VA Product Design
Creating Value Through ERM

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Agenda

- Research Project Overview
- VA Market Overview
- Product Design and Risk Mitigation
- Research Project – Current Status

Variable Annuity Research Project Overview

VA Research Project

VA Risk Mitigation Strategies

- Sponsored by
  - SOA/CAS/CIA Joint Risk Management Research Team
  - SOA Committee on Finance Research
- Objective

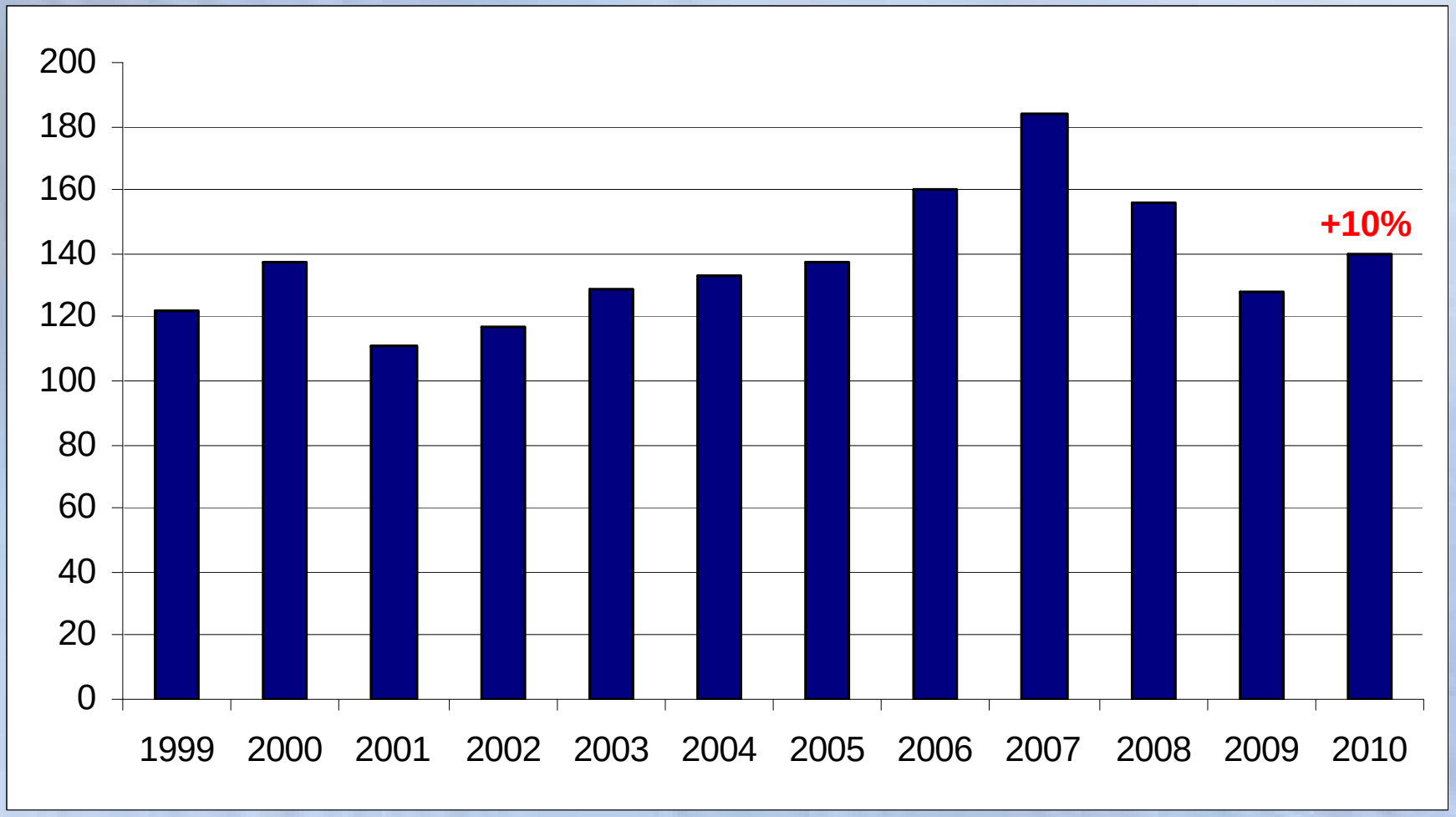
  Identify/create product designs that can generate more manageable risk profiles for VA guarantees (GLWBs)
- Suppliers and customers: lessons from manufacturers
- Either/or vs. Both/and

VA Research Project

- Market trends and scan
- Product choices
  - Considerations
- Experimenting in the kitchen
  - Stages – decide as you go
  - Consultation
- What we will learn
  - Insights into product tradeoffs and risk mitigation
  - Insights into evolving and emerging design processes

Variable Annuity Market Overview

VA Sales (billions)



http://www.limra.com/newscenter/databank/AnnuitySalesEstimates20012010.pdf

Landscape: VA Sales Top 20

Company	2007	2008	2009	2010	% in $ change vs. 2009	% in $ change vs. 2007
Prudential Financial	6	6	2	1	38%	35%
MetLife	2	2	1	2	13%	-14%
Jackson National	12	12	4	3	57%	-2%
TIAA-CREF	3	1	3	4	-1%	-26%
Lincoln Financial Group	5	5	6	5	16%	-48%
AXA Equitable	1	3	5	6	-19%	-70%
SunAmerica/VALIC	11	8	10	7	32%	312%
RiverSource/Ameriprise	9	11	8	8	4%	-59%
Nationwide	13	13	11	9	27%	-61%
AEGON/Transamerica	14	14	13	10	8%	-49%
Sun Life Financial	16	18	14	11	1%	-3%
Allianz Life	15	15	16	12	16%	-41%
Pacific Life	10	10	12	13	-22%	-84%
John Hancock	7	7	7	14	-55%	-81%
ING Group	8	4	9	15	-50%	-83%
Thrivent Financial	21	22	18	16	54%	13%
New York Life	19	20	21	17	67%	-35%
Protective	NR	NR	24	18	136%	156%
Fidelity Investments Life	18	16	19	19	26%	-65%
Ohio National	20	19	17	20	-39%	-59%

Dropped out: Hartford, Genworth, Principal Life, Security Benefit Life

Changing Landscape 1 of 2

- Dominated by Top 20 (~92% of total sales)
- 87% GLB election rate (when available at purchase)
- Number of wholesalers decreased 18% since 2008*
- Growth in 2010 by majority of top 20
- Top 10 in VA assets *and* in sales
  - Met, Pru, Lincoln, AXA, RiverSource, Jackson
    - Hartford, Hancock, Pacific, ING: Assets, not sales
    - Nationwide, AEGON, Allianz, Sun Canada: Sales, not assets
- Genworth exits market
- Cost of VAs dropped in Q2 2010**
  - Average fee fell 4 bps from Q1

*** Source: Market Metrics Q4 2010 productivity study**
****http://registeredrep.com/wealthmanagement/investors_retur_to_variable_annuities/**

Changing Landscape 2 of 2

Some recent changes & proliferation of product filings

- Guardian, Pacific, RiverSource: increased rider and/or base fees
- Hartford: pseudo-WB - Investment & Income components
- ING: simpler design with passive managed funds
- Jackson National: choices in roll-up rate and frequency
- Lincoln: revised i4LIFE® Advantage
- Metlife: lower GMIB rates
- Nationwide: will introduce a transfer product
- Protective: transfer based on moving average returns
- Prudential: lower roll-up rate to 5%
- Sun Life: changed investment option diversification ranges
- Transamerica: transfer to short SP500; built-in delta hedging
- Western & Southern: ETFs to reduce basis risks

Information believed to be accurate

This info quickly becomes obsolete due to rapidity of changes

Product Design
and
Risk Mitigation

Traditional Pricing Process

- Product Oversight Committee
- Coordination of various departments
  - Marketing, Actuarial, IT, Legal, Financial
- Communication important
  - Consistency of features, rates, etc
  - Keep each other informed
- Risk mitigation solutions
  - Price direct
  - Solution reflected via simplified assumption (x bps)
  - Goal: In place prior to launch
- Process silos: coordination vs. collaboration

Pricing and Competition: Then

- Leaders (add a new bell/whistle)
- Fast followers
- Know risk profile and risk appetite first?
- Commodities
- Narrow range for rider charges
- Repeat the cycle

Pricing 101

$100,000,000

$50,000,000

$25,000,000

$10,000,000

$5,000,000

$2,000,000

$1,000,000

Lifelines

1 Competitor brochures

2 Phone a reinsurer

3 Poll the experts

Pricing by Brochures

Choose features/rates

Company	Rollup Rate	Period	wd %	Sec Guar	Etc	Charge
1 Met	6	Q	4.5	200% 10 yr	…	75
2 AXA	5	Annual	5	none	…	70
3 ING	7	Q	5	200% 10 yr	…	80
4 Lincoln	6	Q	4.5	None	…	75
5 Pru	6	Daily	5	200% 10 yr	…	75
Us	**6**	**Q**	**5**	**200% 10 yr**	**…**	**75**

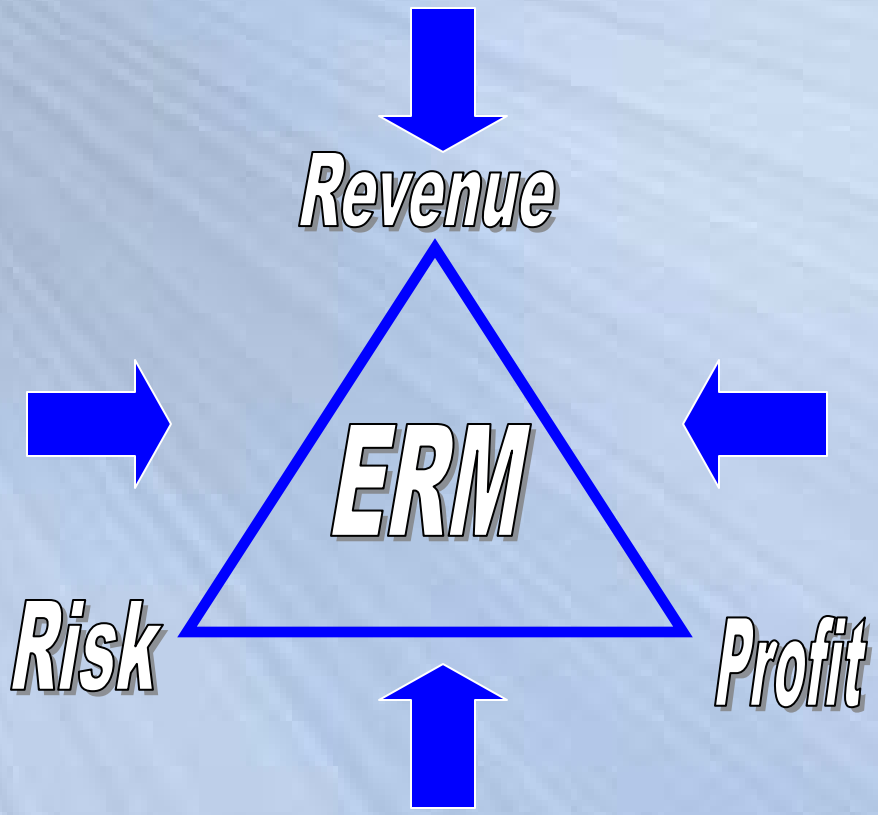
Chart is based on fiction; any resemblance to real facts or figures is coincidental

Pricing and Competition: Now

- Leaders
- Slow followers
  - Activity has not slowed
- Know risk profile and risk appetite first?
- Product differentiation
  - Unique investment restrictions/options
- Wide range for GLWB charges (30-130 bps)
- Off cycle

Challenges for Insurers 1 of 2

Policyholders Distributors
TRUST



Ratings
NAIC SMI
RBC
SEC
Solvency II

Financial crisis
Volatile markets
Capital
Liquidity

Product & model complexity
Earnings volatility
Complex risks

Challenges for Insurers 2 of 2

- Long-term top-line and bottom-line growth
- Balance revenue, profit and risk opportunities
- Align risk preferences, appetite and tolerances with strategy
- Link core risks and collateral risks with core competencies

Do you know your risk profile?

