Efficient VA Hedging Instruments for Target Volatility Portfolios

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Deutsche Bank

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Efficient VA Hedging Instruments
For Target Volatility Portfolios

Agenda

1. • Target Volatility Risk Properties
2. • Target Volatility Puts vs. Vanillas
3. • Other Tactical Hedging Instruments

Target Volatility Risk Properties

Introduction

Over the past five years, the AUM of VA managed volatility funds has grown to over $200bn[1]

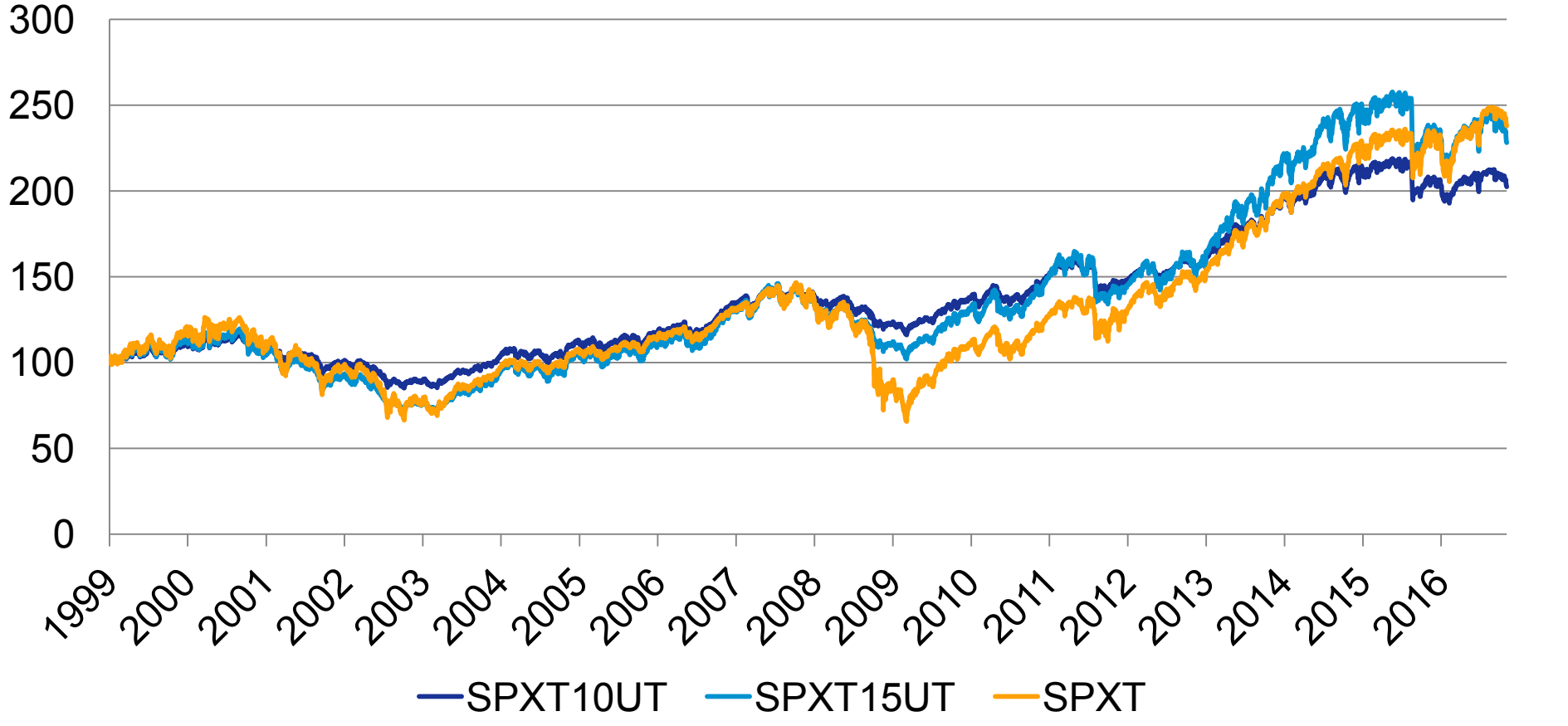
Target volatility strategies are likely to exhibit long-term volatilities close to their targets, neutralizing the vega exposure of VA guarantees

However instantaneous equity risk scenarios still show significant crash-risk. Hedge with vanillas?

(1) *Source: DB Equity Derivatives Research*

Target Volatility Risk Properties

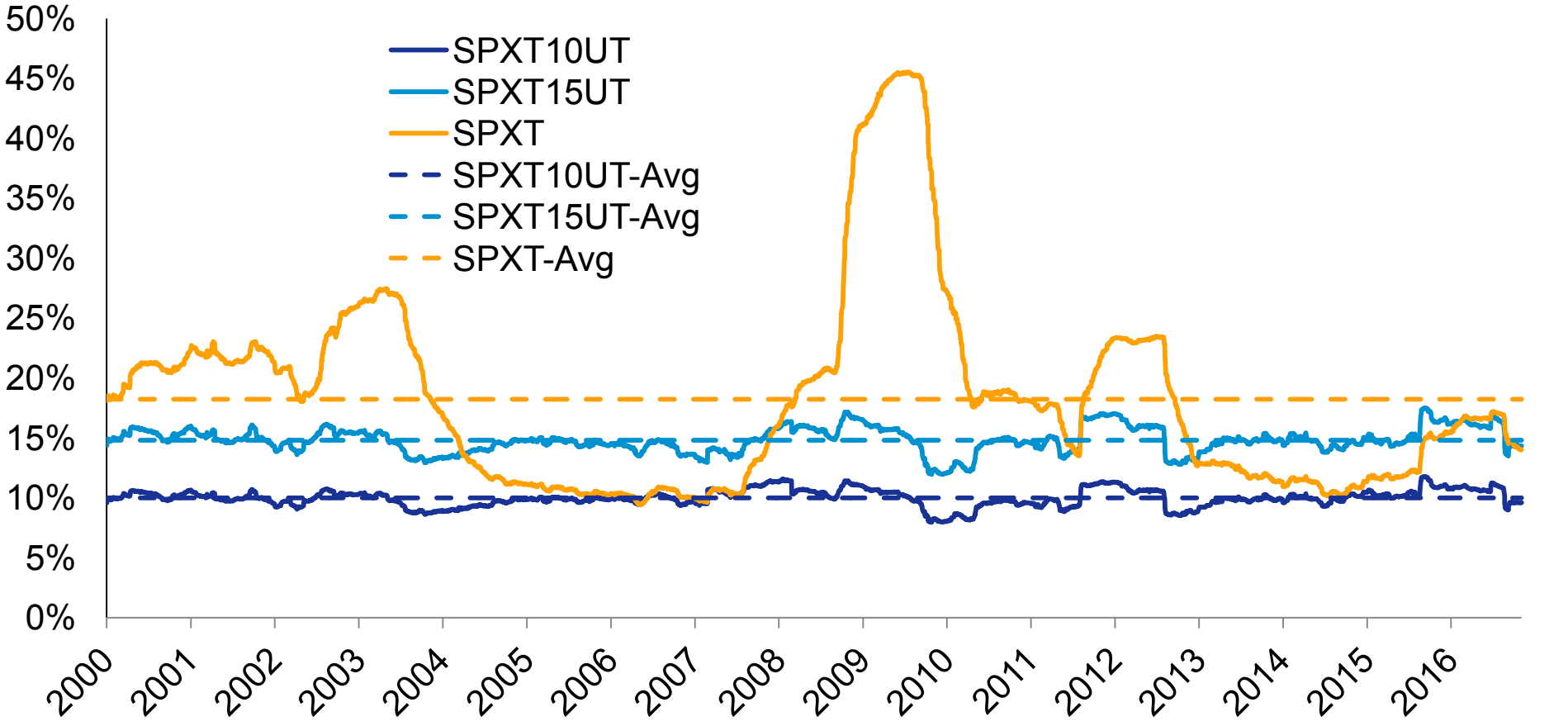
Example: S&P 500 Risk Control Indices



Source: Bloomberg Finance L.P. and DB Structuring

Target Volatility Risk Properties

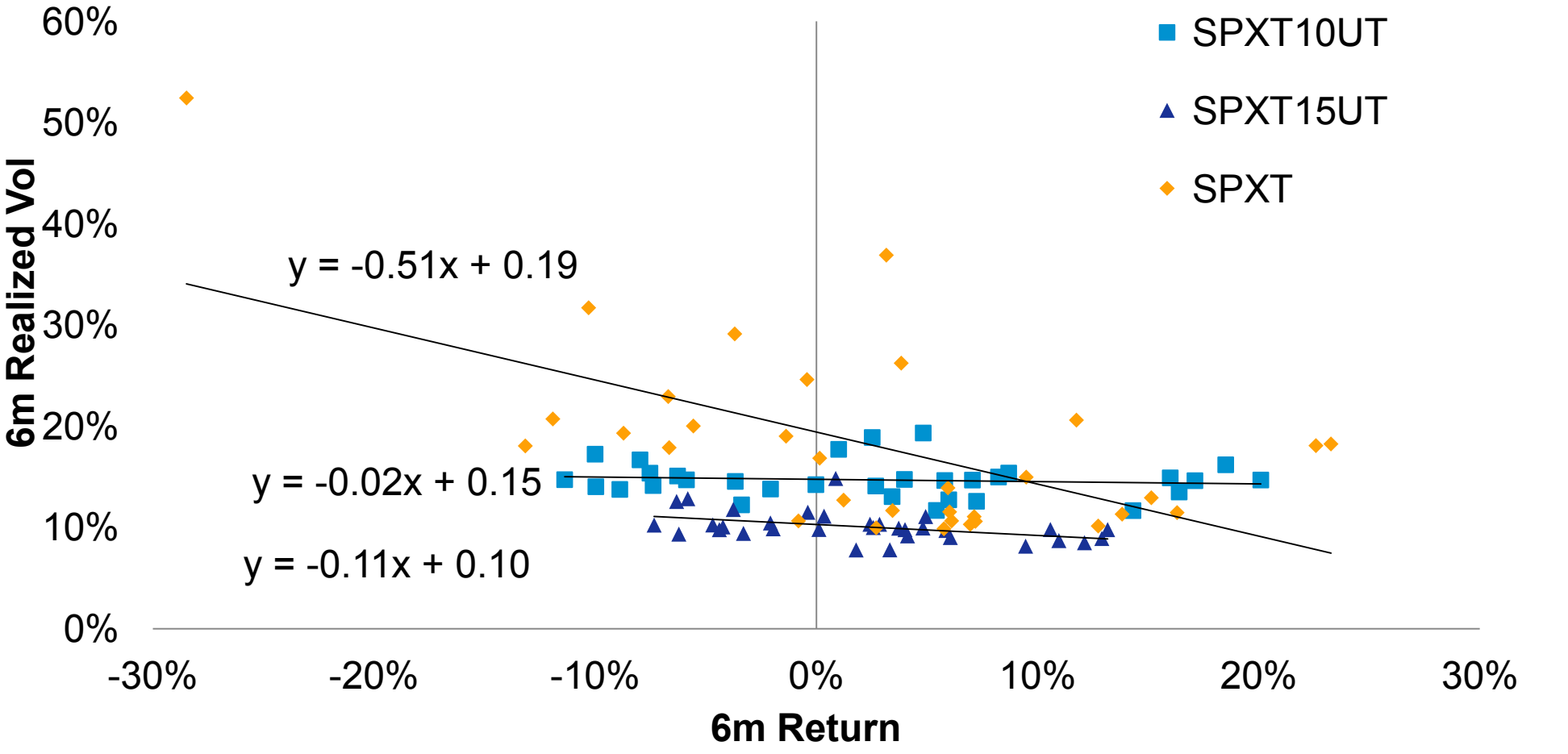
Realized Volatility (1yr)



