Equity Derivatives Teach-In
Products and their Risk Management

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Singapore, August 1st, 2009

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Contents

Products
Variance Swaps

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Products - Variance Swaps

Variance Swaps

- Variance swaps are a method of trading volatility
- Basically, they allow to trade realized volatility against implied volatility.
- For a given volatility strike K, a variance swap pays

$$\frac{RV(T) - K^2}{2K}$$

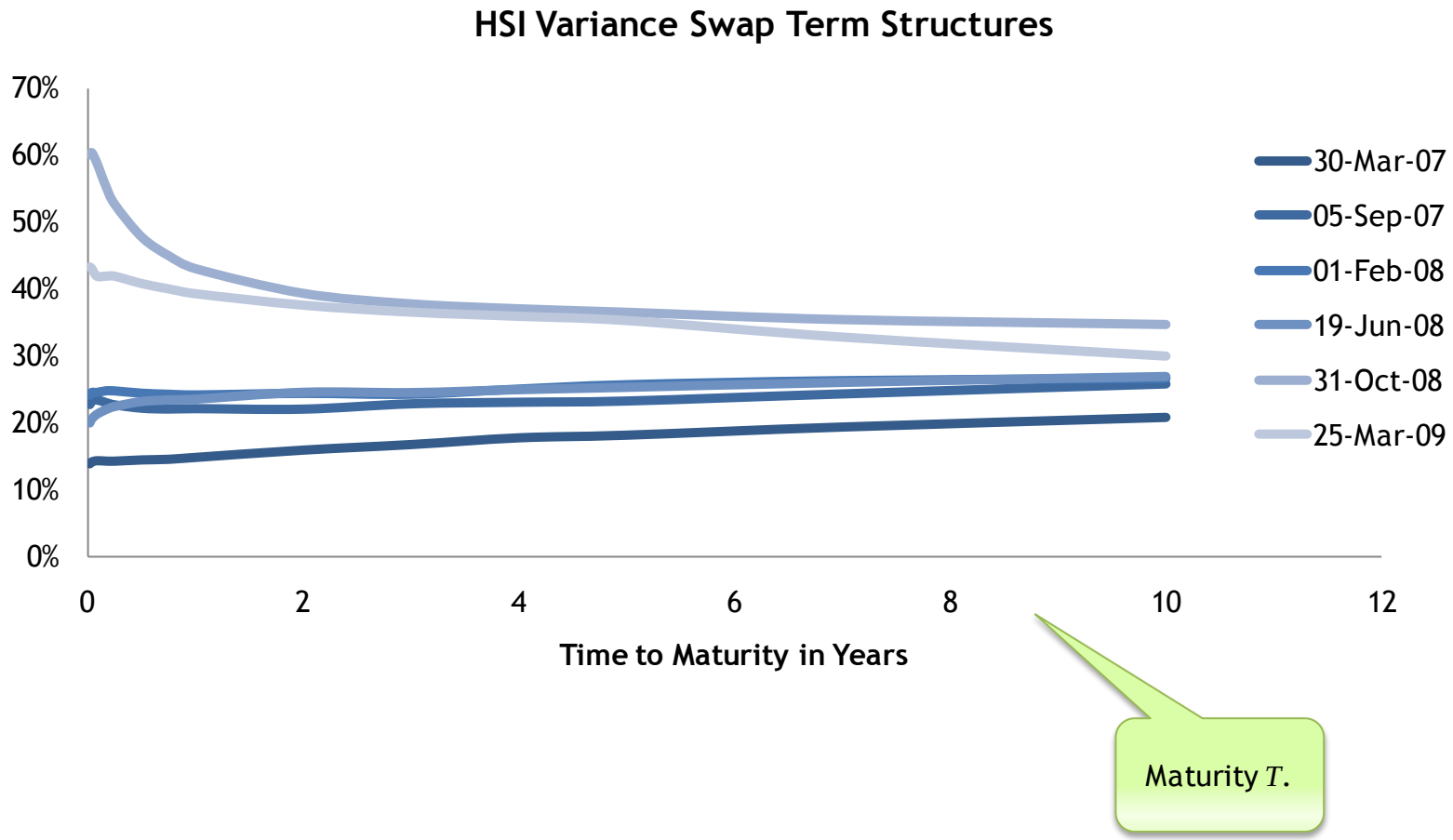
where $RV(T)$ is the realized variance up to maturity T,

$$RV(T) := \frac{252}{n} \sum_{i=1}^{n} \ln\left(\frac{S_{t_i}}{S_{t_{i-1}}}\right)^2$$

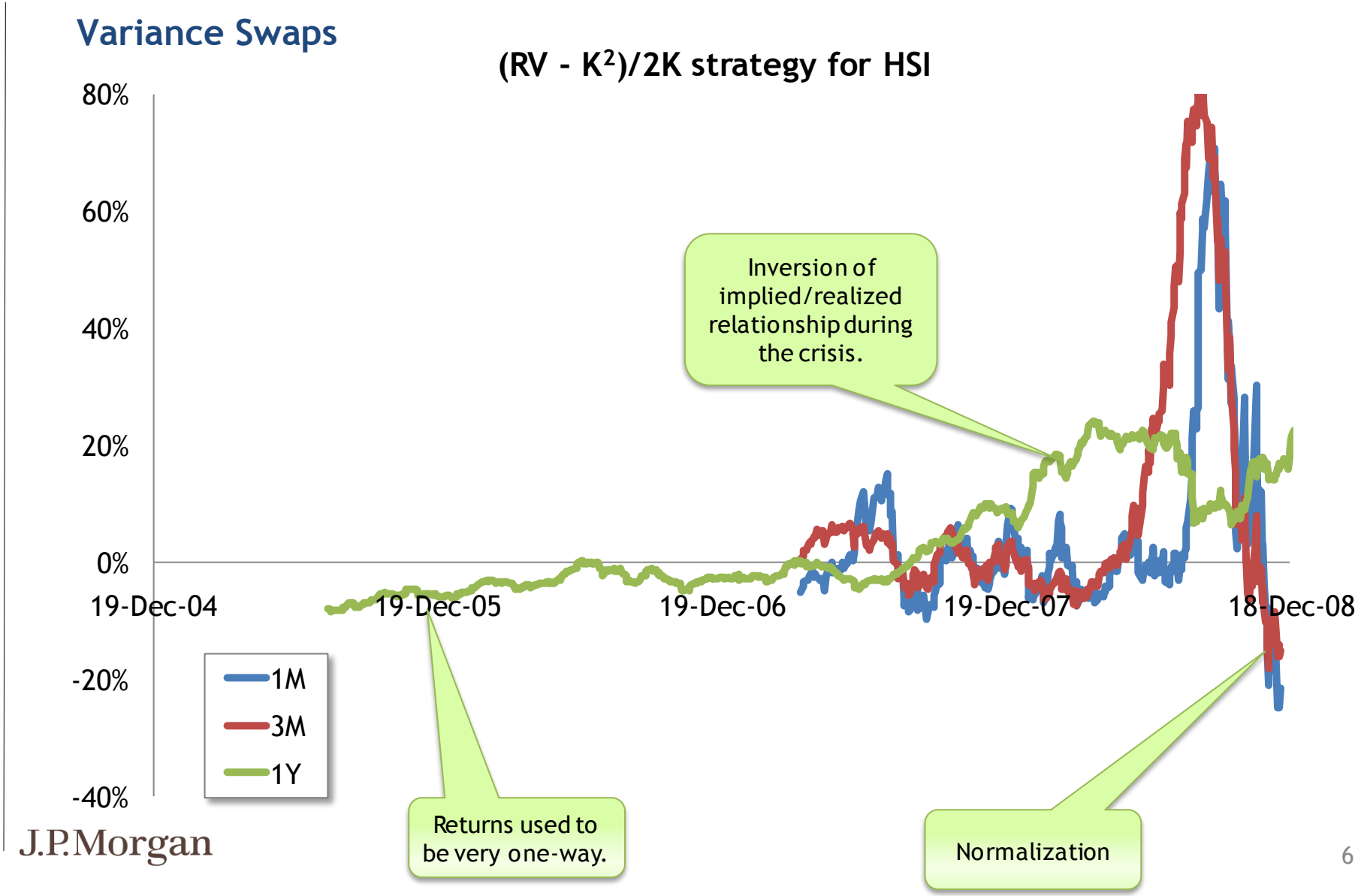
Products – Variance Swaps

Example Variance Swaps HIS

– Term structure of variance swaps



Products – Variance Swaps



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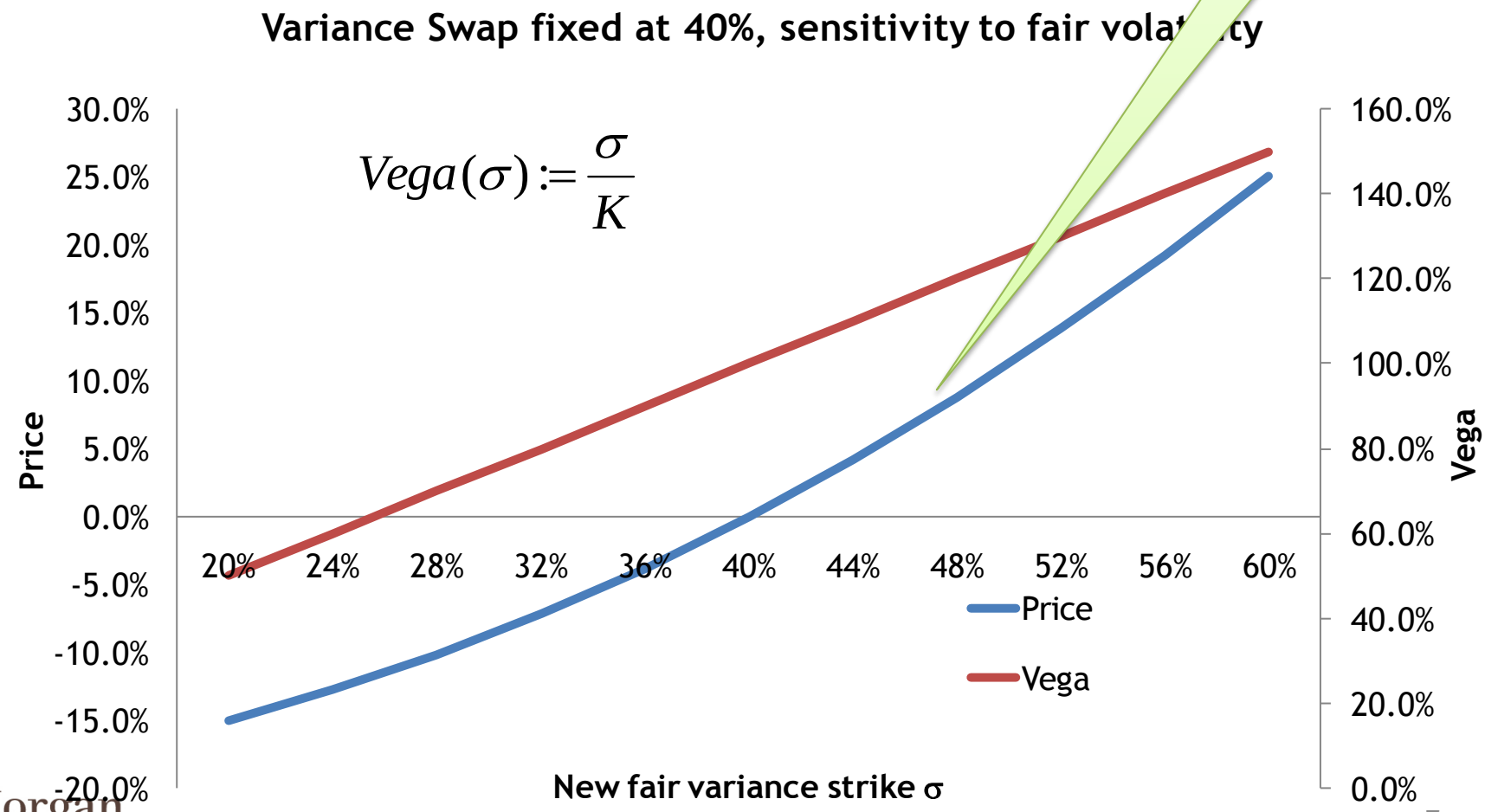
Products – Variance Swaps

Variance Swaps

In particular,, Vega is *not* constant.



Products – Variance Swaps

Variance Swaps

- In theory, variance swap can be replicated by
  1. Enter into a static European hedge
  2. Execute a simple daily delta-hedging strategy

$$RV(T) \approx \frac{2}{T}\sum_{i=1}^{n}\left(\frac{S(t_i)}{S(t_{i-1})}-1\right)-\frac{2}{T}\ln\frac{S(T)}{S(0)}$$

Daily Delta-Hedge with a Cash Delta of 2.