Do you want this risk profile??

Really???

The Right Product Design

- Alignment and fit
  - Right for the customer
  - Right for the company
- Trade-offs between revenue, profit and risk profiles
- Fixed “value pie” for policyholders and companies
- Alchemy
- Internal vs. external risk mitigation
- “And”
  - Design process integration
    - Supplier/user involvement and engagement
    - Internal and external risk mitigation involved in process from beginning to end
    - Collaboration – engaged side by side

Research Project Current Status

Product Feature Considerations

- Guaranteed Base Roll-Up Rates
  - Level
  - Fixed
  - Indexed (e.g., to treasury rates)
- Guaranteed Withdrawal Rates
  - Level
  - Fixed
  - Indexed (e.g., to treasury rates)
- Fees
  - Fixed
  - Vary by allowable fund choices
  - Indexed (e.g. to VIX)
- Investment Options/Restrictions/Mechanisms
  - Automatic rebalancing to funds that short SPX (delta hedge)
  - Target volatility funds
  - Constant Proportional Portfolio Insurance
  - ETFs, hedged funds, passive-managed funds

Market Scan

Feature	In the Market
Fee	Flat 30-130 *OR* Vary by allowed invest options *OR* Indexed
Fee Timing	Monthly, Quarterly *OR* Annually
Roll-up rate	None *OR* 5-10%; Simple *OR* Compound
Roll-up period	10/20 yrs or until 1st wd *OR* thru age 85-95. Some reset 10 yr period with step-up
GMWB Base	Automatic annual step-up = max(AV,roll up base); Step-up could be quarterly, monthly or daily
Additional Guar	None *OR* 200/400% of init prem at 10/20 yrs if no wd's
Guar withdrawals	1-7 tiers. Starting age 45-60. Most do not but some wd% changes as you move thru age bands
Invest Options/ Restrictions	4-8 designated options *OR* Choose from limited number (with or w/o min/max diversification ranges) *AND/OR* Formulaic transfers to/from a WB fixed account

Modeled Product Features 1 of 2

Product	Simple 1	Basic 2	Complex 4	Complex 5
Enhanced Dur	None	10YR	10YR	10YR
Inv. Restriction	None	None	CPPI	Target Vol
Roll-up Type	NA	Simple	Compound	Compound
Roll-up Freq	Annual	Annual	Quarterly	Quarterly
Roll-up Rate	0%	10%	6%	6%
Roll-up Max Age	NA	85	85	85
Ratchet Freq	Annual	Annual	Quarterly	Quarterly

Modeled Product Features 2 of 2

Age at 1st wd	wd%
59½- 64	4%
65-79	5%
80+	6%

Upon Termination: deduct fee pro-rata

$-4-$: Pro-rata on excess

DB: ROP only

7 year surrender charge

Per Policy Fee Bands: $0-49,000 $30; $50,000+ $0 annual

Did not model: Ability to drop riders; ability to increase fees; Joint riders

* NA for Simple product

Risk Profile Measurements

Survey Results 1/2

Primary Risks

- Equity – Delta, Gamma (by equity index)
- Interest – Rho, Convexity (by key rate)
- Basis - R-squared
- Policyholder Behavior – Experience study

Primary Measurements

- Tail Risk (CTE of Net Claims)
- Statutory IRR
- Risk-neutral guarantee cost/hedge cost
- Stat PVDE (Distributable Earnings)
- Potential capital requirements

Survey Results 2/2

Primary sensitivities/analysis

- Policyholder behavior: lapse, adverse utilization, level of withdrawals, lapse and mortality
- Impact of equity performance and high equity vol
- Impact of persistently low interest rates

Other concerns:

- STAT IRR vs GAAP ROE
- Standard models for policyholder behaviors
- The correlation between interest rates and equity markets

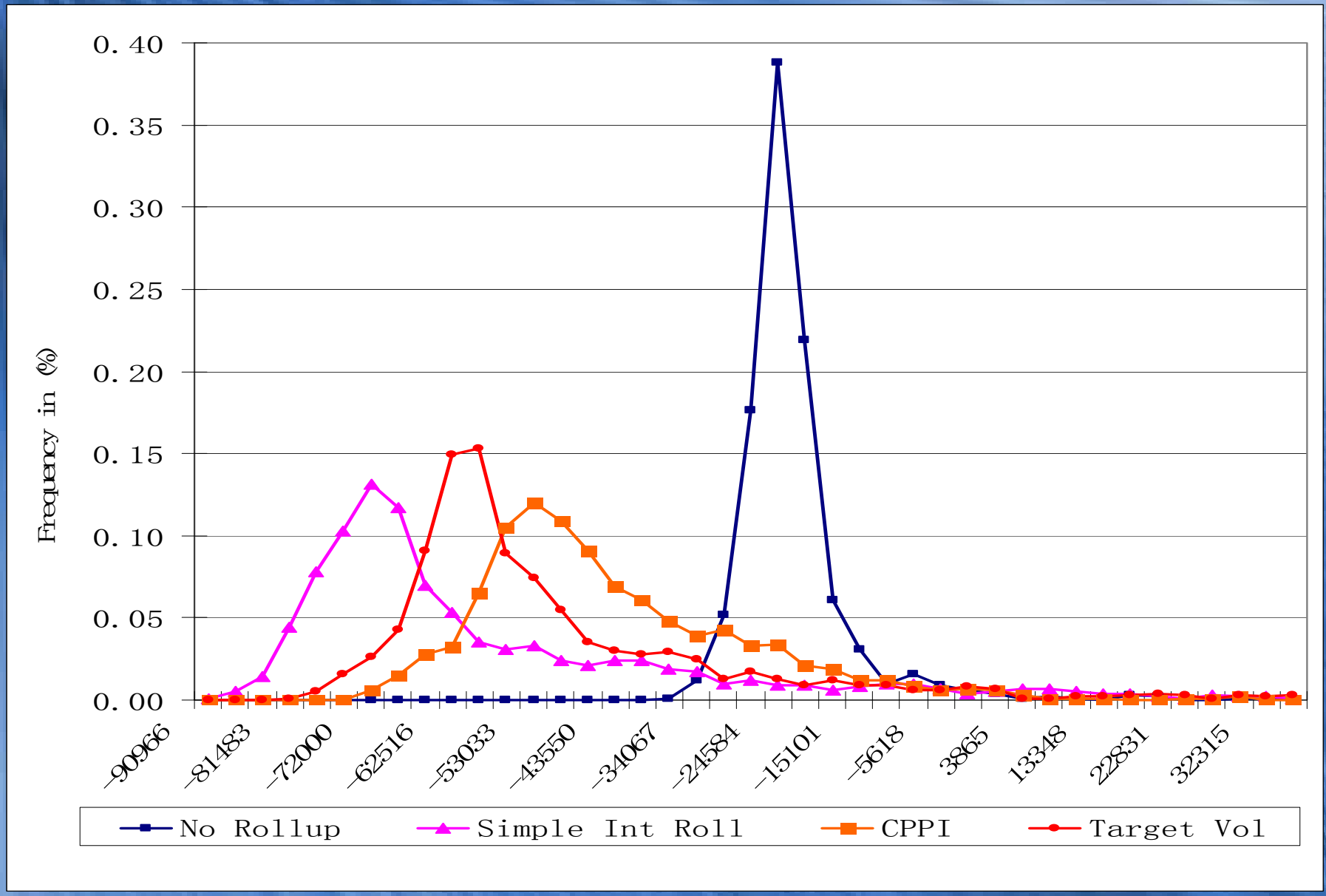
Risk Profile Measurements

- PV net claims/costs distribution
  - PV Claims – PV Fees
  - 1000 real-world scenarios
- Tail risks
  - PV net claims
  - CTE 70/80/90/97/99
- Risk-neutral hedge cost
  - % of rider fees
  - Measured under various market conditions

Risk Profile Measurements

- Market risks (Greeks)
  - Delta
  - Rho
  - Key Rate Rho
  - Gamma
  - Convexity
  - Key Rate Convexity
  - Vega
  - Vomma
  - Cross Greeks
    - DdeltaDrho, DdeltaDvol and DvegaDrho

PV Net Claims Distribution



Tail Risks

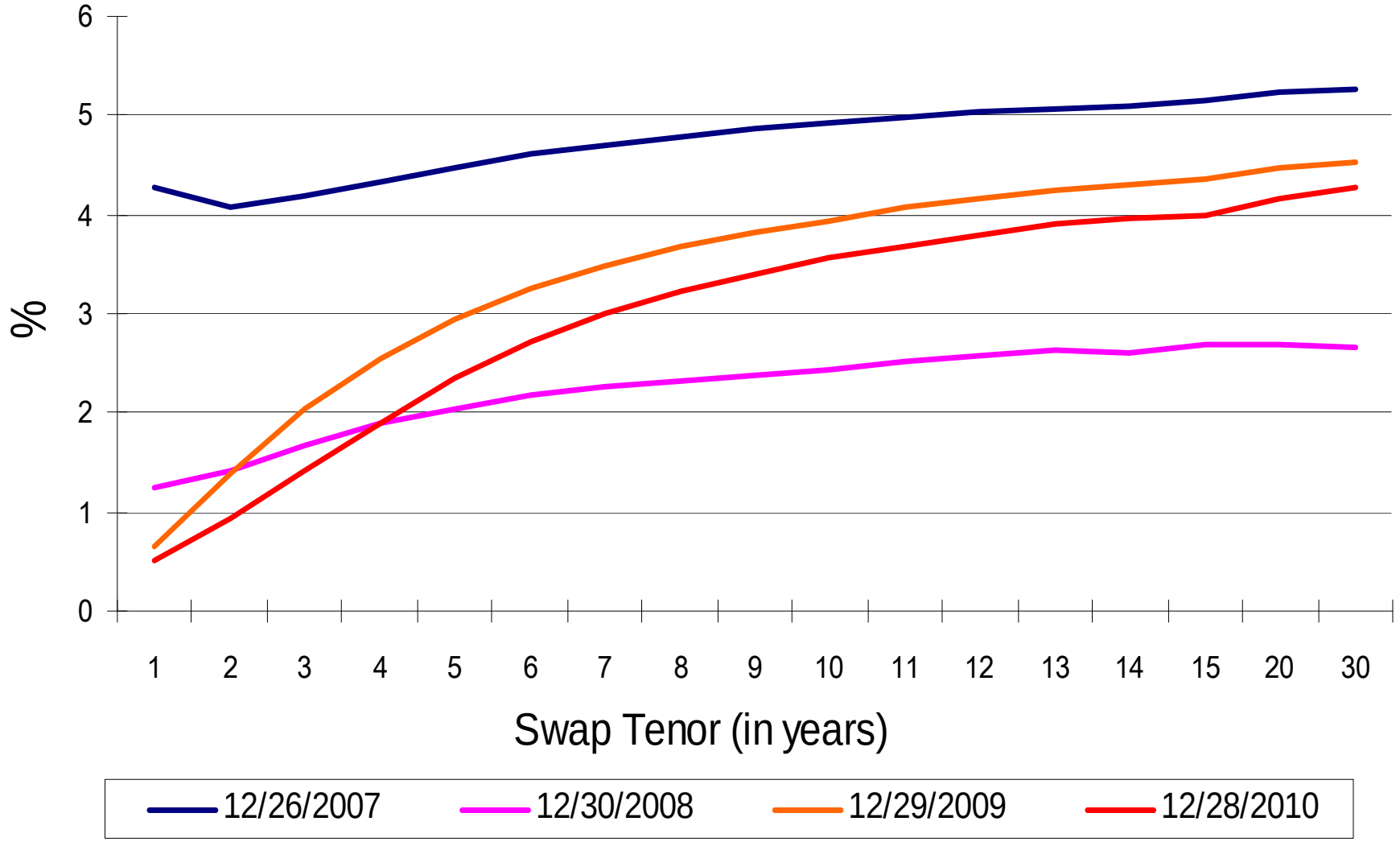
CTE	No Roll-up	Simple Int Roll-Up	Indexed Roll-Up	CPPI	Target Volatility
Avg	(22,645)	(54,195)	(48,492)	(43,860)	(48,552)
70	(15,490)	(16,318)	(23,218)	(24,337)	(20,420)
80	(12,343)	(1,091)	(12,390)	(18,778)	(8,823)
90	(5,120)	26,943	8,652	(10,057)	13,490
97	13,622	81,678	52,385	4,681	58,754
99	39,798	132,436	99,211	18,569	105,659