Source: Bloomberg Finance L.P. and DB Structuring

Target Volatility Risk Properties

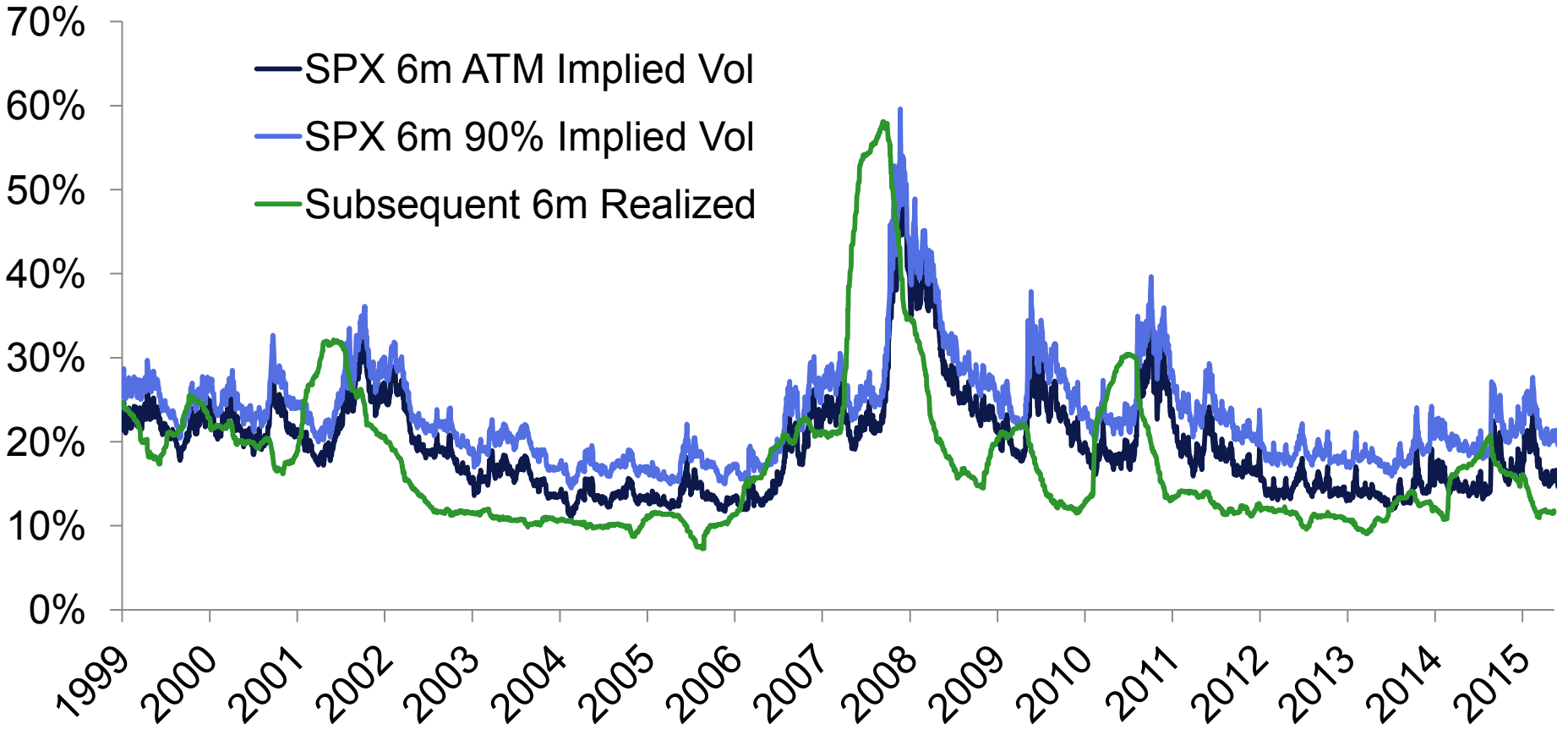
Realized Skew: Realized Volatility vs. Returns
(Semi-annual, Dec '99 – Jun '16)



Source: Bloomberg Finance L.P. and DB Structuring

Target Volatility Risk Properties

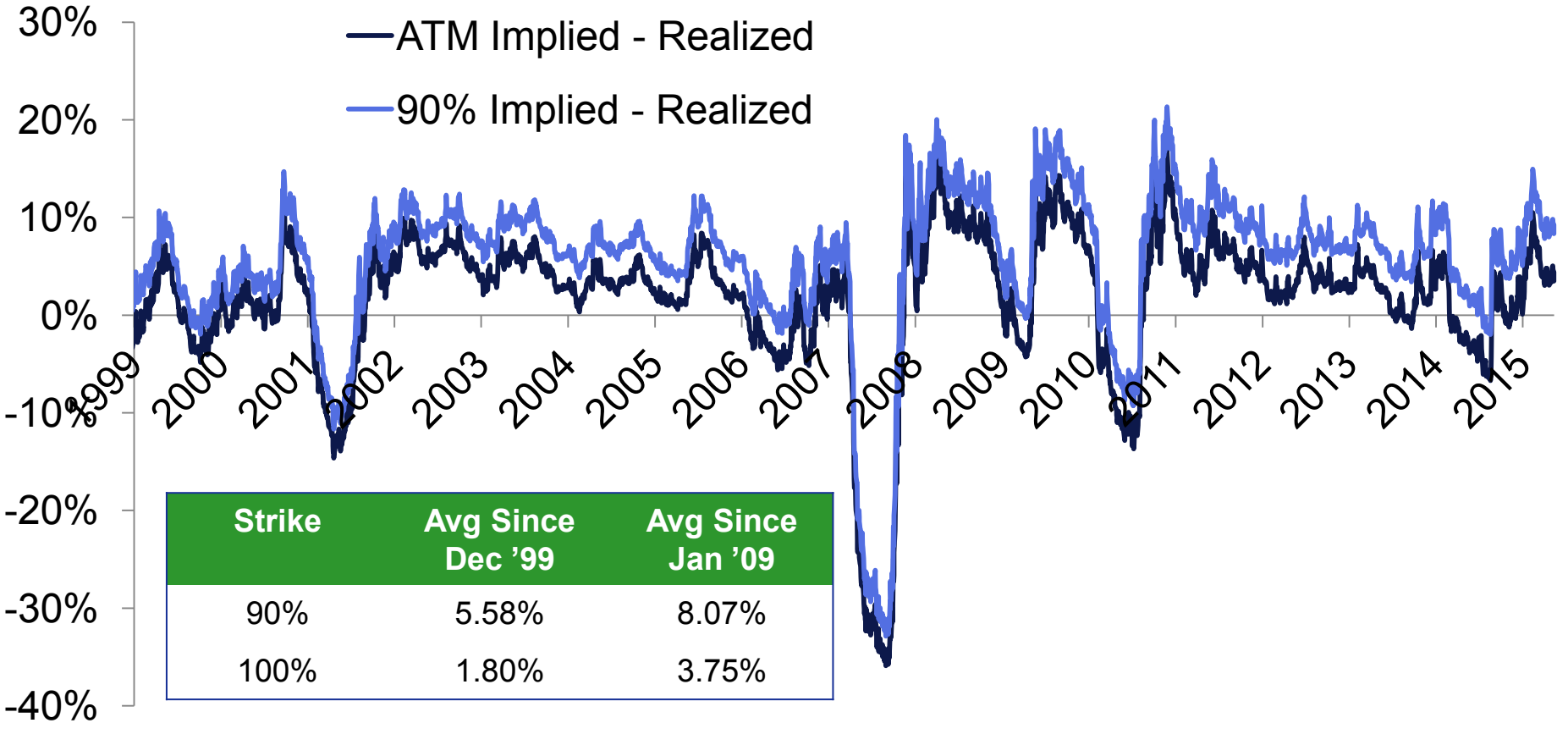
Historical SPX Implied Volatility vs. Subsequent Realized (12/31/1999 – 5/10/2016)



Source: Bloomberg Finance L.P., DB Structuring and DB Equity Derivatives Research

Target Volatility Risk Properties

SPX 6m Implied vs. Subsequent Realized Spread
(12/31/1999 – 5/10/2016)



Strike	Avg Since Dec '99	Avg Since Jan '09
90%	5.58%	8.07%
100%	1.80%	3.75%

Source: Bloomberg Finance L.P., DB Structuring and DB Equity Derivatives Research

Target Volatility Puts vs. Vanillas

Introduction

Intuitively it should be more efficient to hedge liabilities linked to target volatility funds using puts on target volatility indices to avoid overpaying for implied volatility and skew

We compare the performance of hypothetical target volatility puts with the performance of *comparable* listed options

Caveats: (1) The target vol index is a systematic proxy for portfolios which generally contain discretionary funds with diverse mandates (2) Target volatility puts are not widely traded, so pricing is hypothetical

Target Volatility Puts vs. Vanillas

Comparable Instruments Methodology

We compare the PL from buying puts on target volatility indices with the PL from buying comparable vanilla puts, for each trade date

Comparing target volatility puts with vanilla equity puts requires careful consideration as the vanilla equity put embedded in a TV put has changing notional and strike over the life of the trade

We adjust the vanilla strike and notional to have equivalent intrinsic value on trade date for all equity scenarios (“equal crash protection”)

Dynamic Adjustment: Compare TV put to scaled vanilla put adjusted using most recent TV Participation

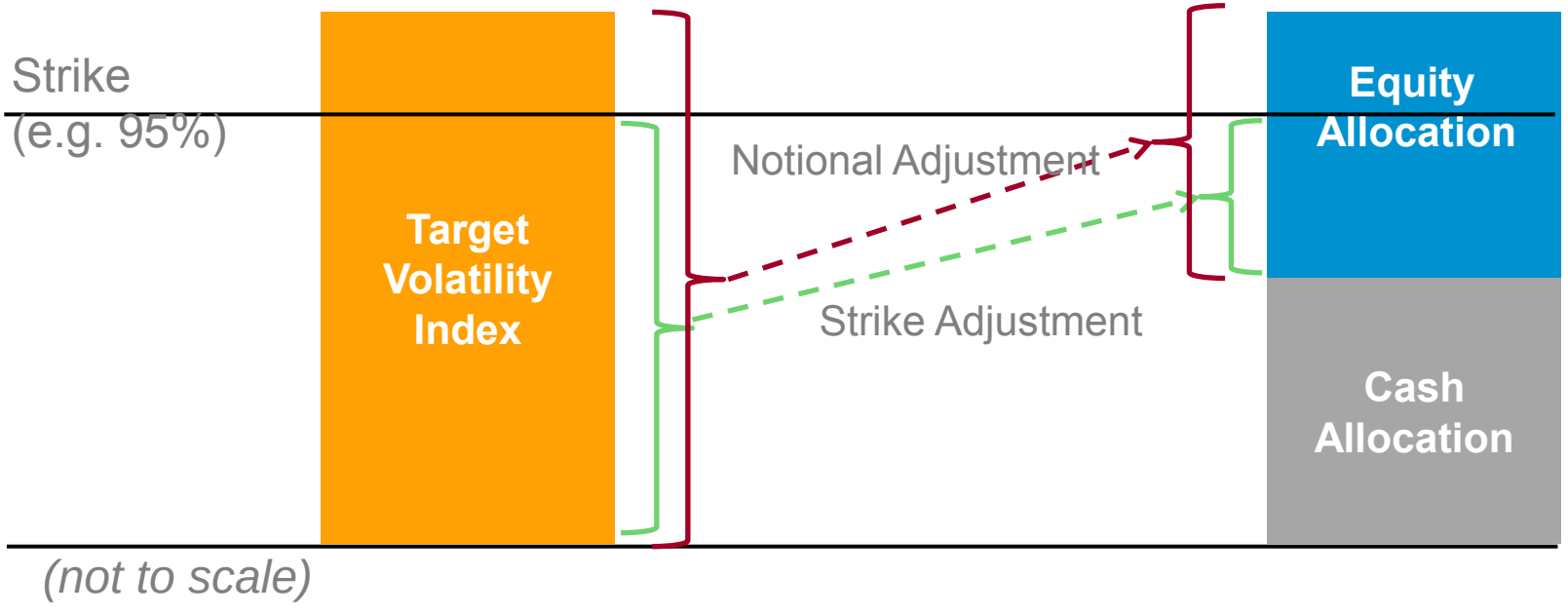
Static Adjustment: Compare TV put to scaled vanilla put using fixed long-term average TV Participation

Target Volatility Puts vs. Vanillas

Comparable Instruments Adjustment

$$Vanilla\ \ Notional\ \ = TV\ \ Notional\ \ \times TV\ \ Participat\ \ ion\ \ \%$$

$$Vanilla\ \ Strike\ \ = 100\ \ \% - \frac{1 - TV\ \ Strike\ \ \%}{TV\ \ Participat\ \ ion\ \ \%}$$



