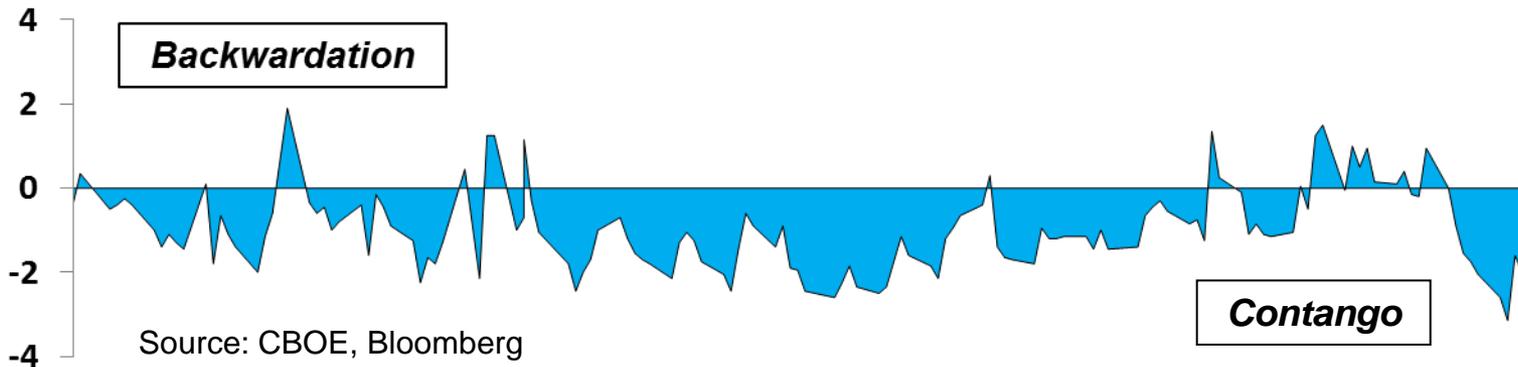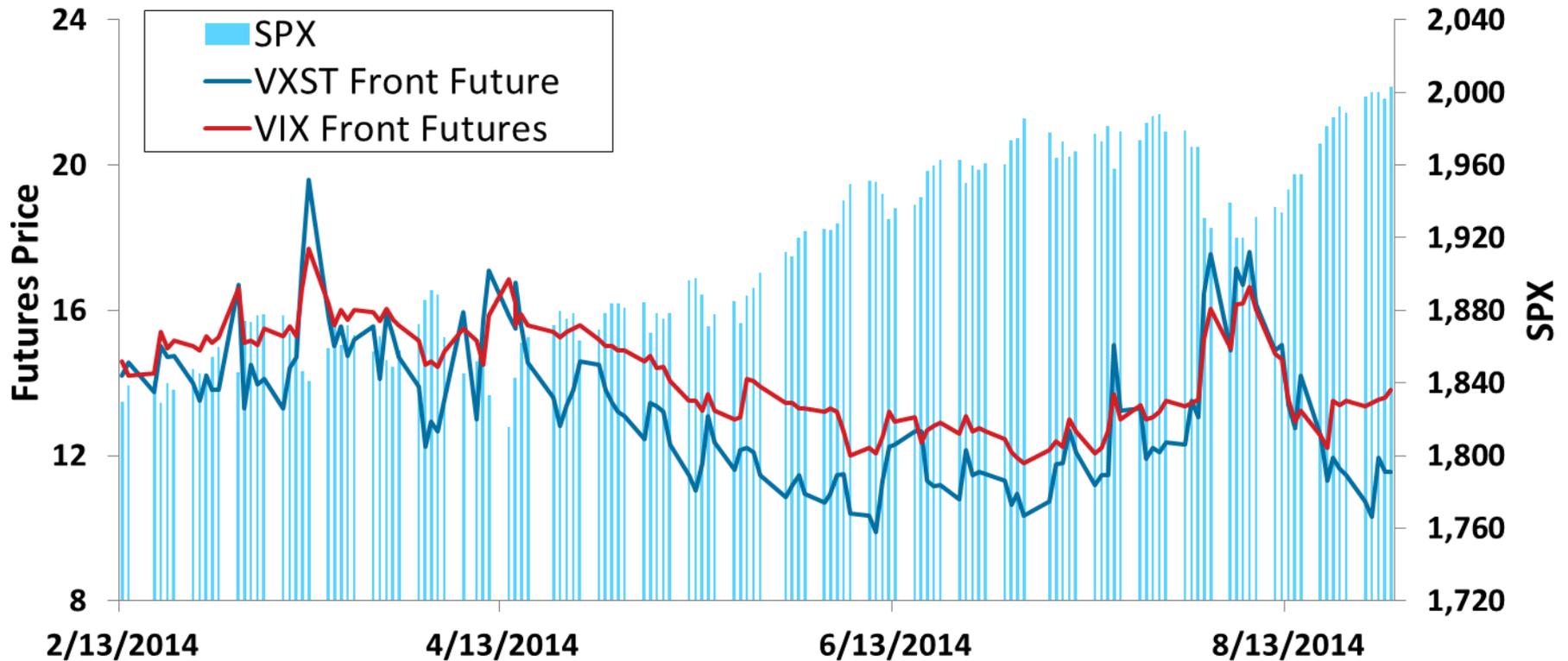
VXST vs. VIX Indexes

