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Connecting Markets East & West

Vol Risk Premia in Equities

“Selling Vol” or Earning a Risk Premium?

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See Disclosure Appendix A1 for analyst certifications and important disclaimers.

May 2015

Table of Contents

Everyone is short vol

But not everyone is getting paid for it!

You’re short even if you don’t know it!

- **Almost all asset classes are short vol**
  - Credit is short vol
  - Equities are also short vol
  - In low rates, govies are short vol
  - MBS is short vol
- **General Rule :**

  if you’re making a return, you probably sold someone some sort of option

Investors are already selling volatility via credit

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In theory long credit is <u>short a put on the assets</u> of a firm (Merton 1974)

The "Merton model" of credit risk

ON THE PRICING OF CORPORATE DEBT: THE RISK STRUCTURE OF INTEREST RATES*

ROBERT C. MERTON*

I. INTRODUCTION

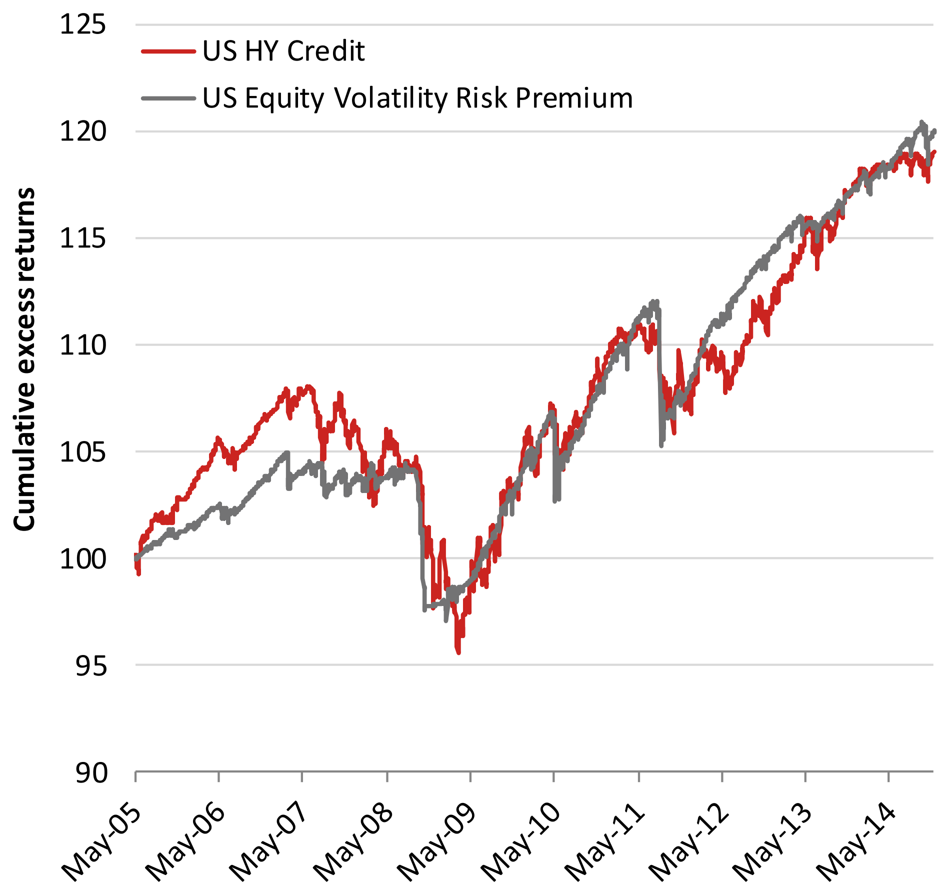
THE VALUE OF a particular issue of corporate debt depends essentially on three items: (1) the required rate of return on riskless (in terms of default) debt (e.g., government bonds or very high grade corporate bonds); (2) the various provisions and restrictions contained in the indenture (e.g., maturity date, coupon rate, call terms, seniority in the event of default, sinking fund, etc.); (3) the probability that the firm will be unable to satisfy some or all of the indenture requirements (i.e., the probability of default).

While a number of theories and empirical studies has been published on the term structure of interest rates (item 1), there has been no systematic development of a theory for pricing bonds when there is a significant probability of default. The purpose of this paper is to present such a theory which might be called a theory of the risk structure of interest rates. The use of the term "risk" is restricted to the possible gains or losses to bondholders as a result of (unanticipated) changes in the probability of default and does not include the gains or losses inherent to all bonds caused by (unanticipated) changes in interest rates in general. Throughout most of the analysis, a given term structure is assumed and hence, the price differentials among bonds will be solely caused by differences in the probability of default.

In a seminal paper, Black and Scholes [1] present a complete general equilibrium theory of option pricing which is particularly attractive because the final formula is a function of "observable" variables. Therefore, the model is subject to direct empirical tests which they [2] performed with some success. Merton [5] clarified and extended the Black-Scholes model. While options are highly specialized and relatively unimportant financial instruments, both Black and Scholes [1] and Merton [5, 6] recognized that the same basic approach could be applied in developing a pricing theory for corporate liabilities in general.

In Section II of the paper, the basic equation for the pricing of financial instruments is developed along Black-Scholes lines. In Section III, the model is applied to the simplest form of corporate debt, the discount bond where no coupon payments are made, and a formula for computing the risk structure of interest rates is presented. In Section IV, comparative statics are used to develop graphs of the risk structure, and the question of whether the term premium is an adequate measure of the risk of a bond is answered. In Section V, the validity in the presence of bankruptcy of the famous Modigliani-Miller

The empirical evidence supports the theory in the US



Source: Merton 1974, On the pricing of corporate debt: The risk structure of interest rates, Journal of Finance, Bloomberg, Nomura. HY Credit is CDX HY on-the-run index. US equity volatility risk premium is short variance swaps on S&P 500.

Empirically, equities are short vol

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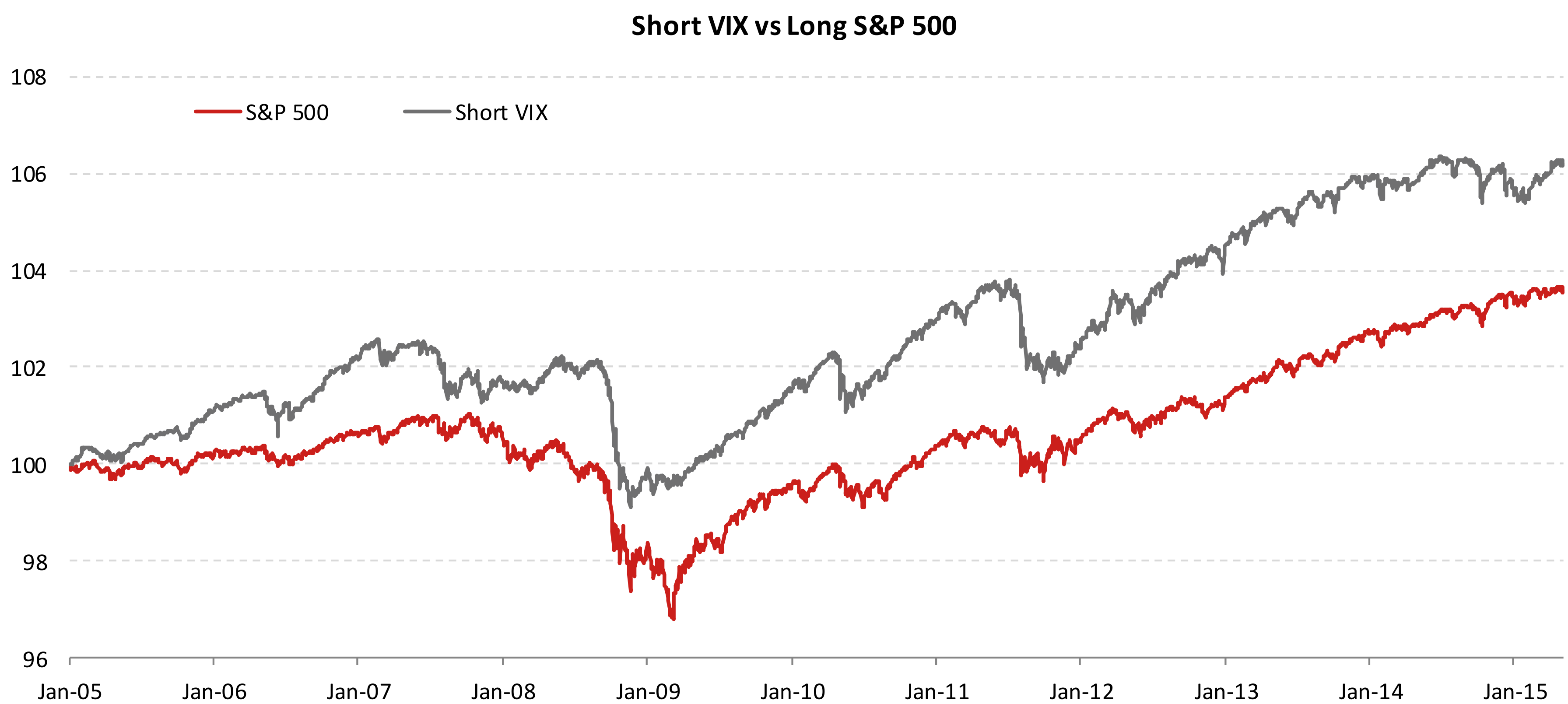
Going short volatility has a very similar performance to going long equities.