Static European "Log-contract"

Products - Variance Swaps

Variance Swaps

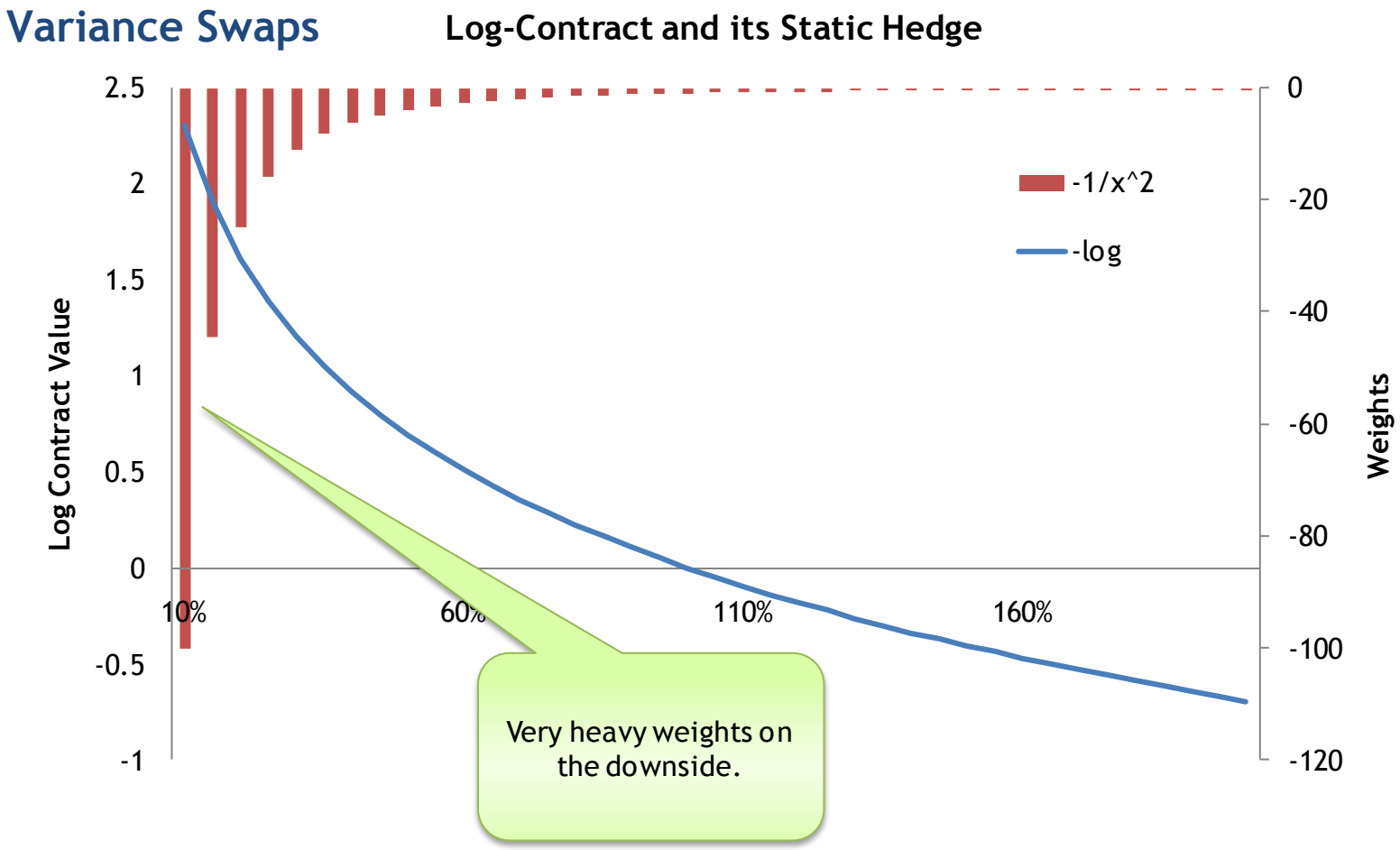
- In theory again, this is no problem:

$$-2\ln\frac{S(T)}{S(0)} = -2\int_0^{S(0)} \frac{1}{K^2}(K - S(T))^+ dK - 2\int_{S(0)}^{\infty} \frac{1}{K^2}(S(T) - K)^+ dK$$

OTM Put positions

OTM Call positions

Products - Variance Swaps



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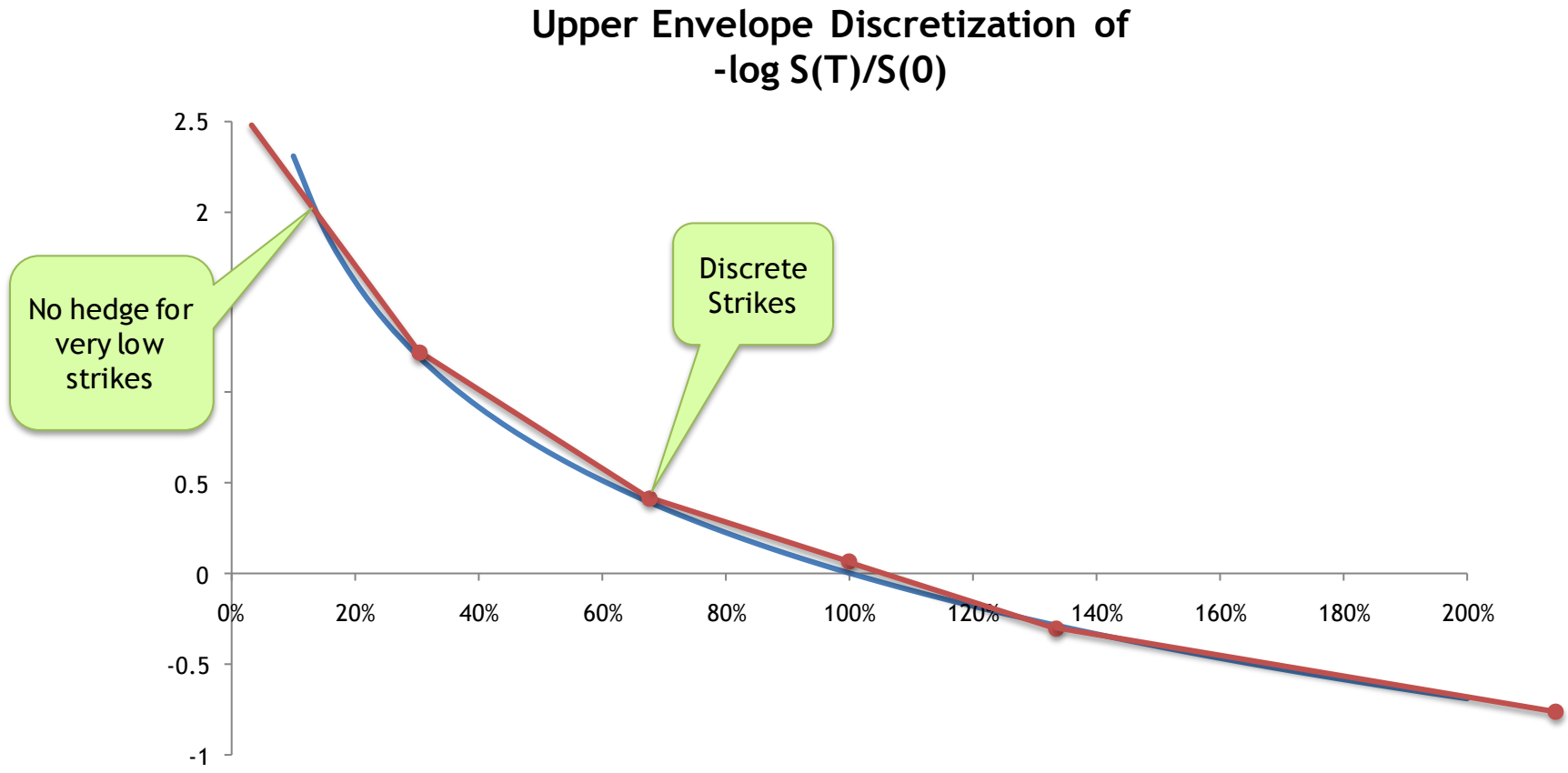
Products – Variance Swaps

Variance Swaps

However, the payoff can be approximated from above/below by vanillas



Products – Variance Swaps

Variance Swaps

- "Natural Product" from a theoretical point of view

- Practical restrictions
  - OTM puts not very liquid → end up with unhedged downside Vega
  - Daily delta-hedge can be expensive for single stocks.

- Liquid market for major indices

→ Very hard to implement for Single Stocks

Products
SPI

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Products – SPI

Synthetic Portfolio Insurance

- Basically synthetic CPPI

- Aim
  - Equity offers better return but is risky
  - We want to invest in equity but such that we will get our investment back if stock market suffers.

- Classic Option Solution:

Zero Coupon

Call

$$\mathrm{Max}\left\{\alpha\frac{S(T)}{S(0)},100\right\}=100+\left(\alpha\frac{S(T)}{S(0)}-100\right)^{+}$$

Find α such that initial value is equal to 100.

Products – SPI

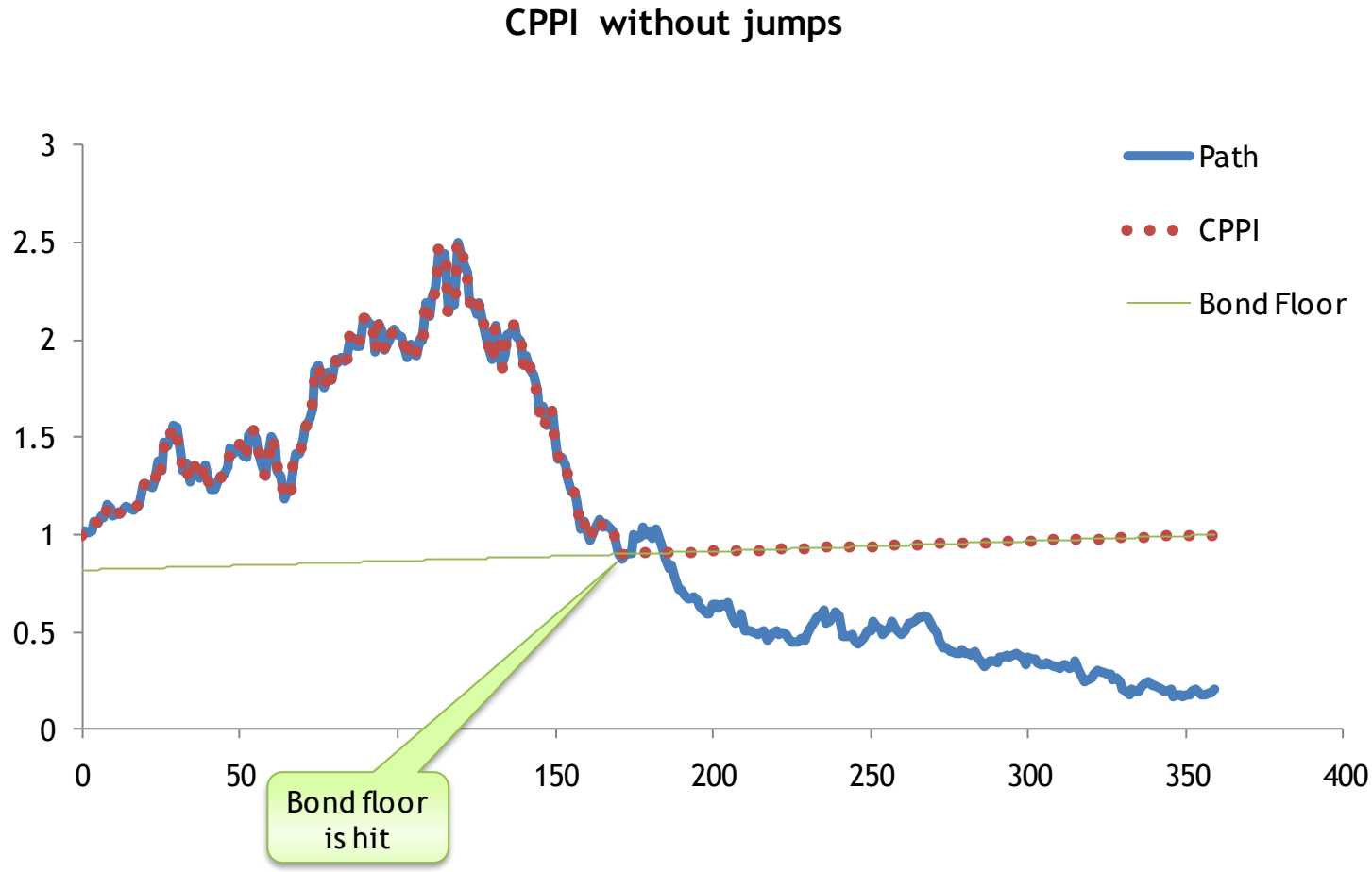
Synthetic Portfolio Insurance

- Classic Option Solution:
  - Typically expensive due to risk premium on option.
  - In particular, volatility right now very high.