Risk Profile Comparison

- Evaluate new business cohorts on four days/market conditions
  - $11 million of initial premiums
  - 12/26/2007: High interest rates
  - 12/30/2008: High implied vol and low interest rates
  - 12/29/2009: Recovered implied vol and interest rates
  - 12/28/2010: Current market
- Implied Volatility:

2007/12/26	2008/12/30	2009/12/29	2010/12/28
21.4%	38.3%	22.7%	21.2%

Swap Curve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Swap Tenor (in years)
12/26/2007
12/30/2008
12/29/2009
12/28/2010

12/26/2007 1 of 2

Greeks	No Roll-up	Simple IntRate	CPPI	Target Vol
Guar Cost	20	60	21	46
1st Order				
Delta	(1,709)	(8,355)	(958)	(2,121)
Rho	(6,377)	(18,553)	(11,825)	(16,070)
Key rate Rho				
1-3 Yr	626	1,059	1,297	1,395
4-6 Yr	612	1,938	1,433	1,287
7-14 Yr	(1,853)	(5,210)	(3,806)	(4,502)
15-30 Yr	(5,763)	(16,340)	(10,749)	(14,250)
Vega	1,945	5,416	2,035	4,063

12/26/2007 2 of 2

Greeks	No Roll-up	Simple IntRate	CPPI	Target Vol
2nd Order				
Gamma	77	236	75	339
Convexity	273	695	695	667
Key rate Con				
1-3 Yr	7	2	24	18
4-6 Yr	13	28	31	37
7-14 Yr	75	216	212	205
15-30 Yr	178	449	429	406
Vomma	76	161	17	80
Cross				
DdeltaDrho	19	190	15	20
DdeltaDvol	(42)	(60)	30	(42)

12/30/2008 1 of 2

Greeks	No Roll-up	Simple IntRate	CPPI	Target Vol
Guar Cost	68	154	84	123
1st Order				
Delta	(5,764)	(18,252)	(3,835)	(7,135)
Rho	(20,047)	(46,750)	(41,277)	(42,746)
Key rate Rho				
1-3 Yr	1,341	1,813	3,218	2,768
4-6 Yr	1,414	3,295	1,628	1,975
7-14 Yr	(6,184)	(12,820)	(15,192)	(12,384)
15-30 Yr	(16,618)	(39,038)	(30,931)	(35,106)
Vega	6,930	13,367	8,188	8,804

12/30/2008 2 of 2

Greeks	No Roll-up	Simple IntRate	CPPI	Target Vol
2nd Order				
Gamma	164	434	147	258
Convexity	785	1,603	1,779	1,585
Key rate Con				
1-3 Yr	10	1	99	46
4-6 Yr	44	43	97	65
7-14 Yr	242	517	623	472
15-30 Yr	490	1,042	960	1,002
Vomma	151	235	301	77
Cross				
DdeltaDrho	80	285	72	66
DdeltaDvol	(83)	(73)	62	(15)

12/28/2010 1 of 2

Greeks	No Roll-up	Simple IntRate	CPPI	Target Vol
Guar Cost	33	87	35	67
1st Order				
Delta	(2,889)	(12,263)	(2,062)	(3,933)
Rho	(10,201)	(28,103)	(19,864)	(23,868)
Key rate Rho				
1-3 Yr	866	1,284	1,971	1,774
4-6 Yr	840	2,452	1,519	1,604
7-14 Yr	(3,025)	(7,868)	(7,016)	(6,800)
15-30 Yr	(8,882)	(23,971)	(16,338)	(20,447)
Vega	2,903	7,194	3,872	5,742

12/28/2010 2 of 2

Greeks	No Roll-up	Simple IntRate	CPPI	Target Vol
2nd Order				
Gamma	111	292	126	131
Convexity	427	1,053	1,067	949
Key rate Con				
1-3 Yr	6	10	30	15
4-6 Yr	23	26	41	48
7-14 Yr	129	352	365	292
15-30 Yr	270	665	631	593
Vomma	109	282	101	160
Cross				
DdeltaDrho	49	287	11	8
DdeltaDvol	(47)	(85)	20	(37)

Convexity as % of Rho 1 of 2

	Convexity	Rho	C/R
No Rollup	427	(10,201)	-4.2%
Simple Int Rate	1,053 →	(28,103)	-3.7%
CPPI	1,067	(19,864)	-5.4%
Target Vol	949	(23,868)	-4.0%

Convexity as % of Rho 2 of 2

	Convexity	Rho	C/R
2yr Swap	54	(21,801)	-0.2%
5yr Swap	284	(52,566)	-0.5%
10yr Swap	953	(95,398)	-1.0%
20yr Swap	2,770	(154,005)	-1.8%
30yr Swap	4,657	(190,079)	-2.4%
5X10 CMS Floor	329	(7,882)	-4.2%
10X10 CMS Floor	1,999	(11,553)	-17.3%
1X10 Swaption	4,220	(42,412)	-10.0%
1X30 Swaption	12,266	(87,810)	-14.0%
5X20 Swaption	7,565	(61,175)	-12.4%

Back Testing

Back Testing

- The behavior of various product designs
- Hedge performance
- Earning patterns
- Methodology:
  - Outer loop: account transaction simulation
    - Single new business cohort (2003)
    - On a daily basis
      - CPPI/target volatility are highly path-dependent
    - Assume all the actuarial assumptions will be realized
    - No basis risk
      - Will introduce basis risk as the next step

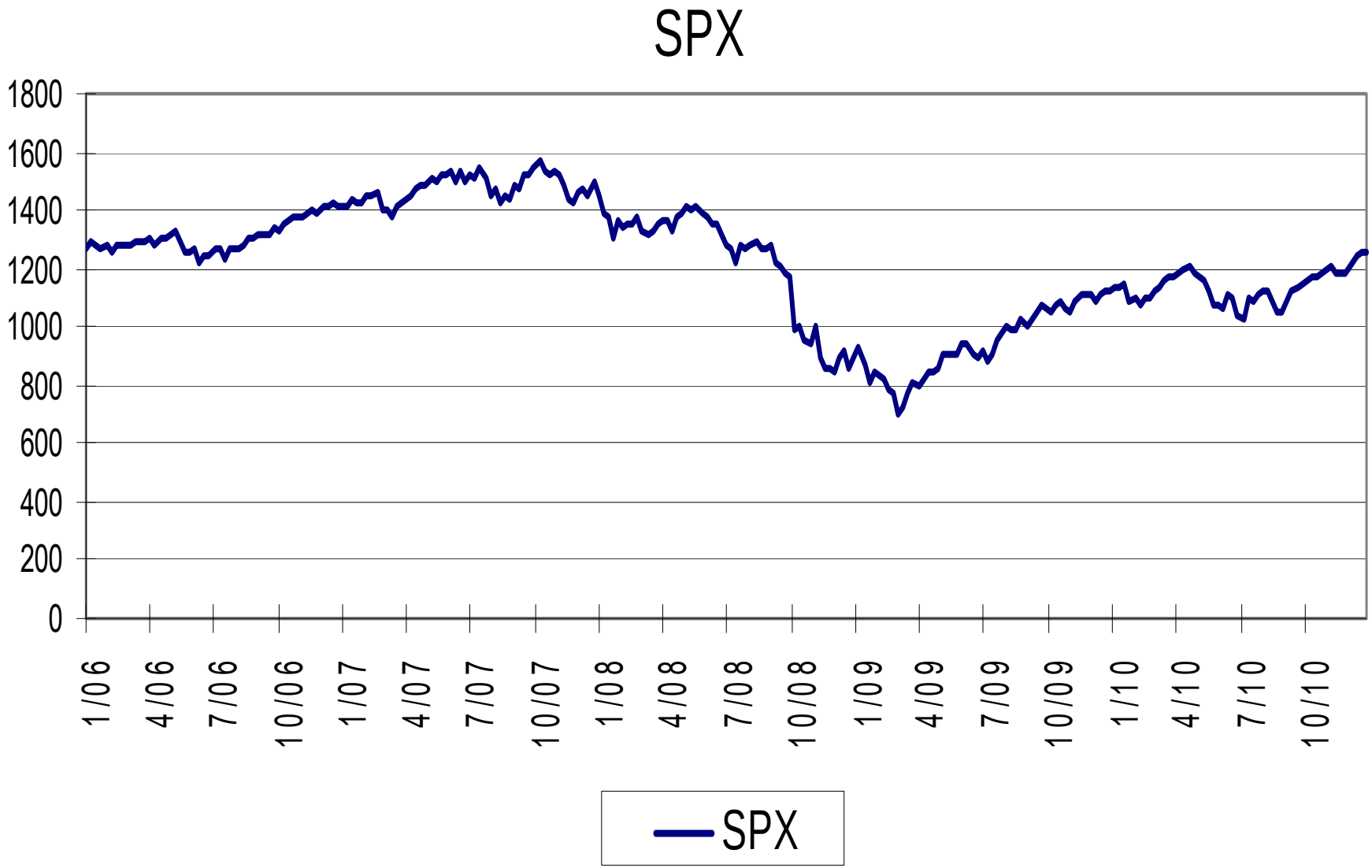
Back Testing

- Hedge Simulation
  - Fair Value Hedge
  - Monthly hedge (Q2 2006 to Q4 2010)
  - Weekly hedge (Q3 2008 to Q1 2009)
  - Will examine tail risk hedge
- Earning measurement:
  - Stat: VACARVM, C3P2
  - GAAP: FAS157, DAC and SOP 03-1(DB)