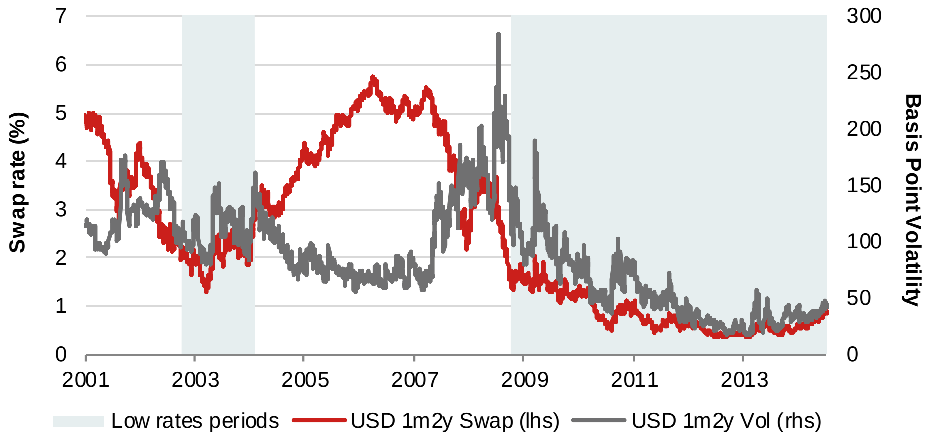


Same Risk, Different Premia

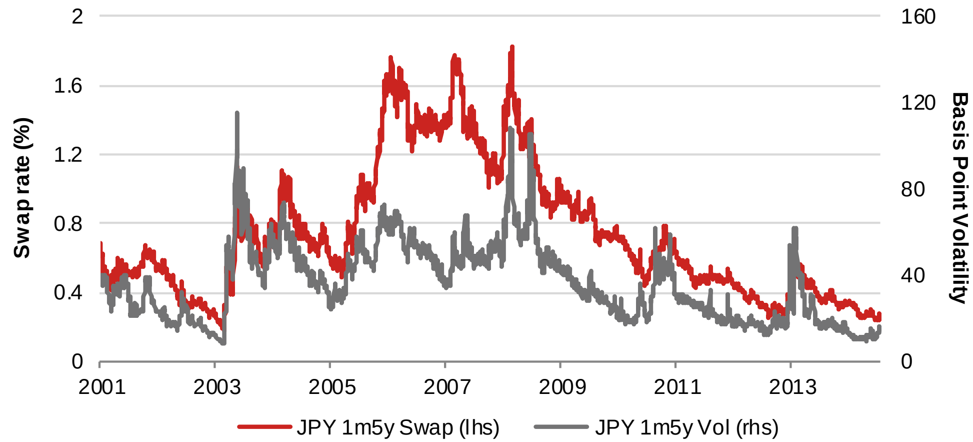
Source: Bloomberg

In low rates environments, govies are short vol

USD front-ends showed a strong comovement in low rates



Comovement is even stronger in low yield market like Japan



Fisher Black suggested at ZIRP bonds turn into options on future policy rates

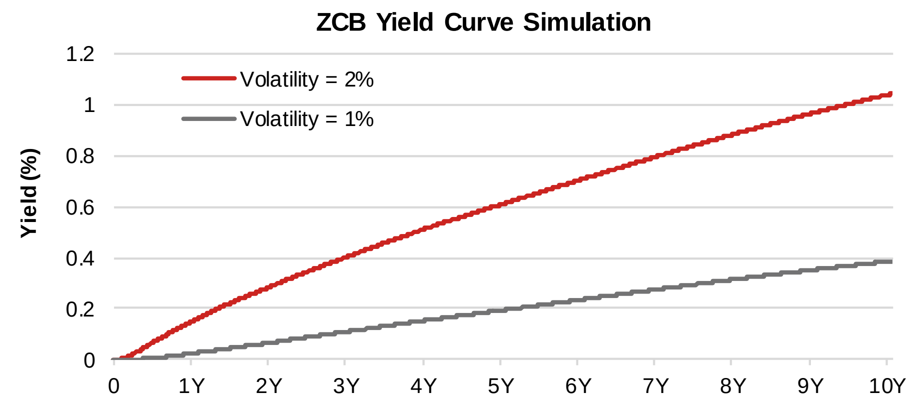
Say x(t) is the shadow rate[1] and r(t) is the short rate.

$$dx_t = \mu(x,t)dt + \sigma dW_t$$
$$r_t = \max(0, x_t)$$

Hence, ZCB yield slope depends on the volatility:

$$y_T = -\log(E_T[\exp(-\int r_s ds)]) \sim \sigma\sqrt{T}$$
$$y_{T_1} - y_{T_2} \sim \sigma(\sqrt{T_1} - \sqrt{T_2})$$

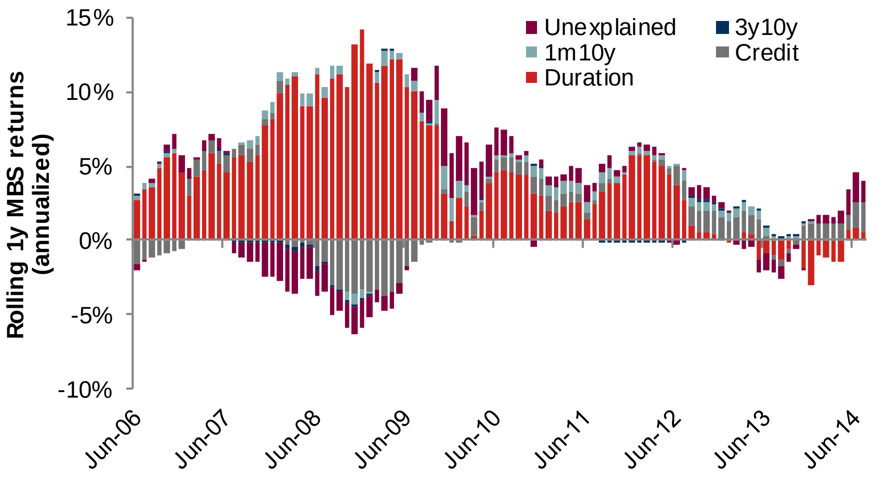
Higher vol = higher rates and steeper curves



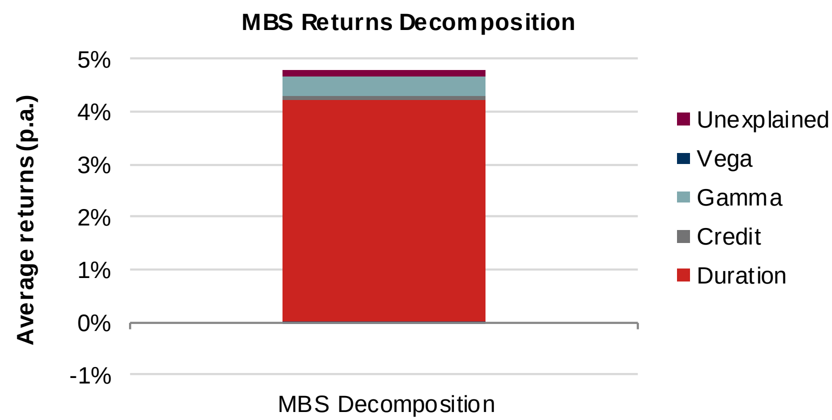
Source: Nomura Research, Bloomberg
1: Shadow rate is defined as the short rate without cash-and-carry constraints

Mortgages (MBS) – also short volatility

Duration is the main component in MBS returns

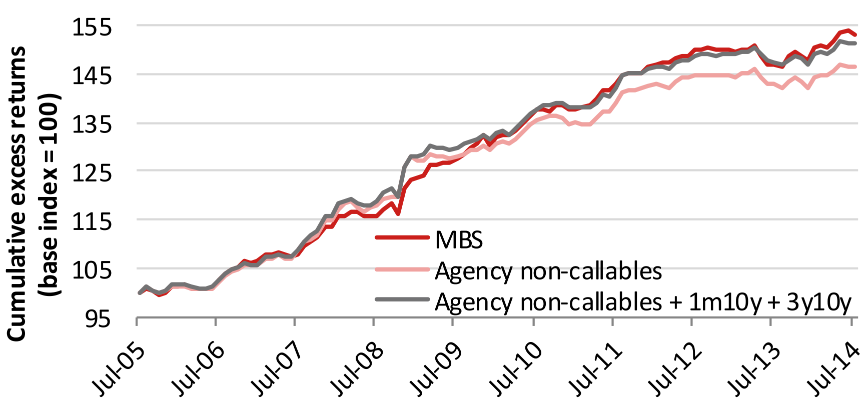


Optionality drives the outperformance of MBS

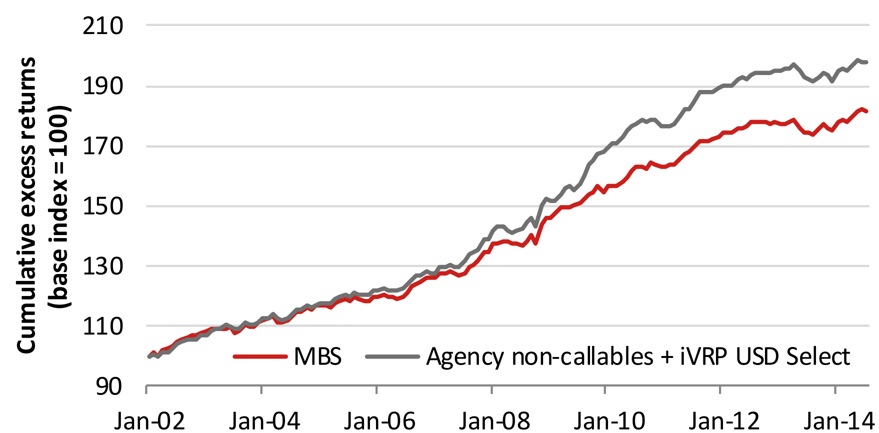


* *Sample period: Aug 2005 – Jul 2014*

Duration and optionality help to replicate MBS returns



MBS optionality replaced by iVRP outperforms



Source: Citi Yieldbook, Nomura Research
* *Agency non-callables returns are adjusted to match the same duration as MBS.*

Smart money sells vol!