❖ **Sensitivity and Timing**

❖ **Relative Volatilities**

❖ **Option Pricing**

Event specific

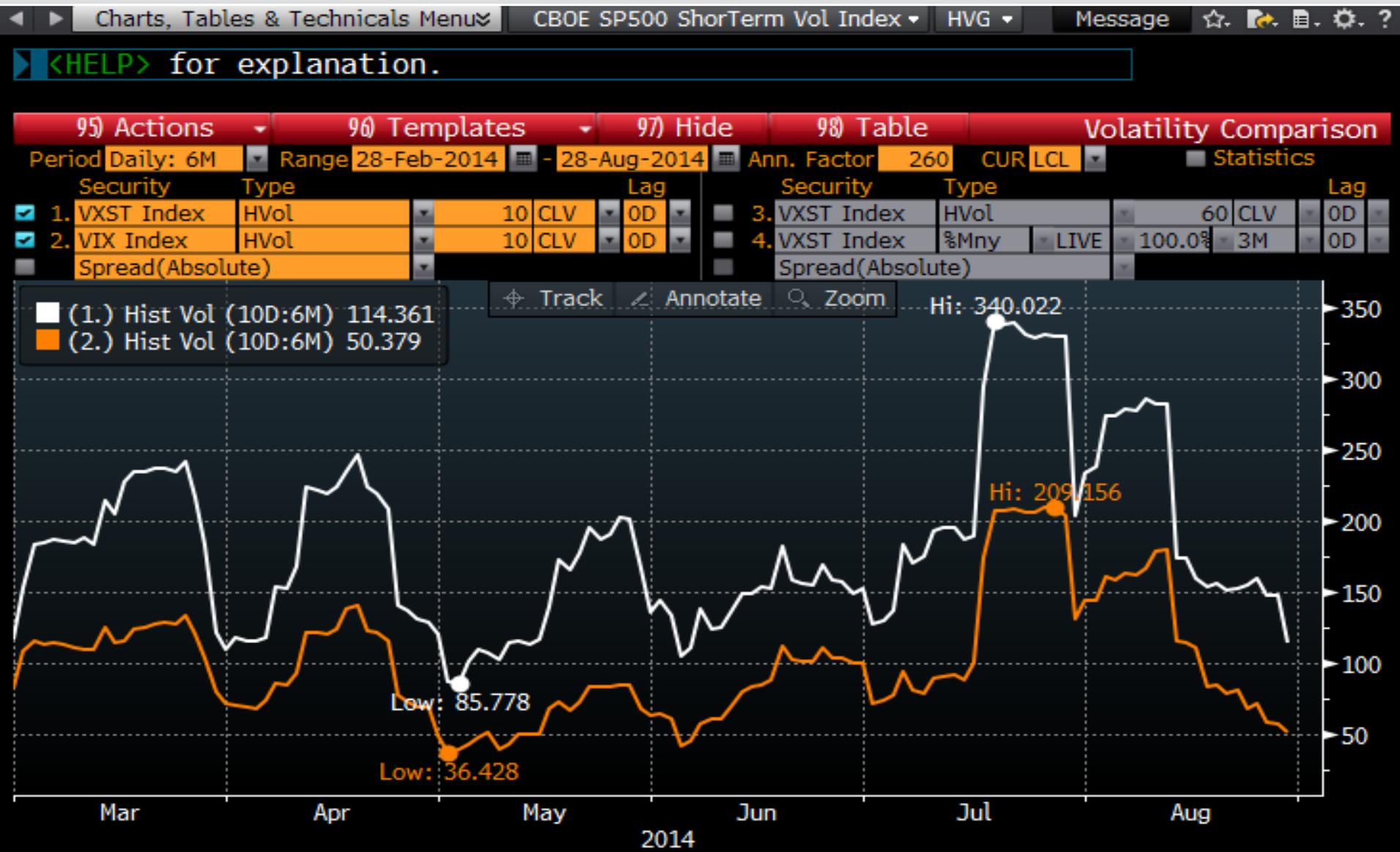**What do you want to own if they actually say something?**
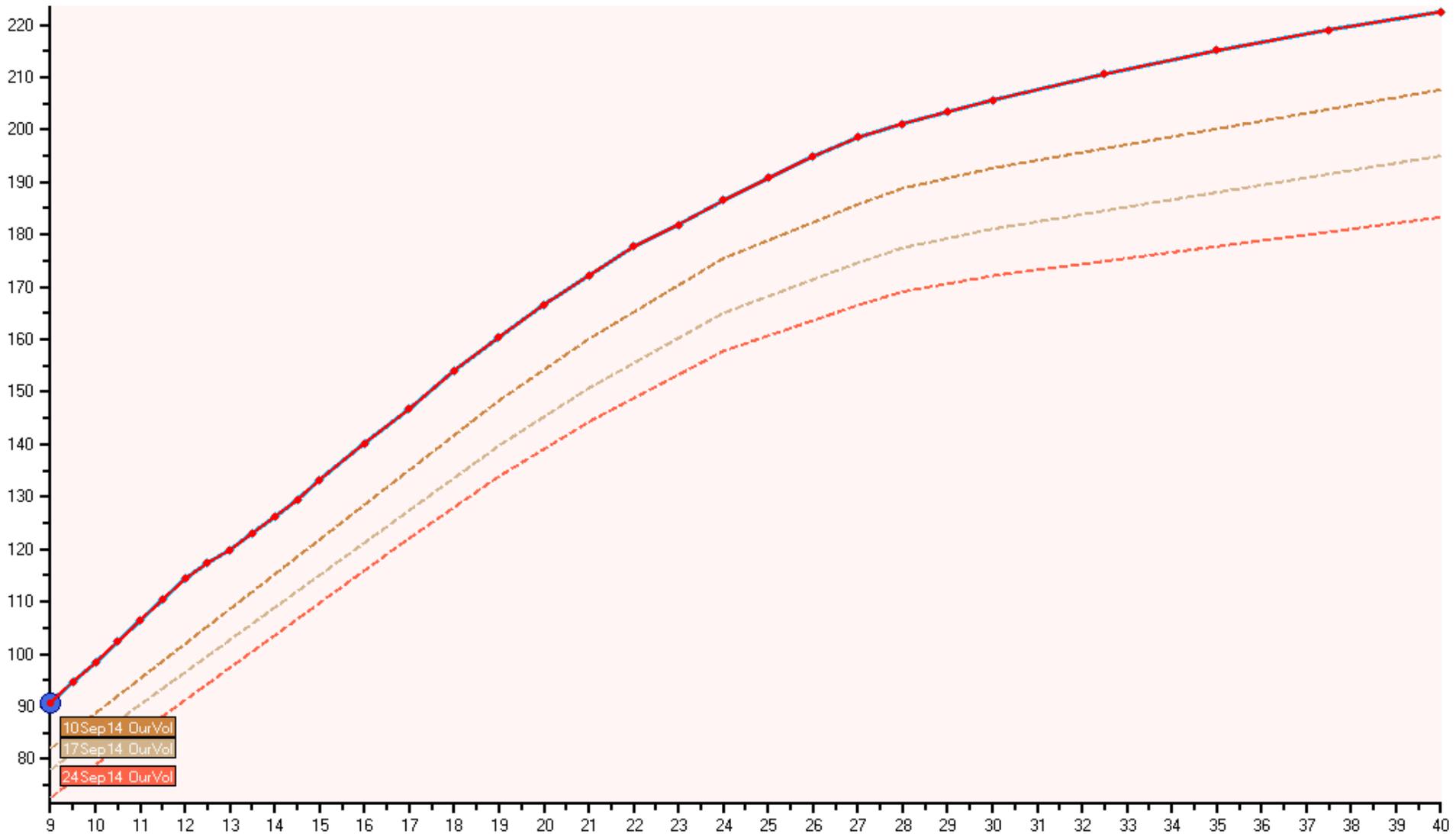
Unique Properties & Opportunities

