Time Horizons in Risk Assessment

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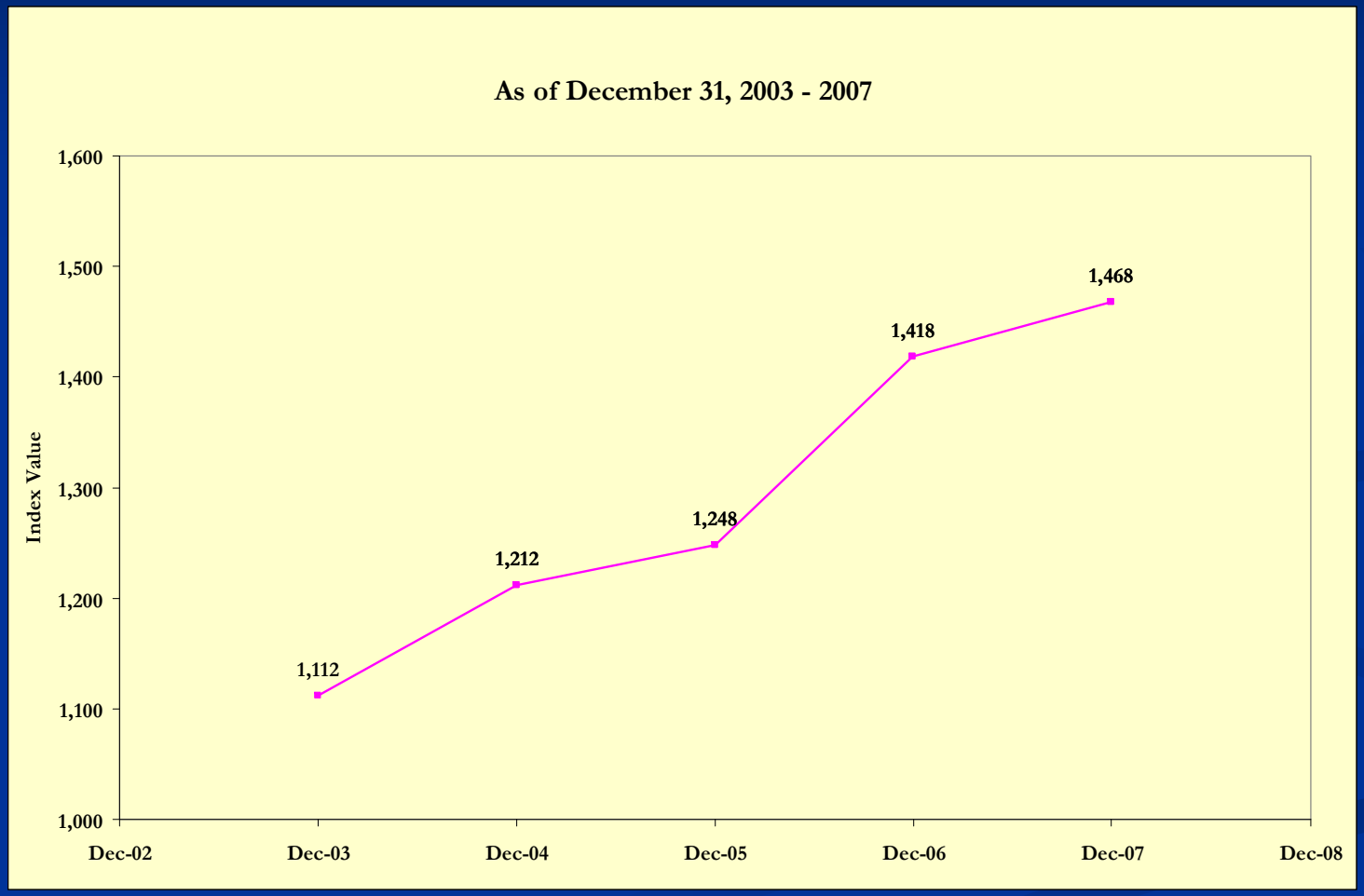
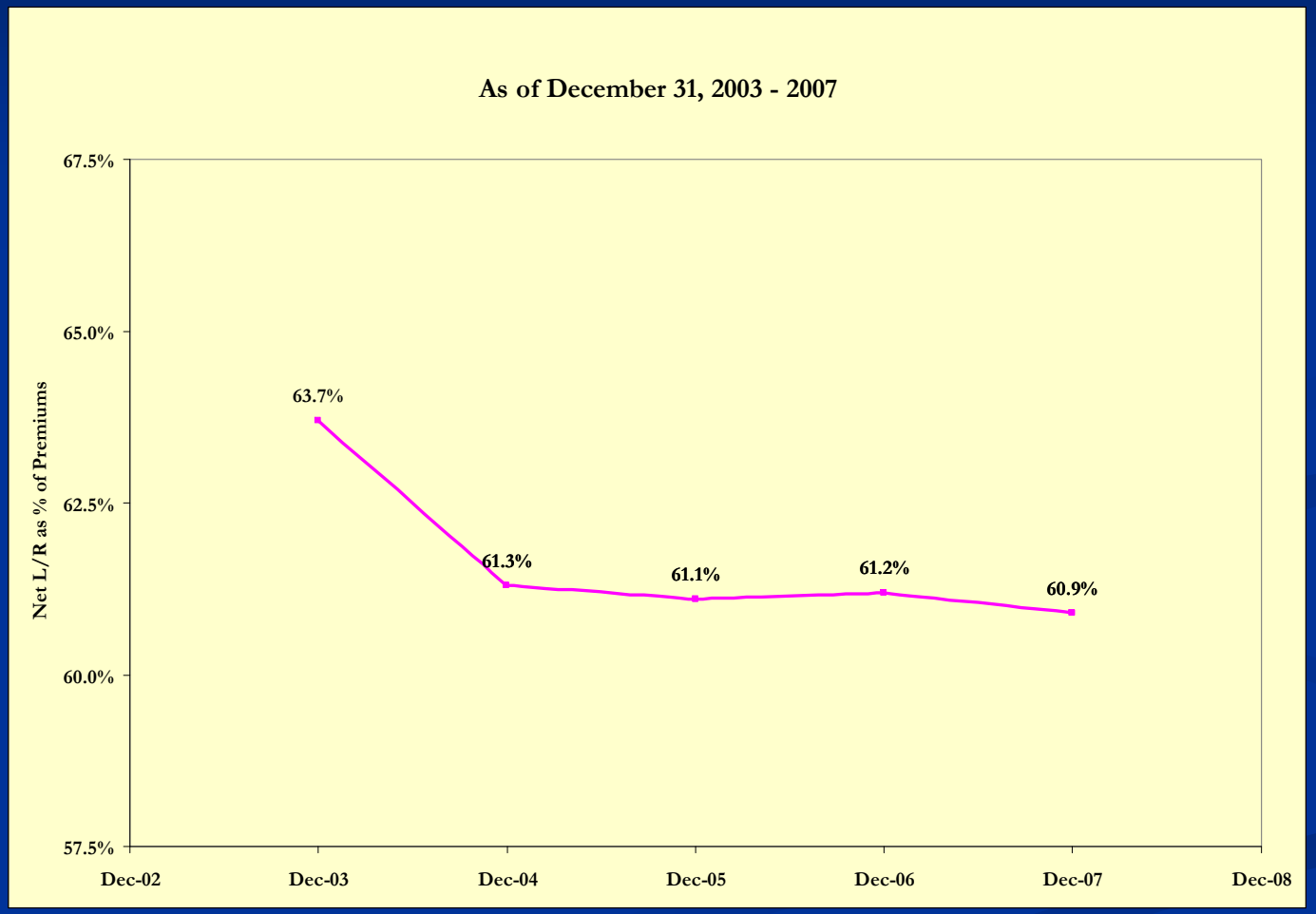
Time Dependency of Financial Variables