Wait a second!

Didn't Buffett call Derivatives "Financial Weapons of Mass Destruction"?

Didn't Lehman fall because they were short vol?

Source: Wikimedia (http://commons.wikimedia.org/wiki/File:Warren_Buffett_KU_Visit.jpg) and WikiMedia (http://commons.wikimedia.org/wiki/File:Lehman_Brothers.svg)

The insider's story

Buffett Sold Vol

BERKSHIRE HATHAWAY INC.

$4.2bn

Lehman Bought Vol

LEHMAN BROTHERS

OTM puts "worst of"
(SPX, NKY,SX5E) basket

Source: see Matt Levine, Lehman Brothers Maybe Sold Warren Buffett a Rainbow, Bloomberg View, 6 Feb 2014 and quoted sources.

Why did Buffett sell vol?

Derivatives = Insurance!

"*Our insurance-like derivatives contracts*, … are coming to a close…….almost certain to realize a final 'underwriting profit'*

- Warren Buffett"

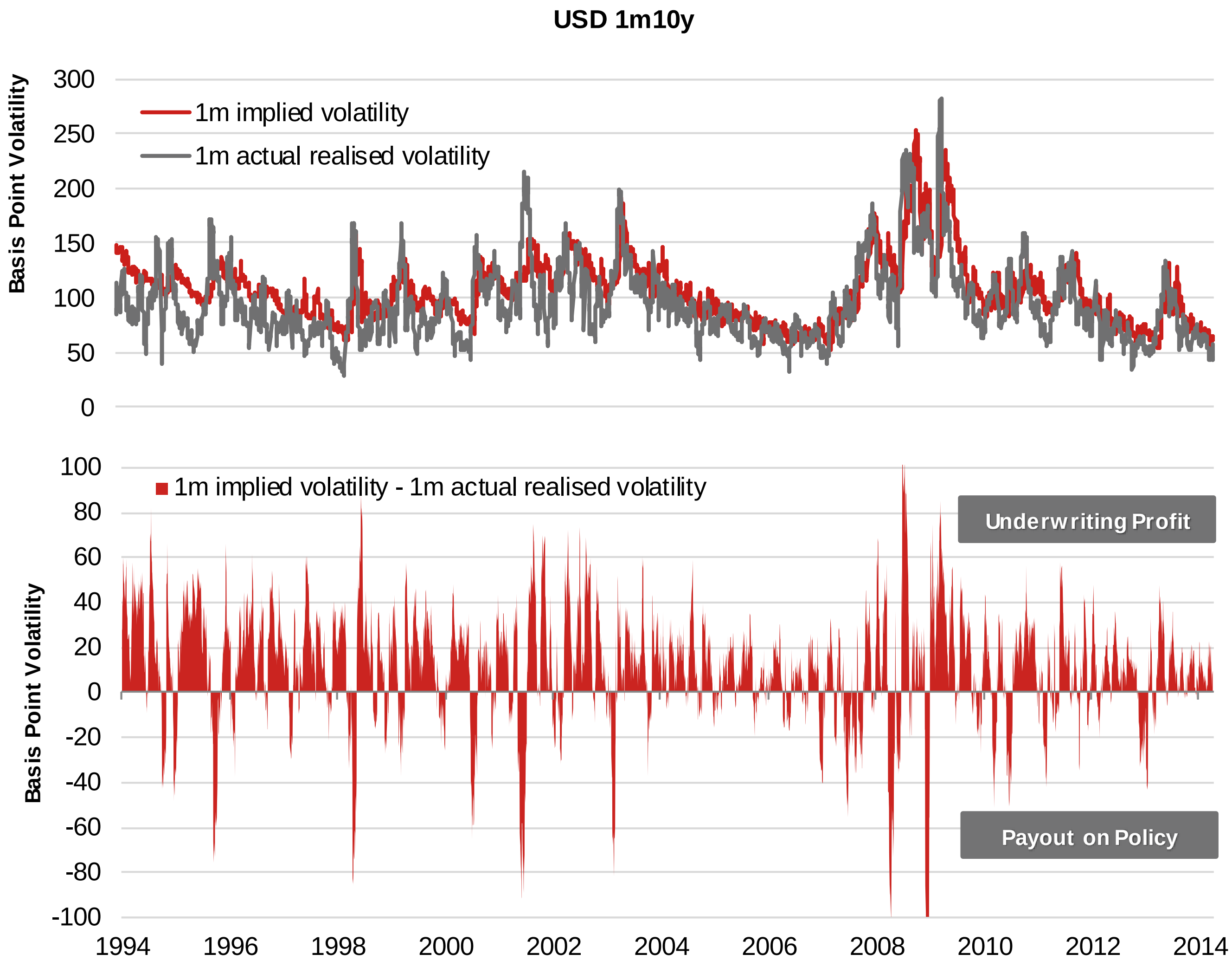
* Equities puts, CDO Tranches, CDS, etc

Source: Nomura Research

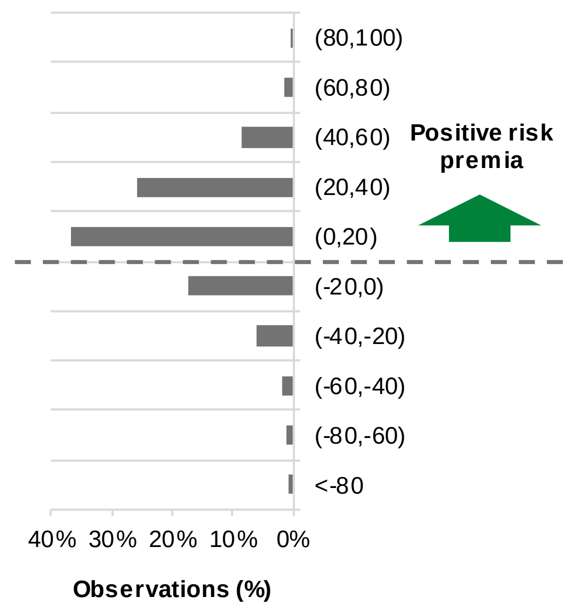
Vol as Insurance

When should you sell it and which vol should you sell?

Selling vol usually makes money



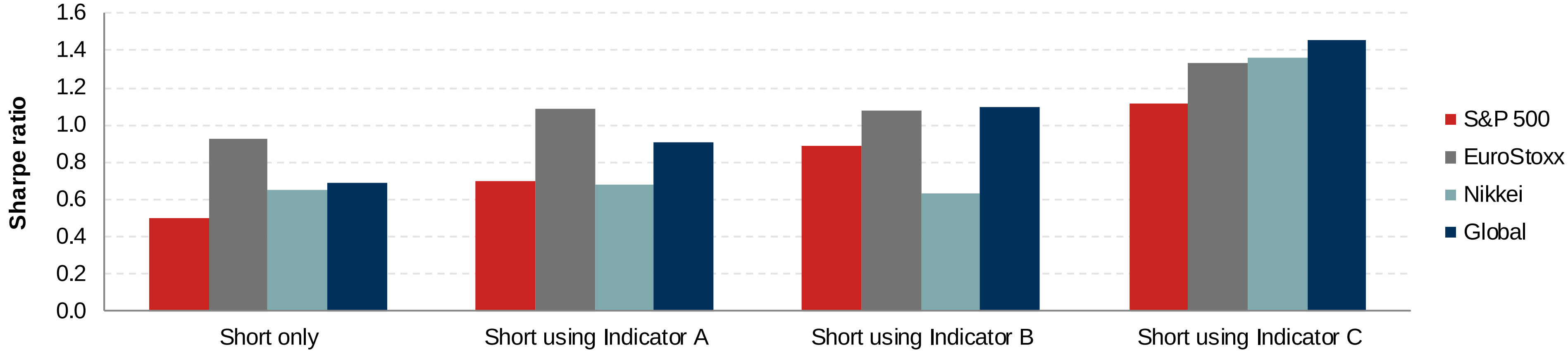
- Historically, implied volatility tends to exceed realized volatility over the long term.
- In more than **70%** of cases, implied volatility was greater than realized volatility.
- Average gain is **11.3bp** and positive as well