Source: CBOE, Bloomberg

Volatilities of VXST & VIX Indexes

VXST Option Pricing

- S&P 500 Variance ("VA") futures replicate the pay-off profile of an OTC variance swap using a daily-margined future contract

- RIVET^{TM} backed VA futures use the patented RIVET^{TM} methodology developed by DRW Innovations

- The RIVET^{TM} methodology aligns the economics between OTC variance swaps and a listed variance futures, allowing for a direct comparison of pricing and size
  - Variance futures match OTC quoting conventions
    - Markets are displayed in "vol and vega"
    - Each quote represents a spot starting contract
  - VA contracts listed for each SPX maturity

RIVET^{TM} and the RIVET LOGO are trademarks of DRW Holdings, LLC.

CFE VA Prices vs. OTC Dealer Run

S&P 500® Variance Futures ("VA")

> **Advantages of S&P 500 Variance Futures over OTC swap**

- Greater accessibility for all market participants

- Reduced counter-party risk

- Increased transparency – access to trade information and daily mark-to-market values

- Greater price discovery and larger, more diverse liquidity pools

- Standardized contract terms

> **Competitive margin rates**

New & Improved VIX® Index…

Beginning October 6, 2014, the VIX Index will be calculated using *SPX Weeklys^{SM}*

- Keeps pace with changing trends in the underlying options market; SPX Weeklys^{SM} account for one-third of all SPX options traded.

- More precise measurement of 30-day volatility – always interpolating between 23- and 37-day SPX options.

- ***VIX formula is not changing***, just the SPX option series that are used to calculate "cash", or "spot", VIX Index values.

- ***No impact on pricing of VIX futures & options.*** The final settlement value for VIX futures and options will continue to use the same VIX formula and the opening prices of standard (i.e., 3rd Friday expiration) SPX option series.

VIX® Settlement

Overview

> A Special Opening Quotation ("SOQ") of VIX using the **opening** prices of constituent SPX option series; special auction process (HOSS)

> Open to customers and broker-dealers; quotes and orders

> "Strategy" orders must be submitted by 8:15 am CT

> System messages indicate either Expected Opening Price ("EOP") or trading imbalances for each series; series open only if there is a clearing price within allowable price range

> Series must be **non-zero bid** after opening trade match in order to be used in the SOQ calculation; two consecutive "zero-bid" series truncates the strike range

HOSS Auction Process

> Finds a single clearing price that maximizes the number of contracts traded within an allowable price range

> Pro-rata matching algorithm; no customer priority

> Each series is a separate auction; no spreads allowed… yet

> Orders accepted right up to the open; series will not open with imbalance

System Messages

Via CBOE Streaming Markets ("CSM") and CFE website every 30 seconds

❯ Expected Opening Price ("EOP") – the estimated opening price.

- "If the market opened now…"
- Displays price and quantity

❯ Imbalance ("Need More…") – the opening price is not within the allowable price range.

- Displays price and quantity of liquidity needed to open
- e.g., Needs More Sellers… 150 at 8.20

More granularity available on CSM in real-time

❯ Pre-open "top-of-book" bid/ask price, size

❯ Depth of book (5 layers)