- **Many financial values vary over time, e.g.:**
  - Stock prices
  - Ultimate loss ratio estimates
  - Capital (GAAP and statutory)
- **Such values can be seen as observations from a time-dependent stochastic process**

Market Value of Common Stocks
S&P 500 Stock Index

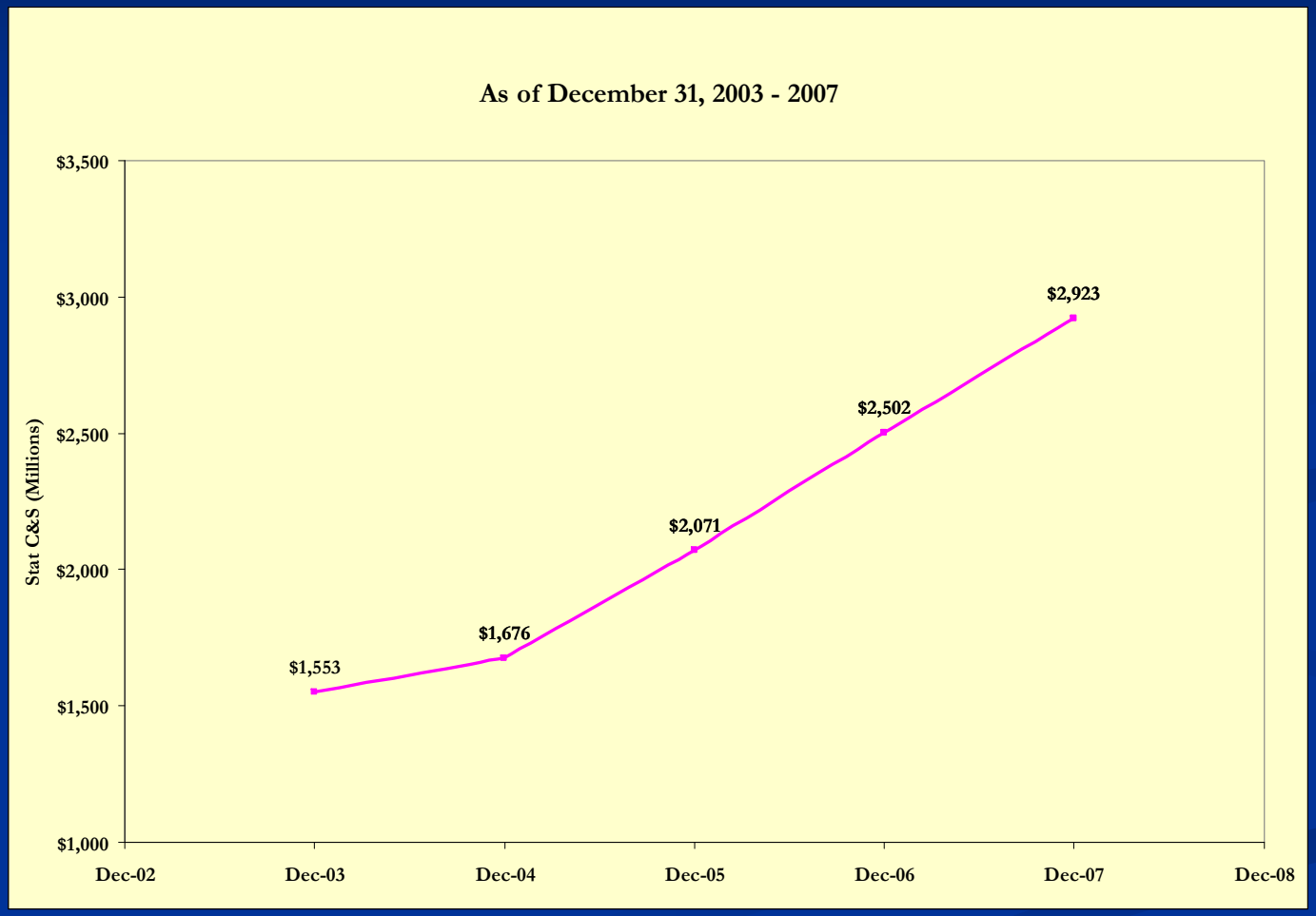


Estimated Ultimate Loss Ratio
Commercial Auto Liability (U.S. Industry) / Accident Year 2003



Statutory Capital & Surplus

Odyssey America Reinsurance Corporation



Temporal Aspects of Risk Assessment

- **Risk assessment is about the future**
- **How will financial variables behave…?**
  - Tomorrow
  - Next week
  - Next quarter
  - Next year
- **Selected time horizon depends on context and purpose**