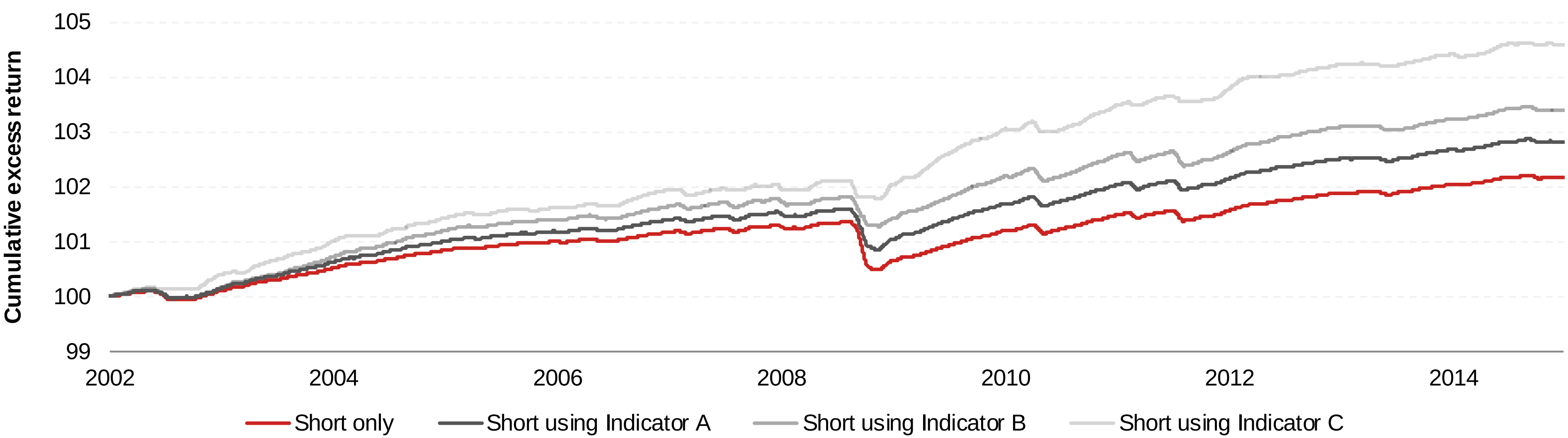
Source: Bloomberg, Nomura. The 1m10y swaption straddle implied volatility used in the above analysis is derived from the price of an ATMF 1m10y swaption, and the realised volatility is computed as being the actual realised volatility of the underlying 10y forward swap from the start date to the expiry date of the corresponding swaption straddle. The analysis is done on a daily basis and based on historical data from May 1994 to Sep 2014.

When should you sell vol?

Simple indicators improve the short gamma performance consistently



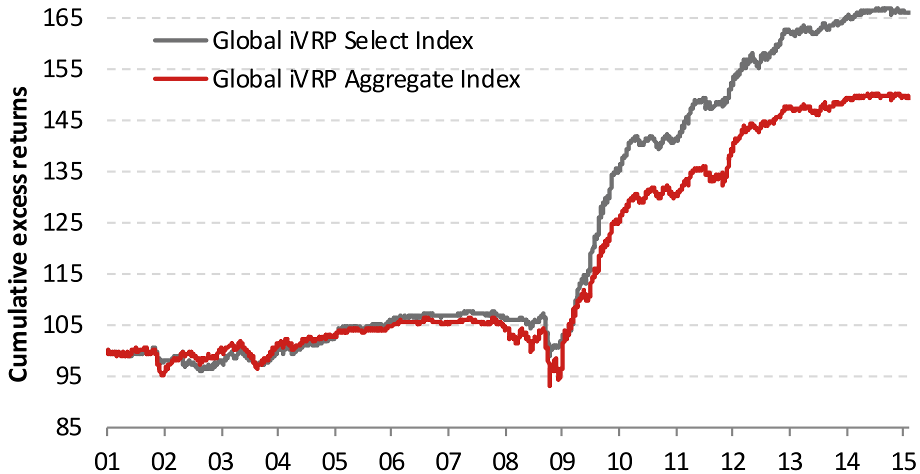
Global Equity Volatility Risk Premia

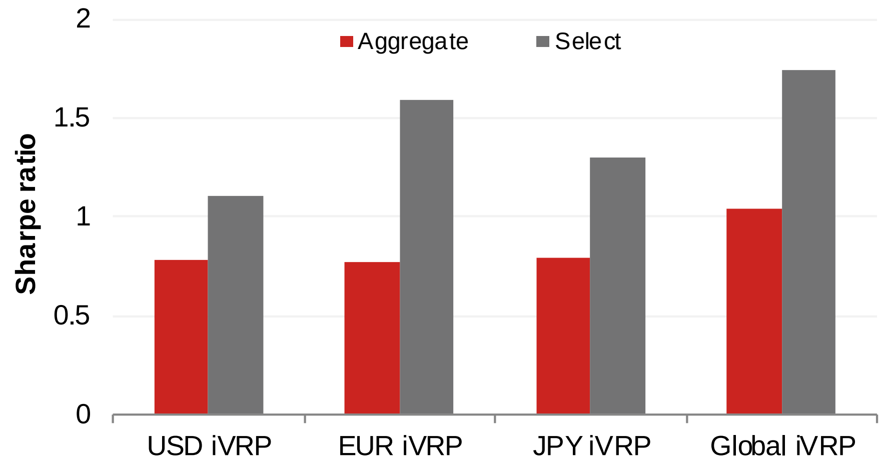


Source: Nomura Research. The global portfolio consists of 33% S&P 500, 33% EuroStoxx and 33% Nikkei. The sample period is Jan 2002 to Dec 2014. For comparison purpose, the volatility of returns are rescaled to 5%.

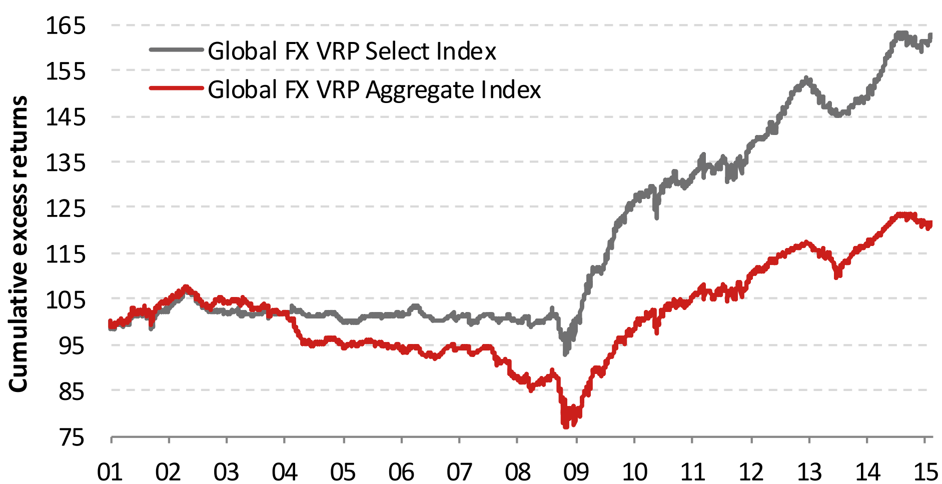
Styles make everything better!

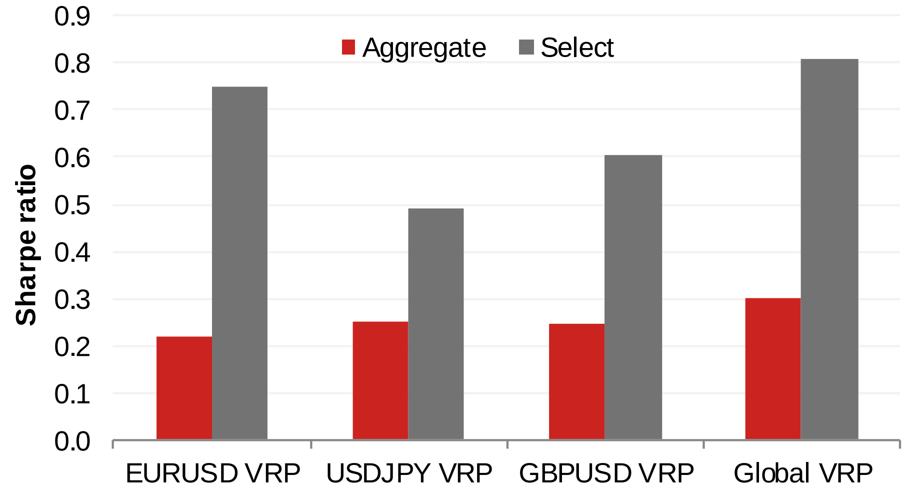
Styles without timing improves diversified portfolio in rates