- CPPI
  - Dynamic rebalancing between the equity and the zero bond (“bond floor”)
  - If the value of the portfolio reaches the bond floor, we still guarantee the terminal payoff.

Products – SPI

Synthetic Portfolio Insurance



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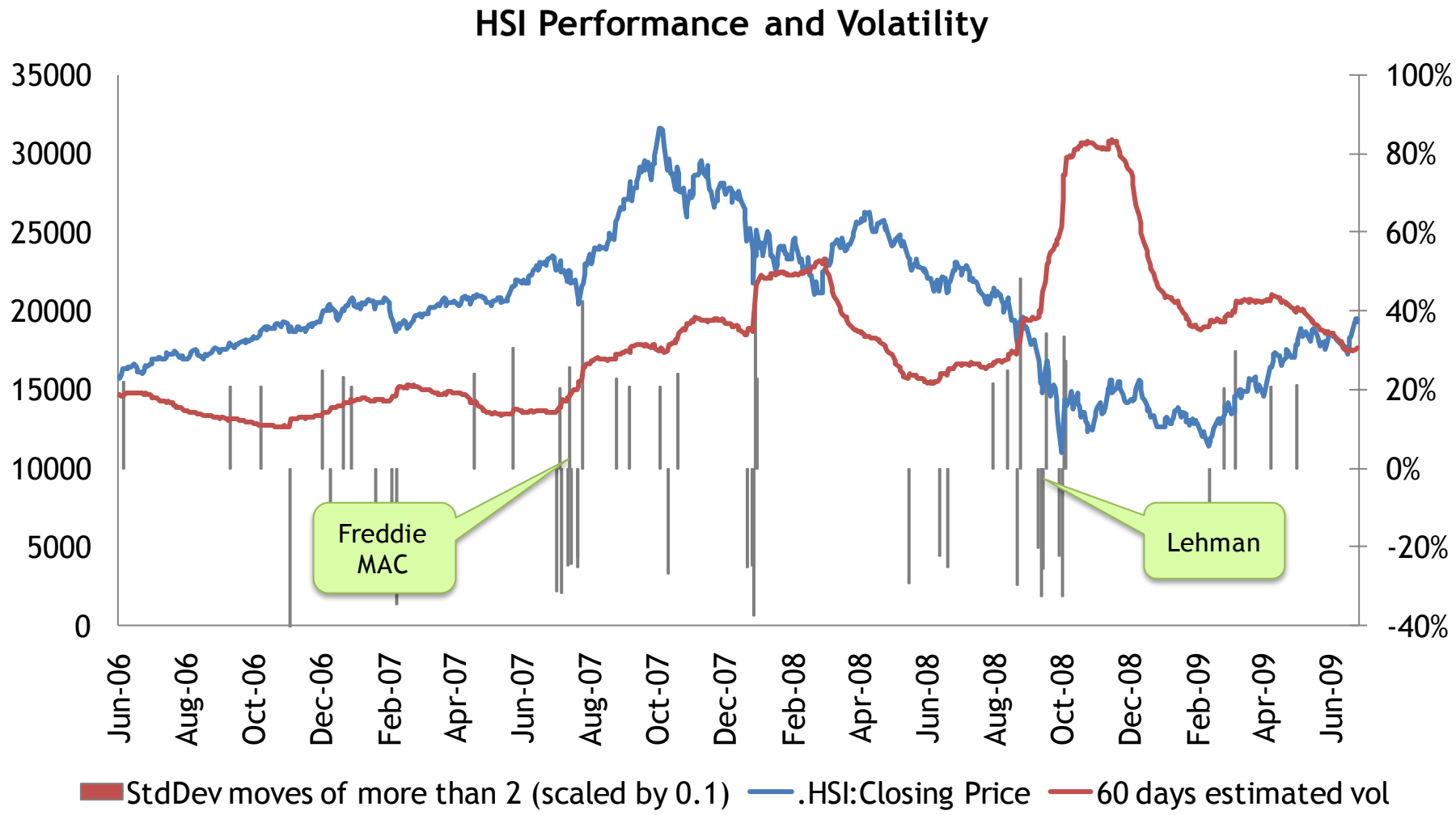
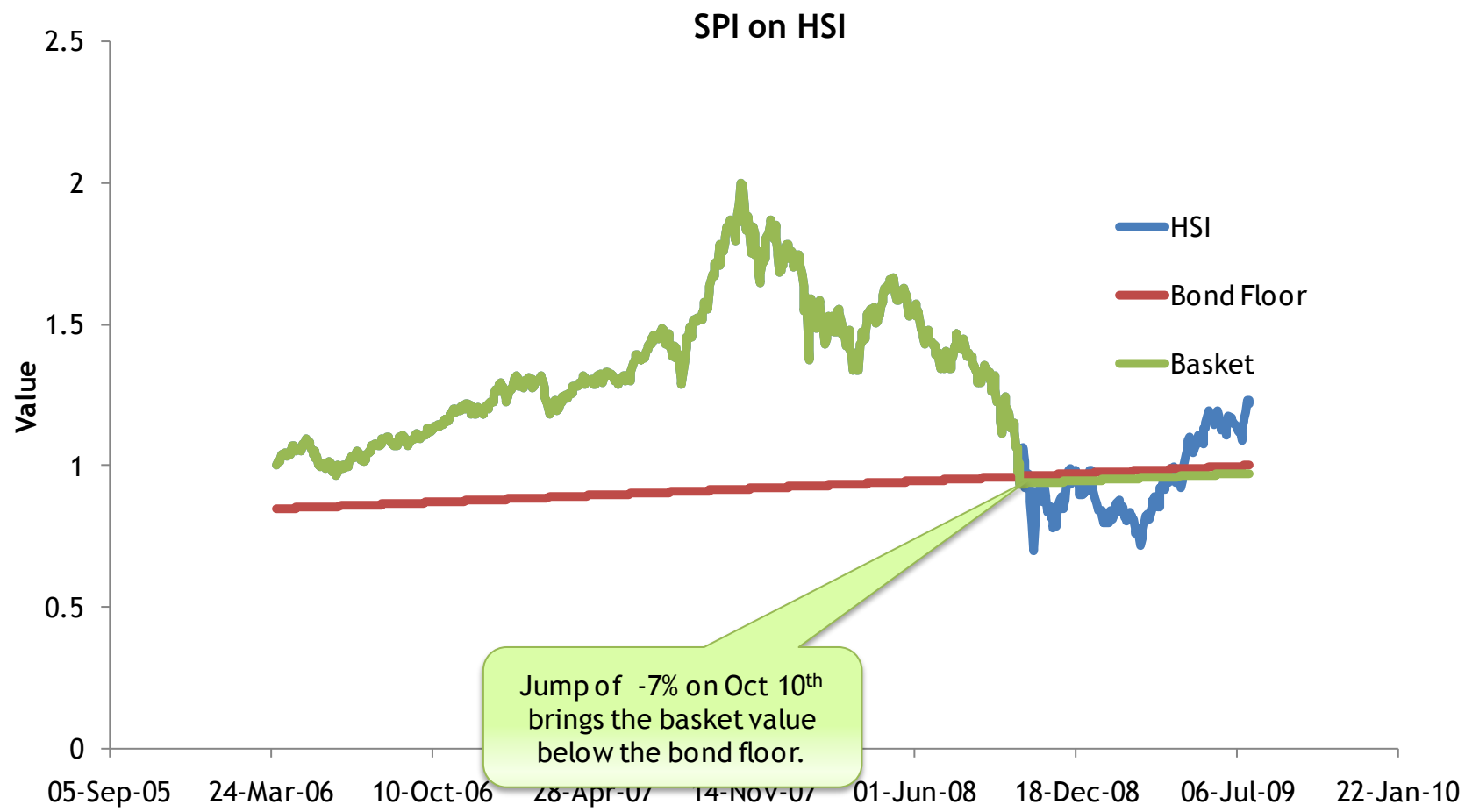
Products – SPI

Evidence for jumps



Products – SPI

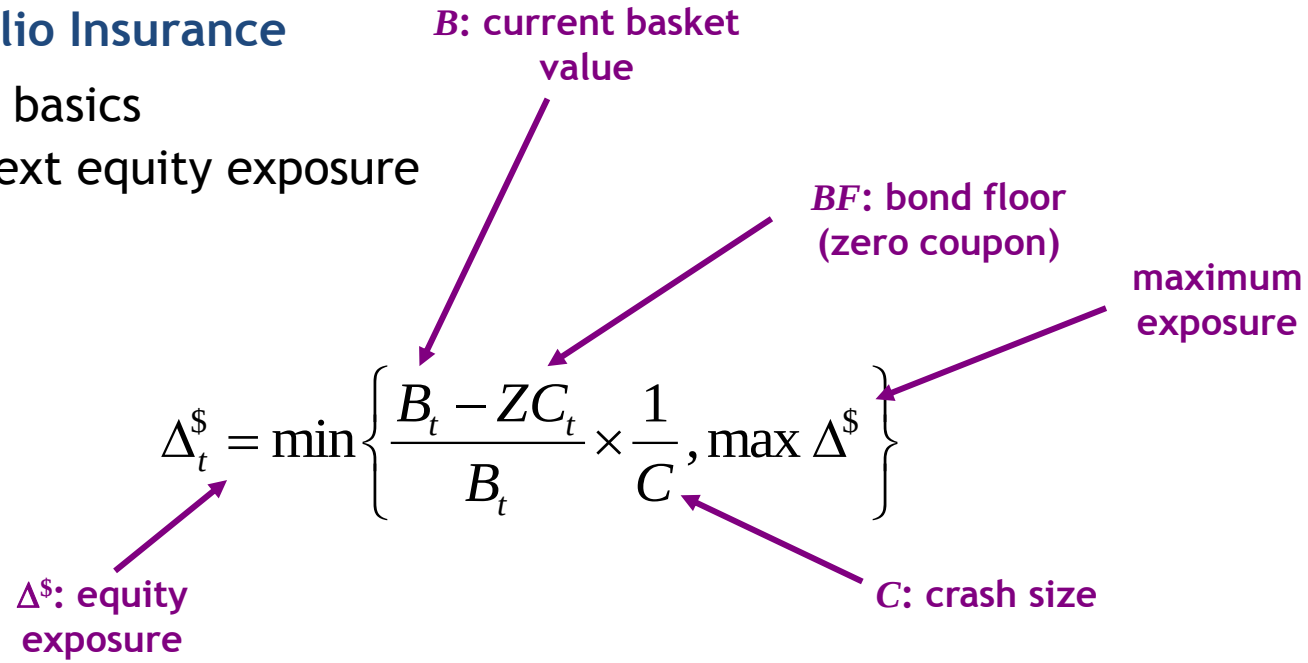
Synthetic Portfolio Insurance



Products - SPI

Synthetic Portfolio Insurance

- SPI algorithm basics
  - Compute next equity exposure



  - In the next step, the new basket value is given as

$$B_{t+1} = B_t \times \left[1 + \Delta_t^{\$} \times \left(\frac{S_{t+1}}{S_t} - 1\right) + \left(1 - \Delta_t^{\$}\right) \times \left(\frac{ZC_{t+1}}{ZC_t} - 1\right)\right]$$

S: equity

Products – SPI

If $\max\Delta^{\$}$ is bigger than 100%, then the SPI can "over-leverage".