Value-at-Risk (VaR)

- **VaR has emerged as a favorite financial risk measure**
- **Defines downside risk as the amount of loss corresponding to a given cumulative probability ("confidence level")**
- **$VaR_{99.5\%}$ refers to the 99.5 percentile loss (adverse change) amount**
- **Because financial risks are time-dependent, a *time horizon* must also be defined**
  - Traders typically use *daily* time horizon
  - Solvency II calls for *one-year* time horizon

Value-at-Risk Time Horizons

- **Shorter time horizons typically imply lower VaR_{α} amounts for given α**
  - Daily $VaR_{99\%} \leq$ One-Year $VaR_{99\%}$
- **Shorter time horizons typically imply higher confidence level statements**
  - Daily $VaR_{99\%}$ = One-Year $VaR_{99\%-c}$ $(0 < c < 99\%)$
- **Similar to effect in cat analysis of using smaller or larger geographic regions for probability statements, e.g.:**
  - 100-year return time Louisiana-only loss amount (Louisiana $VaR_{99\%}$) typically less than countrywide $VaR_{99\%}$ loss amount

Commercial Auto Liability Example
Accident Year 2007

- **Estimated ultimate net loss ratio**
  - U.S. industry
  - Schedule P (Part 2 Losses / Part 1 Premiums)
  - 62.4% as of 12/31/07
- **How will that estimate change over …**
  - One year?
  - Two years?
  - Time to ultimate settlement?
- **History provides a guide**

Prospective Path of Ultimate Loss Ratio Estimates
Commercial Auto Liability / Accident Year 2007

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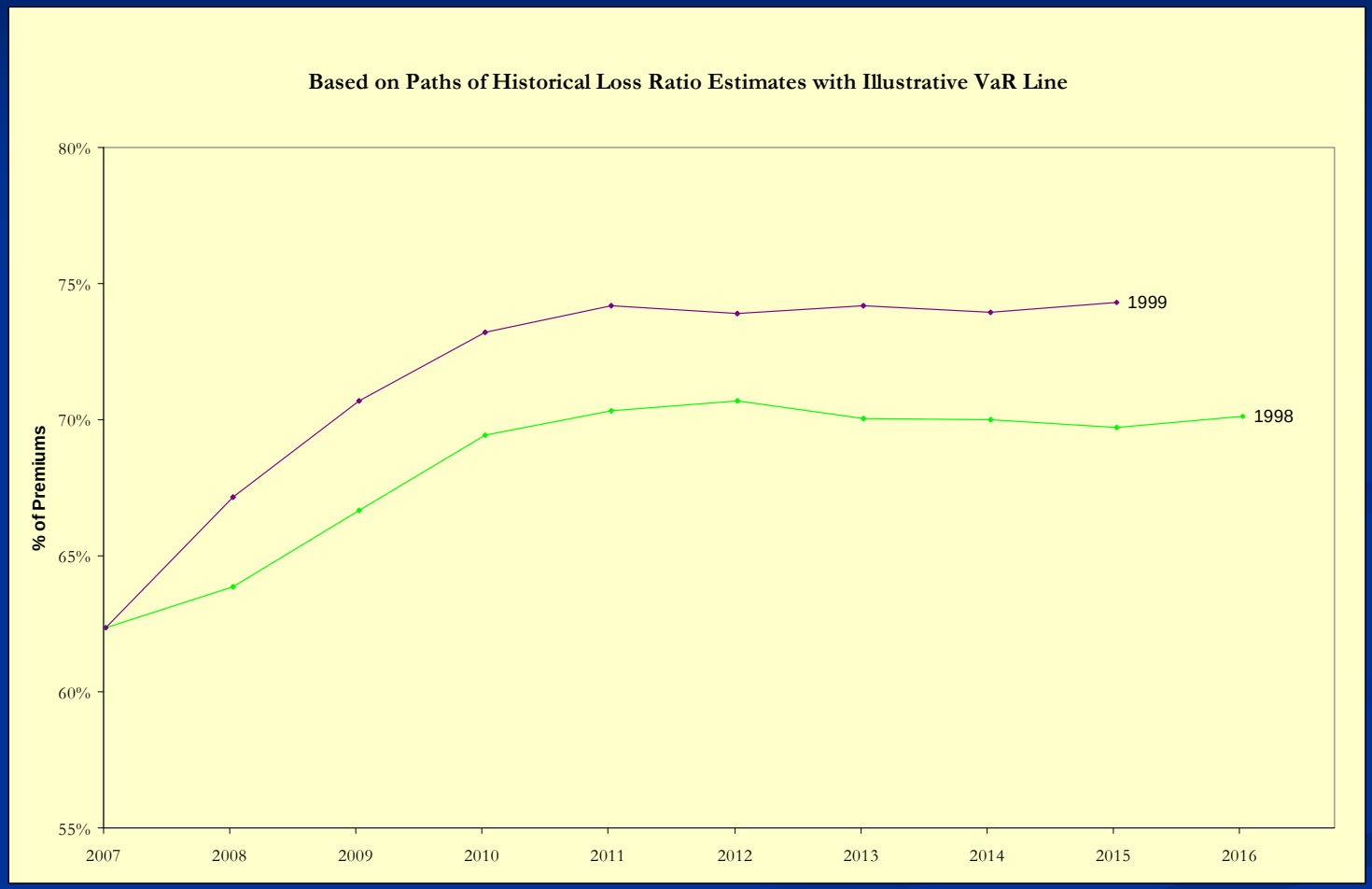
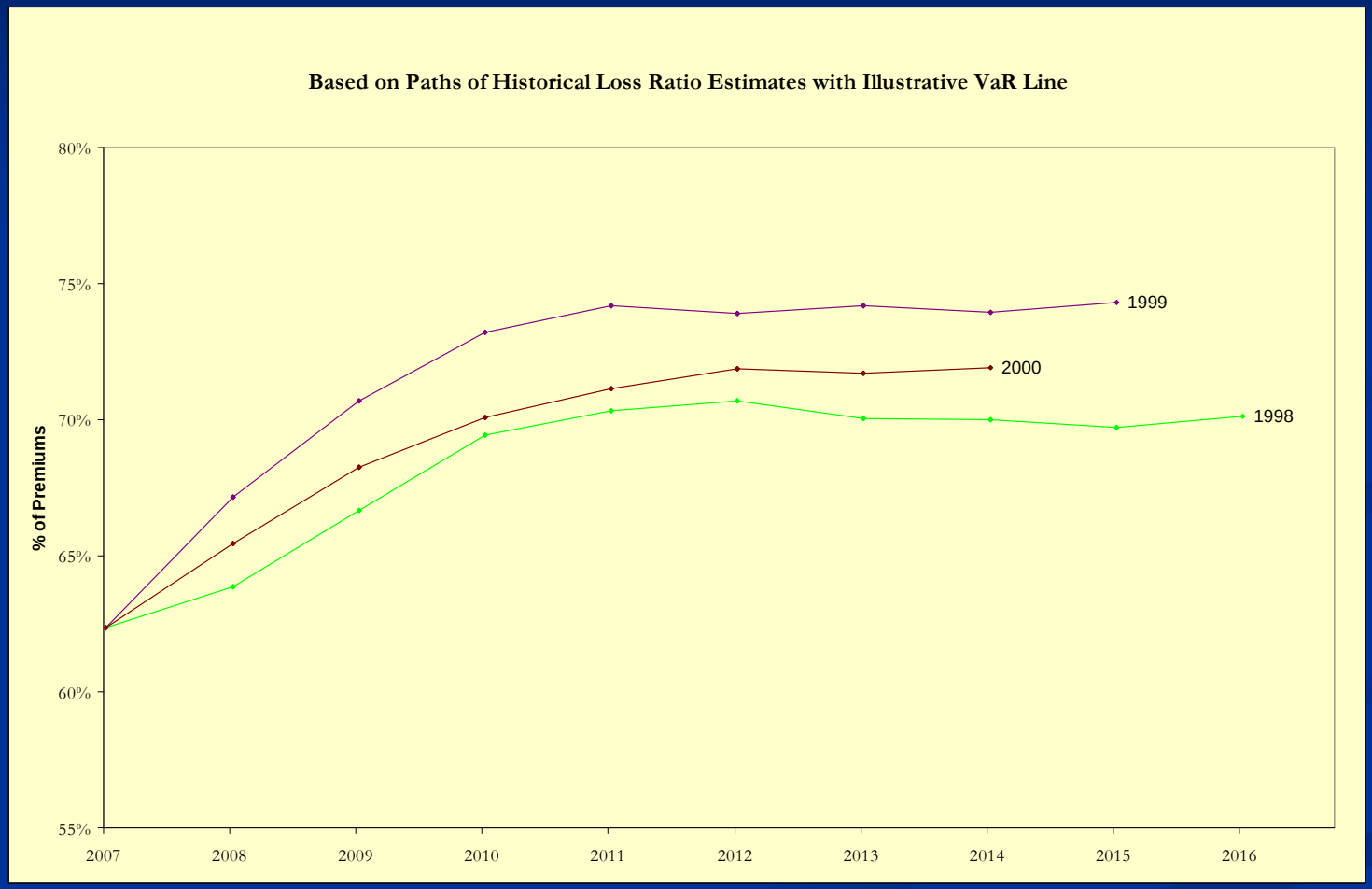
Commercial Auto Liability / Accident Year 2007