Styles without timing improves diversified portfolio in FX

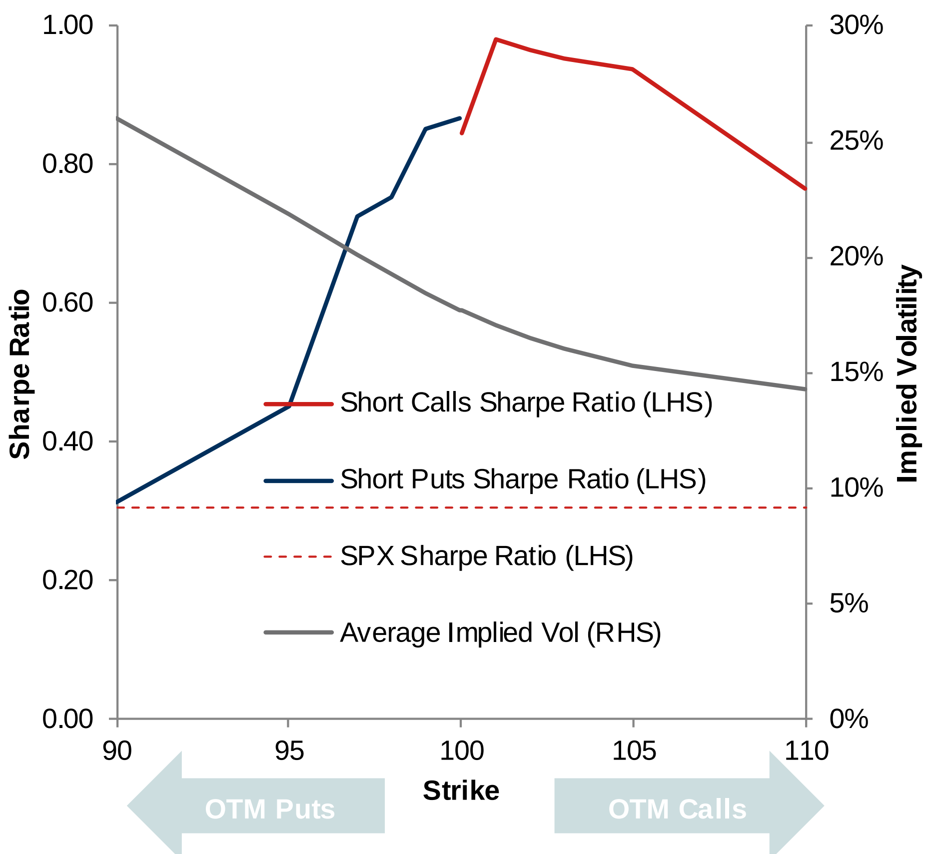




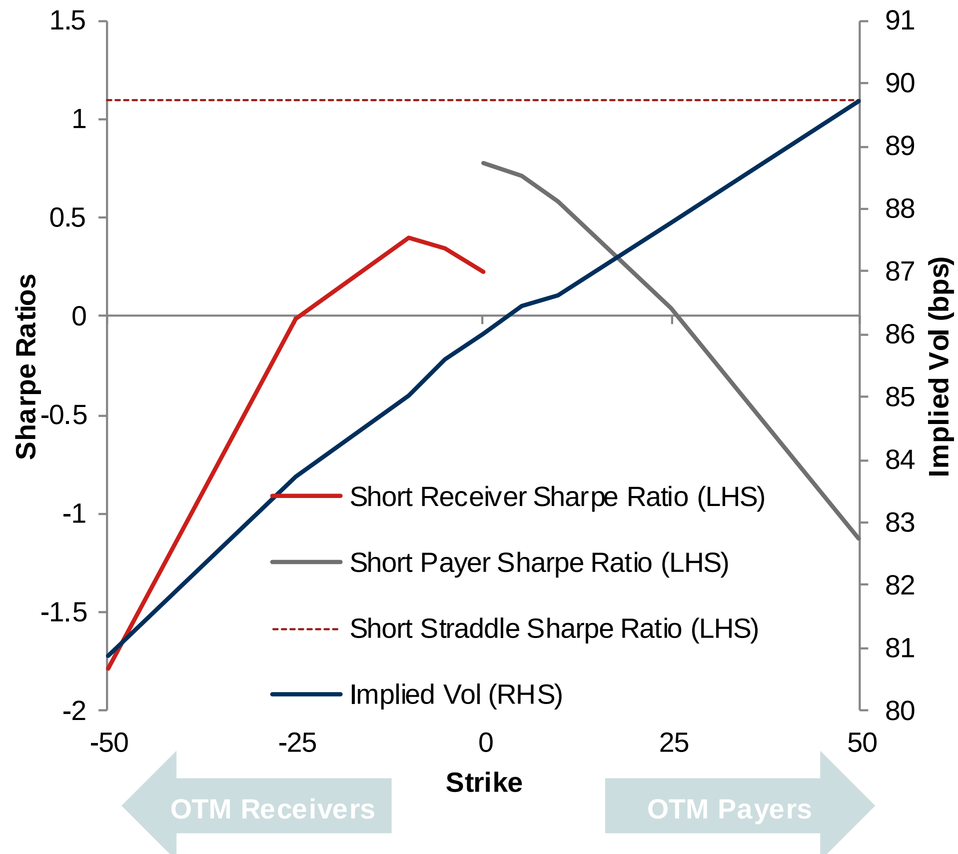
Source: Nomura Research. The sample period is Jan 2001 to Jan 2015. The iVRP Aggregate index sells straddles on 1m/3m expiries + 2y/5y/10y/20y/30y tails across USD/EUR/JPY, and delta-hedged until expiry. The FX VRP Aggregate index. The FX VRP Aggregate index sells straddles on 1w/1m/3m/6m expiries and delta-hedged until expiry.

Which vol should you sell?

S&P 500 OTM call outperformed

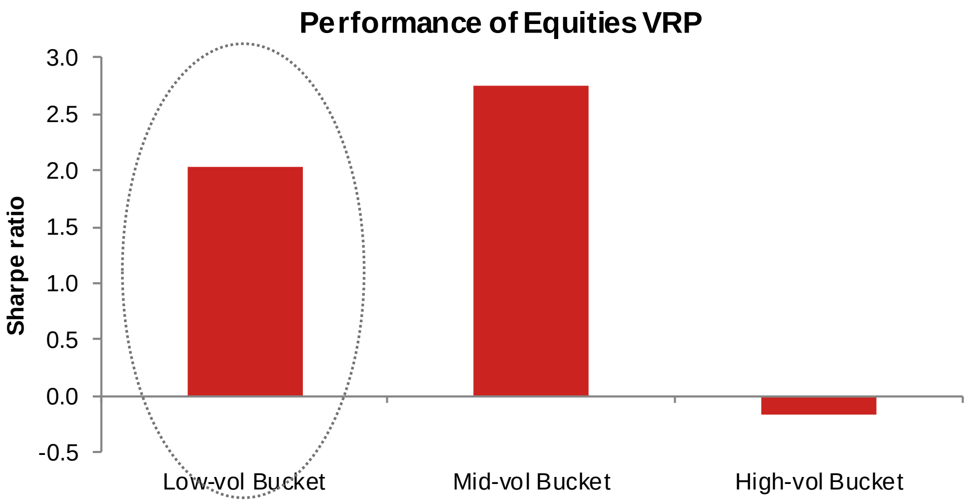


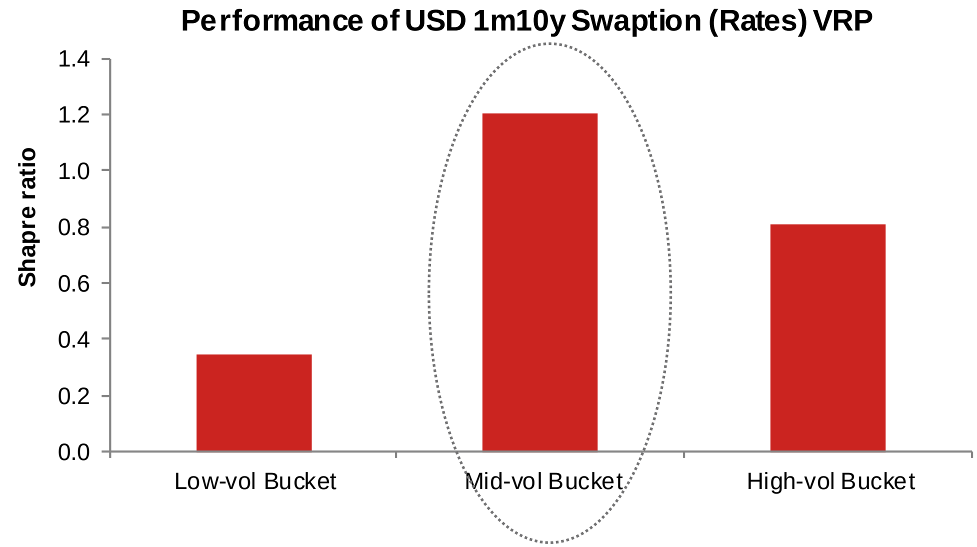
USD 1m10y ATM straddle swaption outperformed

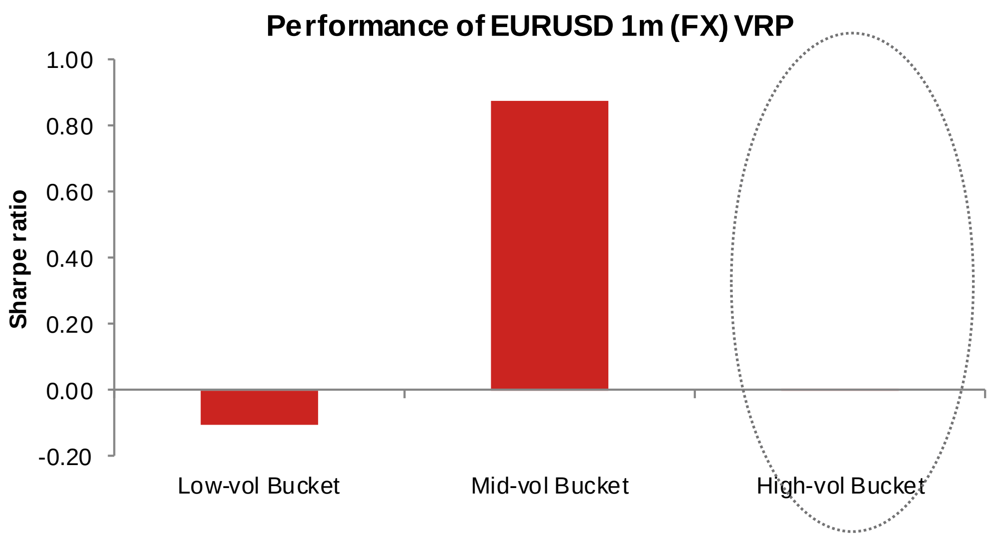


Source: Nomura Research. The sample period for equities vol/underlying is 1998 to 2015. The sample period for rates vol/underlying is 2010 to 2015.