Target Volatility Puts vs. Vanillas

Back-test methodology for TV 10% 6m 95% Put, Dynamically Adjusted

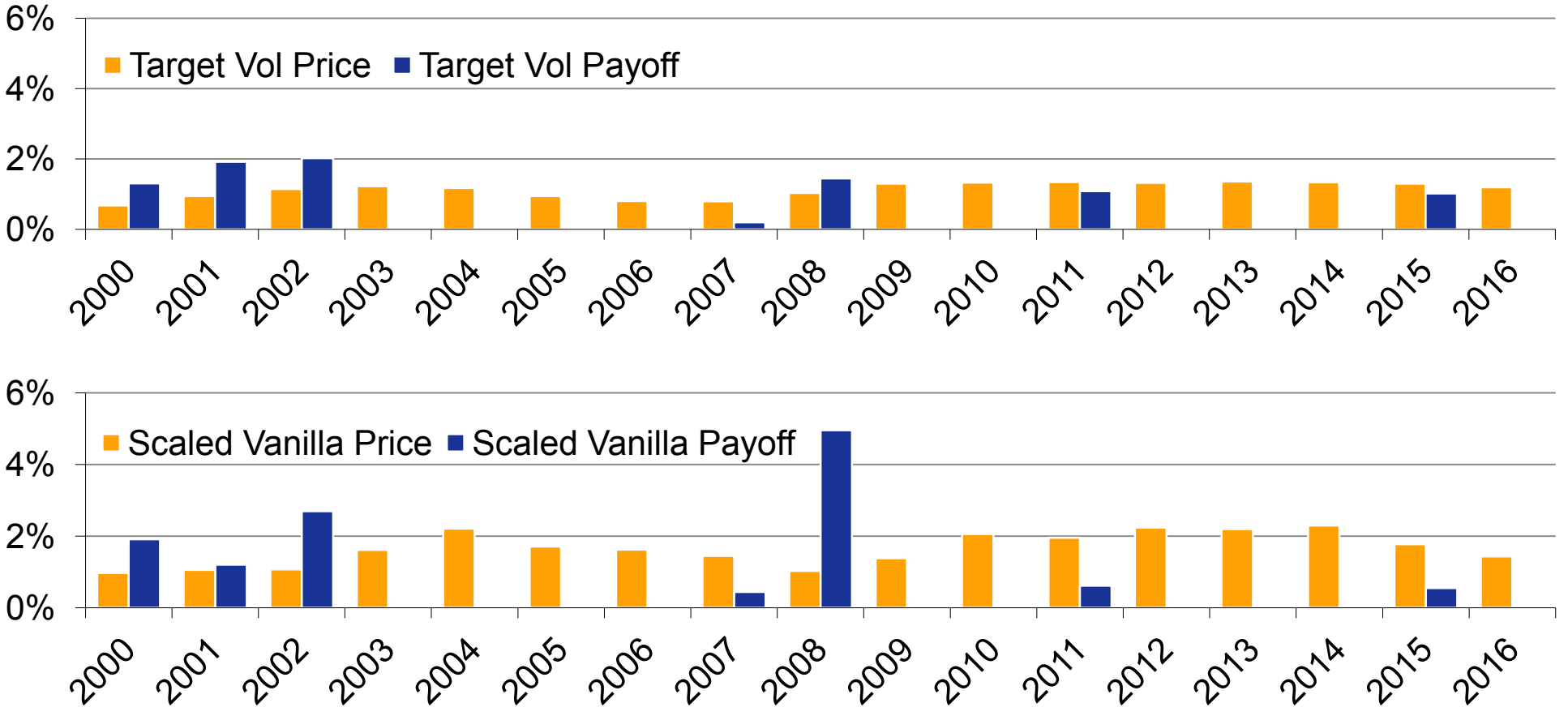
Select Listed Expiration	• For each trading day, locate SPX listed expiration closest to 6 months
Select Scaled Vanilla Strike	• For selected expiration, locate strike closest to participation-adjusted TV equivalent • Example: 70% participation → 1-.05/.7 = 92.85%
Adjust TV Tenor and Strike	• Adjust TV tenor and strike slightly to correspond with listed option used for scaled vanilla
Price TV and Vanilla Puts	• 10% TV 6m 95% put →BS: 12.5[1] vol, fwd = libor flat • 10% TV 12m 90% put →BS: 12.5[1] vol, fwd = libor flat • Scaled Vanilla → Listed mid-market

(1) Indicative and hypothetical

Target Volatility Puts vs. Vanillas

SPXT10UT 6m 95%; Dynamic Adjustment

Average Price and Payoff by Trade Date Year

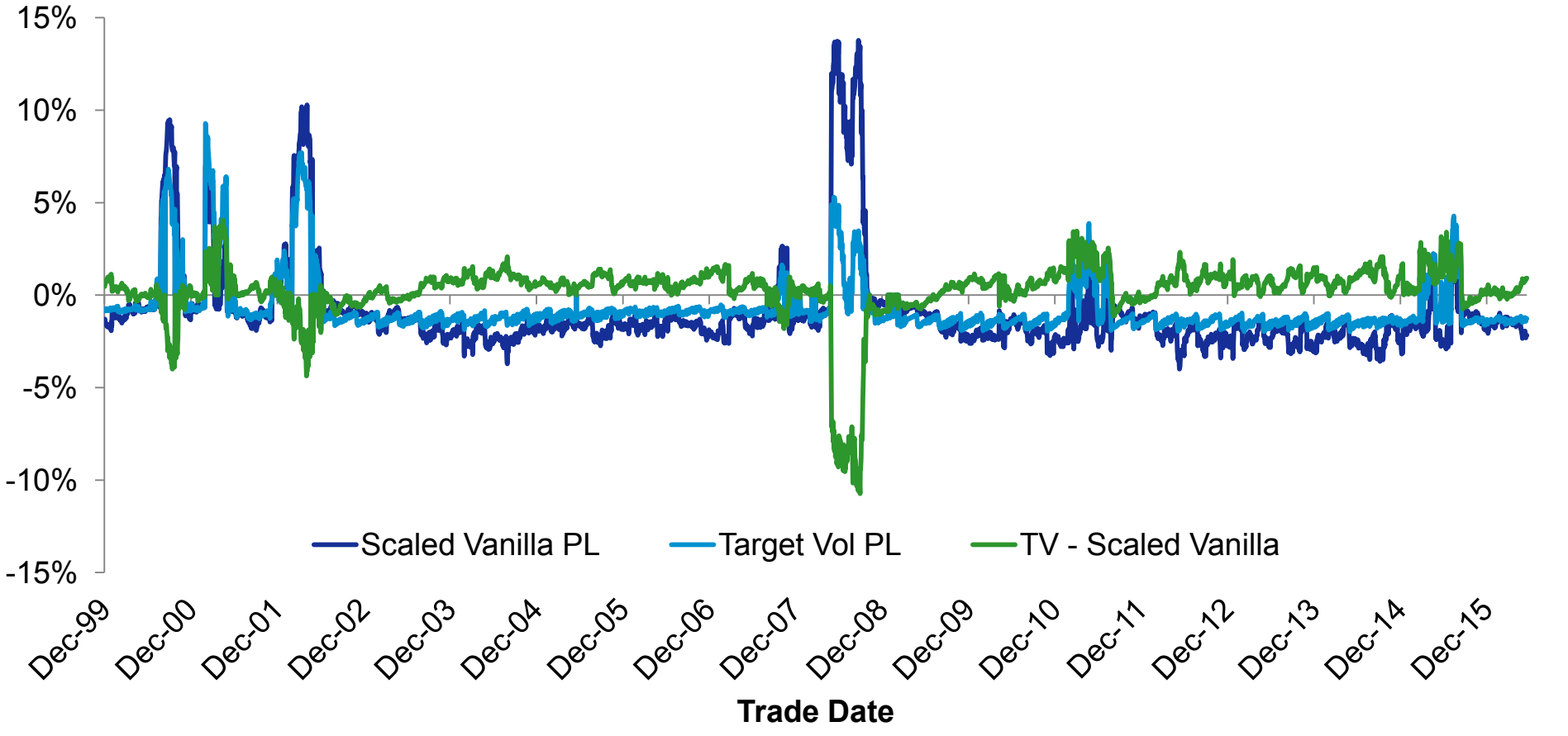


Source: Bloomberg Finance L.P., DB Structuring and DB Equity Derivatives Research

Target Volatility Puts vs. Vanillas

SPXT10UT 6m 95%; Dynamic Adjustment

PL by Trade Date (Jan '00 – Oct '16[1])



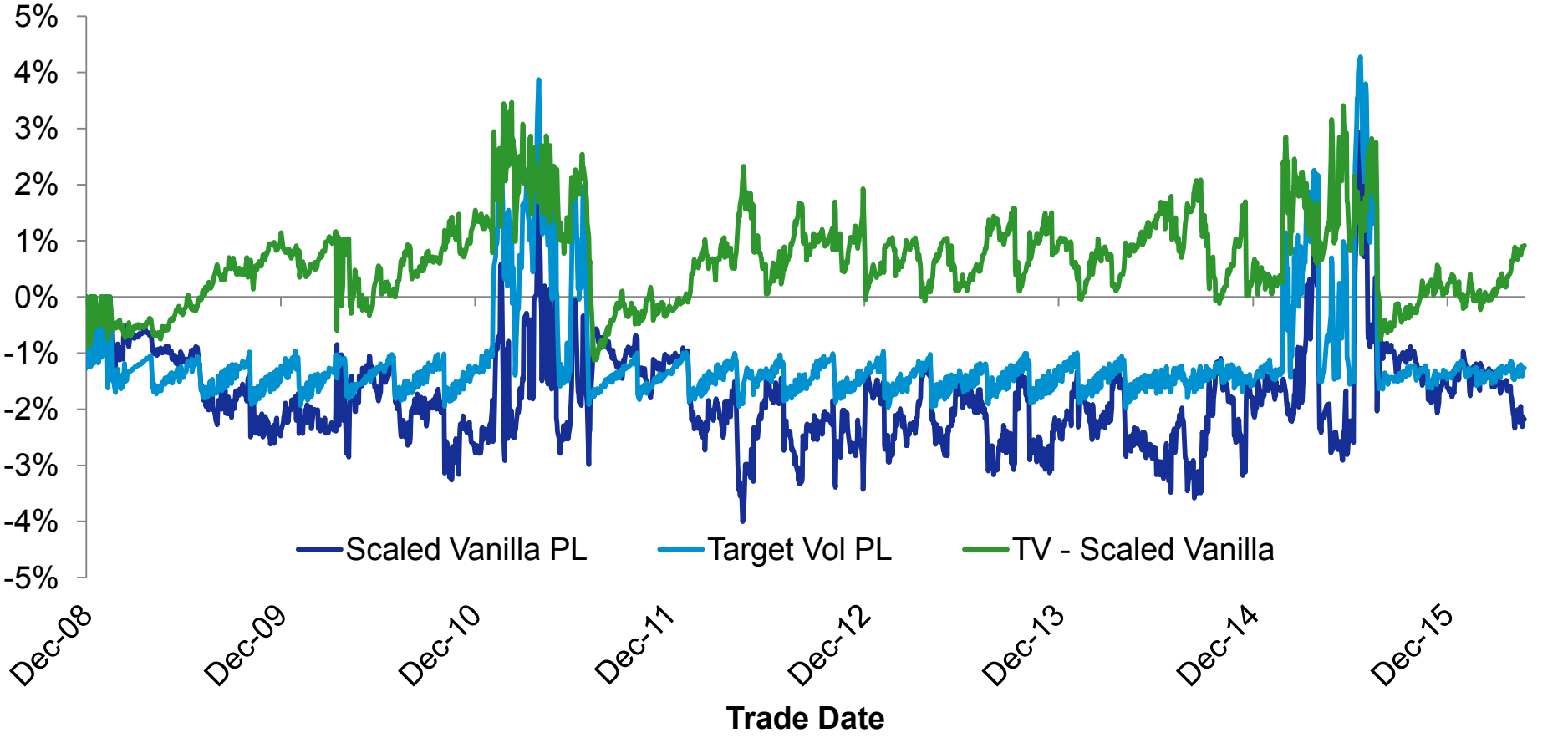
(1) Assuming that options unexpired as of Nov 11, 2016 expire OTM

Source: *Bloomberg Finance L.P., DB Structuring and DB Equity Derivatives Research*

Target Volatility Puts vs. Vanillas

SPXT10UT 6m 95%; Dynamic Adjustment

PL by Trade Date (Since 2009[1])