Prospective Path of Ultimate Loss Ratio Estimates
Commercial Auto Liability / Accident Year 2007



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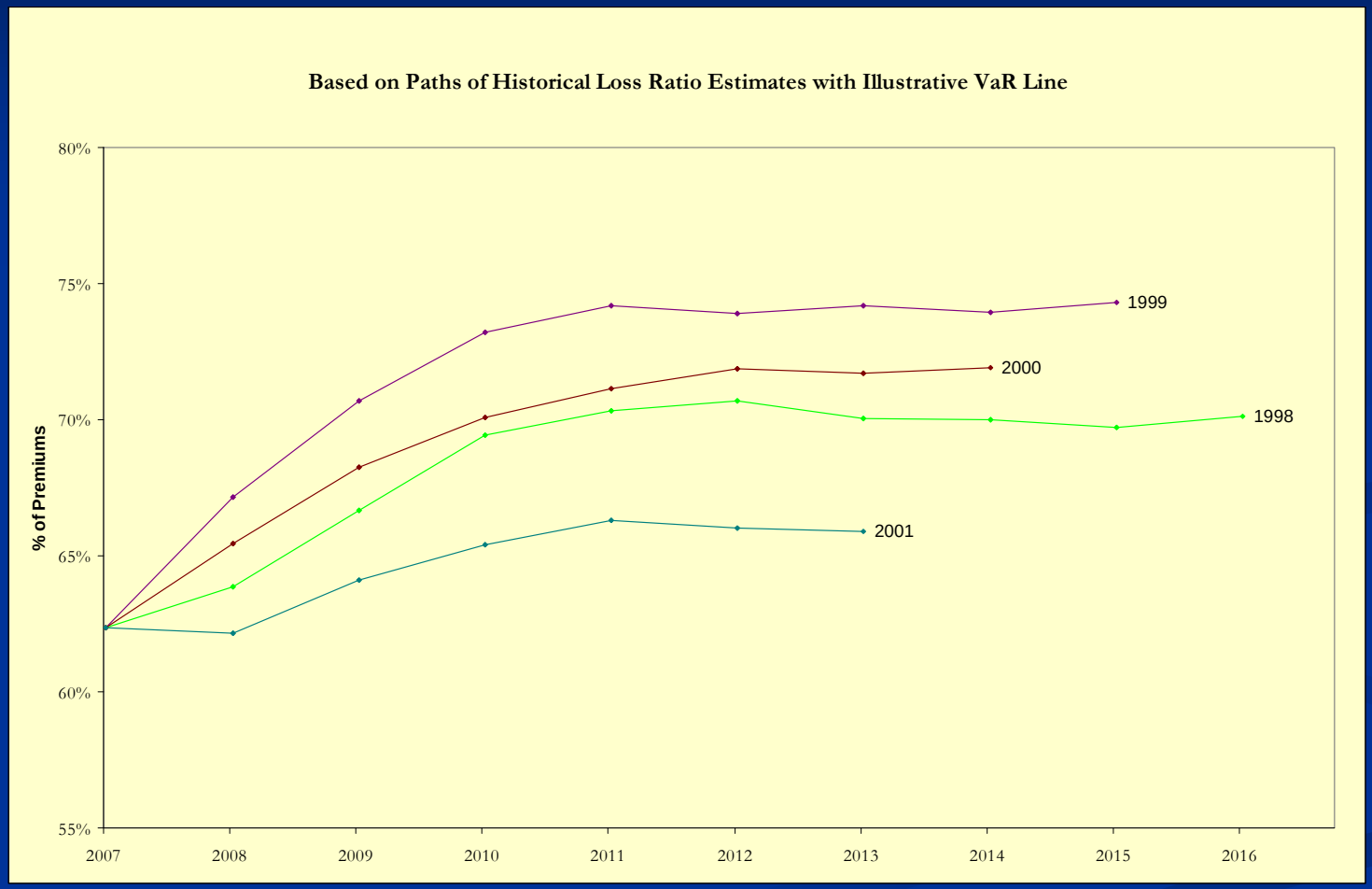