Do NOT sell vol when vol is high!







Moderate vol does best

Now:

- FX is High
- Rates is Mid
- Equities is Low

Source: Nomura Research, Bloomberg. The sample period is Jan 2006 to Jan 2015 across equities, rates and FX. Sharpe ratio is calculated by monthly data.

Vol Risk Premia are Pervasive

Diversification and outperformance

Vol risk premia exist across equity markets

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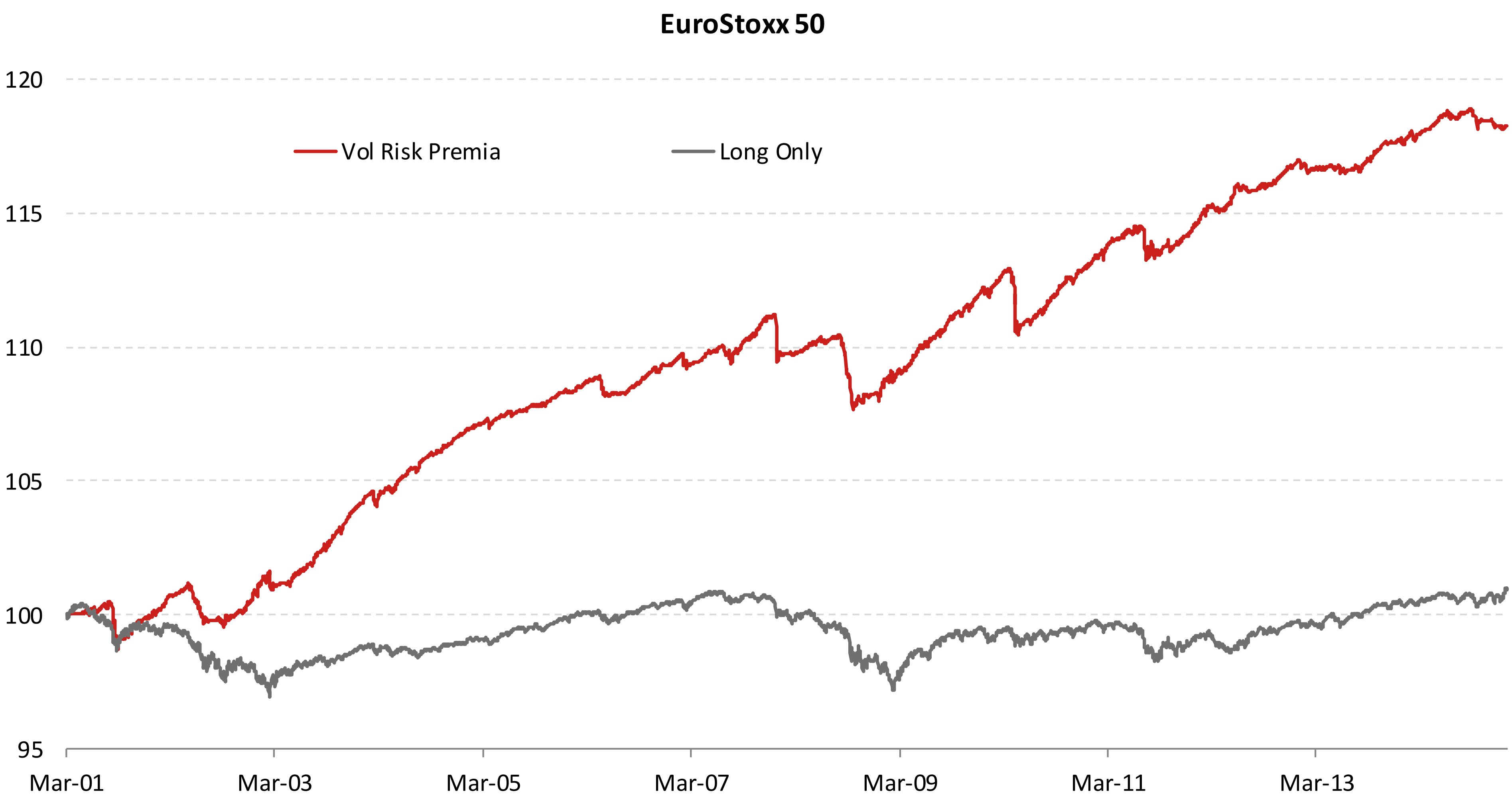
In Europe as well, VRP outperformed significantly



Source: Nomura Research, Bloomberg. For comparison purpose, the volatility of returns are rescaled to 1%.

Vol risk premia exist across equity markets

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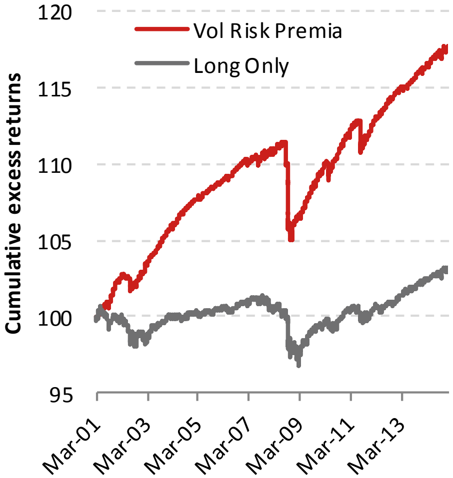
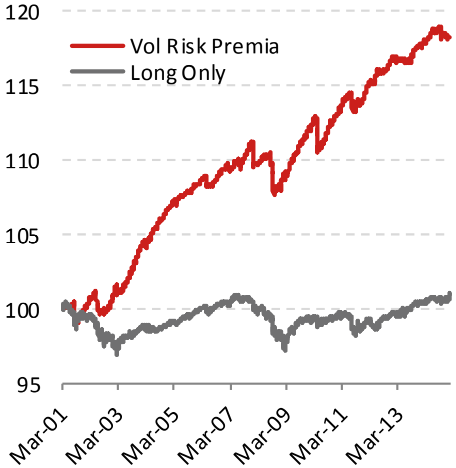
Short gamma strategies outperformed across equity markets (vol scaled and centered indices)