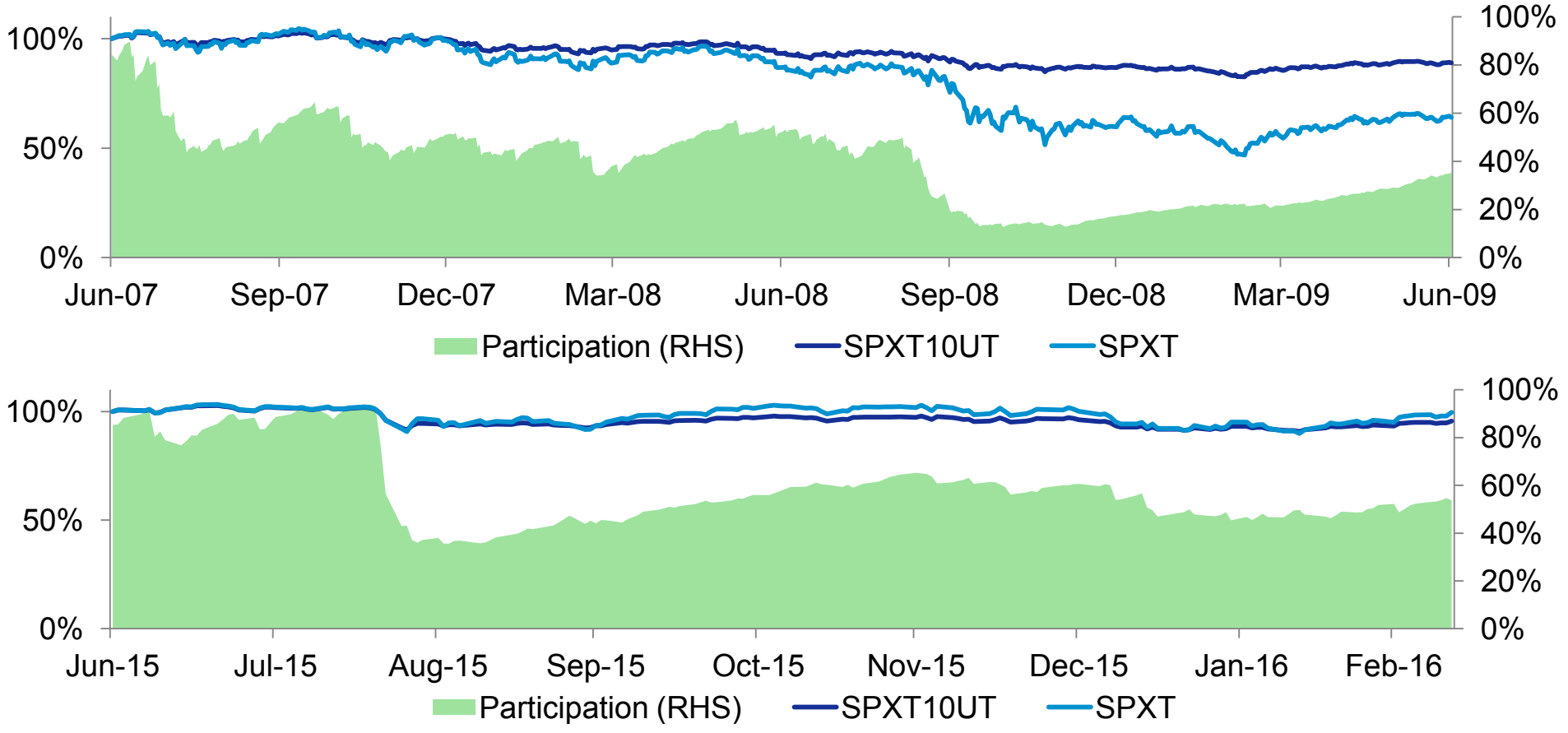


(1) Assuming that options unexpired as of Nov 11, 2016 expire OTM

Source: *Bloomberg Finance L.P., DB Structuring and DB Equity Derivatives Research*

Target Volatility Puts vs. Vanillas

Target Vol Behavior in Different Sell-Offs



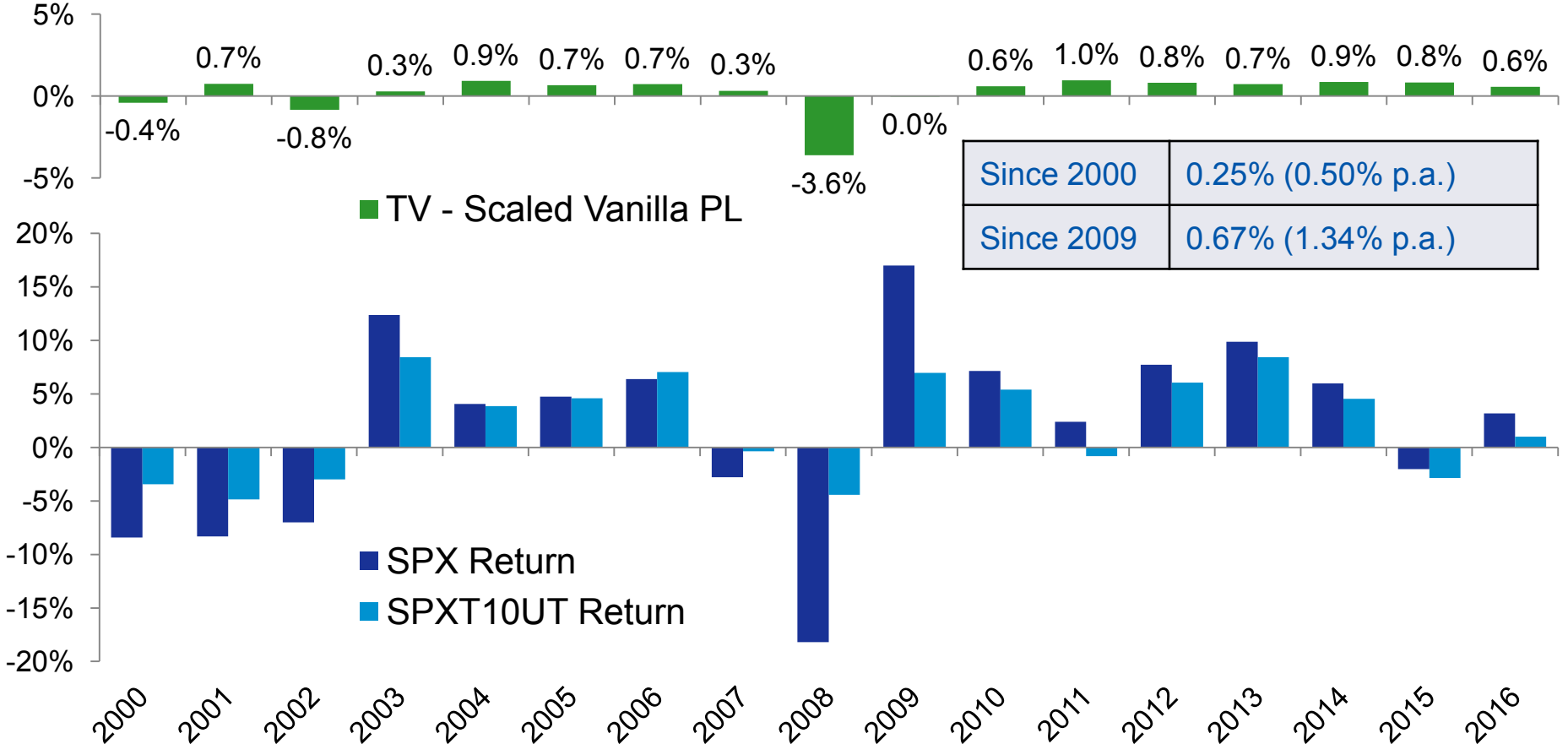
Source: DB Structuring, Bloomberg

Source: Bloomberg Finance L.P. and DB Structuring

Target Volatility Puts vs. Vanillas

SPXT10UT 6m 95%; Dynamic Adjustment

Target Vol Put vs. Scaled Vanilla PL, Average by Trade Year



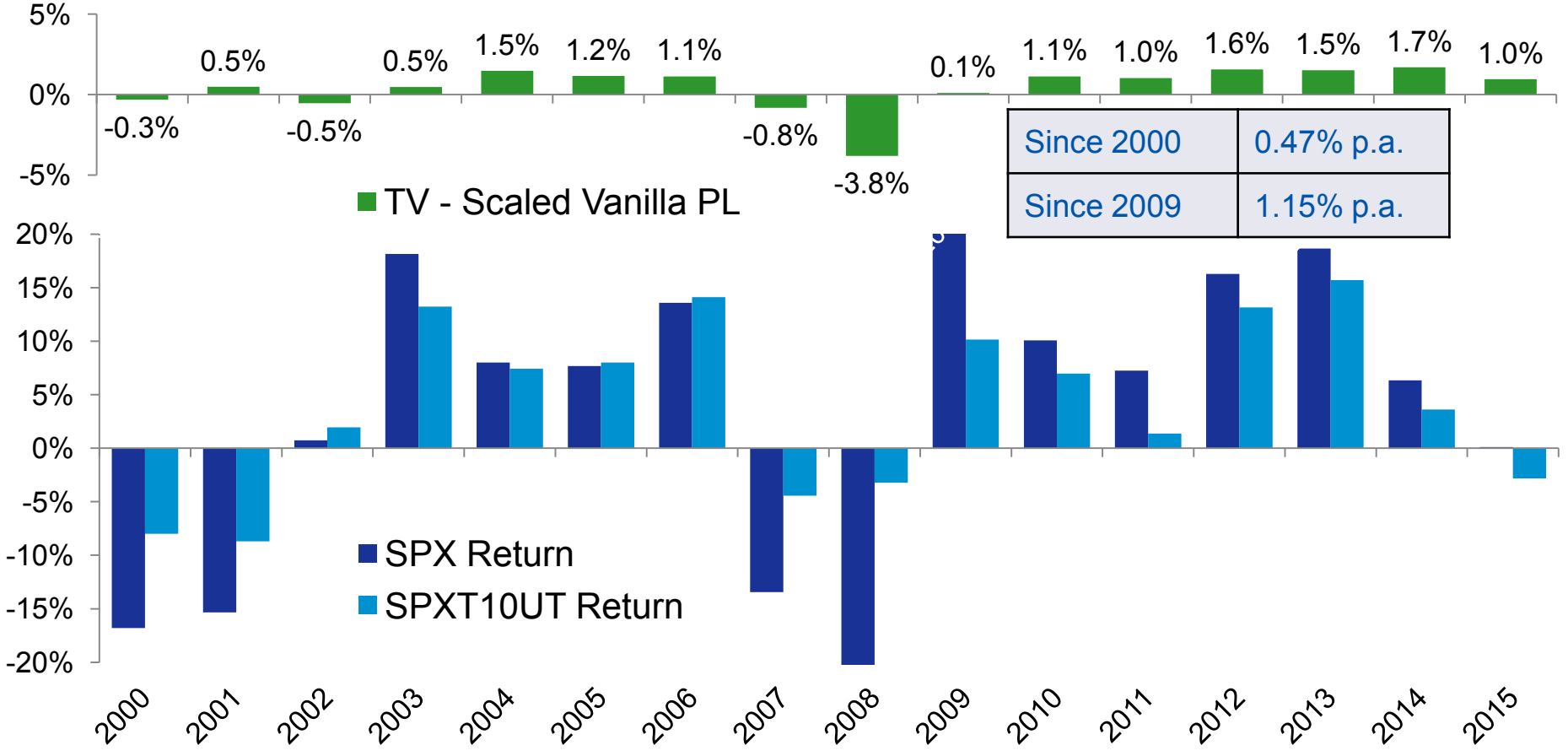
Since 2000	0.25% (0.50% p.a.)
Since 2009	0.67% (1.34% p.a.)