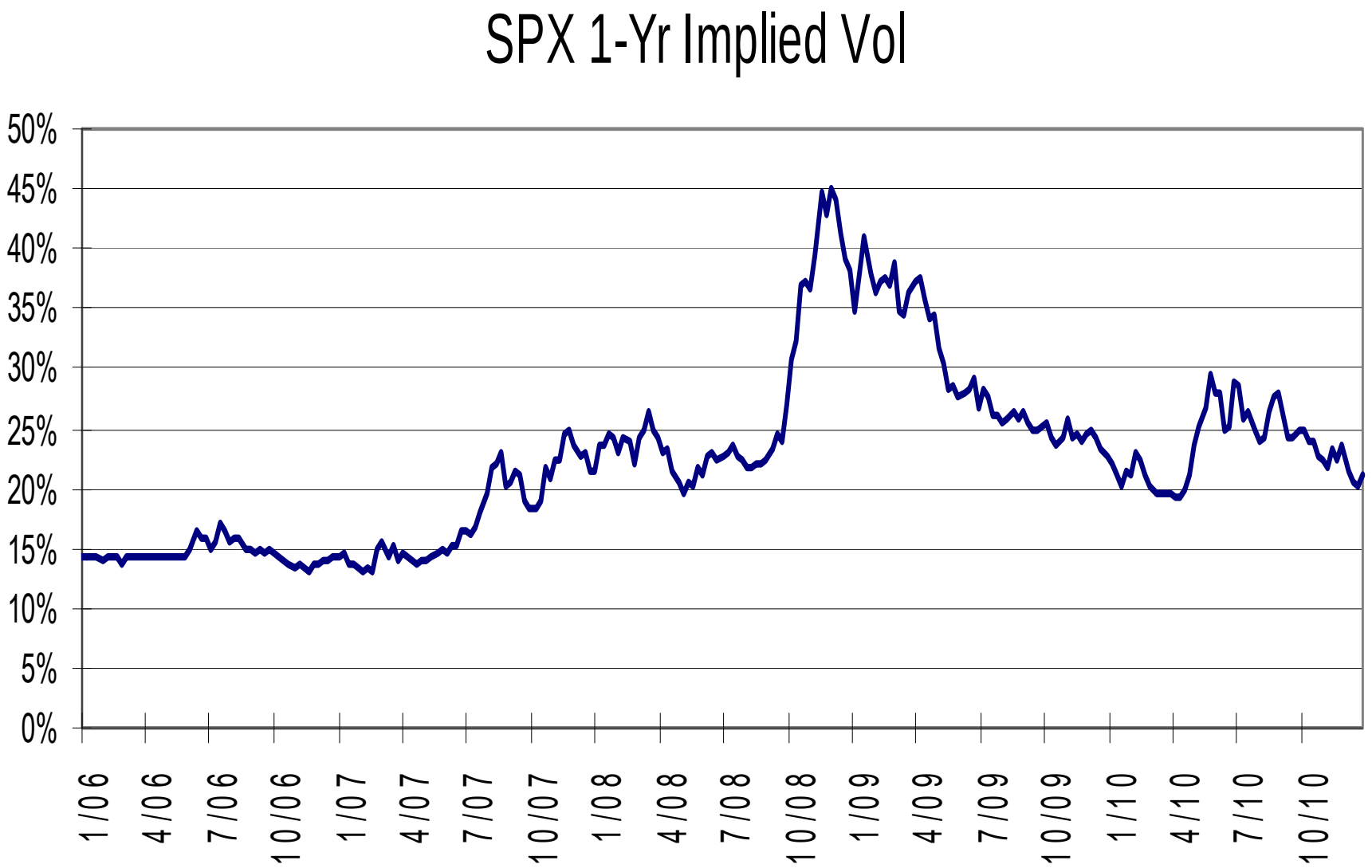
Market Performance

- Our back testing period is from 2006 to 2010.
  - Market growth (2006 ~ Q3 2007)
  - Declining market until Q1 2009
  - Then recovering market