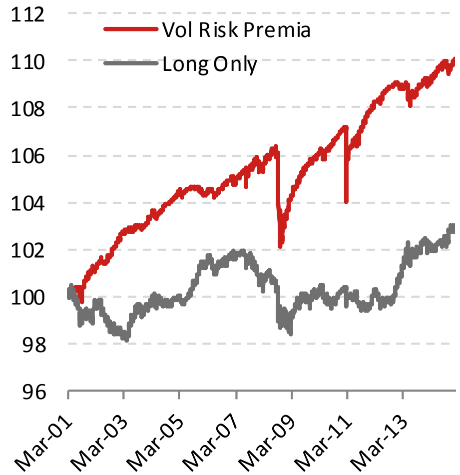
S&P 500



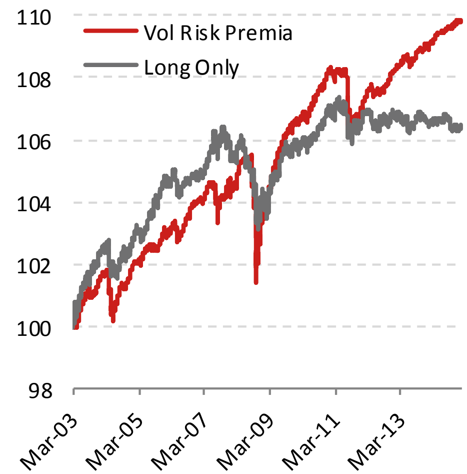
EuroStoxx 50



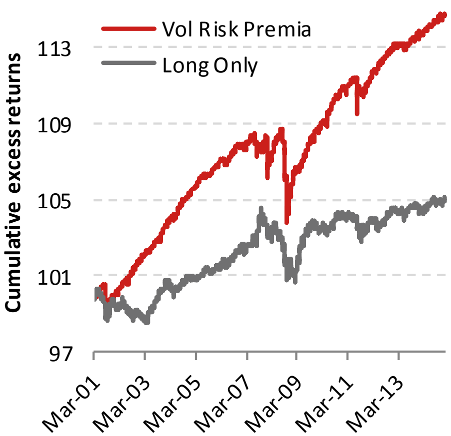
Nikkei 225



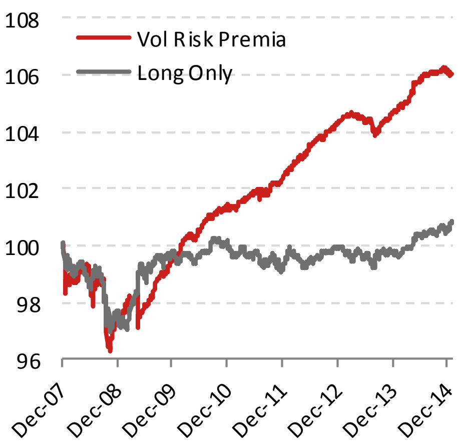
Kospi 200



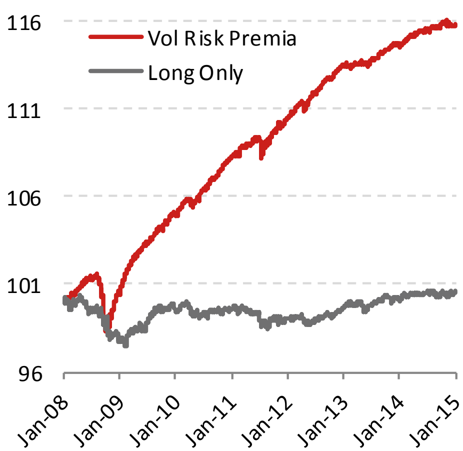
Hang Seng



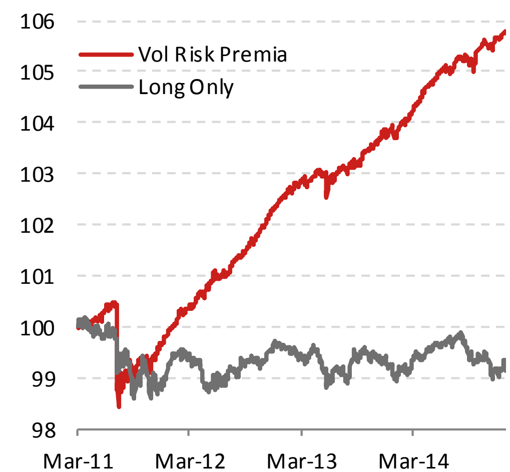
Nifty 50



ASX 200



MSCI EM



Source: Nomura Research, Bloomberg. For comparison purpose, the volatility of returns are rescaled to 1%.

Equity vol premia truly diversify

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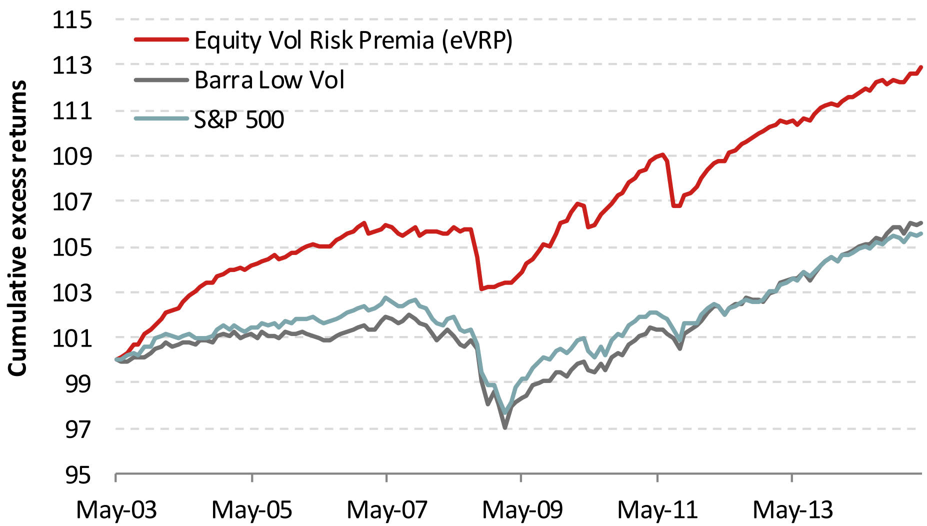
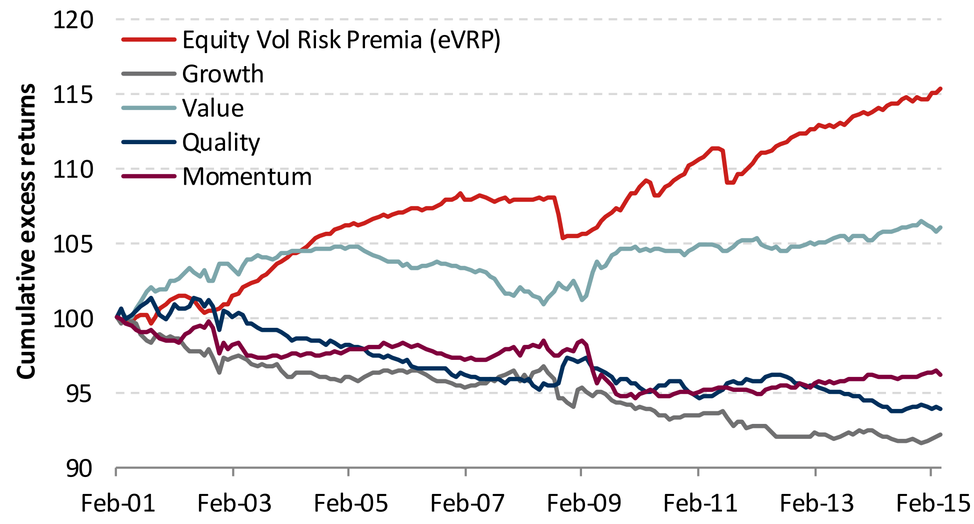
Equity vol risk premia outperformed traditional equity factors





	eVRP	Growth	Value	Quality	Mmtm	Low Vol	S&P 500
Ret (p.a.)	20.6%	-4.7%	3.6%	-3.7%	-3.7%	5.8%	4.0%
Vol (p.a.)	20.4%	8.2%	8.6%	8.4%	13.4%	11.7%	15.2%
Sharpe	**1.01**	**-0.57**	**0.42**	**-0.44**	**-0.27**	**0.49**	**0.27**
MDD	-55.6%	-71.3%	-32.9%	-64.6%	-72.2%	-57.8%	-75.8%
Calmar	**0.37**	**-0.07**	**0.11**	**-0.06**	**-0.05**	**0.10**	**0.05**

	eVRP	Growth	Value	Quality	Mmtm	Low Vol	S&P 500
eVRP	100%						
Growth	22%	100%					
Value	2%	-61%	100%				
Quality	-34%	10%	-21%	100%			
Momentum	-7%	43%	-70%	48%	100%		
Low Vol	50%	0%	32%	-40%	-17%	100%	
S&P 500	59%	4%	24%	-57%	-35%	88%	100%

Source: Nomura Research. The sample period is Feb 2001 to Apr 2015.

Vol risk premia exist across asset classes

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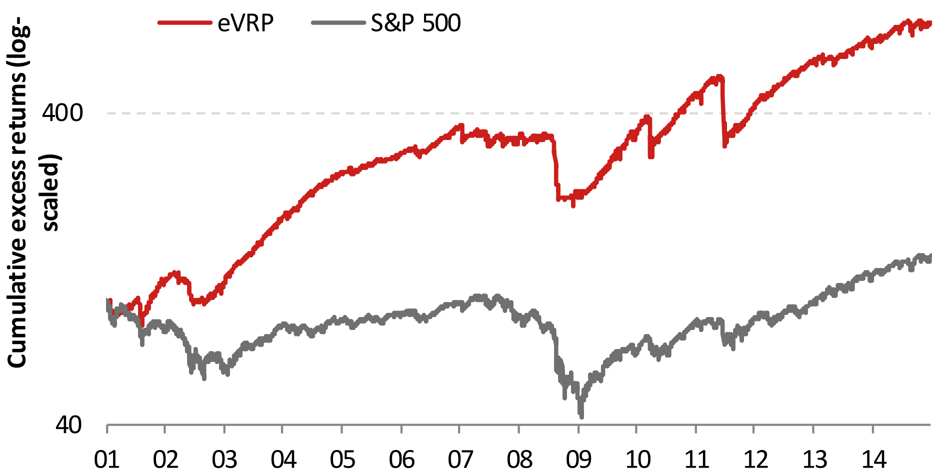
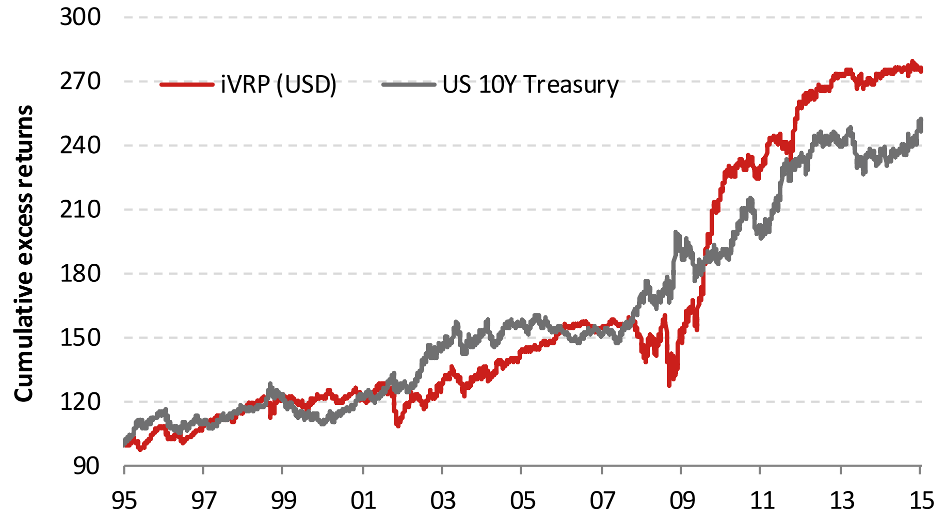
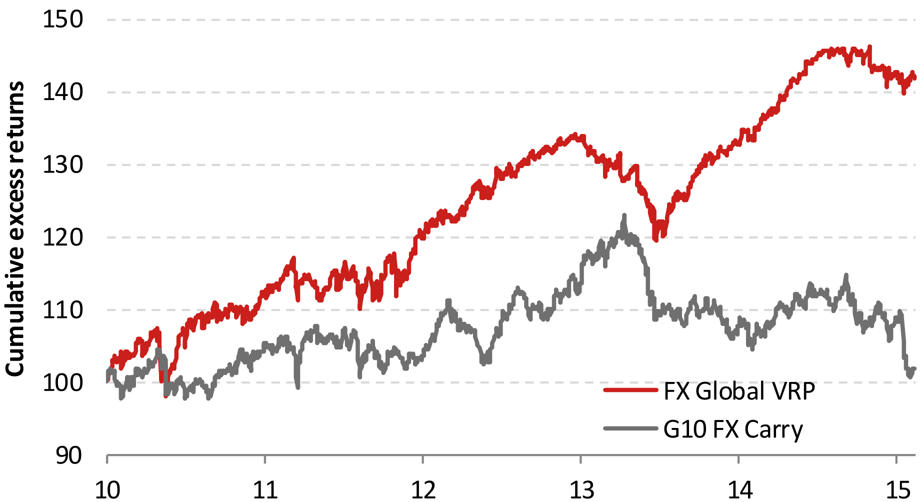
Short gamma strategies outperformed across asset classes and are decorrelated