Synthetic Portfolio Insurance

- SPI algorithm basics

$$\Delta_t^{\$} = \min\left\{\frac{B_t - ZC_t}{B_t} \times \frac{1}{C}, \max \Delta^{\$}\right\}$$

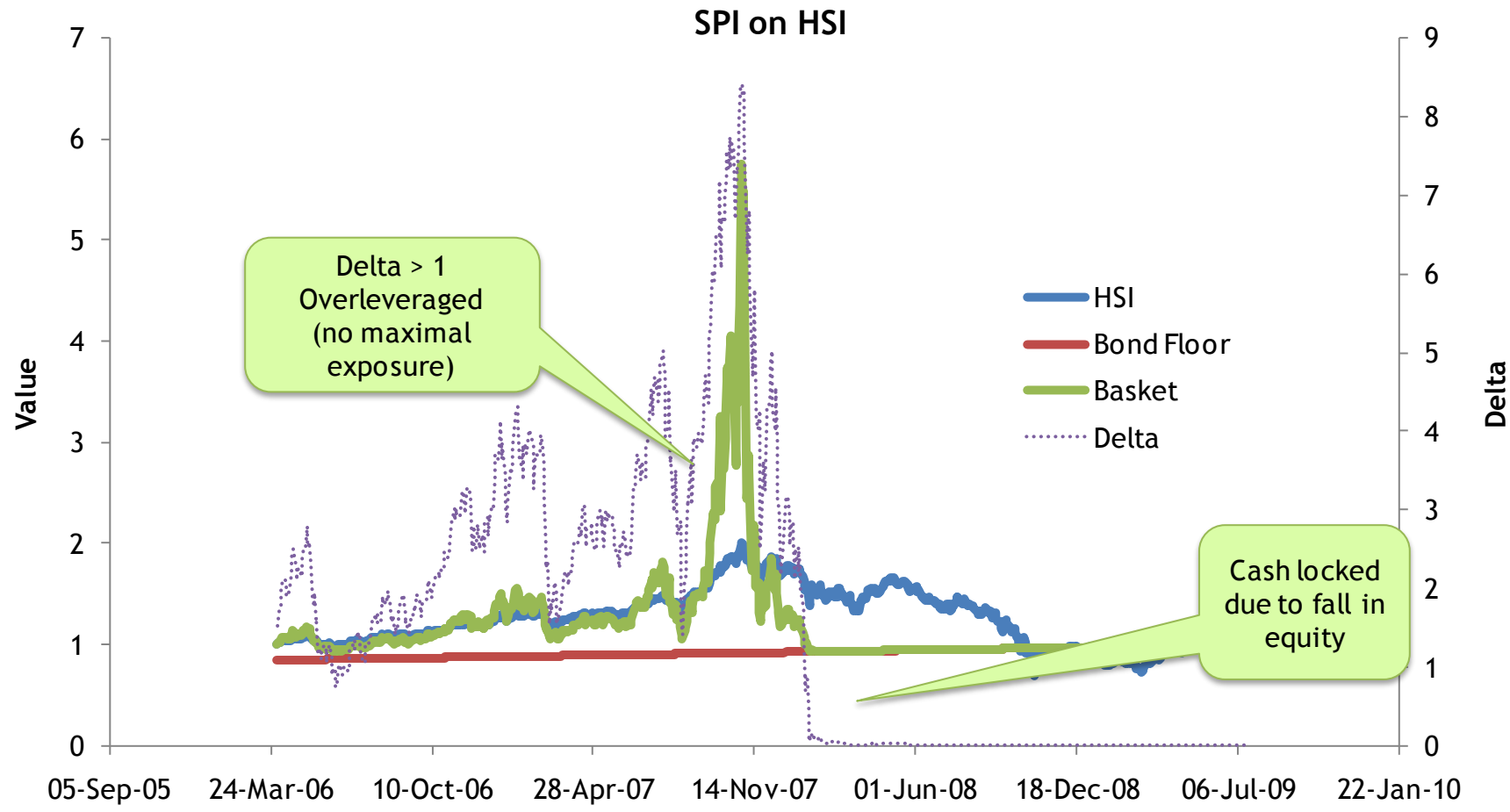
and

$$B_{t+1} = B_t \times \left[1 + \Delta_t^{\$} \times \left(\frac{S_{t+1}}{S_t} - 1\right) + \left(1 - \Delta_t^{\$}\right) \times \left(\frac{ZC_{t+1}}{ZC_t} - 1\right)\right]$$

- Risk Properties of the Basket Value (which is guaranteed at 100% at maturity)
  - Crash risk: a drop in equity of up to C percent is protected.
    → any crash over this is protected by the issuer
  - Increase in crash protection reduces equity exposure.
  - If C → 0, then the equity exposure becomes $\max\Delta^{\$}$ until the basket hits the bond floor (cf. previous example).

Products – SPI

Synthetic Portfolio Insurance



Products – SPI

Synthetic Portfolio Insurance

- Basic algorithm may get “cash locked”
  → equity market crash eliminates earlier gains

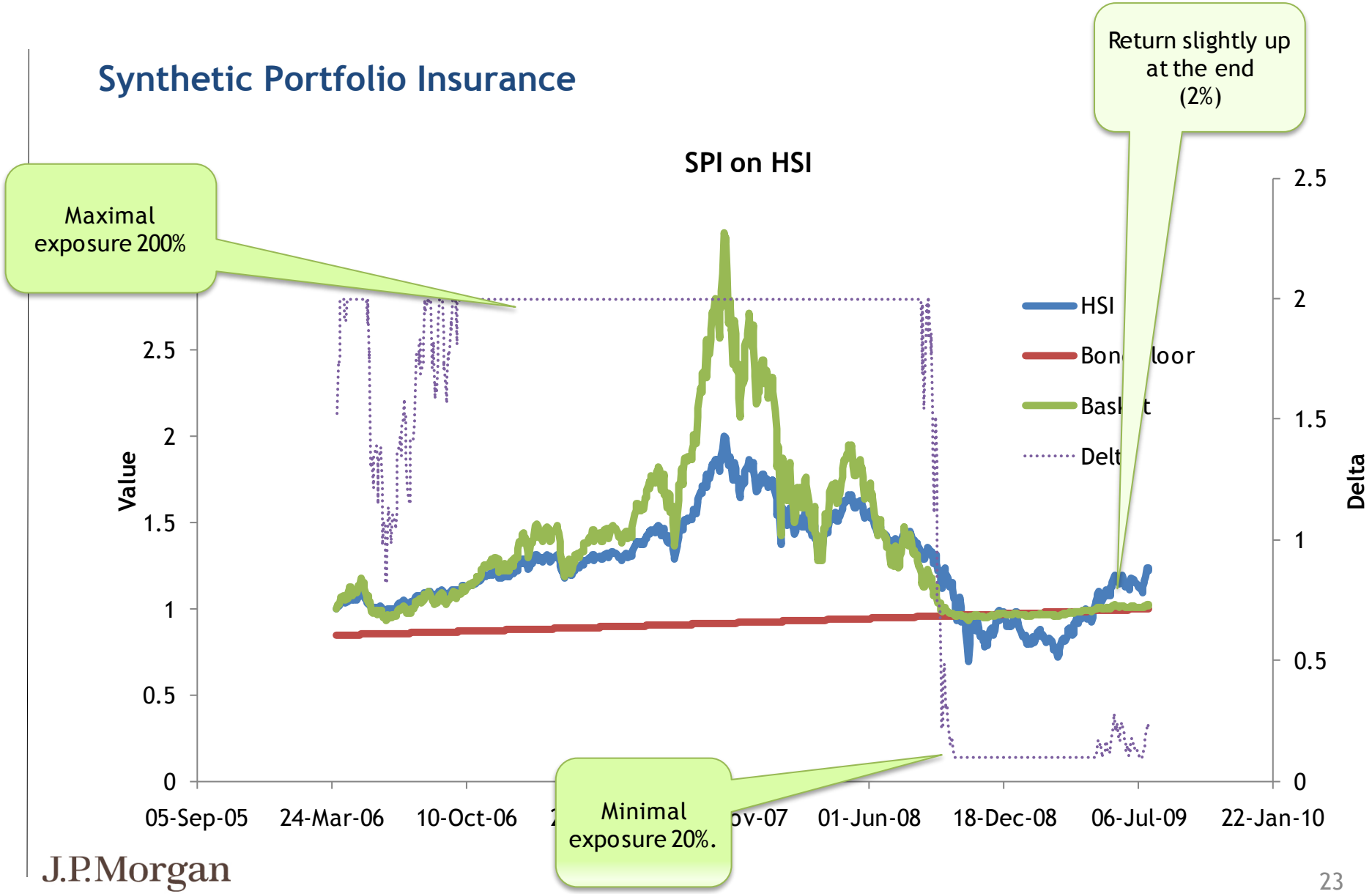
  Note: the same happened to the classic option solution

Remedy – Minimal Exposure

- Equity exposure is floored
- Leads to a true option value in the SPI

Products – SPI

Synthetic Portfolio Insurance



Products – SPI

Synthetic Portfolio Insurance

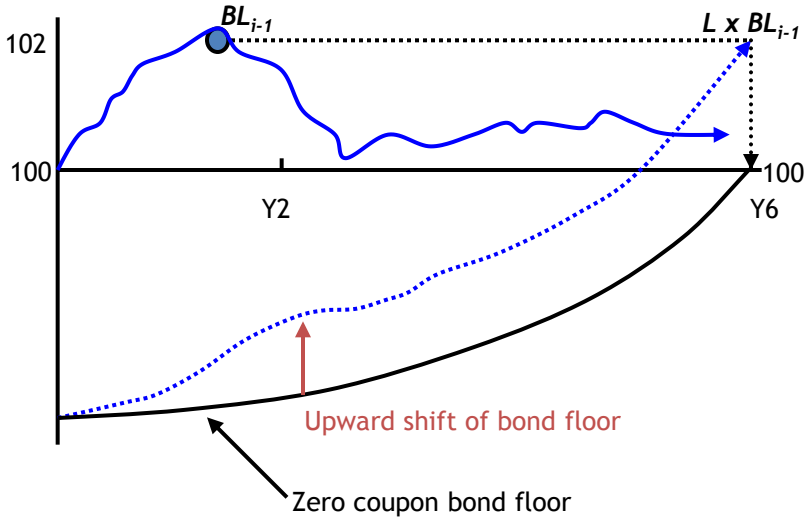
- Basic algorithm may get "cash locked"
  → equity market crash eliminates earlier gains

Remedy – Minimal Exposure

- Equity exposure is floored
- Leads to a true option value in the SPI
- Real Vega

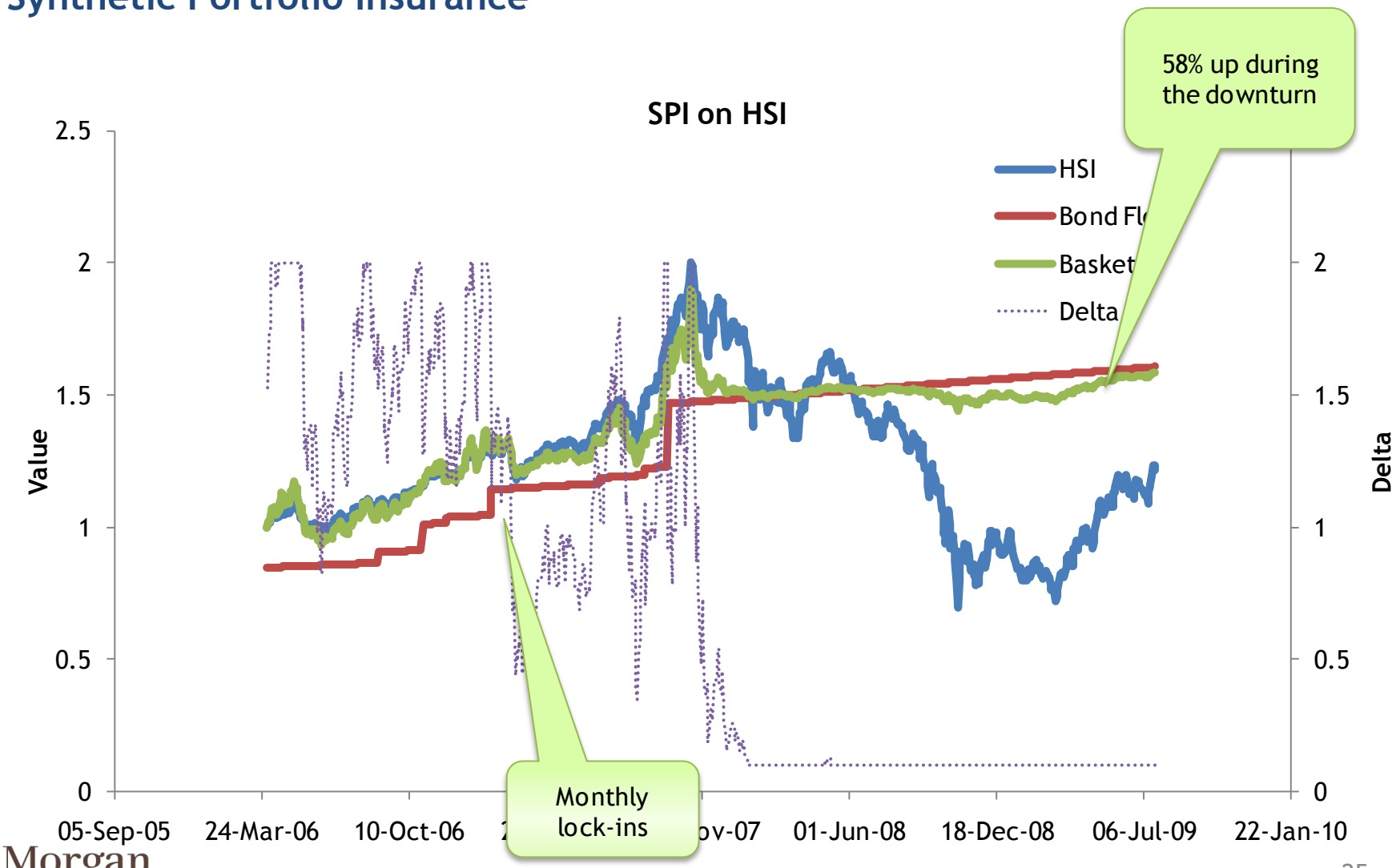
Remedy – Lock-In

- Terminal payoff of previous values bond values of "lock-in" dates.