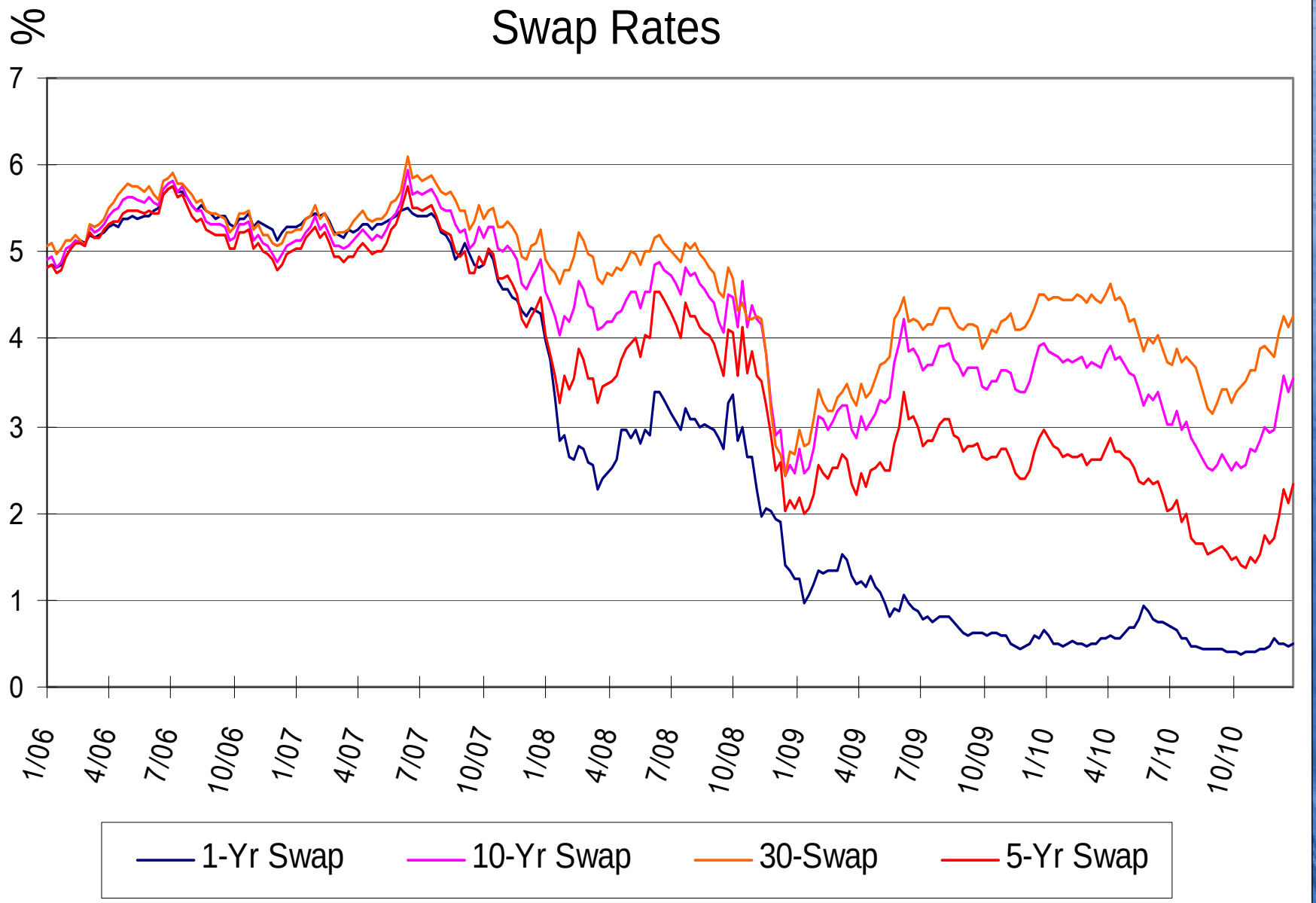
Equity Market



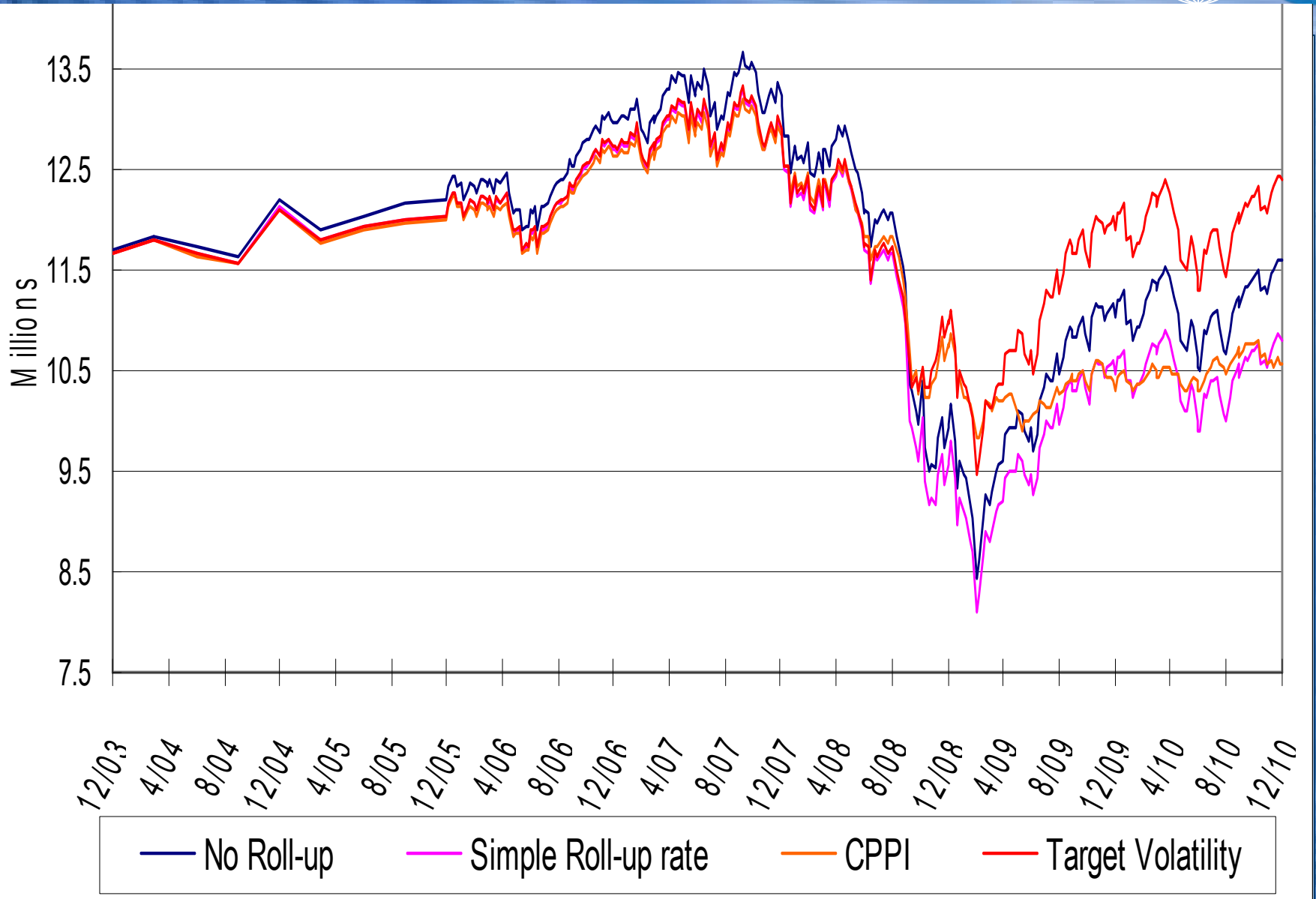
Implied Volatility



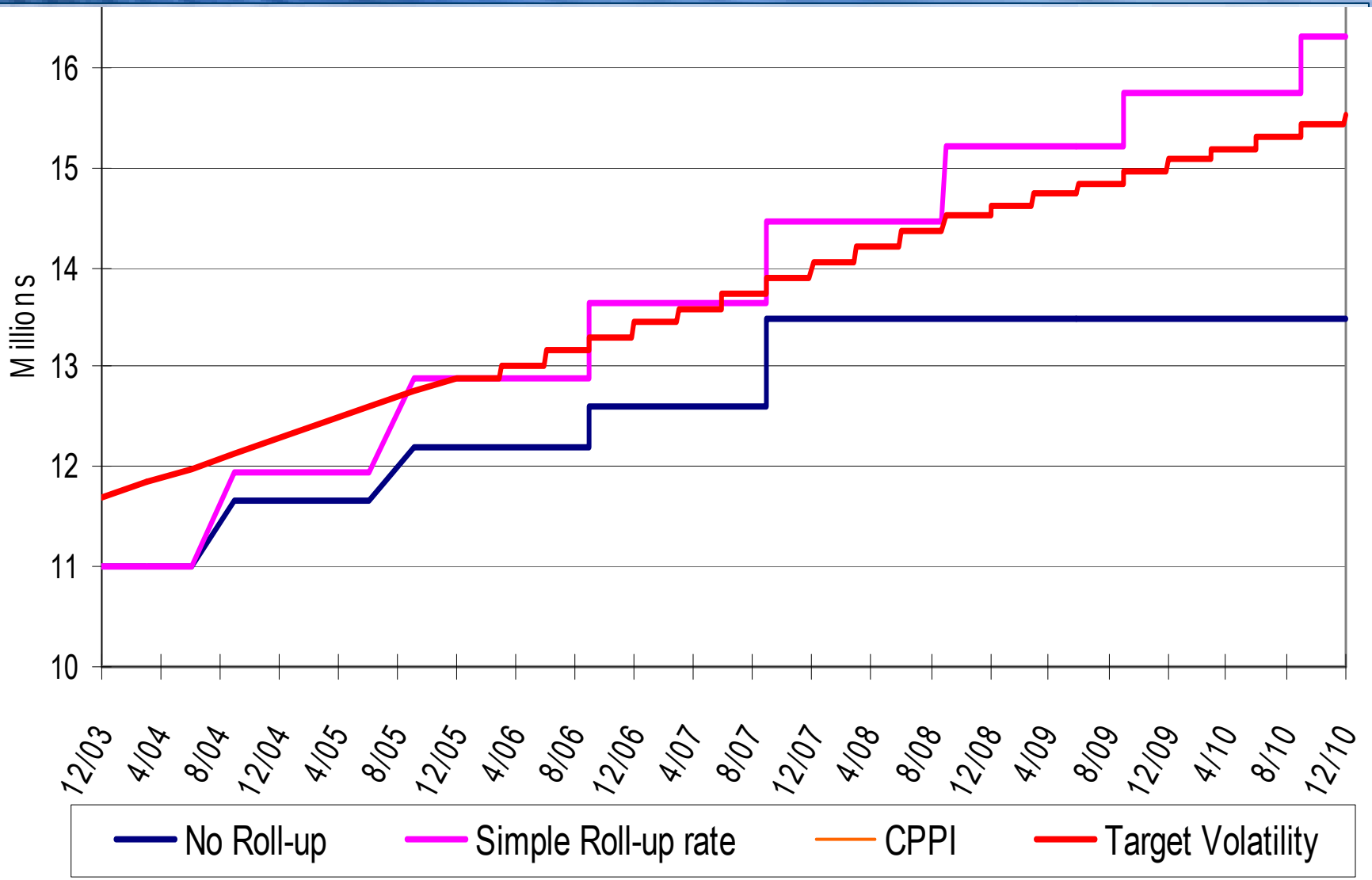
Interest Rates



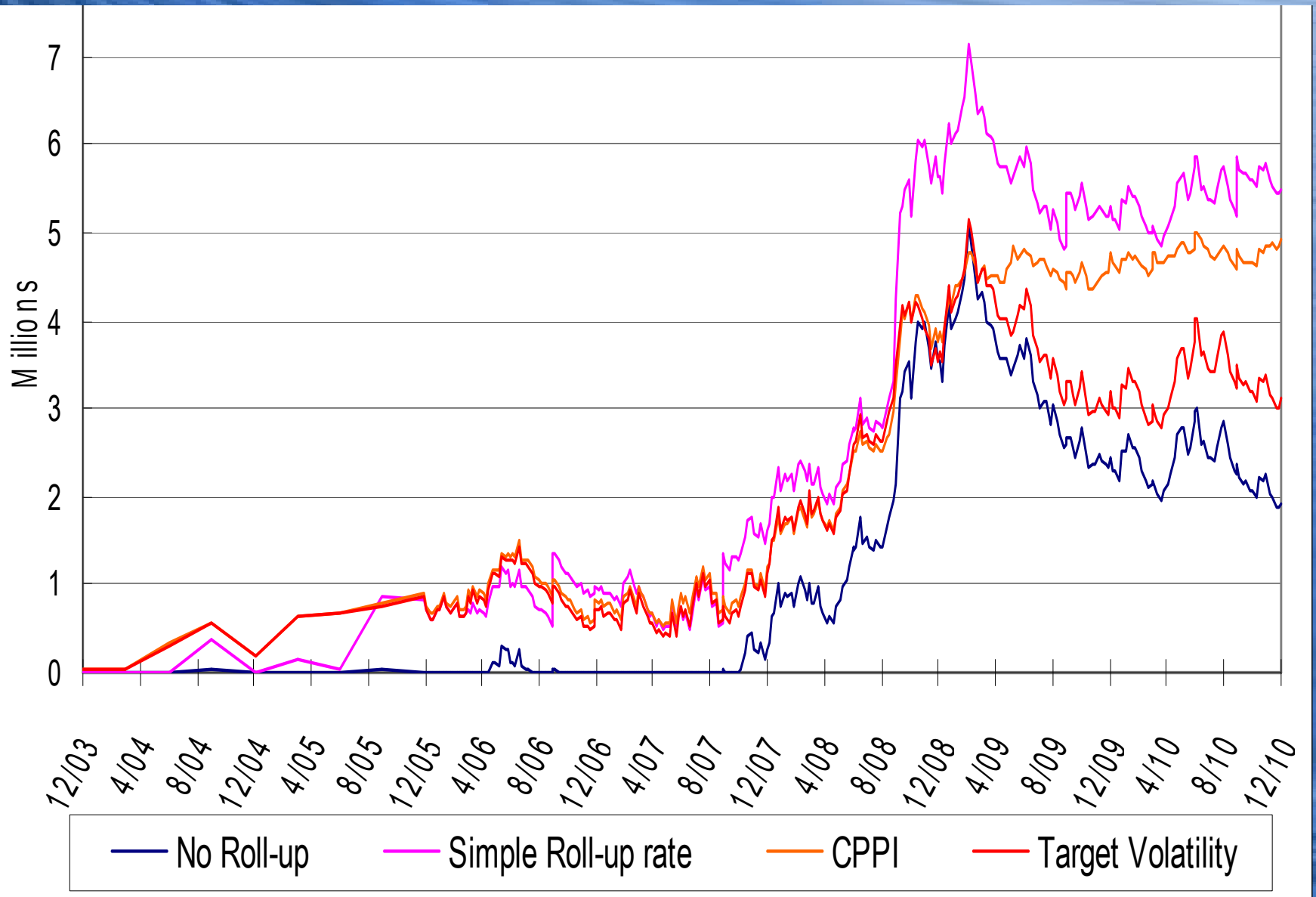
Account Values



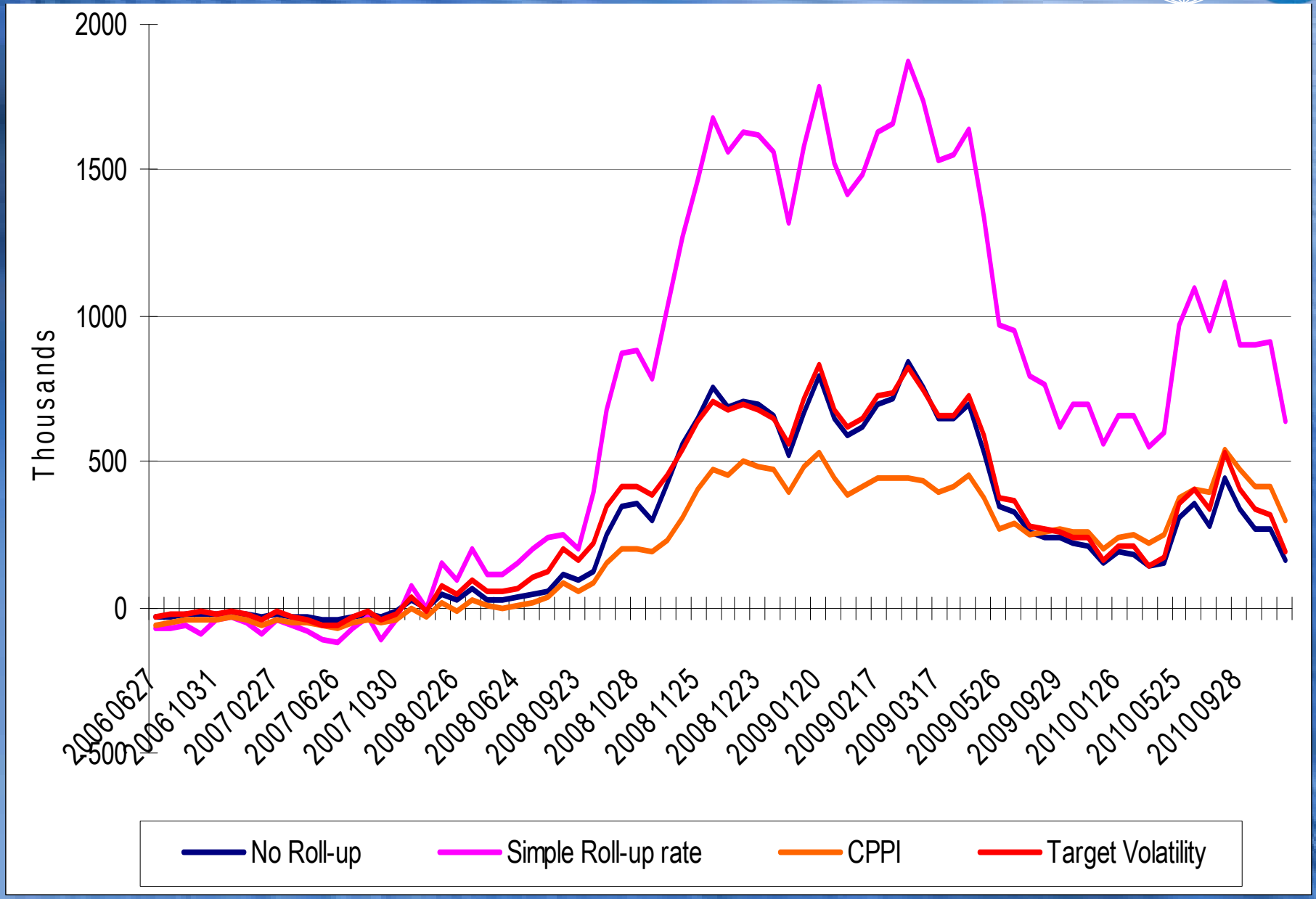
GMWB Benefits



GMWB Benefits-Account Values