VIX Settlement Timeline

Day before VIX Settlement

VIX Settlement Day

After the Close

"VIX Likely Series" file posted to CFE website

7:00 am

CBOE Order Book opens; begins accepting orders

8:30 am

SPX series with no imbalances open

After 9:15 am

"VIX Settlement Series" file posted to CFE website

8:15 am

Cut-off time for "strategy" orders

8:45 – 9:15 am

VIX Settlement Value ("VRO") typically disseminated
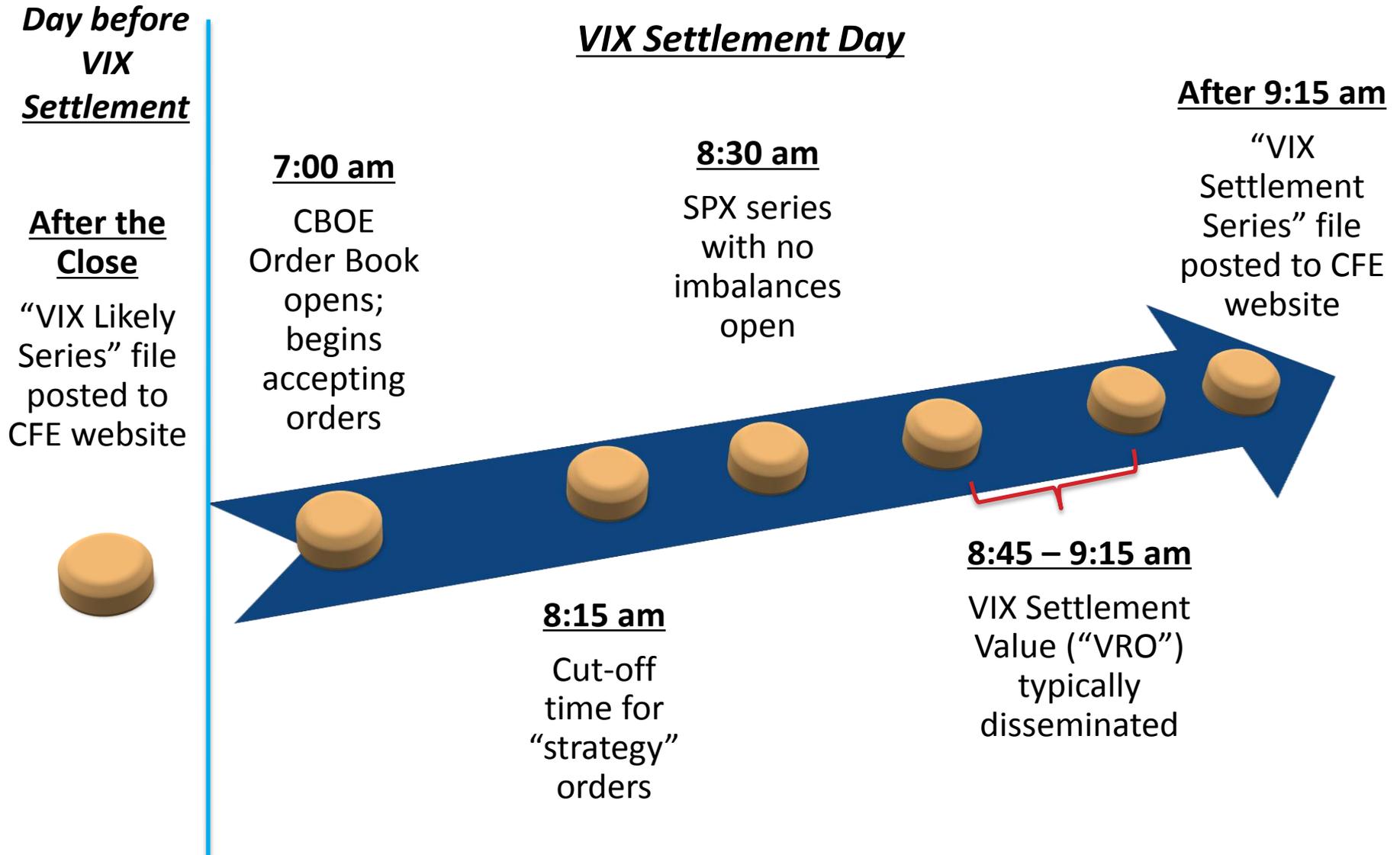
What is a "strategy order"

▶ VIX formula defines the quantity of each option series in a replicating "strip" with a given vega exposure

▶ Contracts (K) = $\dfrac{2}{T}\left(\dfrac{\Delta K}{K^2}\right)e^{rT}\left(\dfrac{\$vega}{2\sigma}\right)\times 100$

Feb. 19, 2014 VIX expiration
v = $8.5 MM
σ_{Settle} = 15.47
K_0 = 1830

Valid Opening Price Range

> HOSS prevents SPX series from opening outside of a valid price range defined by:
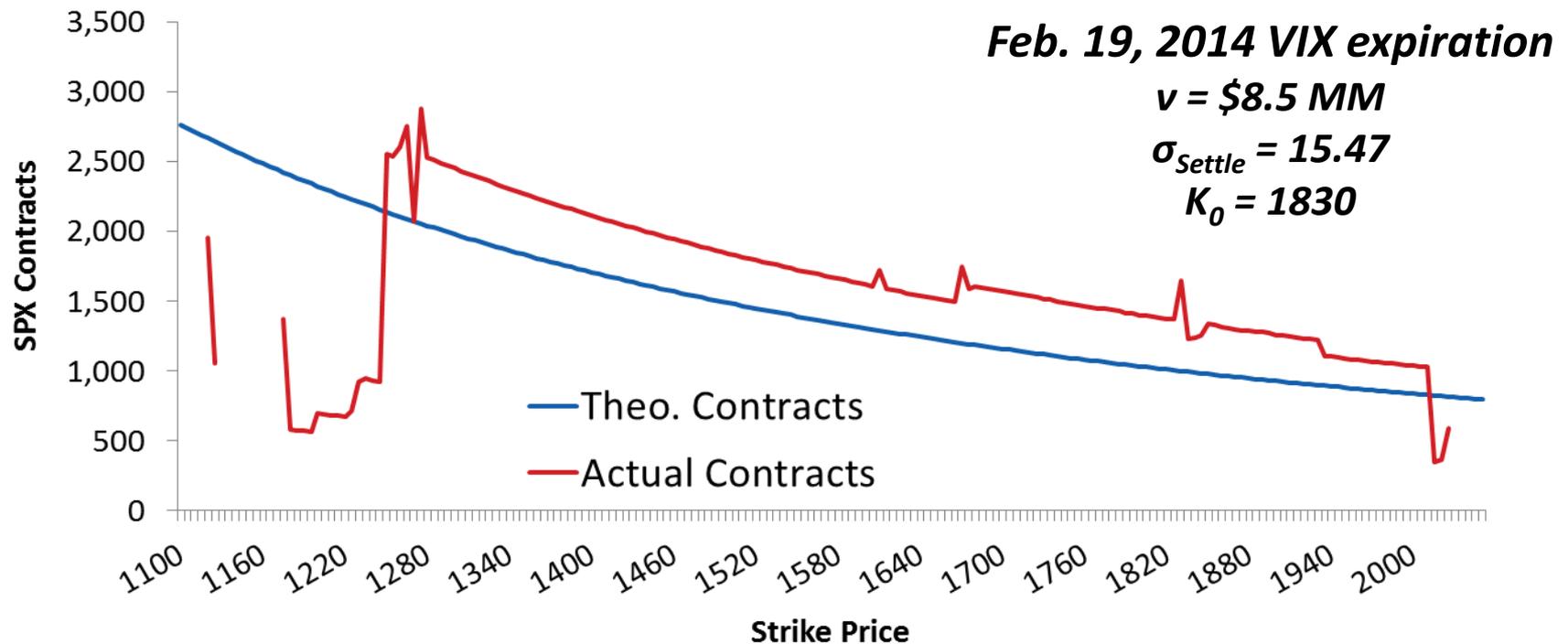>
> - Midpoint of best bid / best offer prices
> - Opening Exchange Prescribed Widths ("OEPW") for that series