Products - SPI

Synthetic Portfolio Insurance



Products – SPI

Synthetic Portfolio Insurance – Other features

- Coupons
  - SPI can easily be extended to pay coupons
  - TARN features possible
  - Equity-linked coupons
- Linear bond floor
  - Avoids reduction in equity exposure due to rate movements
- Advanced underlyings
  - Bespoke baskets
  - Best-Ofs
  - SPI on SPI (high risk on low risk)

Products – SPI

Synthetic Portfolio Insurance – Summary

- Very natural alternative to principal protection with options
  - Inexpensive
  - Transparent
- Risk Management
  - Crash risk
  - Operational effort for daily tracking and reporting of NAV etc.
  - Efficient execution in particular for bespoke baskets
- Real Vega
  - Minimal exposure
  - Best-Of SPI

Products
S&P Vol Control

Products – Risk Control

S&P Risk Control

- Recall the SPI – here, we defined a strategy $\Delta^{\$}$ (equity exposure) to modify the behavior of the basket.

$$\frac{dB_t}{B_t} = rdt + \Delta_t^{\$} \frac{dS_t}{S_t}$$

- A VolControl is a similar approach with the aim of achieving a given predefined target volatility σ^{target}.

Products – Risk Control

S&P Risk Control

- The volatility of a strategy $\Delta^{\$}$ with basket value

$$\frac{dB_t}{B_t} = rdt + \Delta_t^{\$} \frac{dS_t}{S_t}$$

is theoretically given as

$$\Delta_t^{\$} \sigma_t^{\text{realized}}$$

- Hence, lets set

$$\Delta_t^{\$} := \frac{\sigma_t^{\text{target}}}{\sigma_t^{\text{realized}}}$$

Products – Risk Control

S&P Risk Control

- Basic algorithm

$$\Delta_t^{\$} := \min\left(\frac{\sigma_t^{\text{target}}}{\sigma_t^{\text{realized}}}, \max \Delta^{\$} \right)$$

$$\sigma_t^{\text{realized}} := \sqrt{RV(T, T - N \text{ days})}$$

***RV*: Realized variance**

- Actual product
  - Realized variance is the average of two horizons (e.g. 100 and 200 days)
  - Maximum equity exposure used

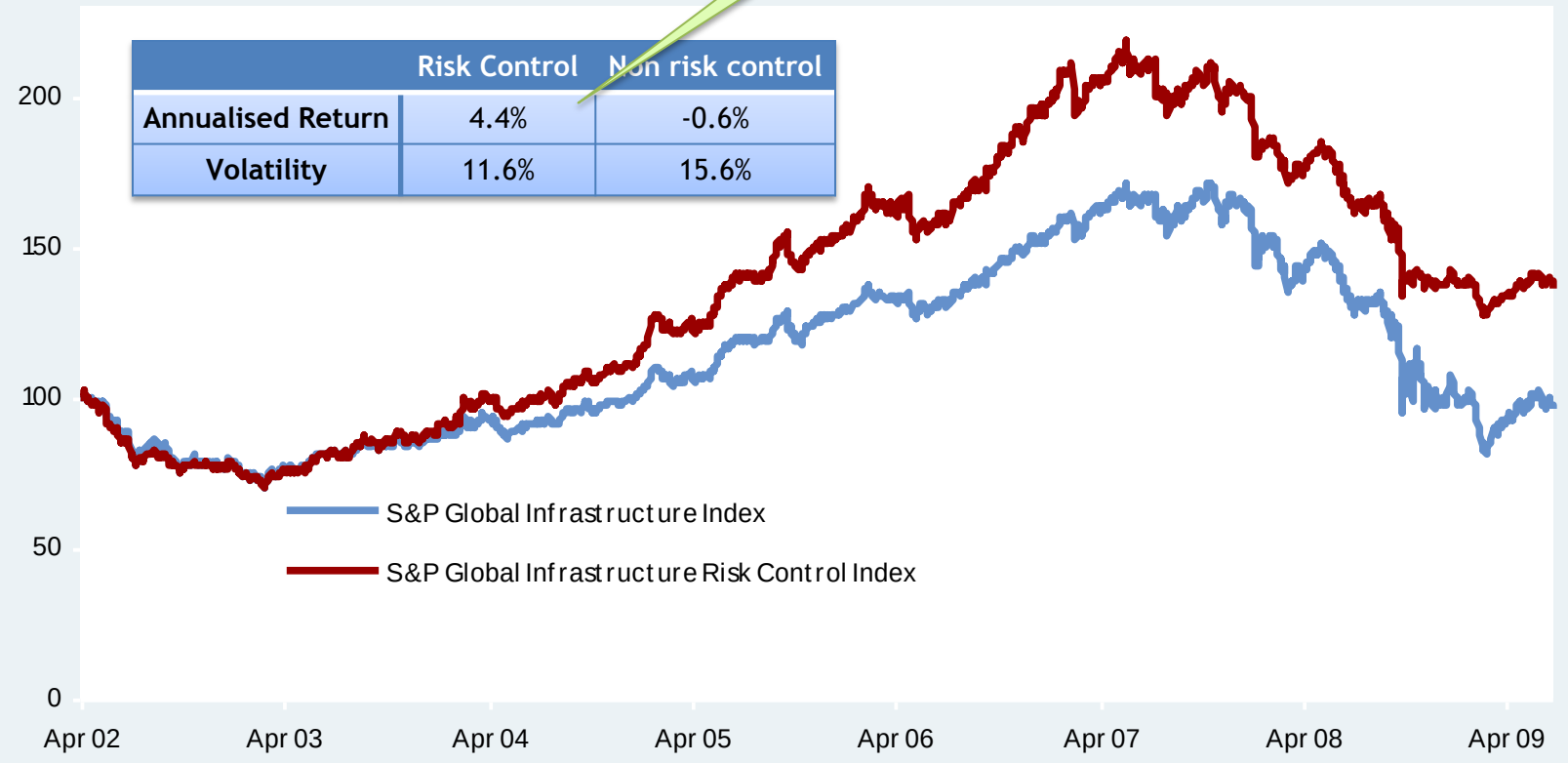
Products – Risk Control

Better risk profile due to Vol Control

S&P Risk Control

S&P Global Infrastructure Risk Control Index: Historical performance

	Risk Control	Non risk control
Annualised Return	4.4%	-0.6%
Volatility	11.6%	15.6%



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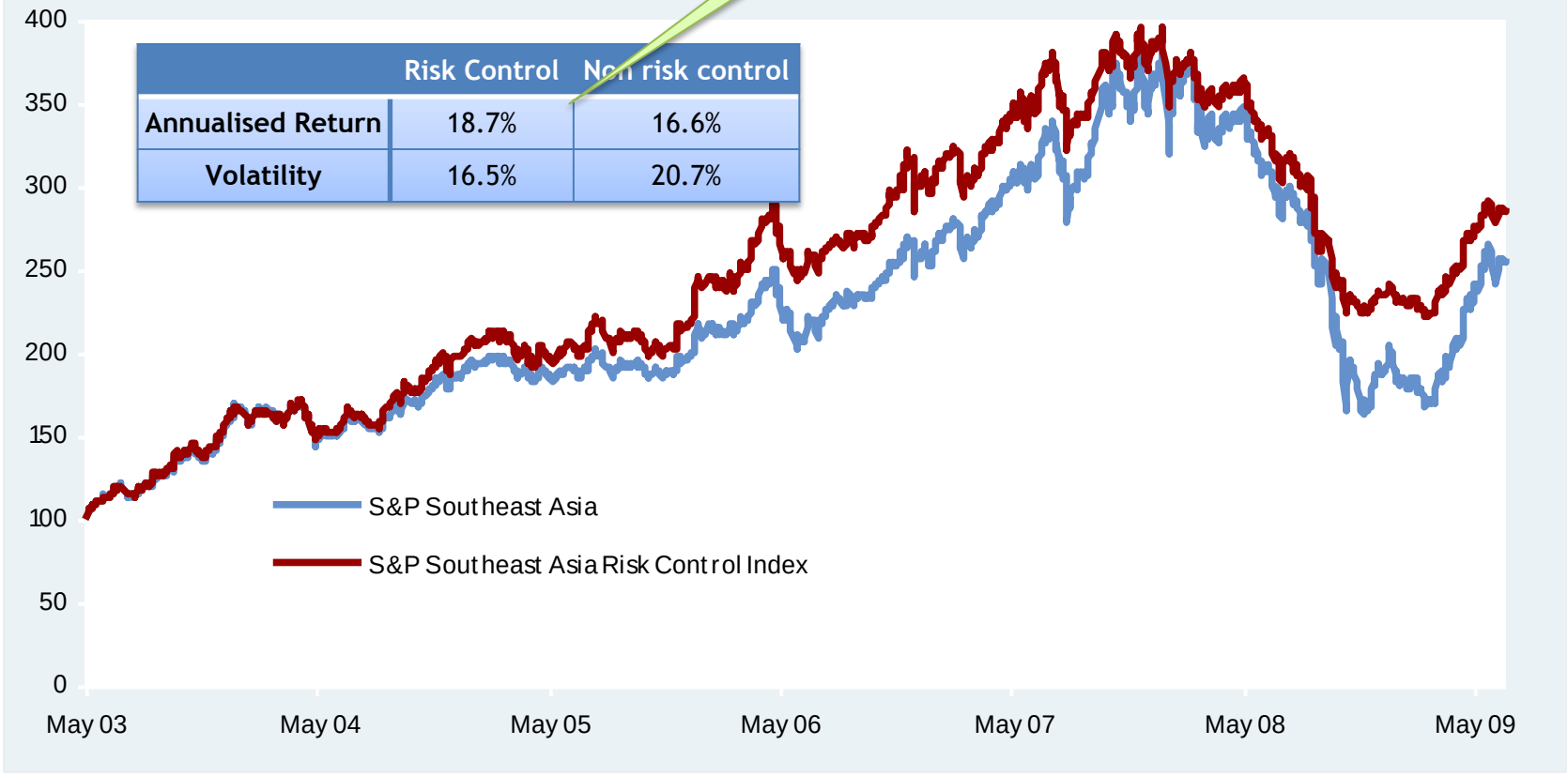
Products – Risk Control