Fair Values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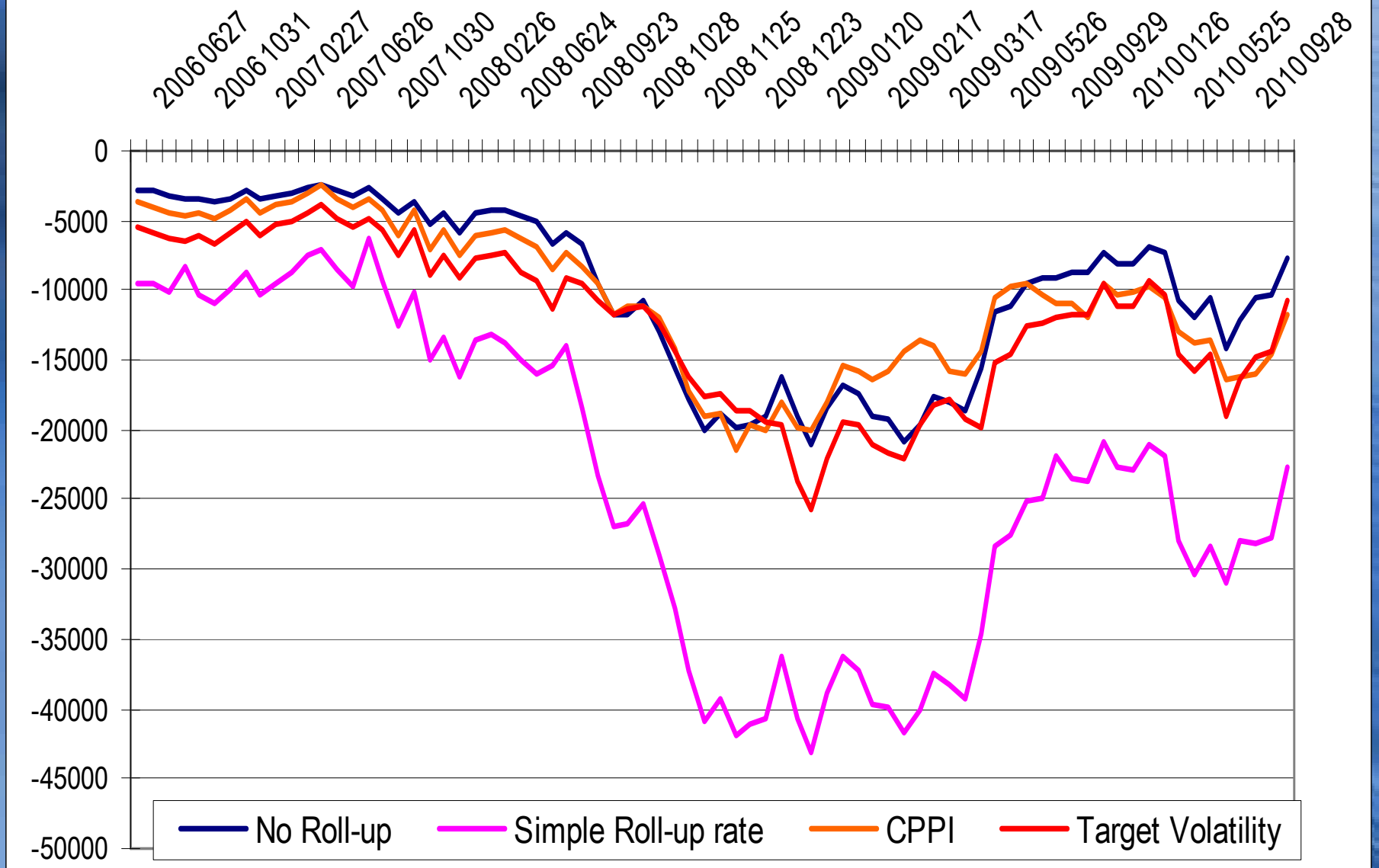
No Roll-up
Simple Roll-up rate
CPPI
Target Volatility

Delta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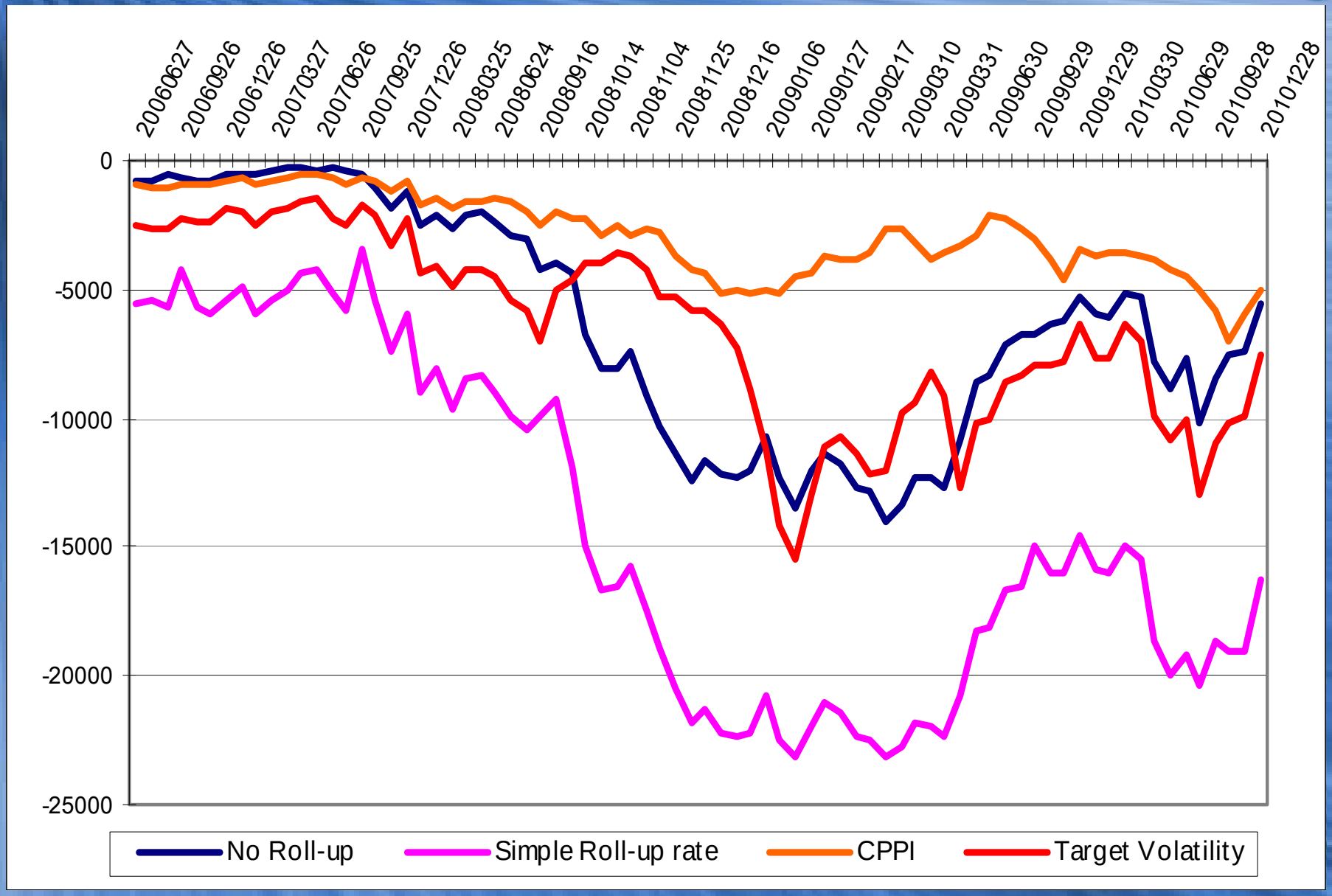
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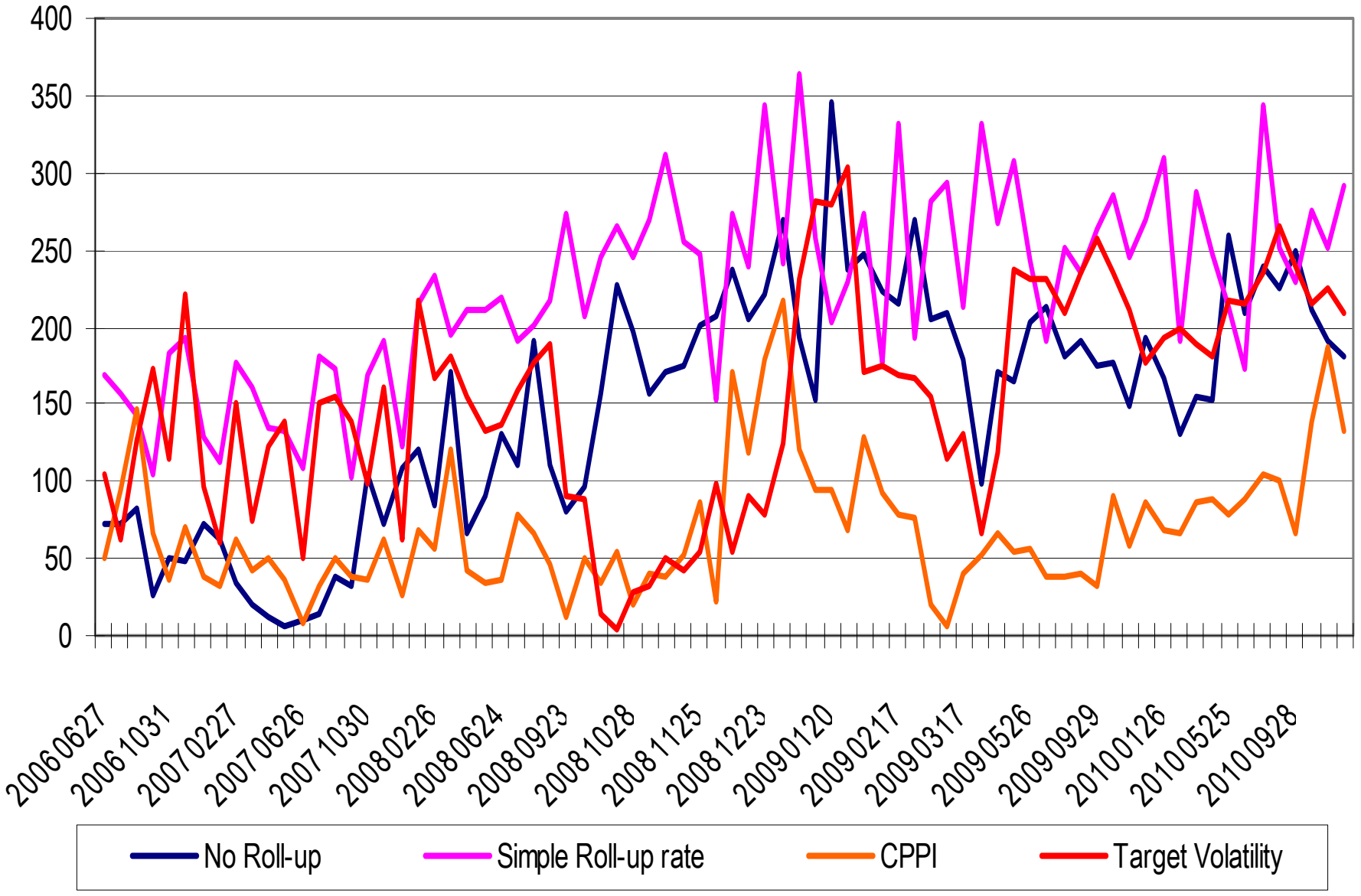
Target Volatility