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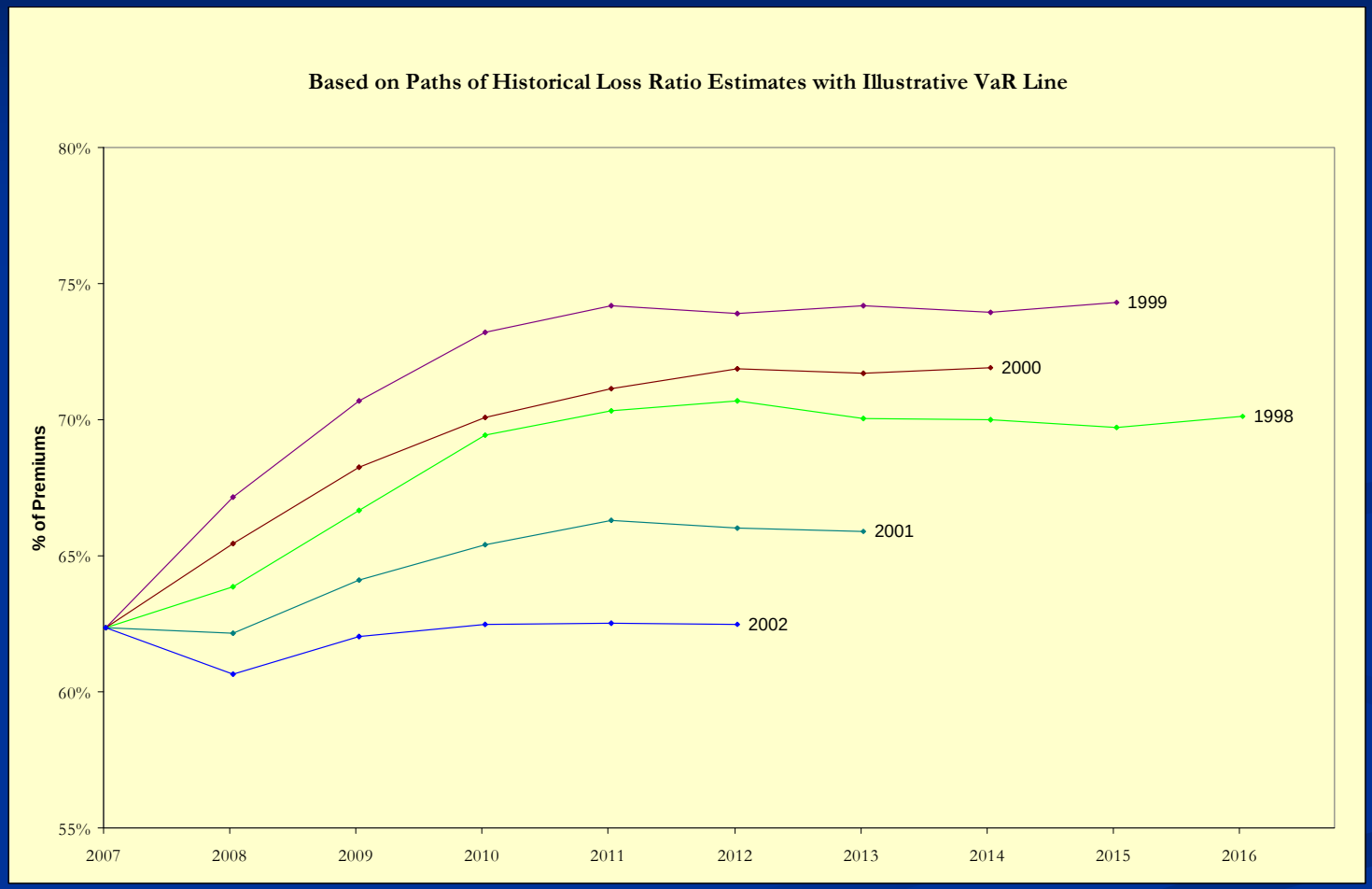