Better risk profile due to Vol Control

S&P Risk Control

S&P Southeast Asia Risk Control Index: Historical performance

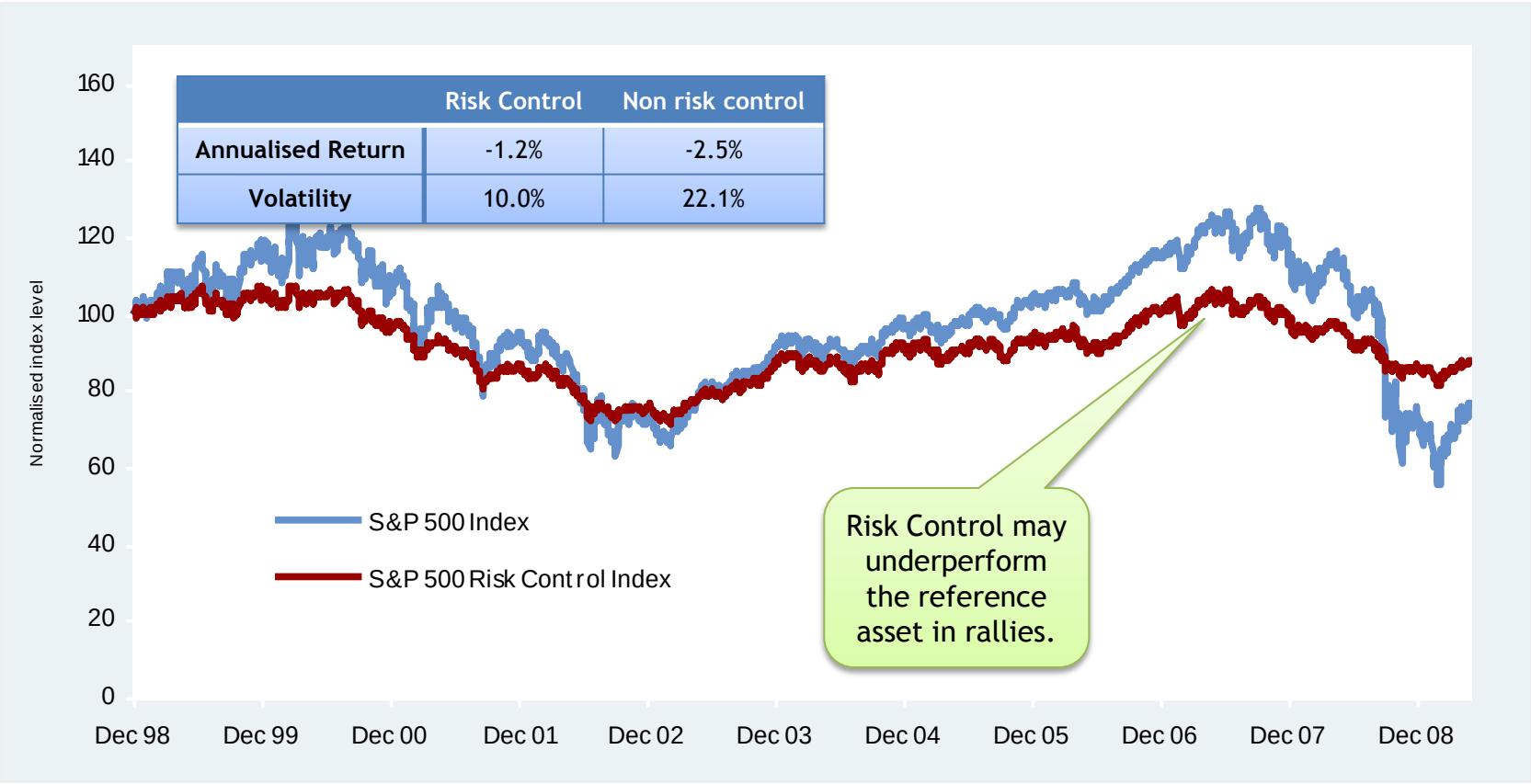


Source: S&P, Bloomberg. Data: May 2003 – July 2009. Past performance is not a guide to future returns. "Risk Control" and S&P Southeast Asia Risk Control Index refers to S&P Southeast Asia Risk Control 18% Index USD (ER). Please see the backtesting disclaimer at the end of this presentation.

Products – Risk Control

S&P Risk Control

S&P 500 Risk Control Index: Historical performance



Source: S&P, Bloomberg. Data: Dec 1998 – June 2009. Past performance is not a guide to future returns. "Risk Control" and S&P 500 Risk Control Index refers to S&P 500 Risk Control 10% Index (ER). Please see the backtesting disclaimer at the end of this presentation.

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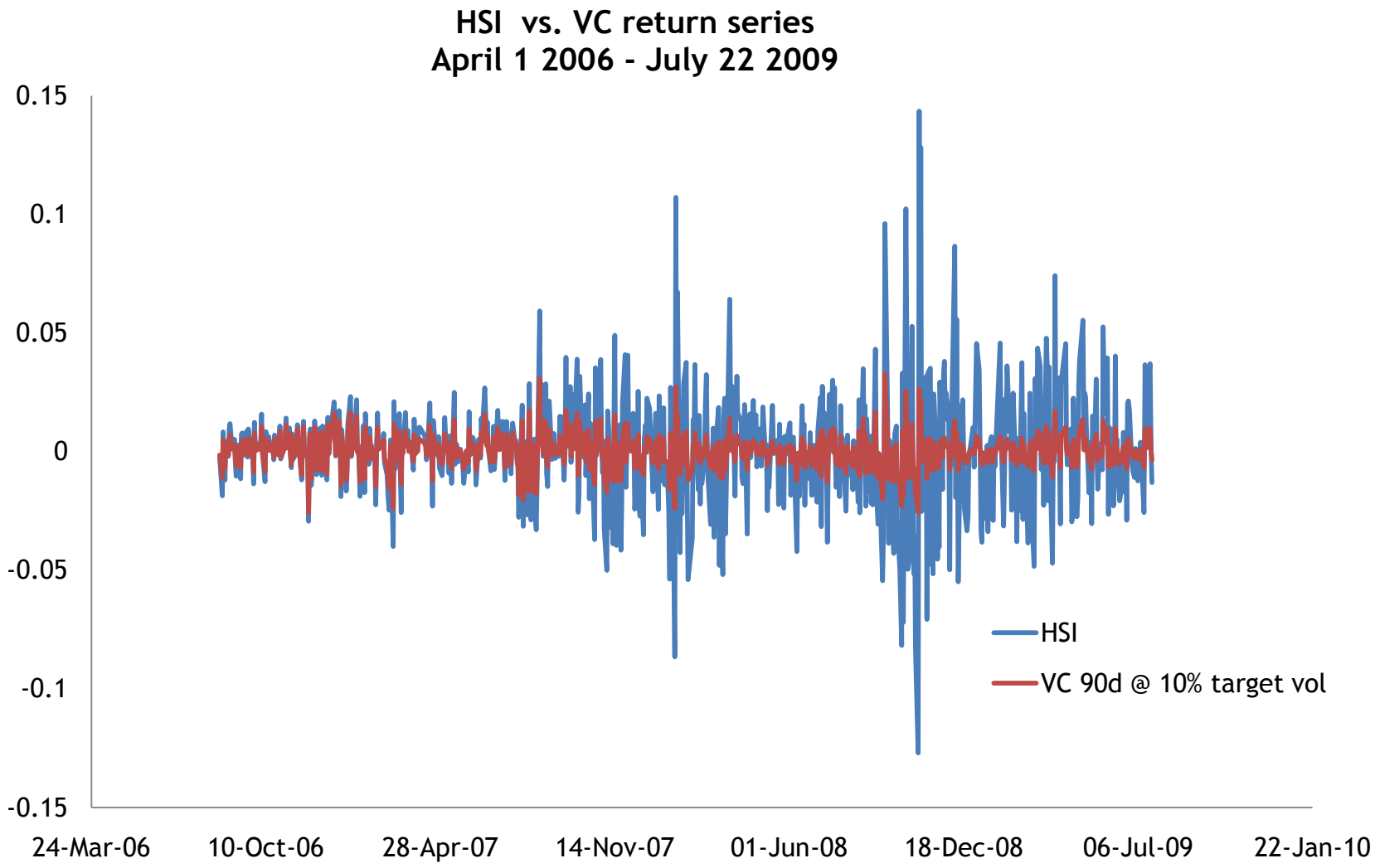
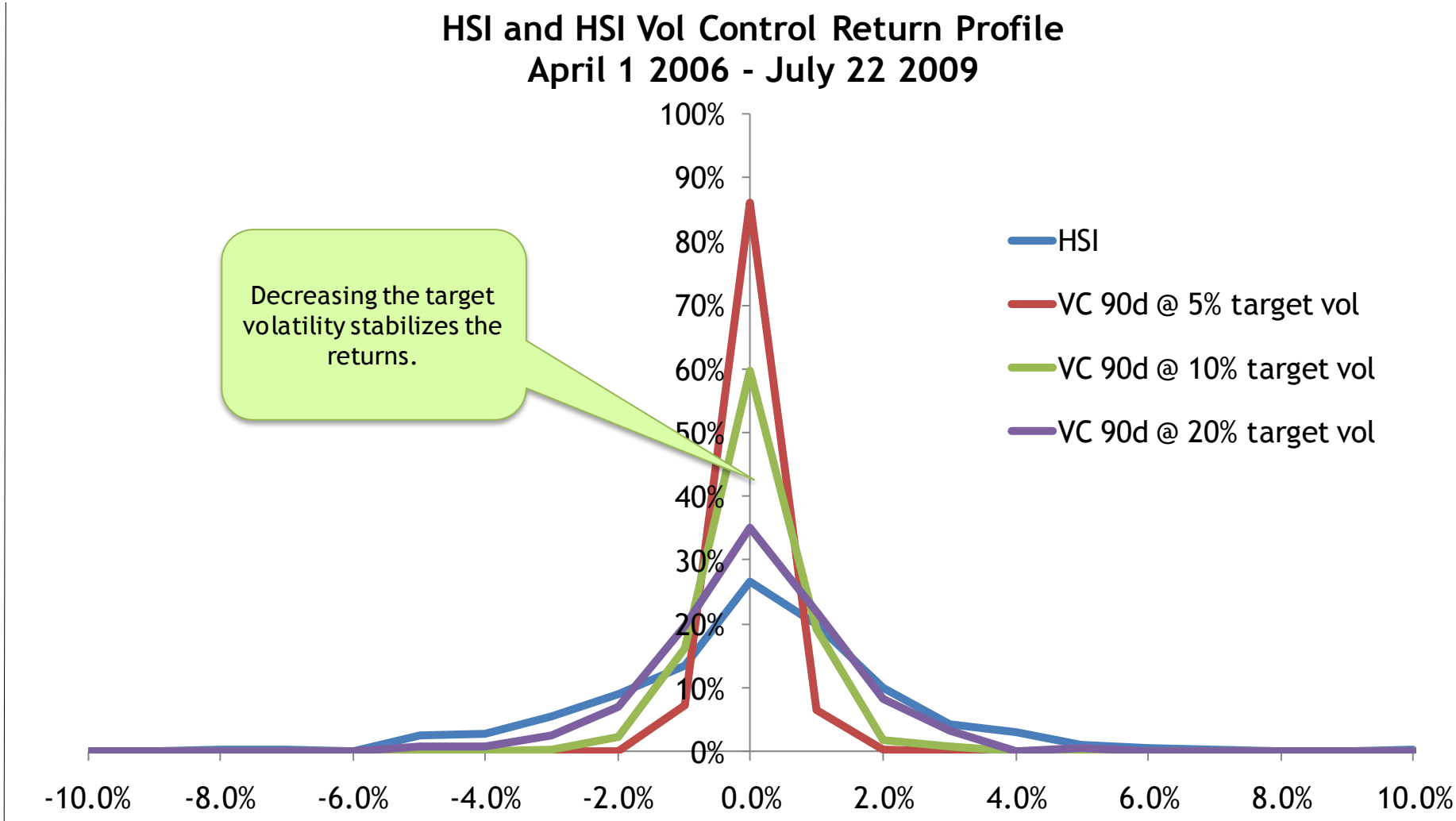
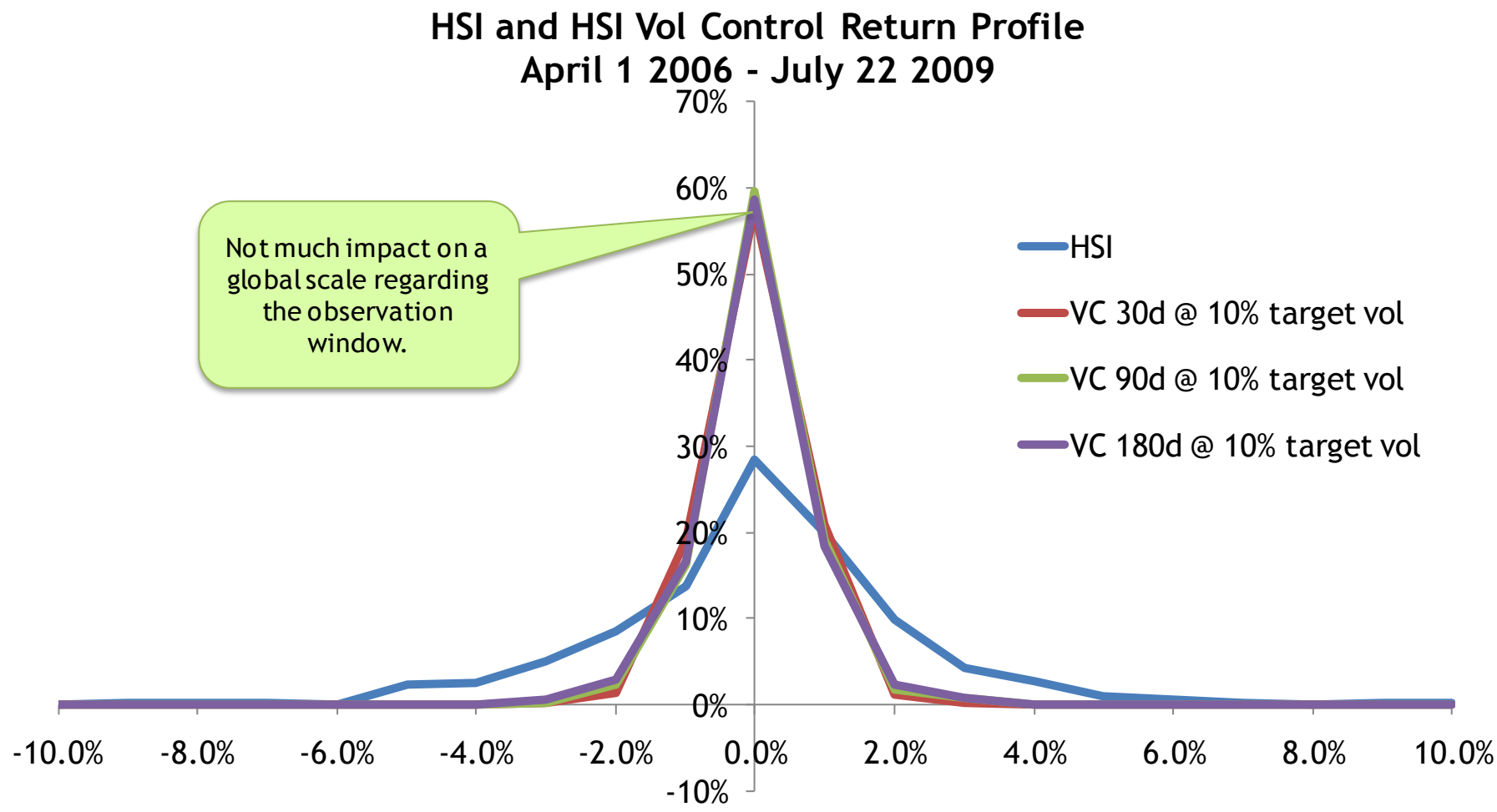