Gamma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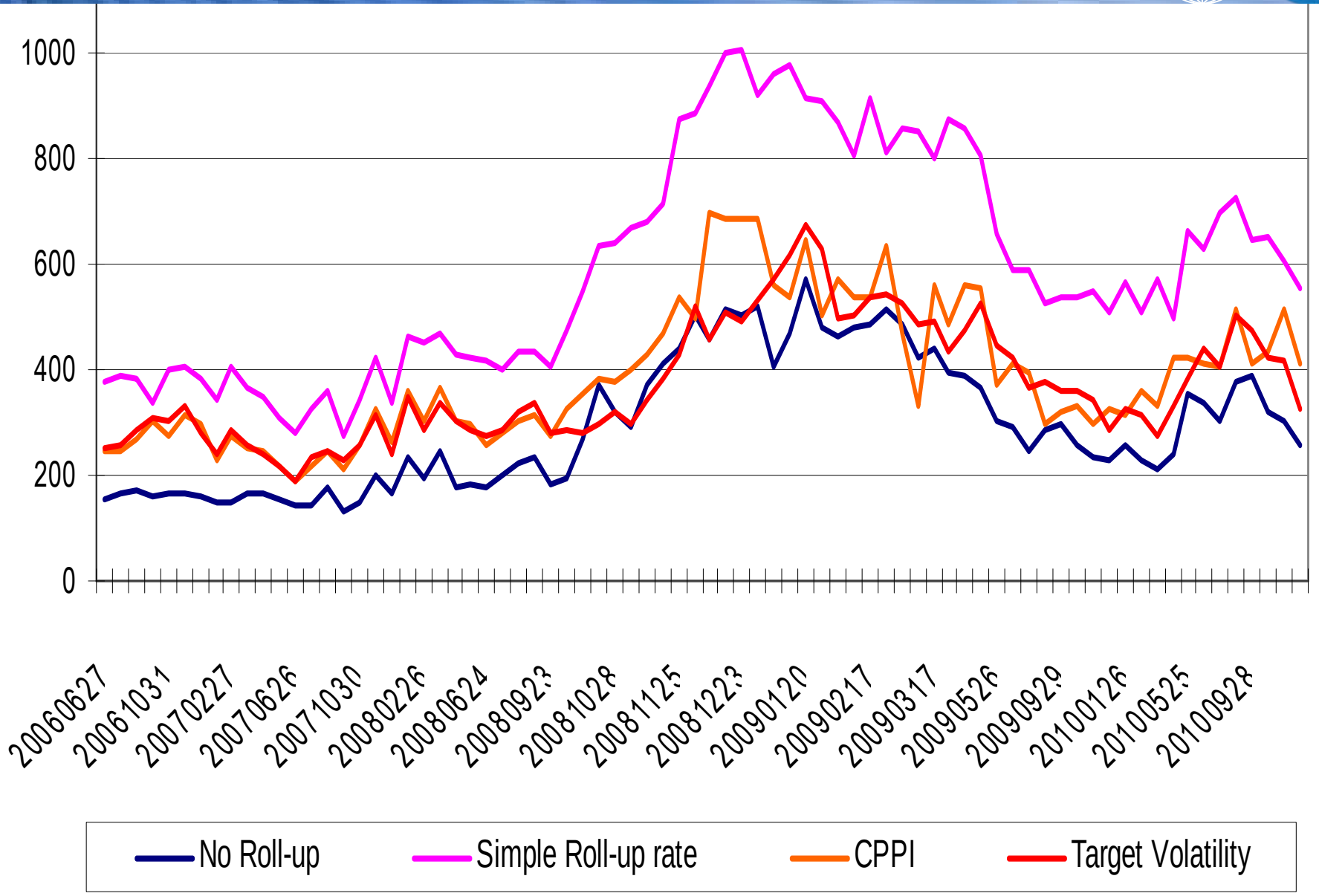
Convexity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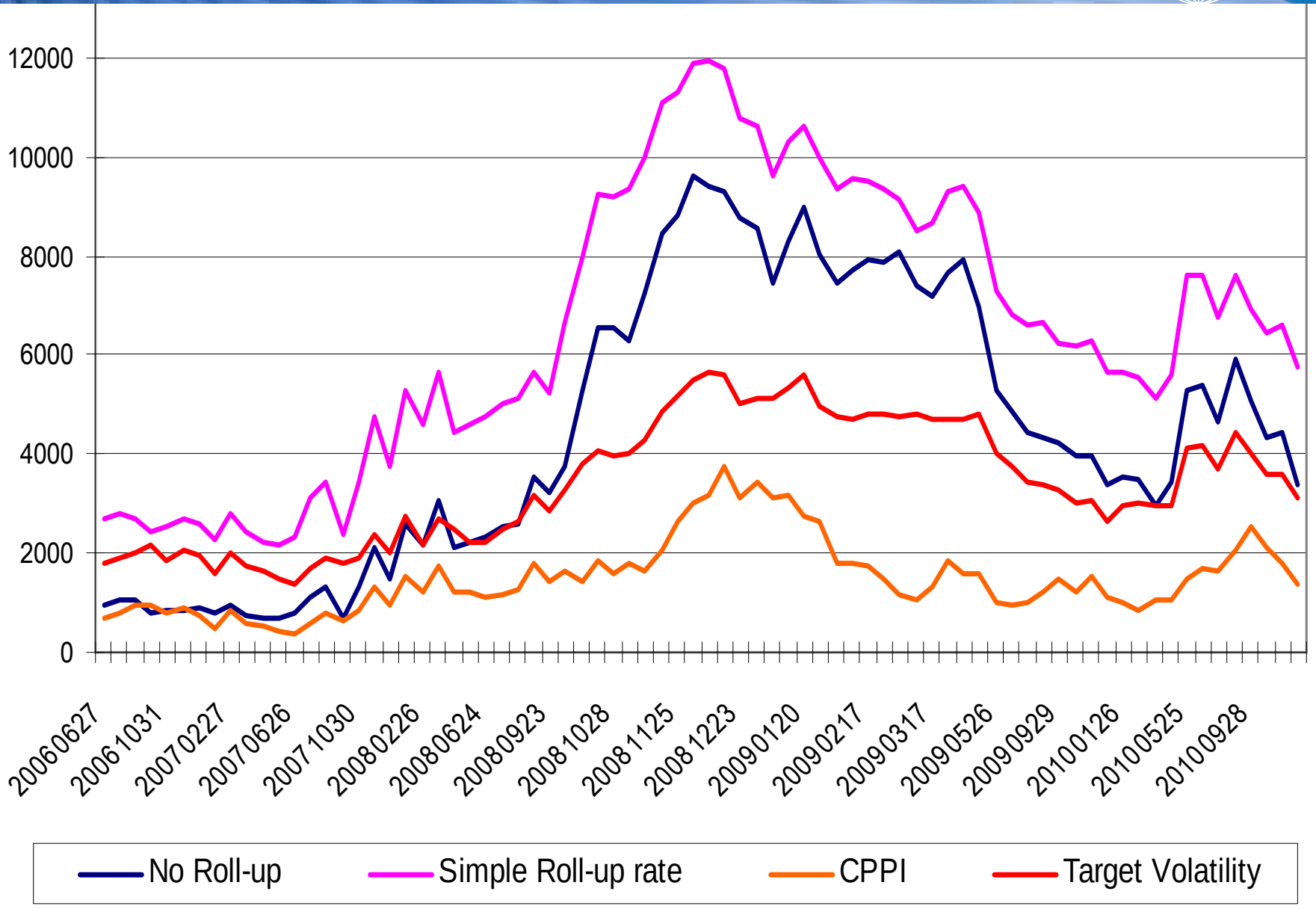
20090120
20090217
20090317
20090526
20090929
20100126
20100525
20100928
No Roll-up
Simple Roll-up rate
CPPI
Target Volatility

Vega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No Roll-up
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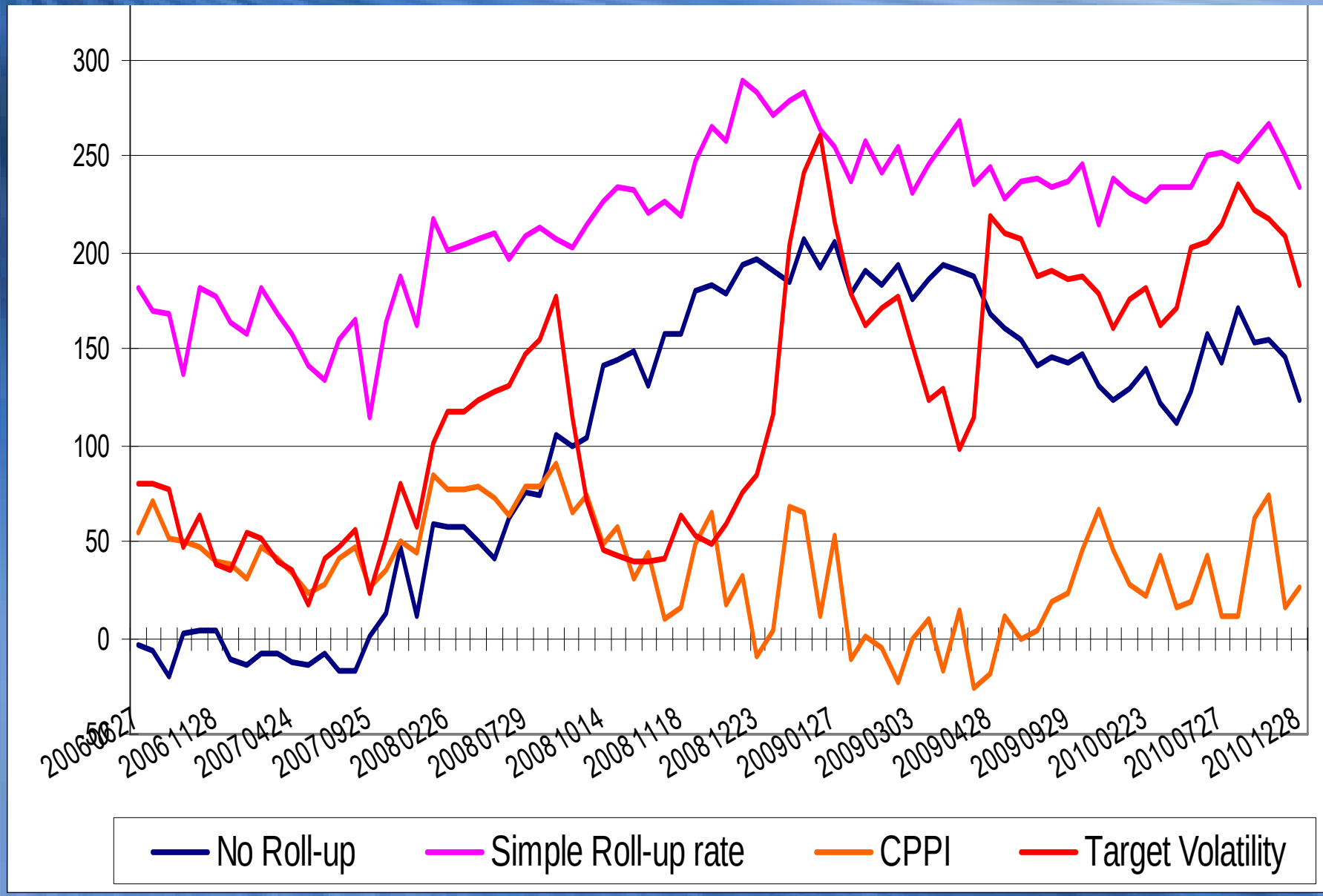
Target Volatility