Source: *Bloomberg Finance L.P., DB Structuring and DB Equity Derivatives Research*

Target Volatility Puts vs. Vanillas

SPXT10UT **12m 90%**; Dynamic Adjustment

Target Vol Put vs. Scaled Vanilla PL, Average by Trade Year



Source: *Bloomberg Finance L.P., DB Structuring and DB Equity Derivatives Research*

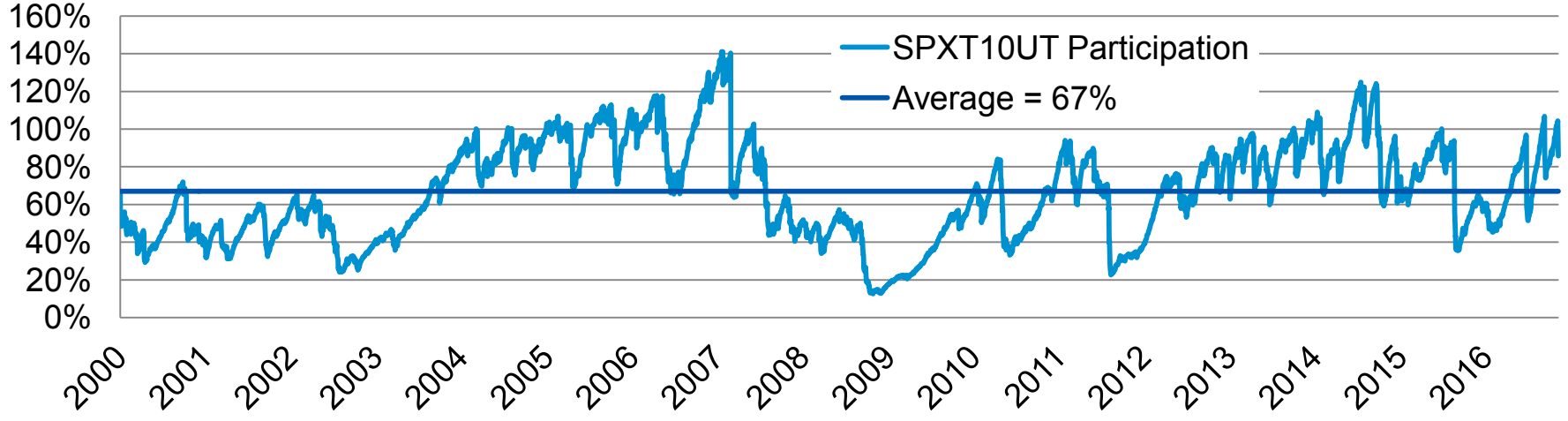
Target Volatility Puts vs. Vanillas

Comparable Instruments Methodology

We assume that the liability's equity exposure matches the proxy index. But comparing to the vanilla, does a daily dynamic participation adjustment fairly capture equal crash risk?

Hedging with vanillas, as participation increases (decreases) would need to buy (sell) puts to hedge crash risk of target vol liability. IE, buy when vol is falling, sell when vol is rising

In another comparison we adjust each vanilla put strike and notional using the same long-term participation of 67%

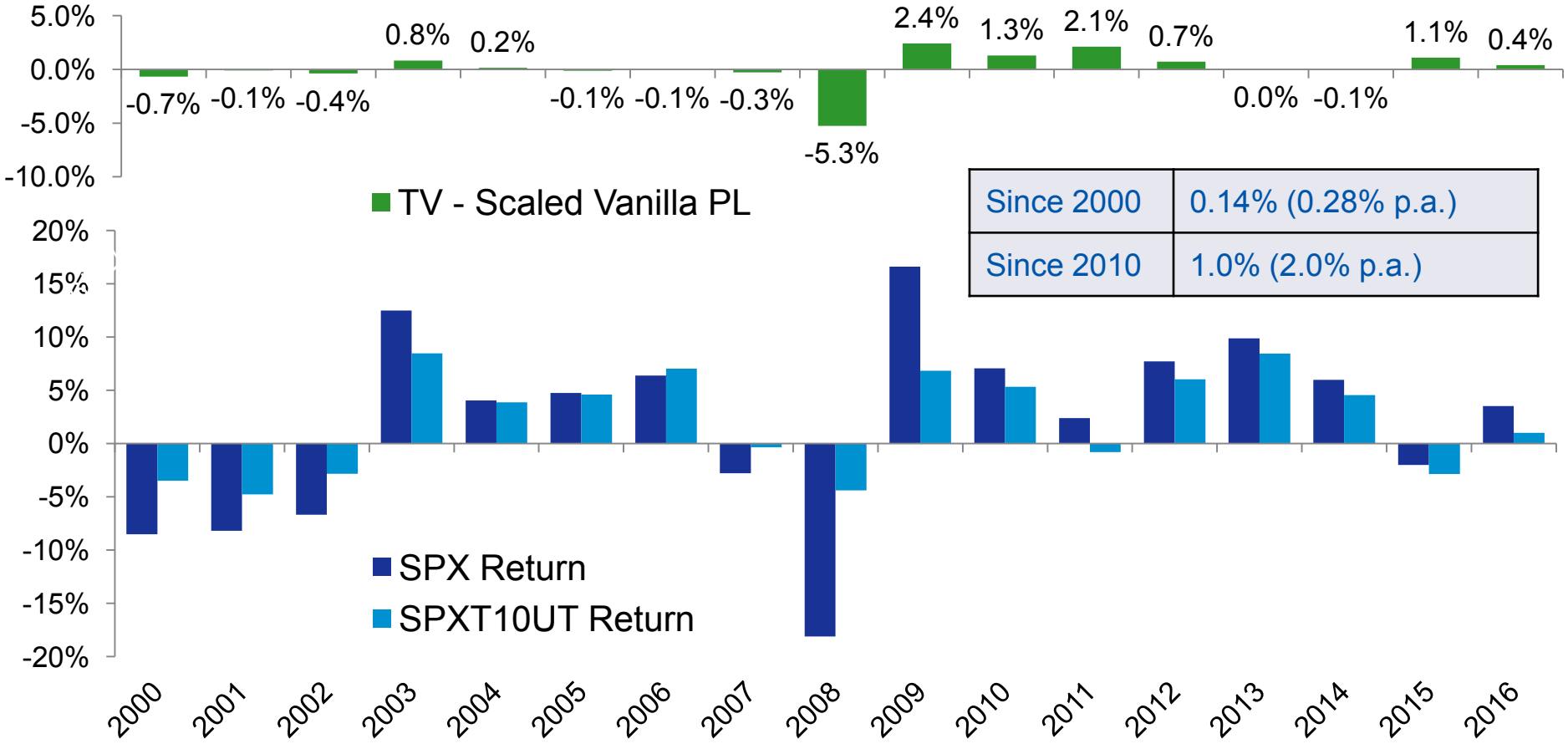


Source: Bloomberg Finance L.P. and DB Structuring

Target Volatility Puts vs. Vanillas

Back-tested PL Comparison – 6m 95% Static (67% Participation)

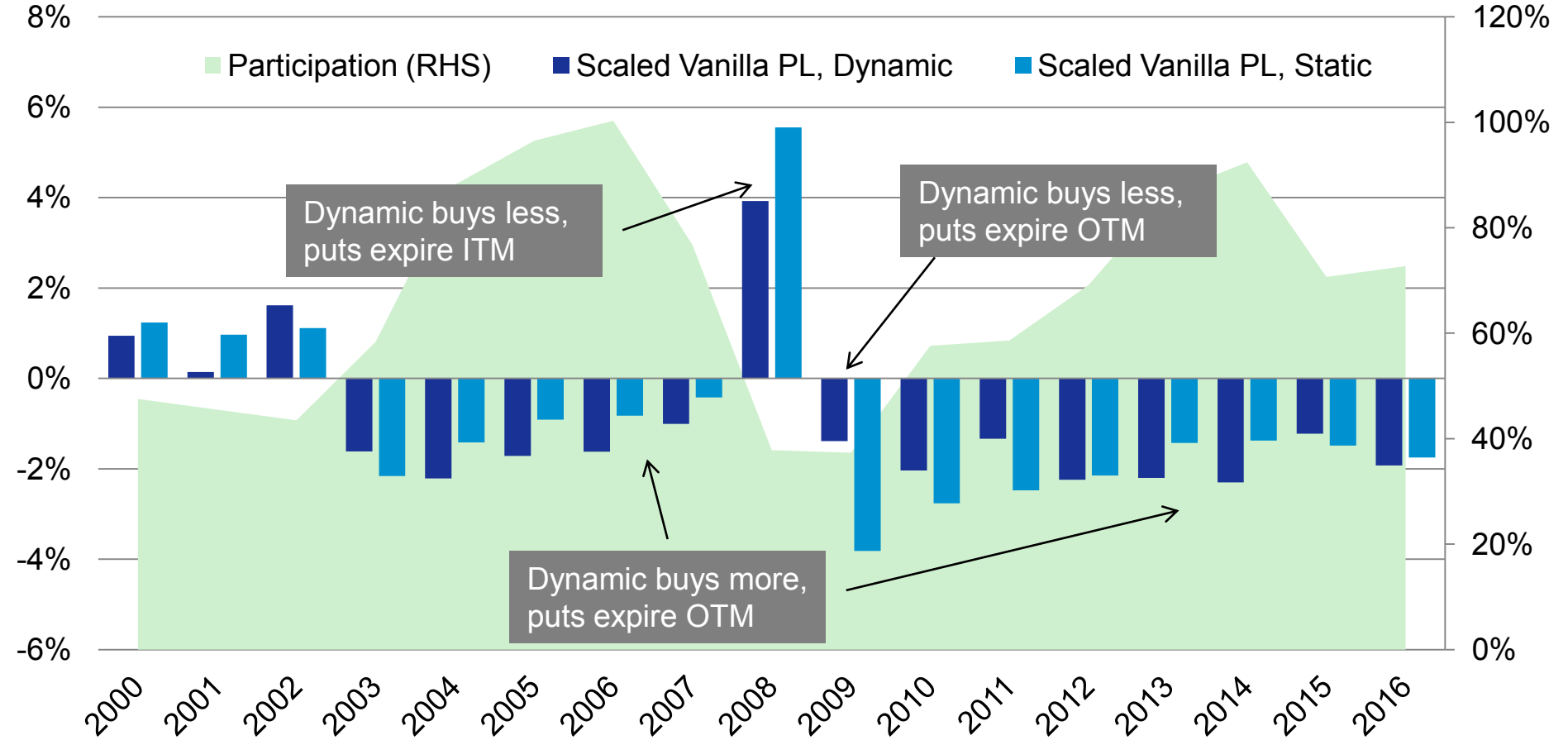
Target Vol Put vs. Scaled Vanilla PL, Average by Trade Year



Source: Bloomberg Finance L.P., DB Structuring and DB Equity Derivatives Research

Target Volatility Puts vs. Vanillas

Dynamic vs. Static Hedging with Vanillas



Source: Bloomberg Finance L.P., DB Structuring and DB Equity Derivatives Research

Other Tactical Hedging Instruments

1x2 Put Spread	• Finance tail risk protection by selling ATM gamma
Conditional Up-Variance Swap	• Monetize skew to buy cheap vega, plus 1-day gap protection
Variance KO Put	• Monetize vol and skew with limited risk

Delta-Hedged 1x2 Put Spread

Using vanilla options, VA hedgers can set up a position that provides:

- Positive carry
- Long skew, Long convexity, Deep tail risk protection

The strategy entails:

- Selling an ATM or near-ATM put
- Buying 2 OTM puts
- Delta hedging

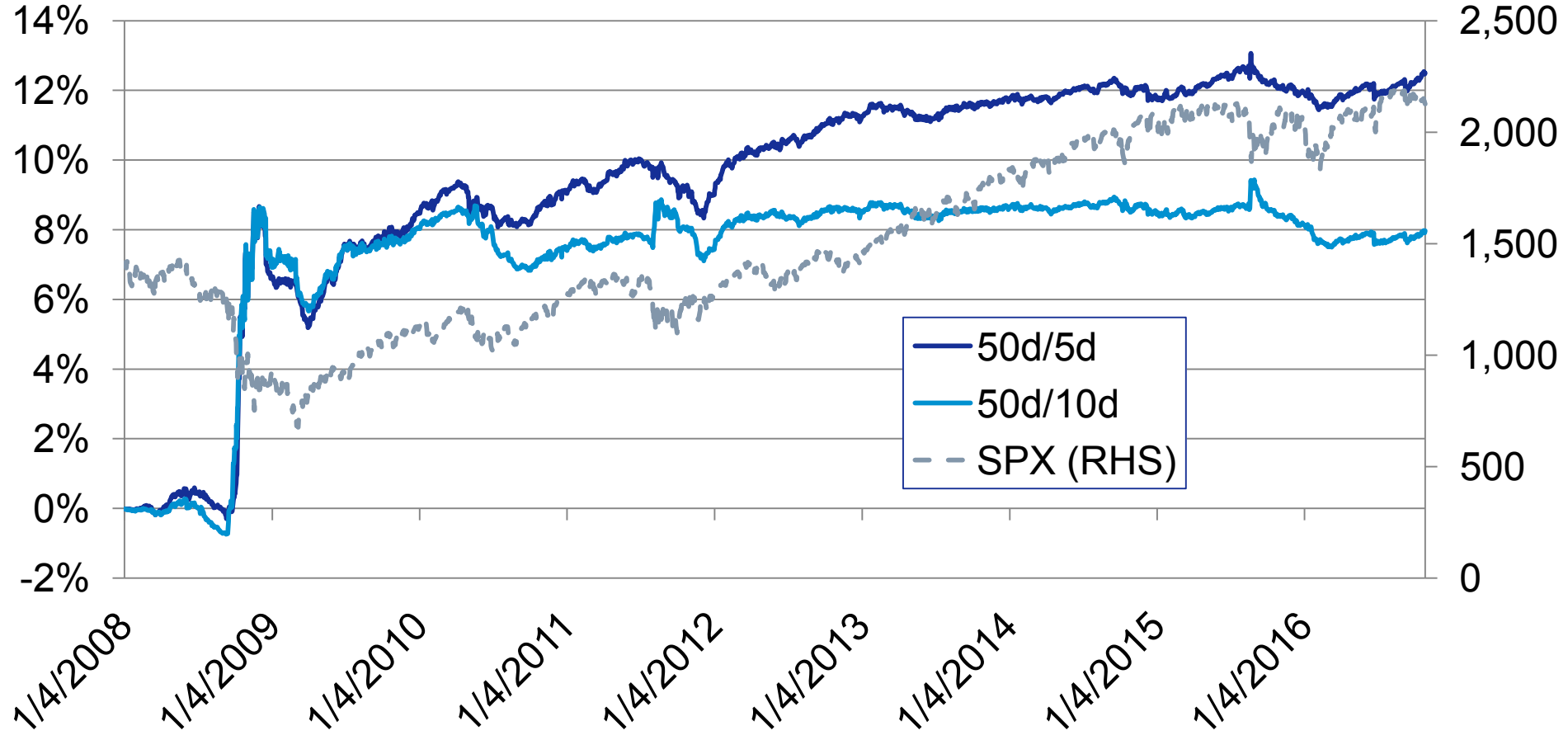
In return for the above benefits, seller is exposed to high implied or realized volatility without a significant selloff in spot

Applicability: Target vol liabilities may incur less daily delta hedging than traditional VA and would be better positioned to sell local gamma

Delta-Hedged 1x2 Put Spread

SPX 6m, Delta-based strikes

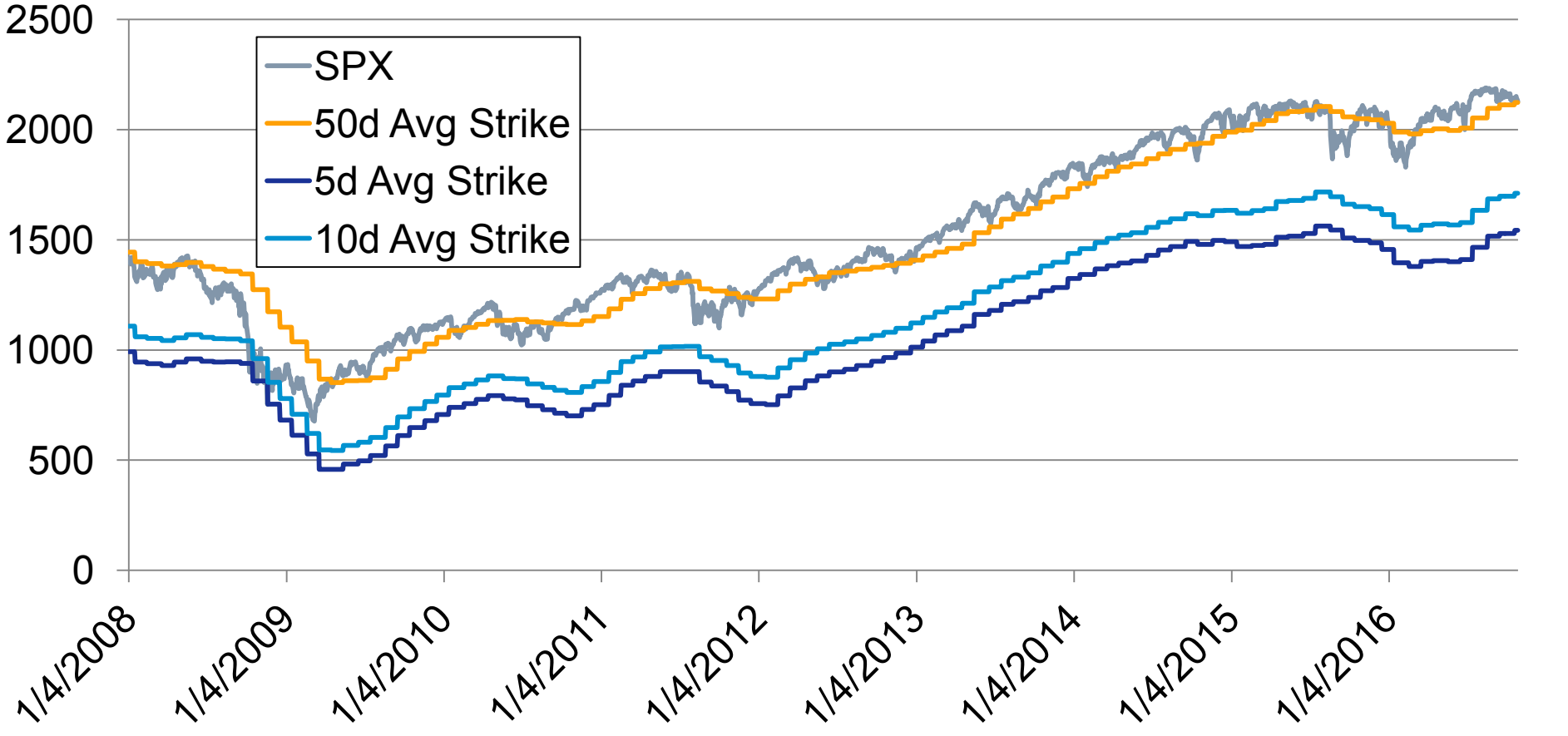
Indicative PL Back-test: Sell $1/6 notional every month