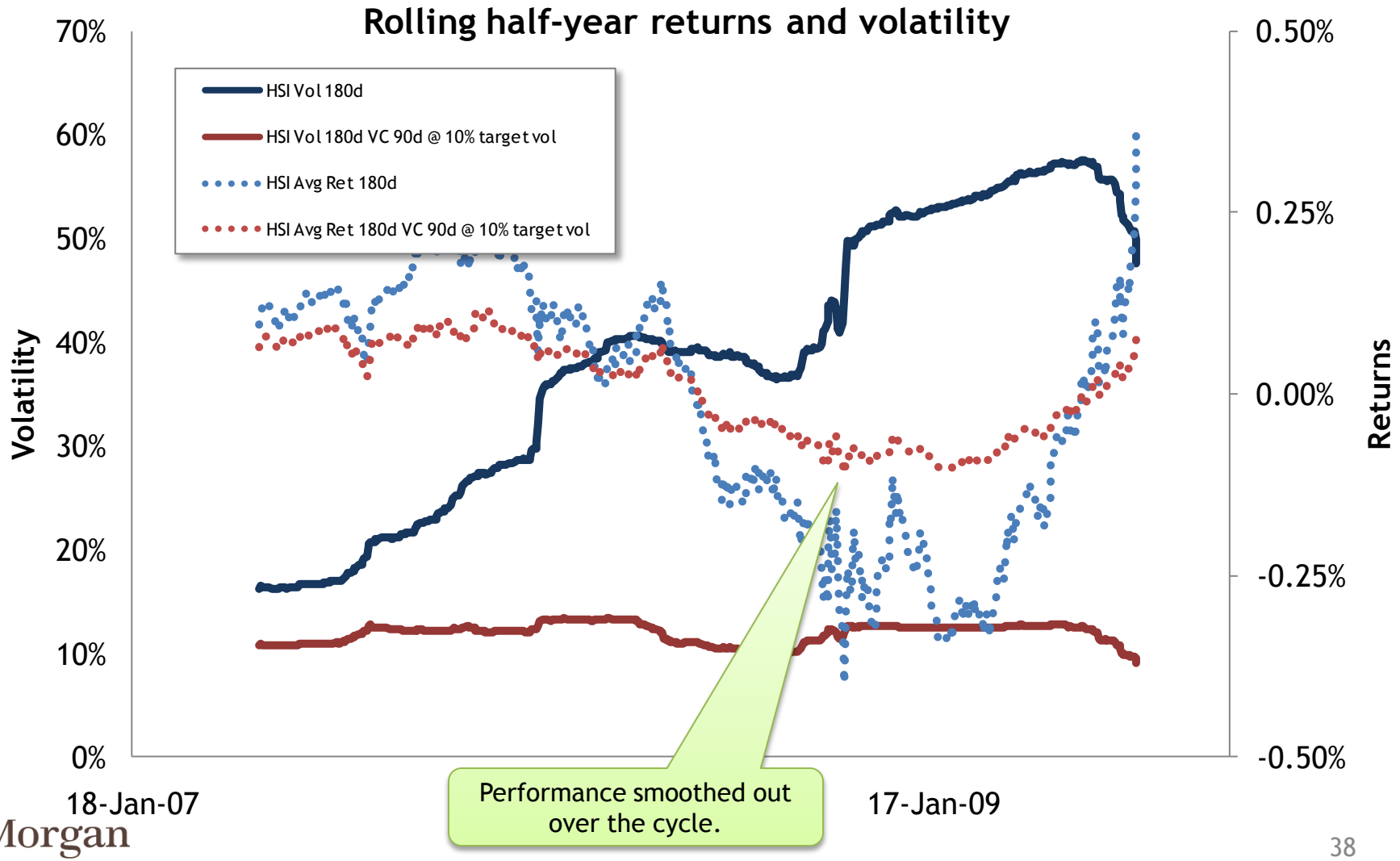
Products – Risk Control



Products – Risk Control



Products – Risk Control



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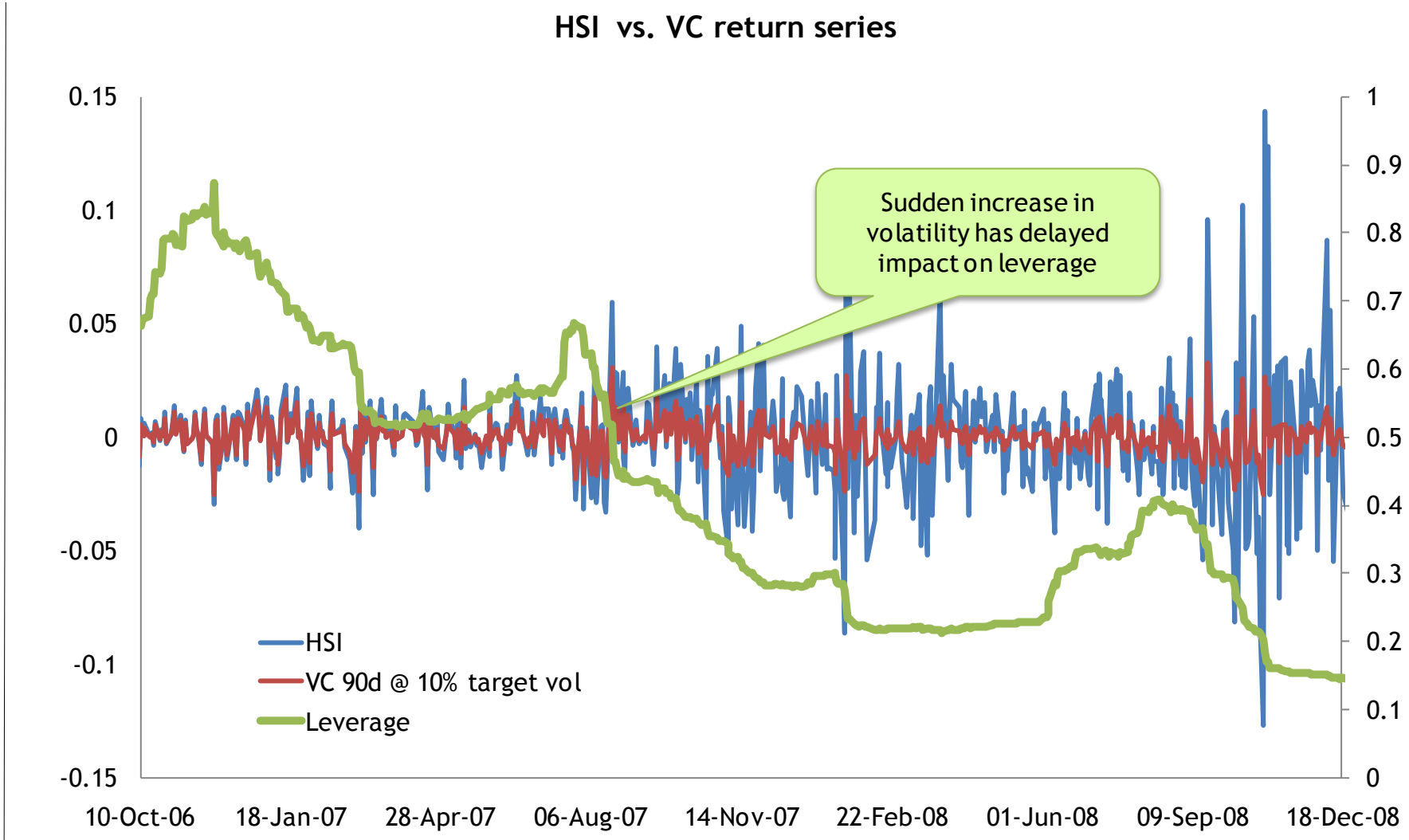
Products – Risk Control



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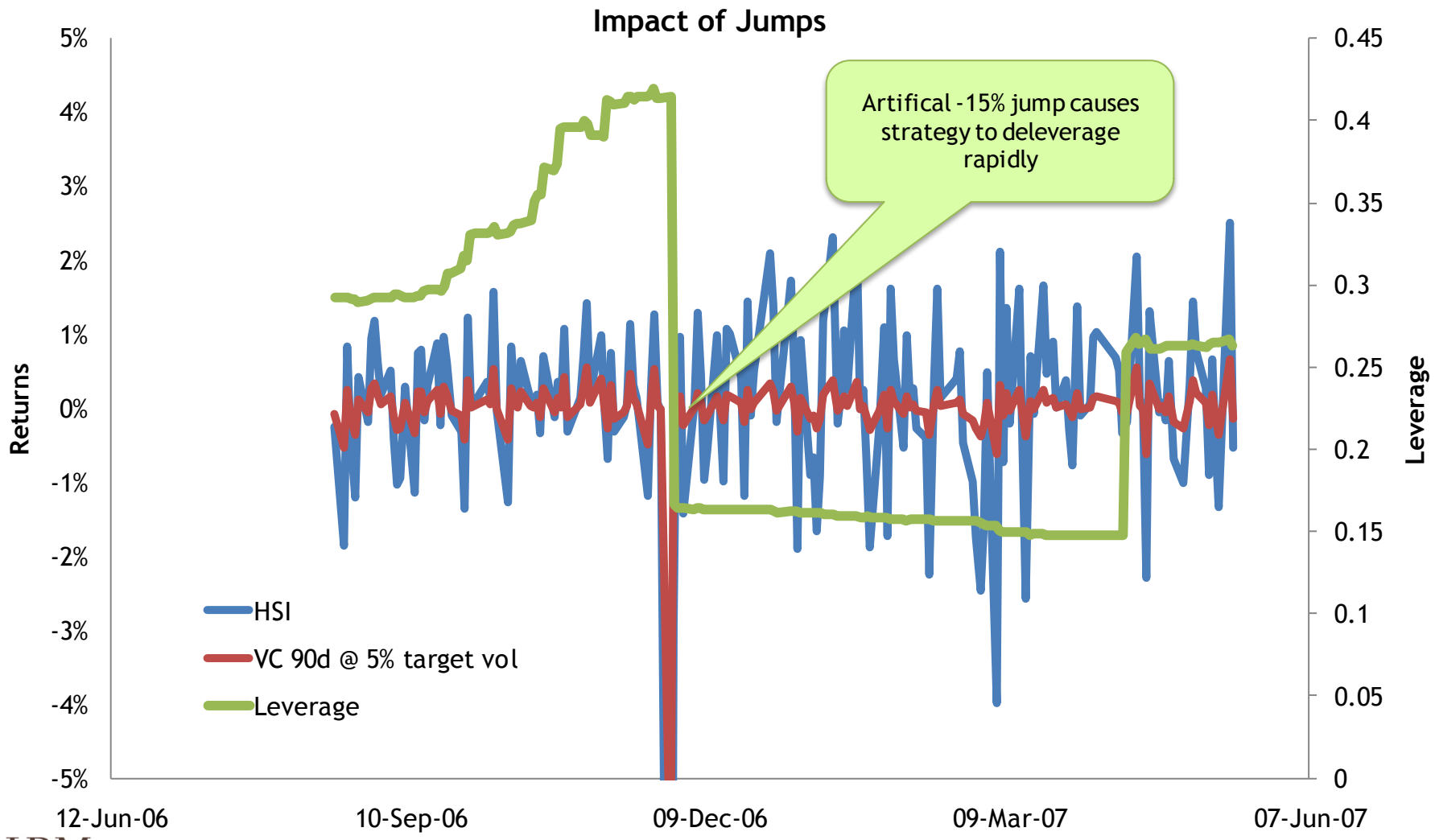
Products – Risk Control