> Valid Opening Price Range equals series midpoint ± OEPW/2

Series Bid Price	Final Settlement Days	Non-Final Settlement Days
0.00 – 1.99	0.60	1.00
2.00 – 5.00	1.00	1.60
5.01 – 10.00	1.20	2.00
10.01 – 20.00	1.60	4.00
20.01 – 30.00	2.40	6.00
30.01 – 50.00	3.40	8.00
50.01 – 100.00	6.00	10.00
100.01 – 200.00	10.00	16.00
>=200.01	16.00	24.00

Valid Opening Range

Need Buyers

Best Bid 2.20

Best Ask 2.80

Mid-Quote 2.50

Need Sellers

2.00 – 3.00
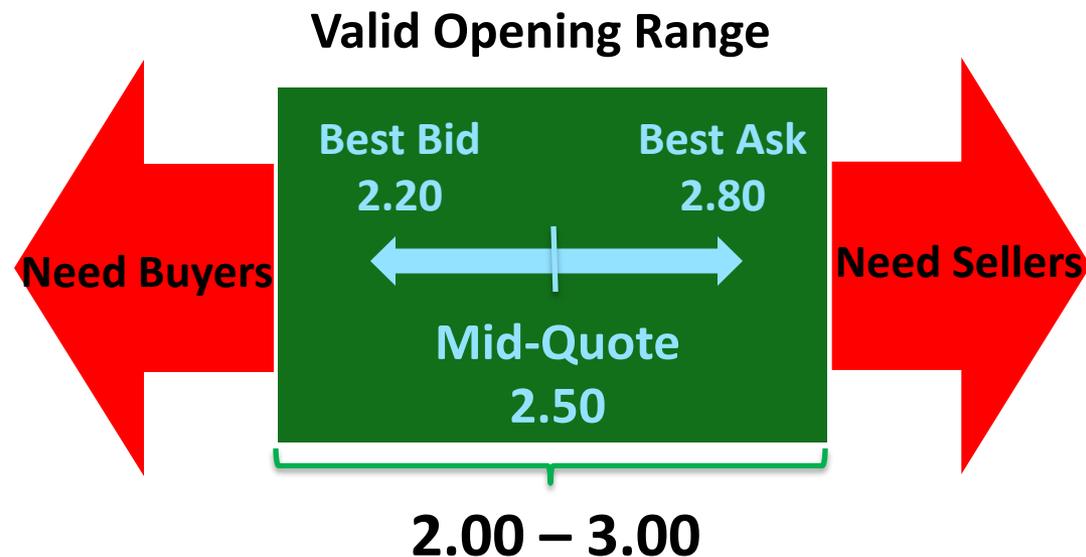
What is a "non-zero" bid?

› A series must have a "non-zero" bid price in order to be used in the VIX calculation, including the SOQ calculation

› We look at the **"book state"** immediately after the opening trade match but before un-filled OPG orders are cancelled. This book state may not be the same as the first quote.

› One or more SPX series may have an opening trade, but not be included in the SOQ calculation

What is a "non-zero" bid?

USE: series is "non-zero" bid

Pre-Open:

Type	Bid Qty	Bid Price	Ask Price	Ask Qty	Type
MM Quote	-	-			
BD	10,000	0.05			
C	2,000	0.10	0.10	5,000	C
C	1,000	0.15			
C	500	0.20			
			0.25	500	MM Quote

Trade Match: 3,500 @ 0.10

Book State After Trade Match **BBO: 0.05 - 0.10 (10,000 x 1,500)**

Type	Bid Qty	Bid Price	Ask Price	Ask Qty	Type
MM Quote	-	-			
BD	10,000	0.05			
			0.10	1,500	C
			0.25	500	MM Quote

Opening BBO: 0 - 0.10 (- x 1,500)

Type	Bid Qty	Bid Price	Ask Price	Ask Qty	Type
MM Quote	-	-			
BD Order Auto-Cancelled					
			0.10	1,500	C
			0.25	500	MM Quote

DO NOT USE: series has no bid

Pre-Open:

Type	Bid Qty	Bid Price	Ask Price	Ask Qty	Type
MM Quote	-	-			
C	2,000	0.10	0.10	5,000	C
C	1,000	0.15			
C	500	0.20			
			0.25	500	MM Quote

Trade Match: 3,500 @ 0.10

Book State After Trade Match **BBO: 0 - 0.10 (-- x 1,500)**

Type	Bid Qty	Bid Price	Ask Price	Ask Qty	Type
MM Quote	-	-			
			0.10	1,500	C
			0.25	500	MM Quote

Opening BBO: 0 - 0.10 (-- x 1,500)

Type	Bid Qty	Bid Price	Ask Price	Ask Qty	Type
MM Quote	-	-			
			0.10	1,500	C
			0.25	500	MM Quote

VIX & VXST Settlement Opportunity

> An average of $6 million Vega and over 130,000 SPX Contracts have traded in series used to settle VIX in 2013.

> Many of these trades come from firms placing SPX strip orders against VIX futures and options positions. These strategy orders are placed by 8:15 a.m.

> Since both long and short strategy orders are placed by firms at VIX settlements, there are frequently buy or sell imbalances to some degree.

> CBOE estimates the mismatches of long and short strips traded have ranged from 10%-40% of the vega traded on VIX settlement days, presenting compelling trading opportunities for liquidity providers.

> Trading VXST settlements could present trading opportunities 52 times each year.

VIX Settlement on February 19, 2014

▸ Buy strip submitted just after 8:00 am; another at 8:15 am.

▸ "Need More Sellers…" messages disseminated via website and CSM

▸ 280,000 March SPX contracts trade on opening print (~ $50 Bln notional), at the offer.