Source: Bloomberg Finance L.P. and DB Structuring

Delta-Hedged 1x2 Put Spread
SPX 6m, Delta-based strikes

Strikes Back-test

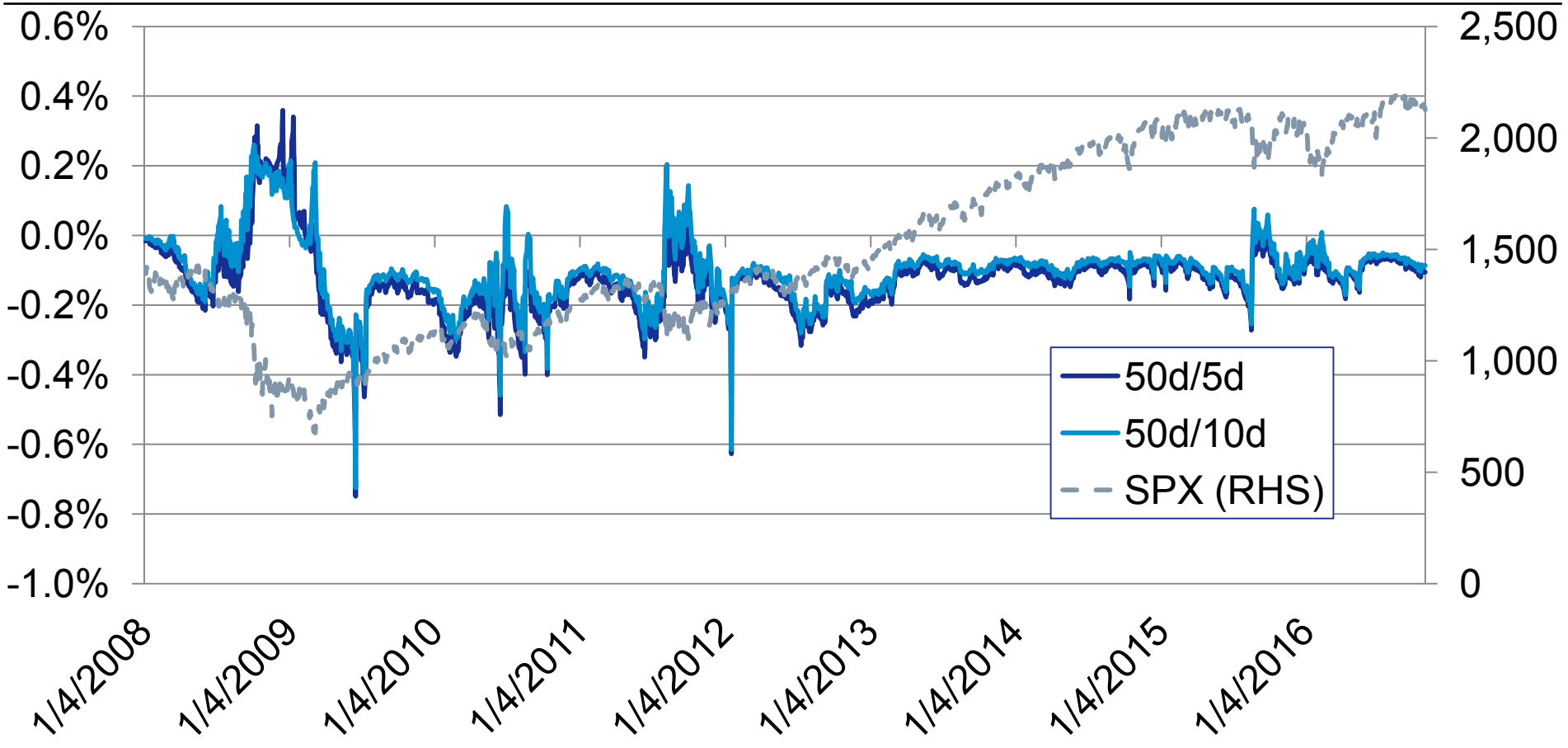


Source: Bloomberg Finance L.P. and DB Structuring

Delta-Hedged 1x2 Put Spread

SPX 6m, Delta-based strikes

Gamma Back-test

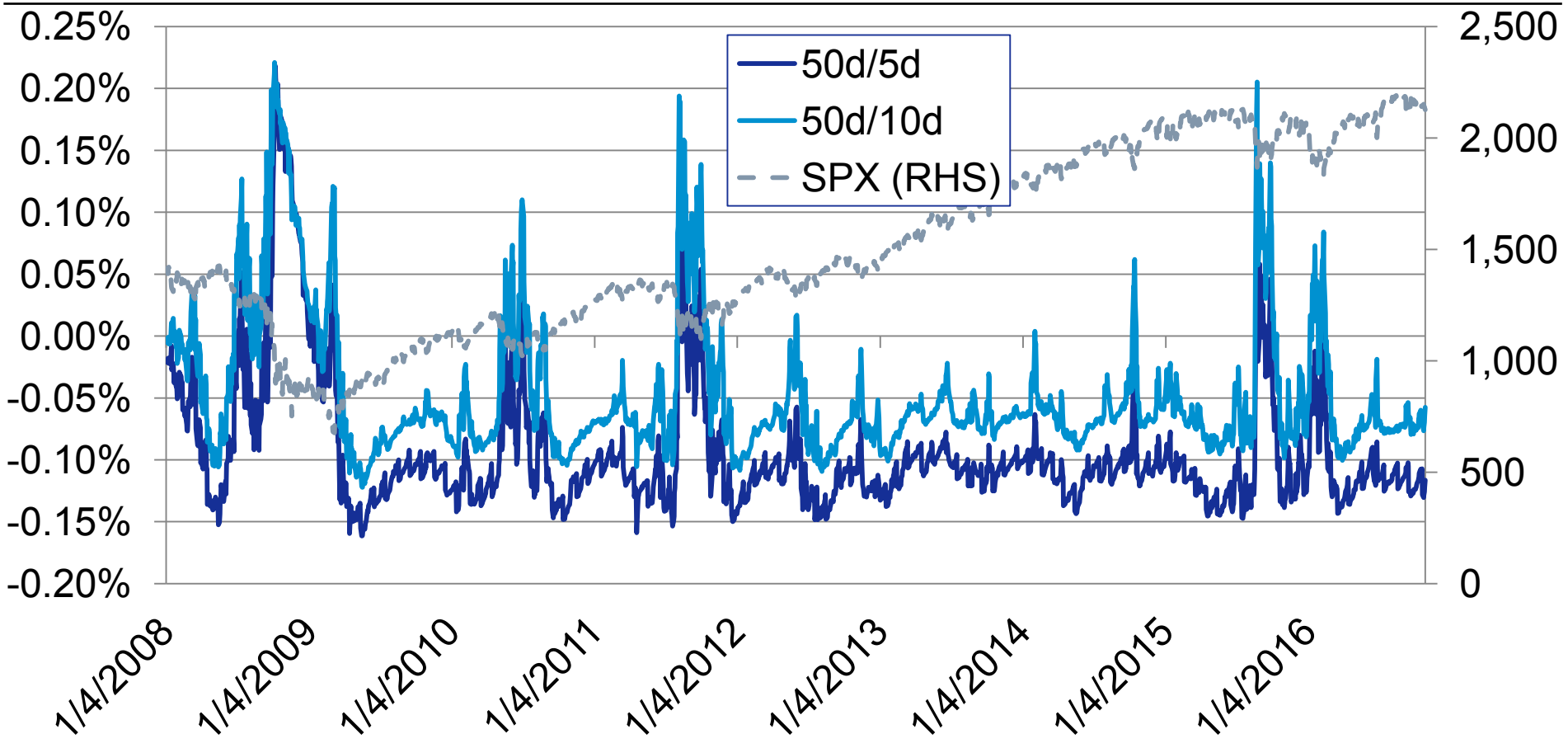


Source: Bloomberg Finance L.P. and DB Structuring

Delta-Hedged 1x2 Put Spread

SPX 6m, Delta-based strikes

Vega Back-test



Source: Bloomberg Finance L.P. and DB Structuring

Conditional Up-Variance Swap

"Conditional Up-Variance Swaps" only accrue variance if the spot price is above a barrier.

Applicability: Use ITM (downside) barrier; Provide 1-day gap protection as barrier is observed t-1; Best for portfolios requiring some long vega exposure

$$\text{Payoff} = \text{Notional} \times \text{OccurenceRatio} \times (\text{UpVarStrike} - \text{UpVarRealized})$$

$$\text{UpVarRealized} = \frac{252 \times \sum_{t=1}^{t=N} \left(\ln\left(\frac{P_t}{P_{t-1}}\right)^2 ind\,(P_{t-1}) \right)}{\sum_{t=1}^{t=N} ind\,(P_{t-1})}$$

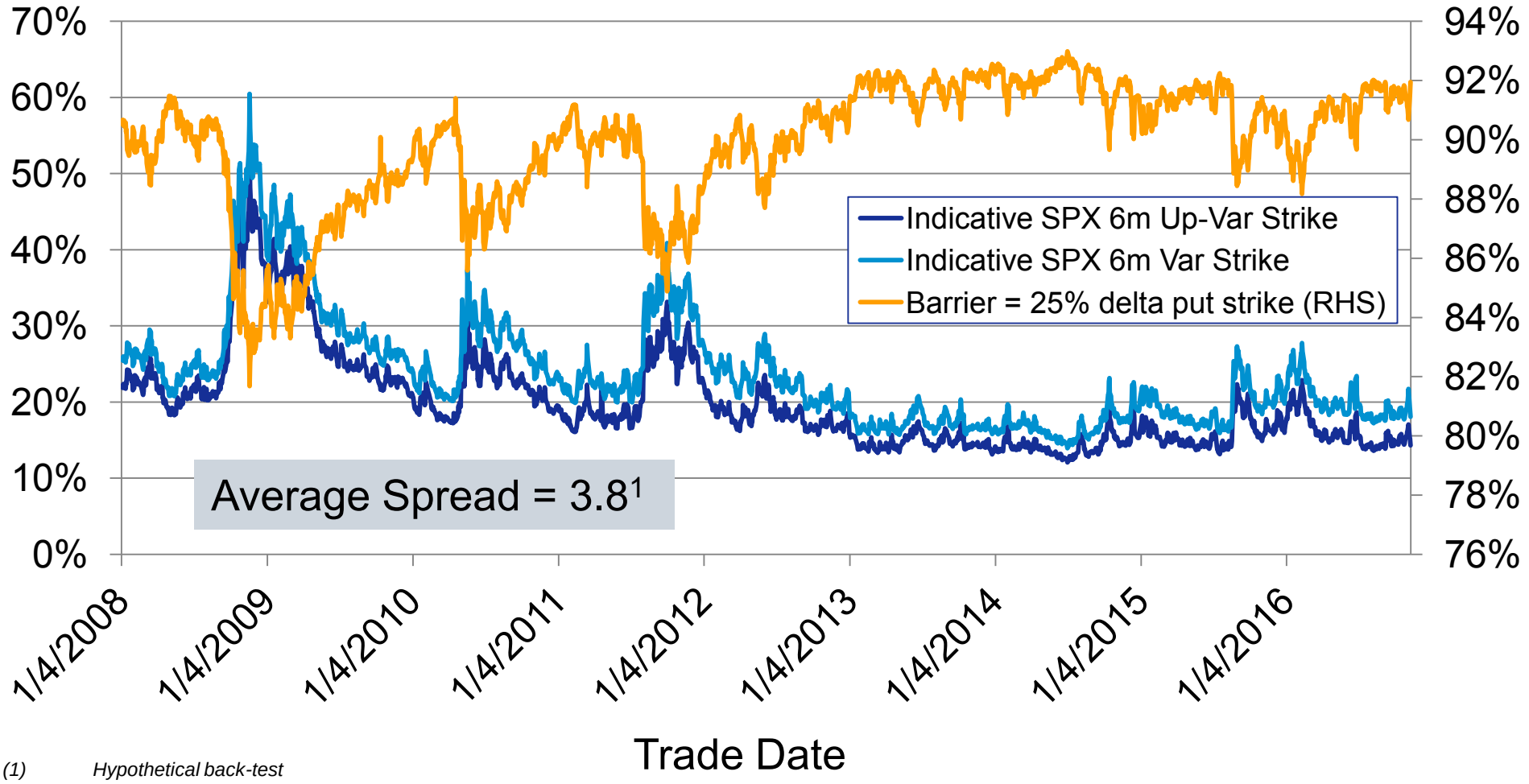
$$\text{OccurenceRatio} = \frac{\sum_{t=1}^{t=N} ind\,(P_{t-1})}{N}$$

$ind(P_{t-1})$ equals 0 if spot at ***t – 1*** is above barrier, otherwise equal to 1

N is expected number of trading days from Trade to Expiration

Conditional Up-Variance Swap

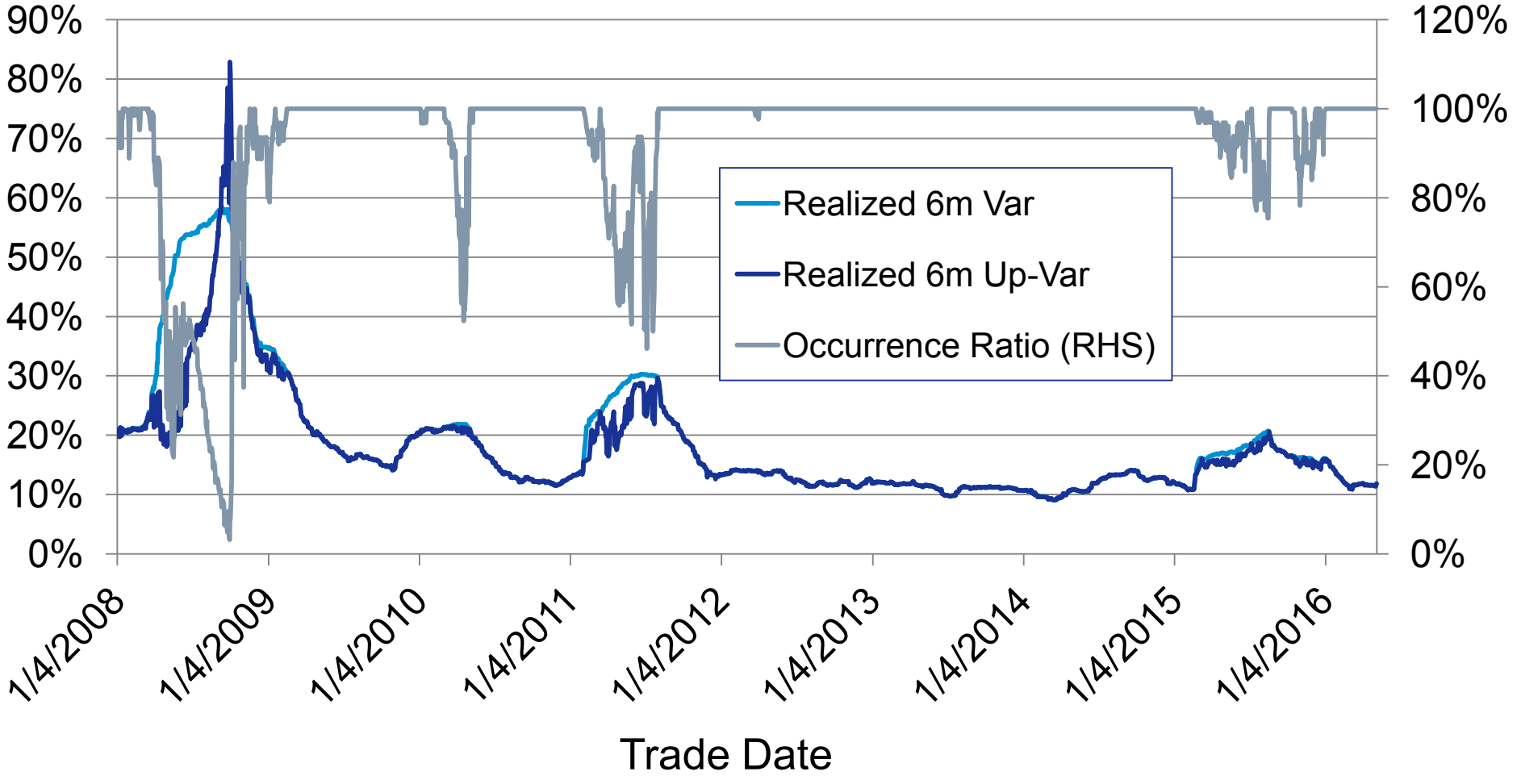
Given steep skew, up-variance strikes are lower than regular variance