DdeltaDrho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20090127
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20090428
20090929
20100223
20100727
20101228
No Roll-up
Simple Roll-up rate
CPPI
Target Volatility

Hedge Performance

- No roll-up:
  - Less rich benefits lower its market risk exposure
  - Better performance than simple-interest-rate roll-up product
  - Still suffers in extremely volatile market
- CPPI and Target Volatility effectively reduce Gamma and Vega risk during market turbulence
- CPPI
  - Lowest exposure to equity market
  - Higher convexity requires additional convexity hedge to reduce interest rate hedge breakage during volatile interest rate period.
  - Low DdeltaDrho
    - Less hedge breakage from equity/interest rate co-movements

CPPI Revisited

CPPI

- A **capital guarantee** strategy:
  - Riskless and risky assets
  - Risky asset(t) = min{ AV(t), max[0, *m*(AV(t)-Capital)] }
  - Capital, multiplier (m) are **constant**
- Assuming continuing rebalancing and continuous market movements,

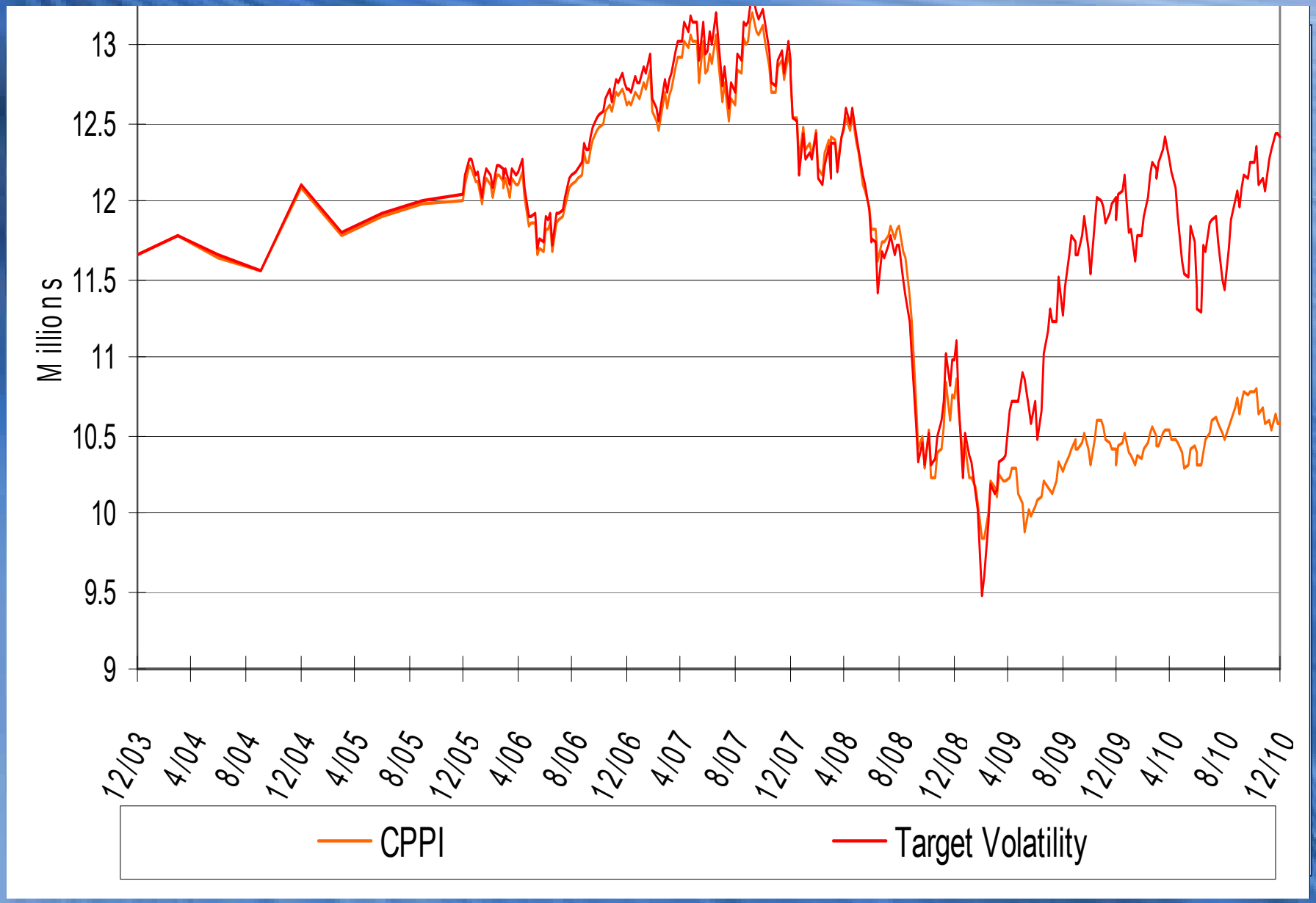
  $$\text{AV at maturity} = \text{Capital} + K*S_t^m$$

  - K is a positive constant
  - No risk!
- With daily rebalance, can protect against a maximum daily loss of 1/m,
  - e.g. m = 5 → 20% of daily drop
- Gap risk: the risk that AV < Capital
  - All the money is locked in riskless assets

Variable Annuities with CPPI

- Unique features from GLB:
  - Rollup
  - Ratchet (look-back)
  - Withdrawals
  - Policyholder behavior
  - Mortality
- The uncertainty of the “true” liability (claims)
  - Can either increase or decrease over time
- CPPI protection for VA is more likely to **break!**
  - Once it is broken, all the AV will be in riskless account
  - Can not participate in future market growth
  - Withdrawals will eat up the entire account value
  - → less lapse → higher claims

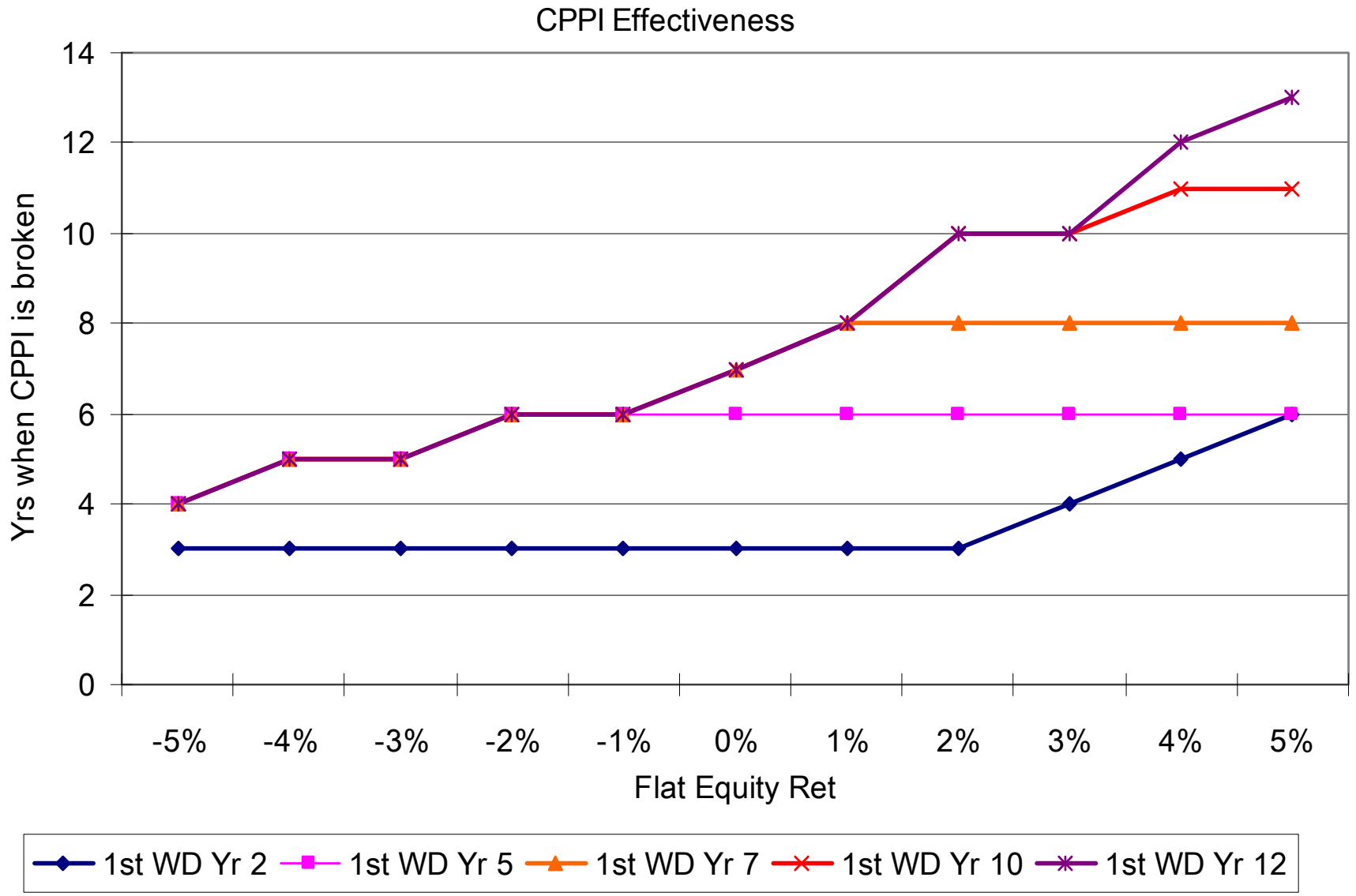
AV Accumulation (2003NB)



Example

- This example illustrates how market returns and withdrawals impact the effectiveness of VA CPPI
- Capital = Actuarial PV of Withdrawals assuming immediate withdrawal after rebalance
- $m = 5$
- Flat equity market
  - From -5% to 5%
- The effectiveness is measured by the year when CPPI protection is broken
  - All the AV is transferred to riskless account
- A rule of thumb:
  - The later the protection is broken, the better protection (the less loss)

Example Results



Next steps

- More for back testing:
  - Test adverse policyholder behavior
  - Basis risks
  - Tail risk hedge
- Stochastic on Stochastic hedging analysis
- Sensitivity analysis to identify critical assumptions
- Keep cooking in the kitchen
  - Go where results/observations take us
- Do YOU have questions/ideas to explore

The Right Product Design

- Alignment and fit
  - Right for the customer
  - Right for the company
- Trade-offs between revenue, profit and risk profiles
- Fixed “value pie” for policyholders and companies
- Alchemy
- Internal vs. external risk mitigation
- Supplier/user involvement and engagement
- Design process integration
  - Internal and external risk mitigation involved in process from beginning to end
  - Collaboration – engaged side by side

Questions

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