▸ Estimated $5 million "edge"

VIX Settlement – 15.47, 0.66 higher than first VIX spot price

Pre-Open

Legend: VIX (Pre-Open) — VXVWB — VXVWA — VIX
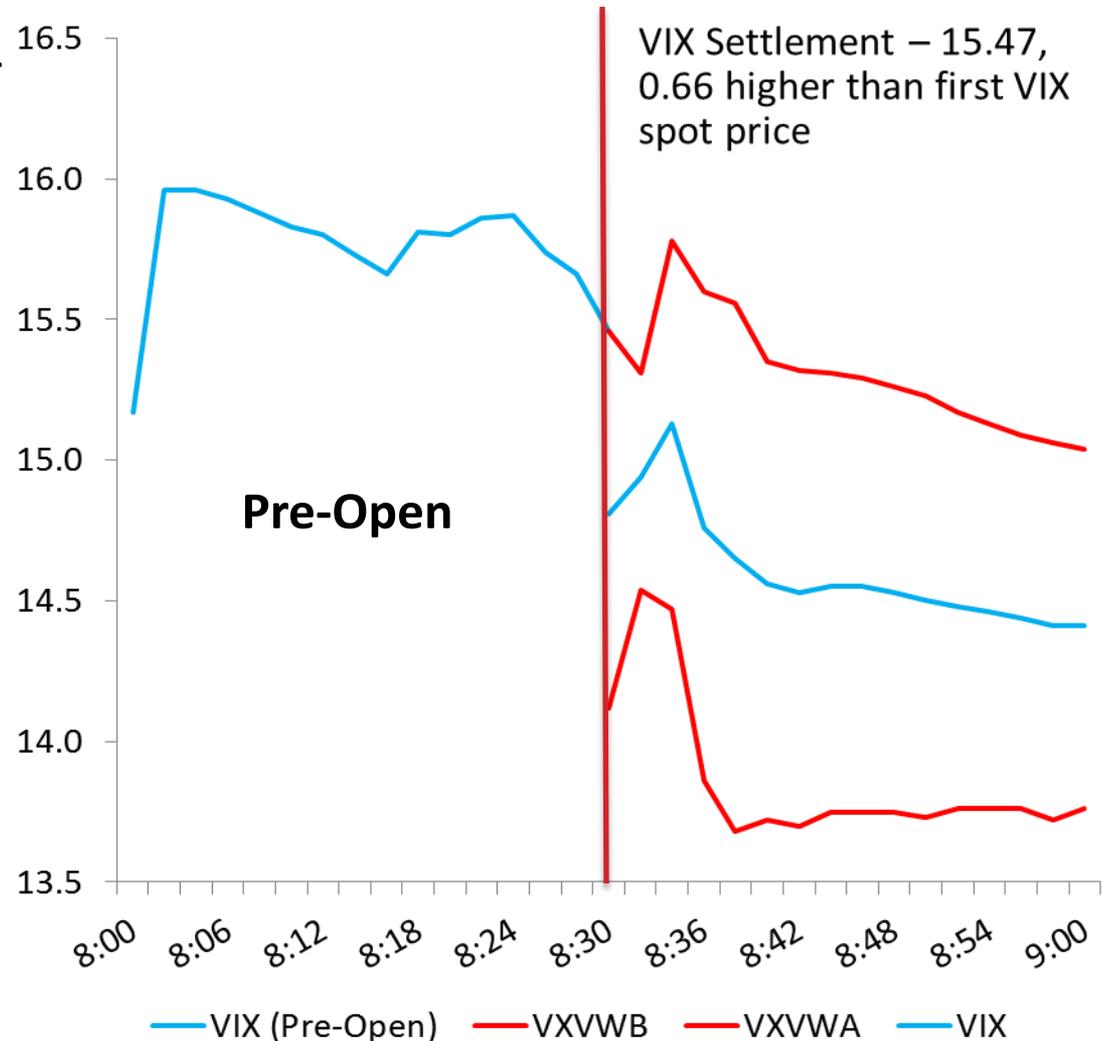
Source: CBOE

CBOE/CBOT 10-year U.S. Treasury Note Volatility Index (VXTYN^{SM} Index) Futures

VIX-like measure of expected 30-day volatility of 10-year U.S. Treasury Note futures prices.

- November 13, 2014 launch
- $5,000 multiplier
- Trading hours: 7:00 a.m. – 3:15 p.m. CT
- Tick size: 0.01 index points ($50)
- Final Settlement Day: 30 days prior to the expiration of constituent options on 10-year T-Note futures ("OZN options")
- Final Settlement Value: Special Quotation ("SQ") of VXTYN using the 2:00 p.m. daily settlement prices for OZN options on the Final Settlement Day. Cut-off for puts & calls is 1 full OZN tick (1/64th of a point)
- SPAN margining