(1) Hypothetical back-test
Source: DB Structuring

Conditional Up-Variance Swap

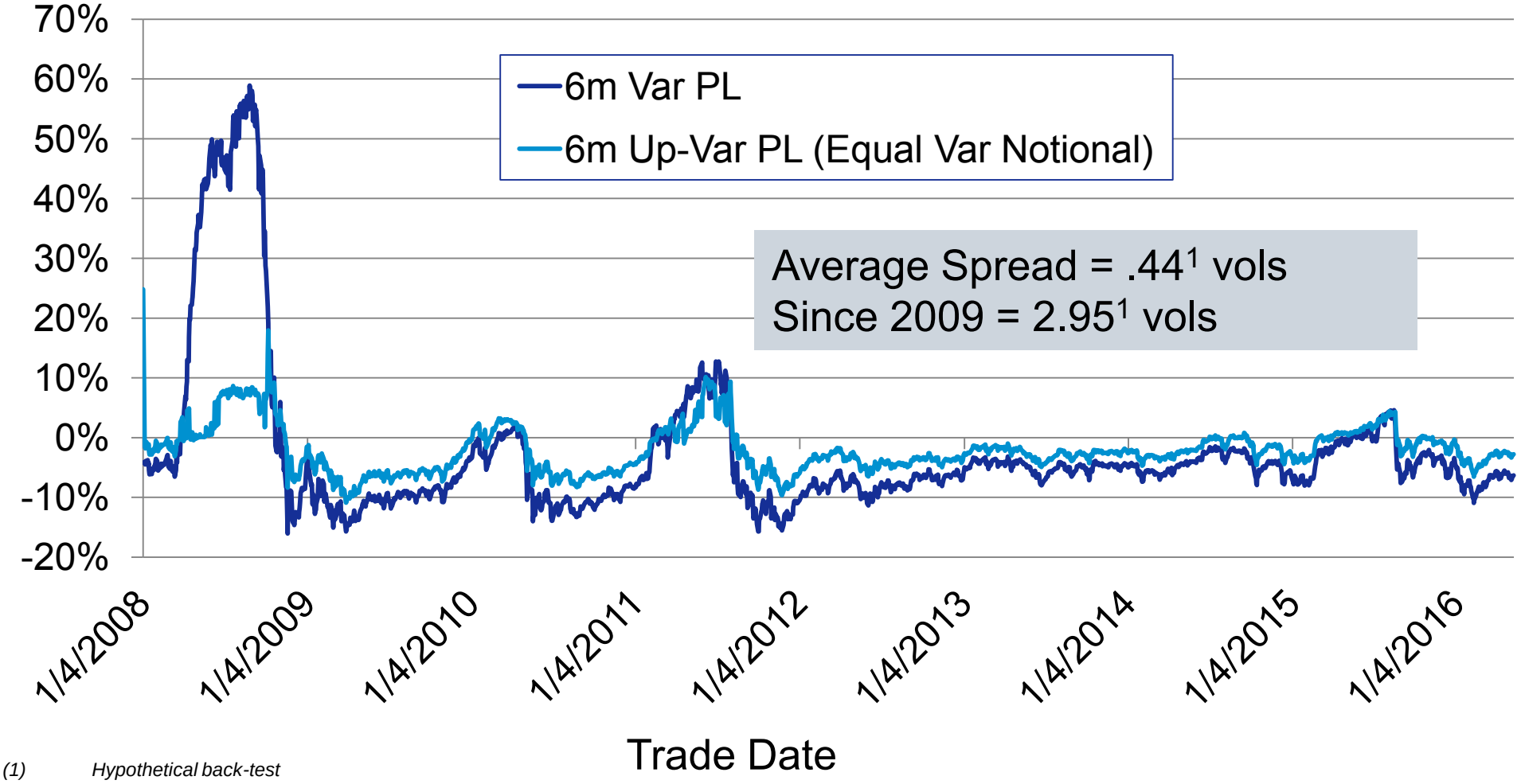
Realized Conditional Variance and Occurrence Ratio



Source: Bloomberg Finance, LP and DB Structuring

Conditional Up-Variance Swap

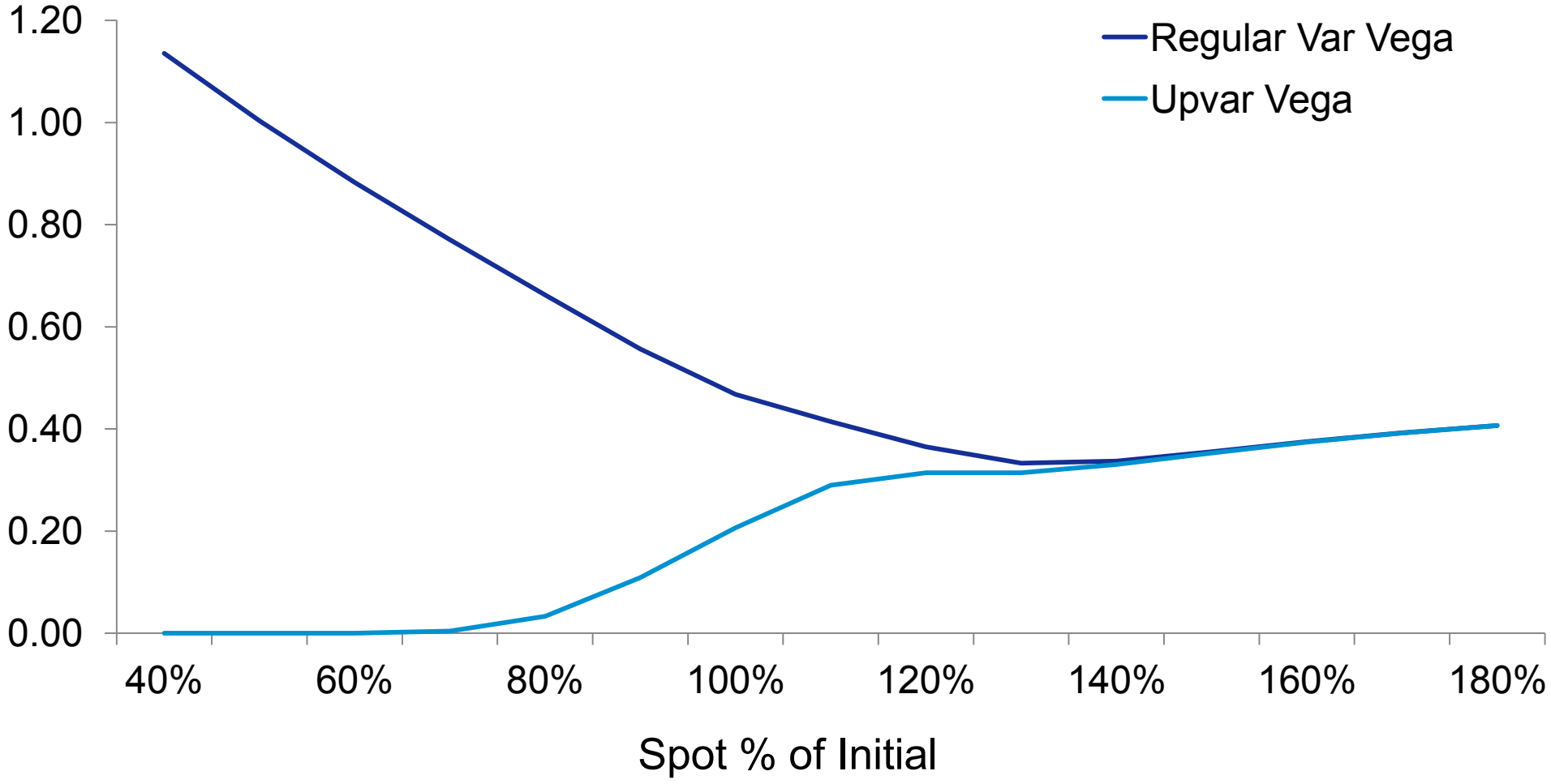
Except for Trades done in 2008, Up-Var generally would have outperformed regular Var



(1) Hypothetical back-test
Source: Bloomberg Finance, LP and DB Structuring

Conditional Up-Variance Swap

Vega scenarios (6m, 92% barrier)



Source: Bloomberg Finance, LP and DB Structuring

Variance Knock-Out Put

A Variance Knock-Out Put pays zero if the realized variance surpasses a “budget” during the life of the trade. Otherwise it pays the same as a vanilla.

Applicability: Typically traded by hedge funds. Structure is short-vega and skew, with limited liability. Target volatility hedgers may be positioned to sell vega and skew opportunistically

Example:

Underlying:	SPX
Tenor:	6m
Strike:	ATM Spot
Variance Budget:	(Implied Variance)^2 * 0.5
Implied Variance:	0.19
Indicative Cost:	1.3% (72% discount to Vanilla)
Vanilla 6m ATM Put:	4.6%

$$\text{Realized Variance}(t) = \sum_{i=1}^{t} \left[\ln\left(\frac{SPX_i}{SPX_{i-1}} \right) \right]^2$$

Variance Knock-Out Put

Implied skew and convexity premia cause the VKO to price the survival rate lower than statistically observed

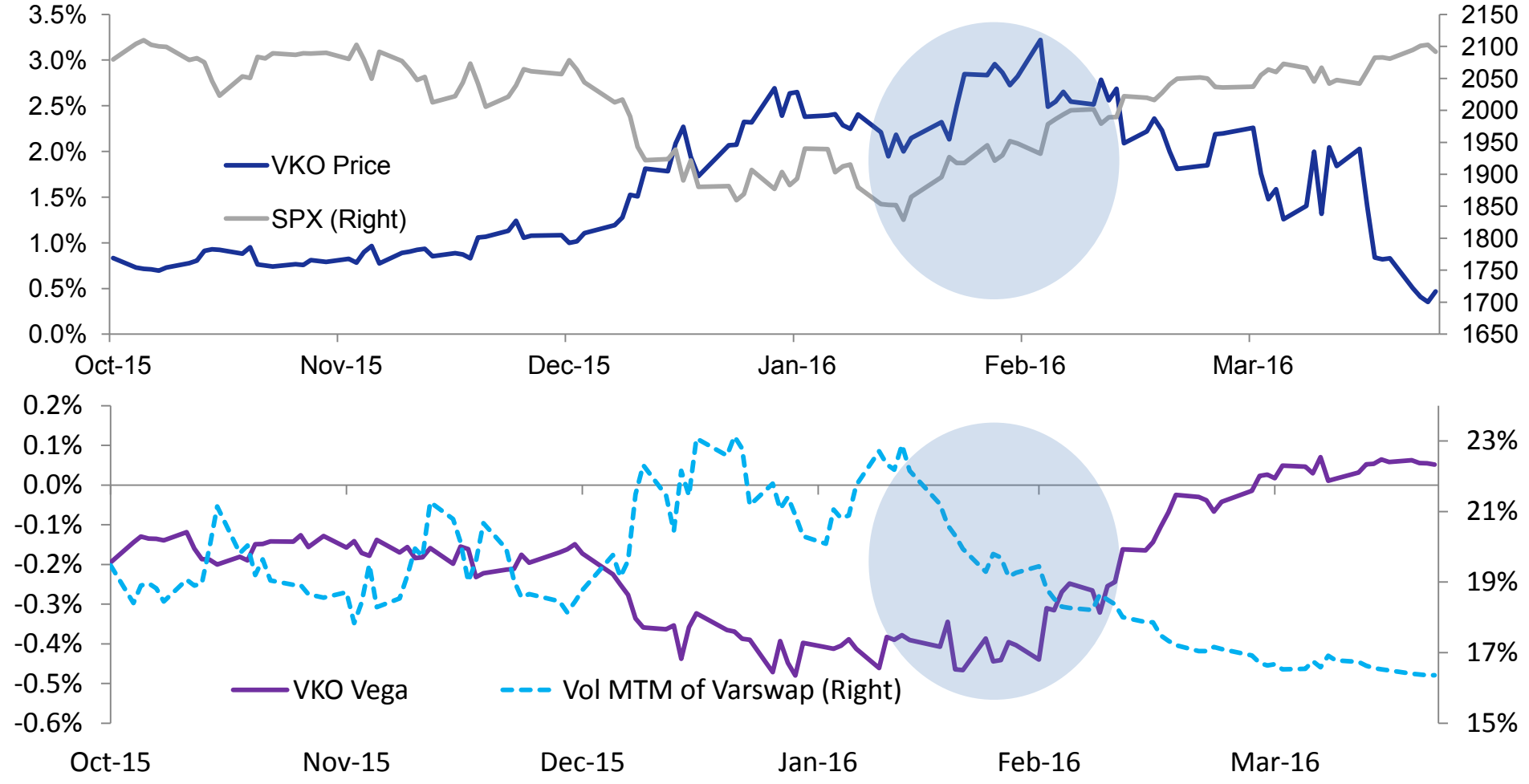
Most negative SPX Returns	Avg SPX Return	Survival Rate	Avg VKO Px/ Vanilla Px[1]
0% to 5%	-36.27%	0.0%	28.5%
5% to 10%	-15.89%	22.9%	28.4%
10% to 15%	-7.89%	54.3%	28.4%
15% to 20%	-4.42%	65.7%	28.8%
20% to 25%	-2.35%	46.2%	29.1%
25% to 30%	-0.19%	81.9%	29.5%
30% to 35%	1.78%	89.5%	35.9%
35% to 40%	2.93%	94.3%	33.2%

Quantile Analysis:
SPX 6m ATM VKO; barrier = 6m SPX implied variance on trade date
Trade Dates Jan '08 to Apr '16

(1) Hypothetically back-tested
Source: *Bloomberg Finance L.P and DB Structuring*

Variance Knock-Out Put

Vega Evolution: SPX 6m ATM VKO (19.4% budget) Back-Tested from 10/30/2015



Source: Bloomberg Finance L.P and DB Structuring

Final Thoughts

Target volatility strategies exhibit less skew as well as more predictable volatility than pure equity. Hedging strategies should benefit from both of these characteristics.

Buying puts on TV Indices may provide crash protection with less risk premium cost.

"Light Exotics" such as Conditional Variance and VKO's can monetize expensive skew.

Ongoing work:

-- Assessing tracking error of VA Portfolios vs. TV Indices. Designing custom benchmarks where appropriate

-- Price discovery for Target Volatility Puts

-- Portfolio diversification from trading combinations of these instruments