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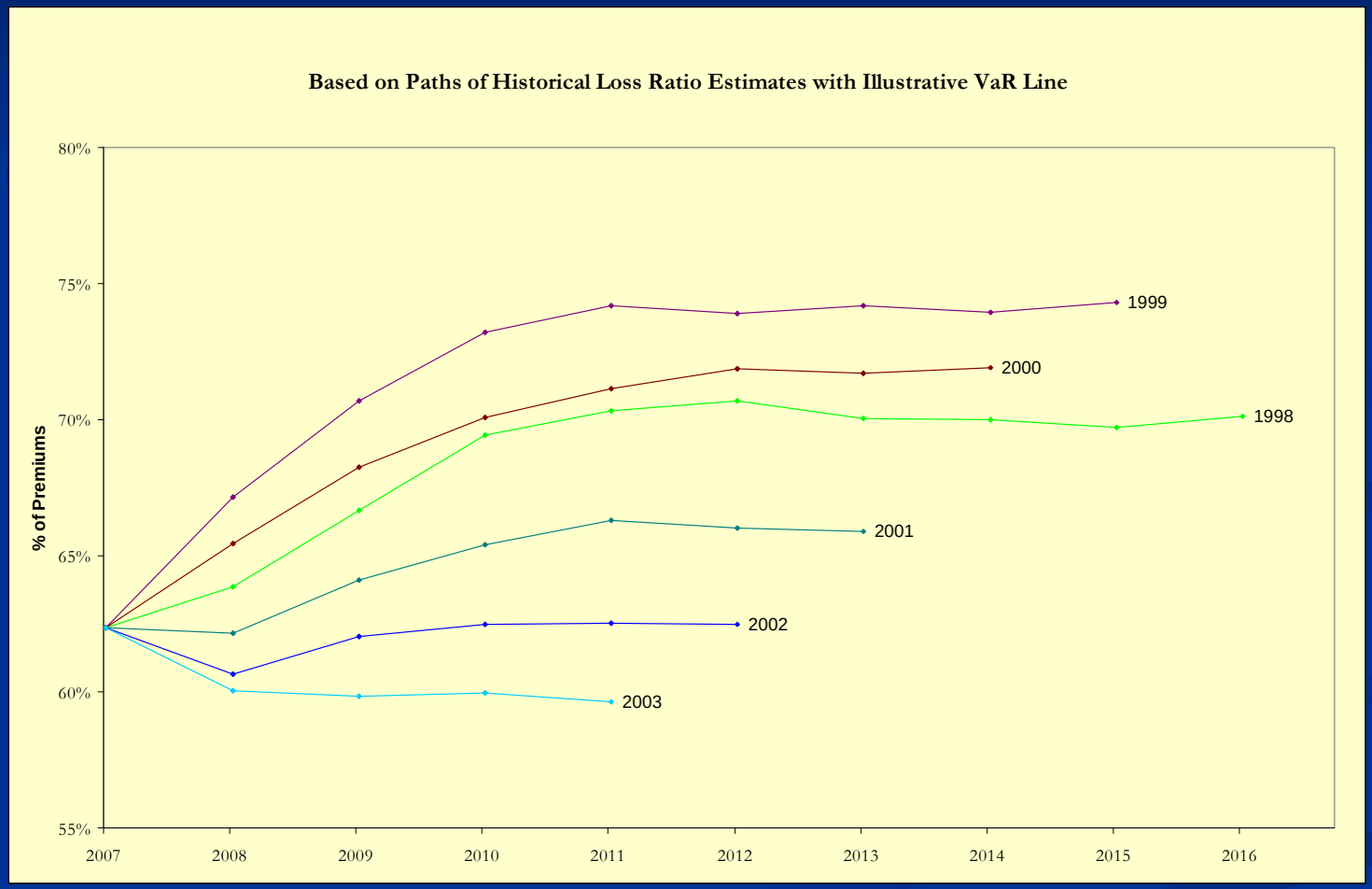

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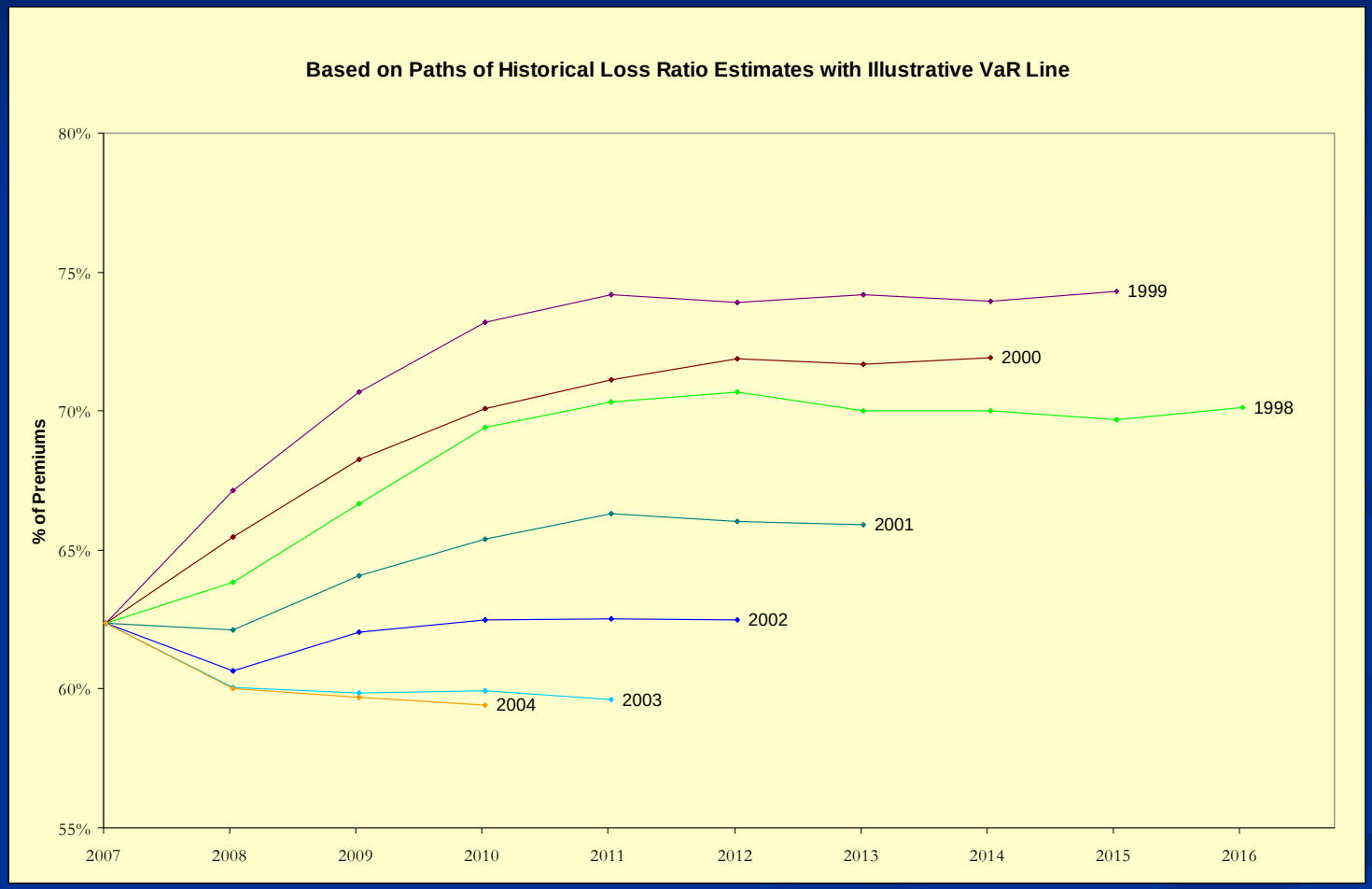