Correlation	eVRP	iVRP (USD)	FX VRP	S&P 500	Treasury	FX Carry
eVRP	100%					
iVRP (USD)	16%	100%				
FX VRP	23%	28%	100%			
S&P 500	52%	16%	25%	100%		
Treasury	-20%	3%	-16%	-35%	100%	
FX Carry	21%	9%	27%	23%	-18%	100%

Source: Nomura Research. G10 FX Carry is the Nomura G10 FX Carry Index. Correlation is calculated based on Jan 2001 to Jan 2015.

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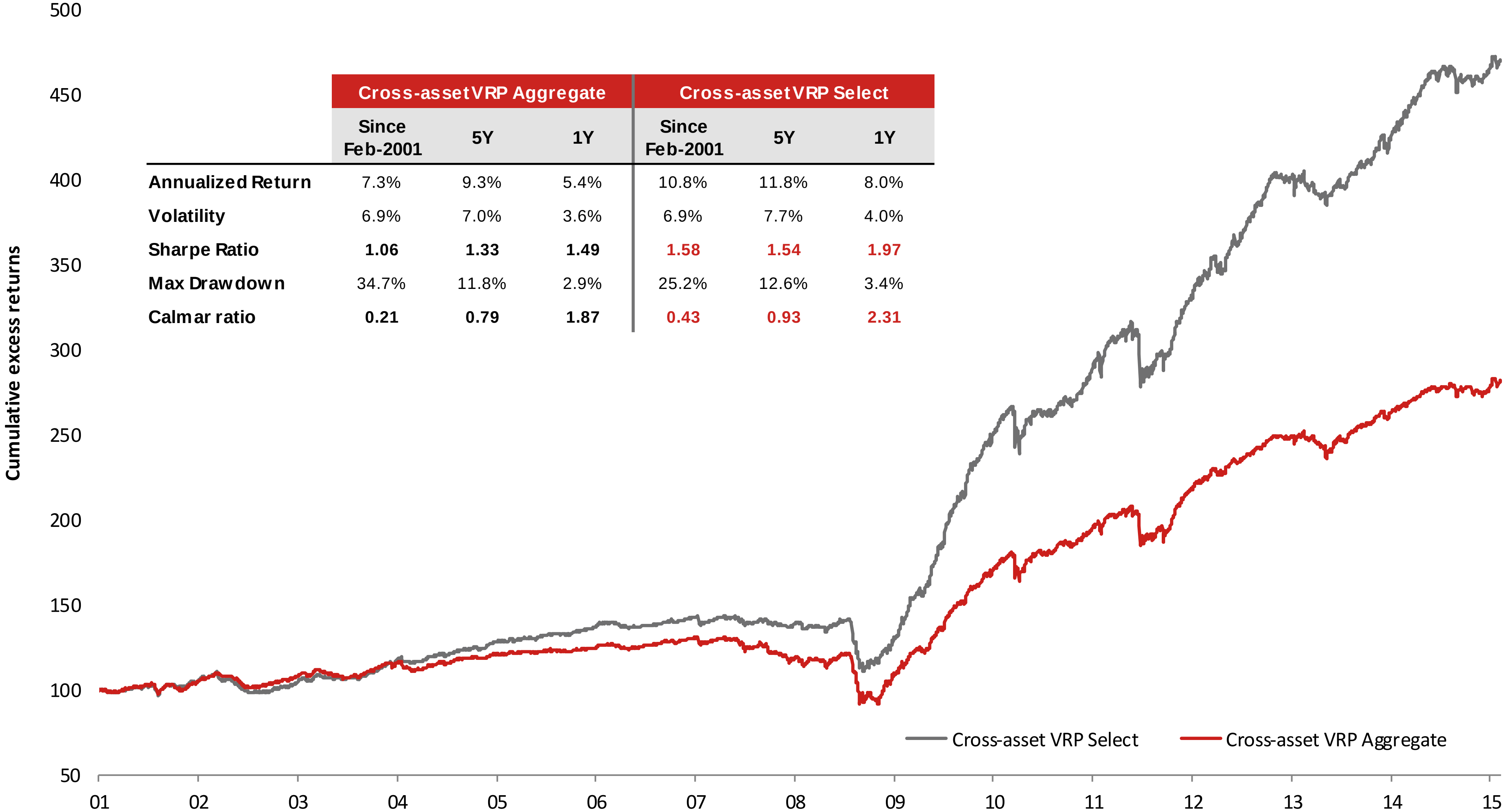
Performance of cross-asset VRP

Cross-Asset VRP using Style-based investing gives superior performance

	Cross-asset VRP Aggregate			Cross-asset VRP Select		
	Since Feb-2001	5Y	1Y	Since Feb-2001	5Y	1Y
Annualized Return	7.3%	9.3%	5.4%	10.8%	11.8%	8.0%
Volatility	6.9%	7.0%	3.6%	6.9%	7.7%	4.0%
Sharpe Ratio	**1.06**	**1.33**	**1.49**	**1.58**	**1.54**	**1.97**
Max Drawdown	34.7%	11.8%	2.9%	25.2%	12.6%	3.4%
Calmar ratio	**0.21**	**0.79**	**1.87**	**0.43**	**0.93**	**2.31**



Source: Nomura Research. The sample period is Feb 2001 to Mar 2015. Cross-asset VRP Aggregate portfolio consists of 33.3% Global iVRP Aggregate + 33.3% Global FX VRP Aggregate + 33.3% eVRP. Each component is leveraged to 10% vol. Cross-asset VRP Select portfolio consists of 33.3% Global iVRP Select + 33.3% Global FX VRP Select + 33.3% eVRP. Each component is leveraged to 10% vol.

Closing thoughts

Conclusions

Volatility = Insurance

Everybody is short – not everybody is getting paid for it.

Not a question of whether to sell vol, but when to sell it

Some vols are better than others

Vol Risk Premia are pervasive

Vol is an asset class you should not ignore

Appendix: Vol Risk Premia – Selling Gamma

Selling vol—short gamma strategies,.

- We can sell options, and delta hedge, mark-to-market regularly
- This is called "shorting Gamma" or obtaining the Volatility Risk Premia
- Effectively, we sell insurance to the market – tail-risk insurance. In general, it is commensurate with the risk.

Note that Gamma, $\Gamma(t) = \frac{\partial^2 C(S,t)}{\partial S^2}$ *is positive for a long call or put position, and negative for a short position.*

Black-Scholes Theory

- According to the Black-Scholes robustness theory, a short variance swap position has the following theoretical PnL (right)
- Hence, selling variance swap allows to capture the Volatility Risk Premia.
- For a variance swap $\Gamma(t)$=constant, so it captures the pure vol risk premium.
- For other markets where variance swaps do not exist, we have to carefully balance risk across entry points (although we cannot alter positions after entry due to transaction costs).

$$E[P\&L] = \int_0^T \frac{1}{2} \underbrace{\Gamma(t)}_{\textbf{Gamma}\text{: Risk/Exposure}} \overset{\textbf{VRP}}{\underbrace{\boxed{\left[\sigma^2_{Imp}(t) - \sigma^2_{Real}(t)\right]}}_{\textbf{Volatility Risk Premia}}} \, dt$$

Source: Nomura Research

Appendix A-1

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