CBOE/CBOT 10-year U.S. Treasury Note Volatility Index (VXTYN^{SM} Index) Futures
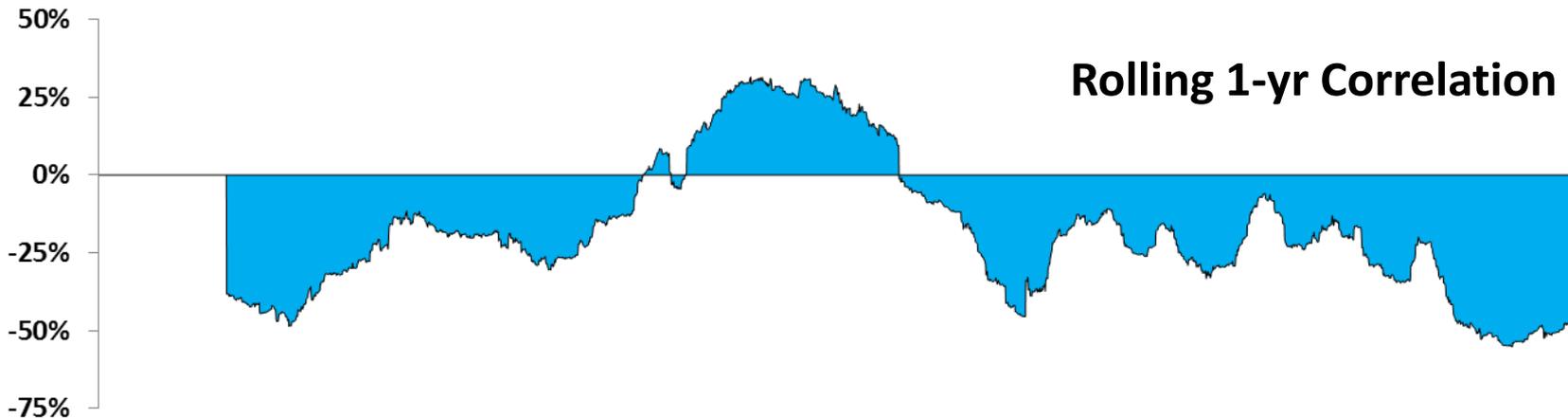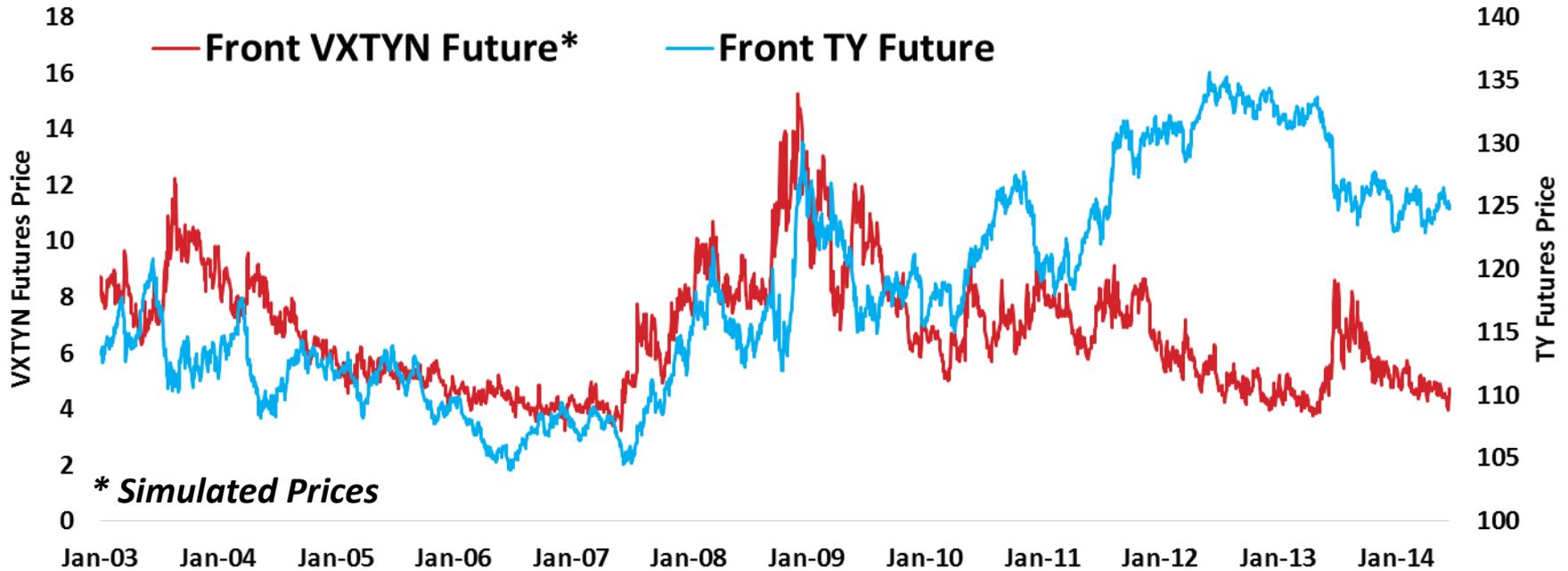
CBOE/CBOT 10-year U.S. Treasury Note Volatility Index (VXTYN^SM Index) Futures

Bloomberg Mortgage-Backed Security Index (BMBS) & 5% VXTYN Futures Overlay*

Legend: BMBS + 5% VXTYN — BMBS Un-Hedged — 30D VXTYN Futures
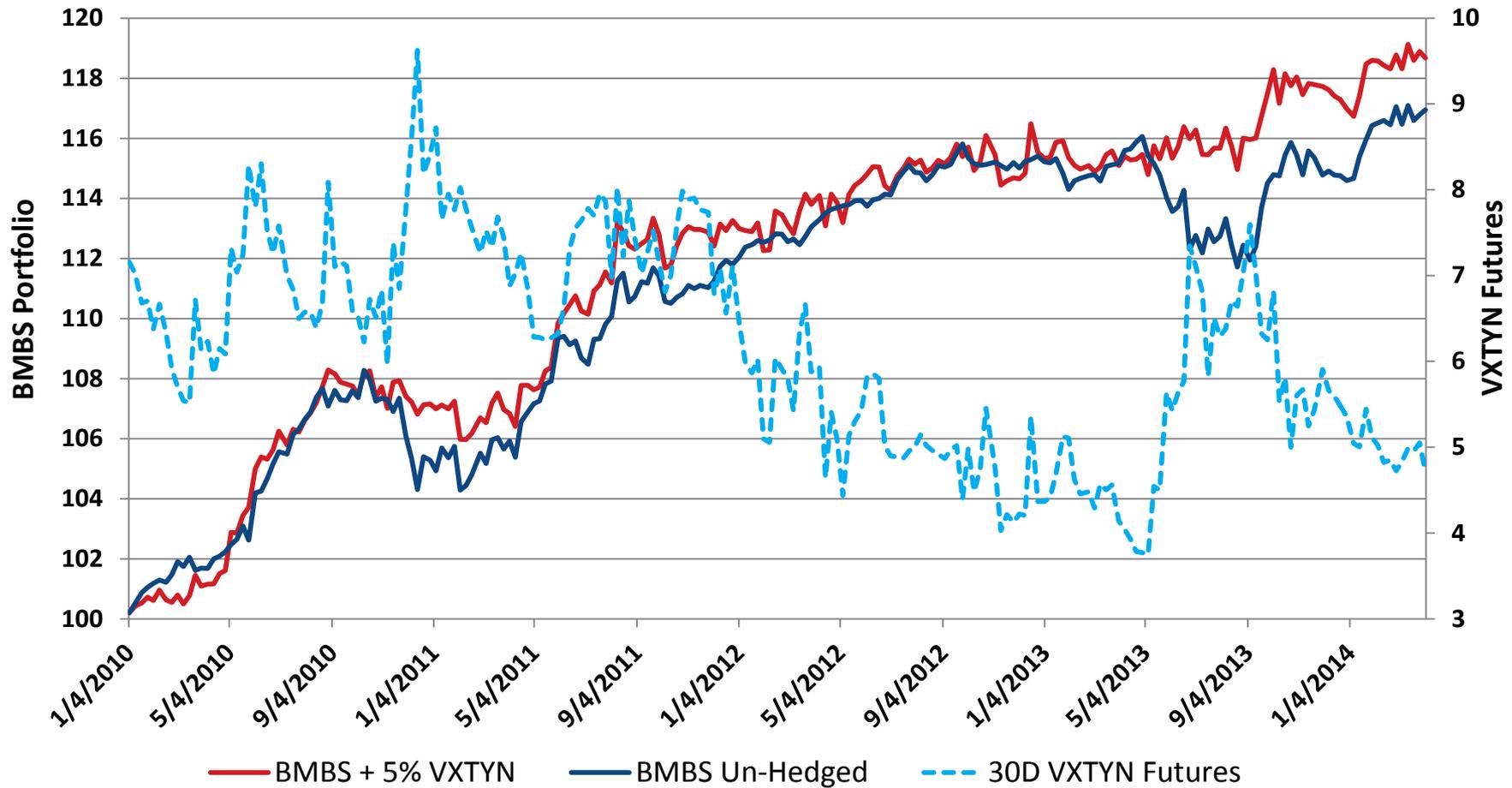
Based on weekly returns from January 4, 2010 through April 4, 2014