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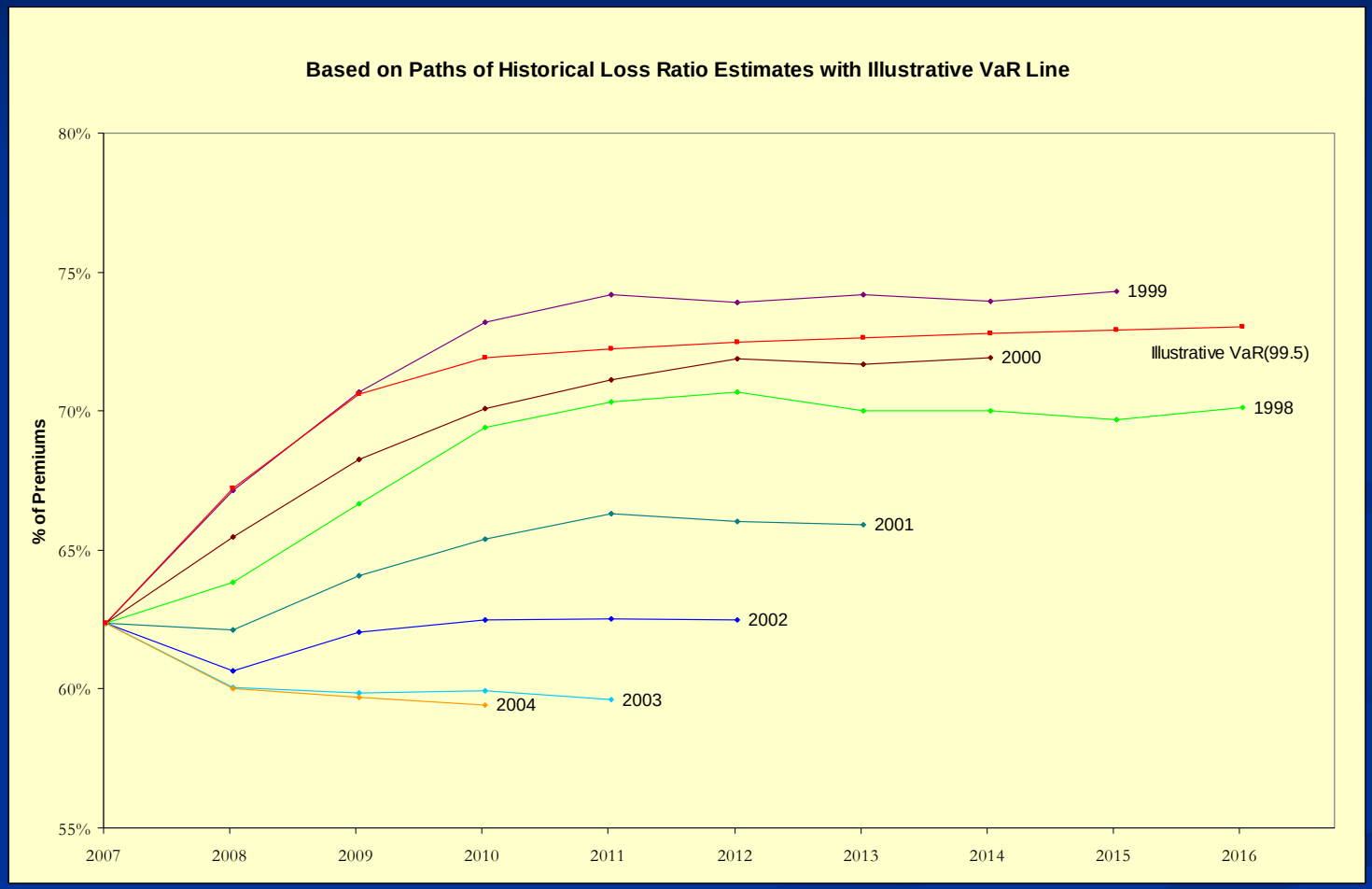