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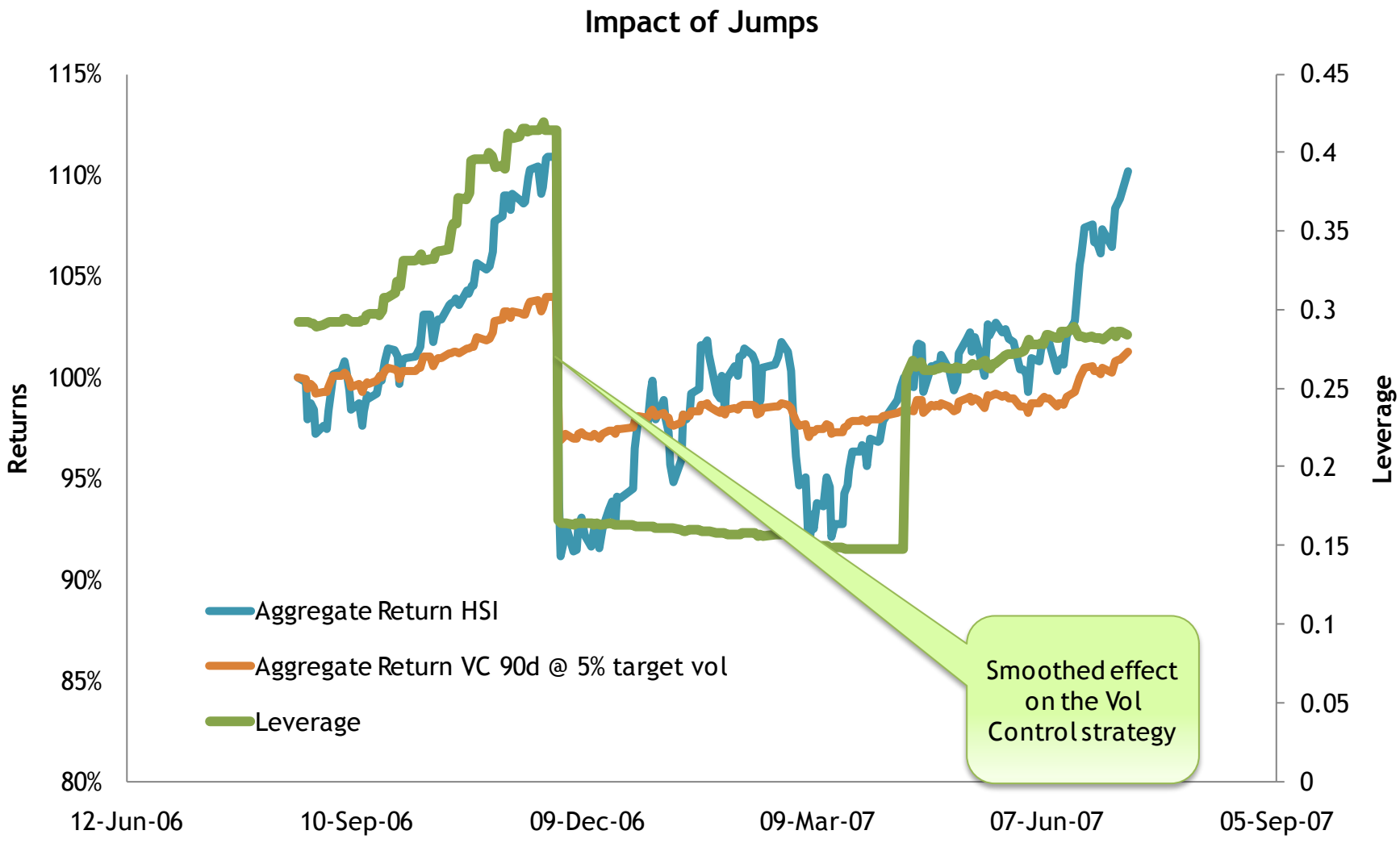
Products – Risk Control



Products – Risk Control

S&P Risk Control - Summary

- Basic algorithm

$$\Delta_t^{\$} := \min\left(\frac{\sigma_t^{\text{target}}}{\sigma_t^{\text{realized}}}, \max \Delta^{\$} \right)$$

$$\sigma_t^{\text{realized}} := \sqrt{RV(T, T - N \text{ days})}$$

  works well in general.
  - Volatility and impact of jumps is reduced

- Jump sensitivity via both delta and the to RV estimator.
  - The Vol Control behaves very tame for most of the time
  - Sudden jump impact which can be severe if happens before maturity.
  - Need ability to manage jumps

Products
Recent Innovations

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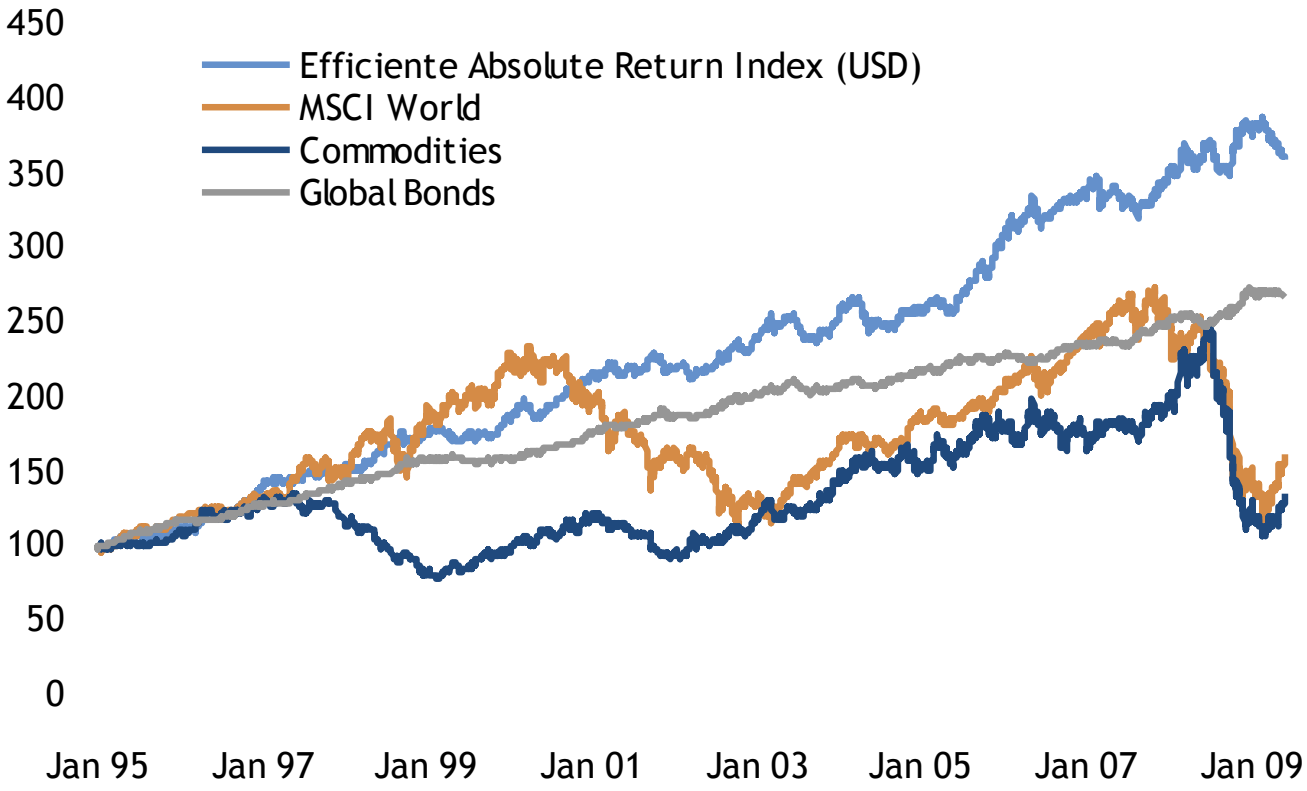
Products - Efficiente Absolute Return

Efficiente Absolute Return

- CAP/M style classic asset allocation cross asset classes.
- Kind of "Vol Control for multi-asset baskets"



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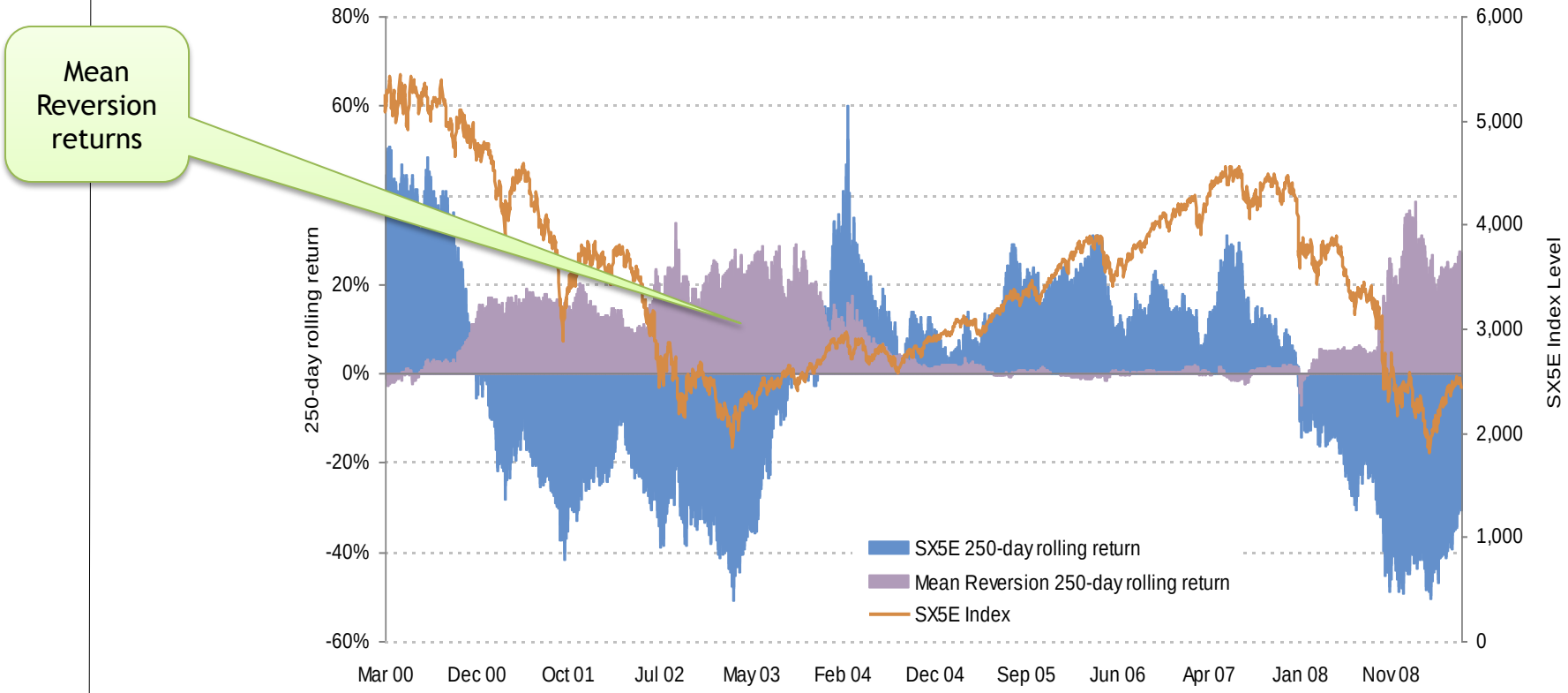
Products – Mean Reversion Algorithms

Mean Reversion

- Long/short delta strategy going long the market following a fall and short the market following a rise.



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