Source: CBOE, Bloomberg

Disclosure

Group One makes markets in VIX options and options on other CBOE volatility indexes, and may currently have a position in any or all of those products. Nothing in this presentation should be considered an endorsement or recommendation of any of those products.

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Appendix

> ## **Additional Information: CBOE Circulars**

- *VIX Settlement Process:*

  - Detailed information regarding the opening procedures on CBOE for the constituent options used to calculate volatility indexes is available in the following CBOE circulars: CBOE Regulatory Circular RG08-042 and CFE Information Circular IC12-04.

- *Operational Systems Settings on Volatility Index Product Settlement Days*

  - Information on operational systems settings including the current OEPW ranges is available in CFE Information Circular IC12-04 or CBOE Regulatory Circular RG12-098.

Appendix

> **Additional Information: General Information on VIX and the VIX Settlement Process**

- *Detailed information on the VIX Methodology and additional information is available on the VIX microsite:*
  - http://www.cboe.com/micro/VIX/vixintro.aspx
- *Detailed information on the VIX settlement process, website-accessible displays of Expected Opening Prices/Sizes, Series Imbalances and other information is available at the following links:*
  - *http://cfe.cboe.com/Products/settlement_VIX.aspx*
  - *http://cfe.cboe.com/*

Appendix

❯ **Additional Information: Contacts**

- *Order Entry Confirmation:*

  - Contact the CBOE Help Desk (866.728.2263 or helpdesk@cboe.com) or Trading Systems Development Floor Support to verify that orders were received in the electronic order book.

- *QRM Handling or Other Issues:*

  - Contact the Help Desk if you would like CBOE to adjust your QRMs.

  - The Help Desk can also be contacted for other VXST settlement-related issues.

Appendix

➢ **Additional Information: VXST Futures**

- *VXST Futures Product Information (Contract Specifications, Data Vendor symbology, etc.)*

  - http://cfe.cboe.com/Products/Products_VXST.aspx

- *Current CFE Margins (all products)*

  - http://cfe.cboe.com/margins/CurDoc/Default.aspx

- *VXST Index General Information*

  - http://www.cboe.com/micro/VXST/default.aspx

- *VXST Settlement Process Information*

  - http://www.cboe.com/publish/RegCir/RG14-005.pdf and http://cfe.cboe.com/publish/CFEregcirc/CFERG14-002.pdf

Appendix

VXST^{SM} Settlement

> VXST futures and options settle to PM-settled SPXW options (a Hybrid class) three (or four) weeks each month and settle to SPX options (a Hybrid 3.0 class) once per month.

- **Like VIX, VXST futures are A.M.-Settled, settling to opening prices of the underlying S&P 500 options.** Like VIX, VXST will settle to a single strip of S&P 500 options that expire in exactly nine day (SPX) or 9 days plus 390 minutes (SPXW).

- The **Modified** HOSS Opening Procedure will be used when VXST settles.

- Hybrid 3.0 is the trading platform for SPX, while Hybrid 2.0 is the trading platform for SPXW. There are some important differences in the handling of quotes and orders when VXST is settled using these different platforms.

Other CBOE Volatility Indexes

US Equity	Foreign Equity	Commodity	Currency	Single Stock
VXN *Nasdaq-100* *(futures only)*	***VXEEM*** *Em. Mkts (EEM)* *(futures & options)*	***GVZ*** *Gold (GLD)* *(futures & options)*	EWZ Euro (FXE)	VXAPL Apple, Inc.
RVX *Russell 2000* *(futures & options)*	***VXEWZ*** *Brazil (EWZ)* *(futures & options)*	***OVX*** *Crude Oil (USO)* *(futures & options)*		VXGOG Google, Inc.
VXV 3M S&P 500	VXFXI China (FXI)	VXSLV Silver (SLV)	**US Equity Sector** VXGDX Gold Miners (GDX)	VXGS Goldman Sachs
VXD DJIA	VXEFA EAFE (EFA)	CME Volatility Indexes: OIV – Crude Oil GIV – Gold SIV – Soybeans CIV – Corn WIV - Wheat	**Interest Rates** SRVX 1yr/10yr USD Swaptions	VXIBM IBM Corp. VXAZN Amazon

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