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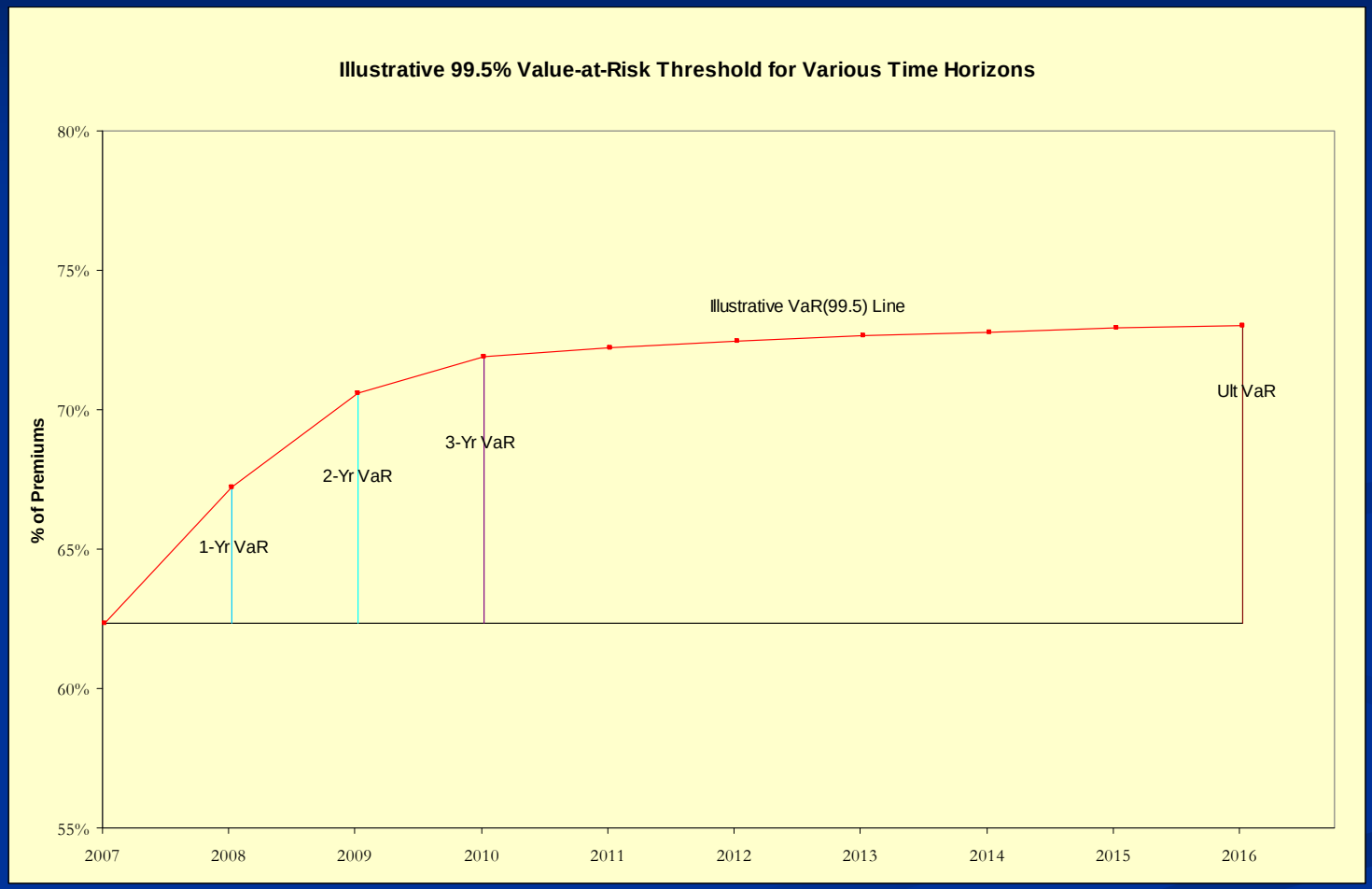


Choice of Time Horizon for Risk Assessment
Case for One-Year Horizon

- **Coincides with main time unit used for financial reporting**
- **Corresponds to typical insurer planning horizon**
- **Many financial and insurance variables expressed in annual terms, e.g.:**
  - Interest rates
  - Investment returns
  - Common stock volatility
  - Loss ratios
  - Loss development
- **Natural horizon for enterprise risk management**
- **Solvency II uses one-year horizon $VaR_{99.5\%}$**

Choice of Time Horizon for Risk Assessment
Case for Longer than One-Year Horizon

- **Implies larger capital requirement, thus providing greater solvency protection**

Capital Adequacy / One-Year Horizon

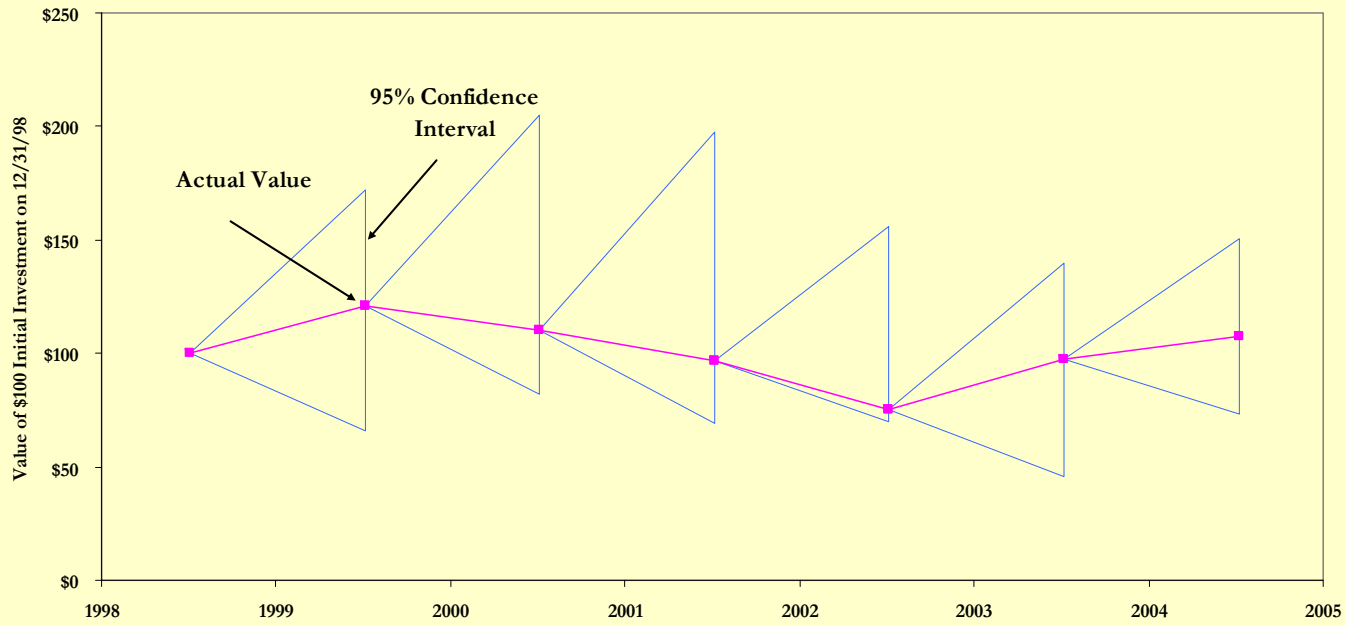
- One-year horizon consistent with strong solvency protection
- Butsic pioneered concept in early 1990s
- "Solvency Measurement for Property-Liability Risk-Based Capital Applications"
- Argued that long term solvency protection achievable by periodic capital rebalancing to maintain a constant low exposure to insolvency over a short horizon

Capital Adequacy / One-Year Horizon

- Yours truly presented a fully elaborated example of Butsic's approach in a 2007 paper
- "Consistent Measurement of Property-Casualty Risk-Based Capital Adequacy"
- Paper calibrated capital to a target Expected Policyholder Deficit (EPD)
- Would work equally well with VaR or TVaR
- Several of the following charts are taken from that 2007 paper

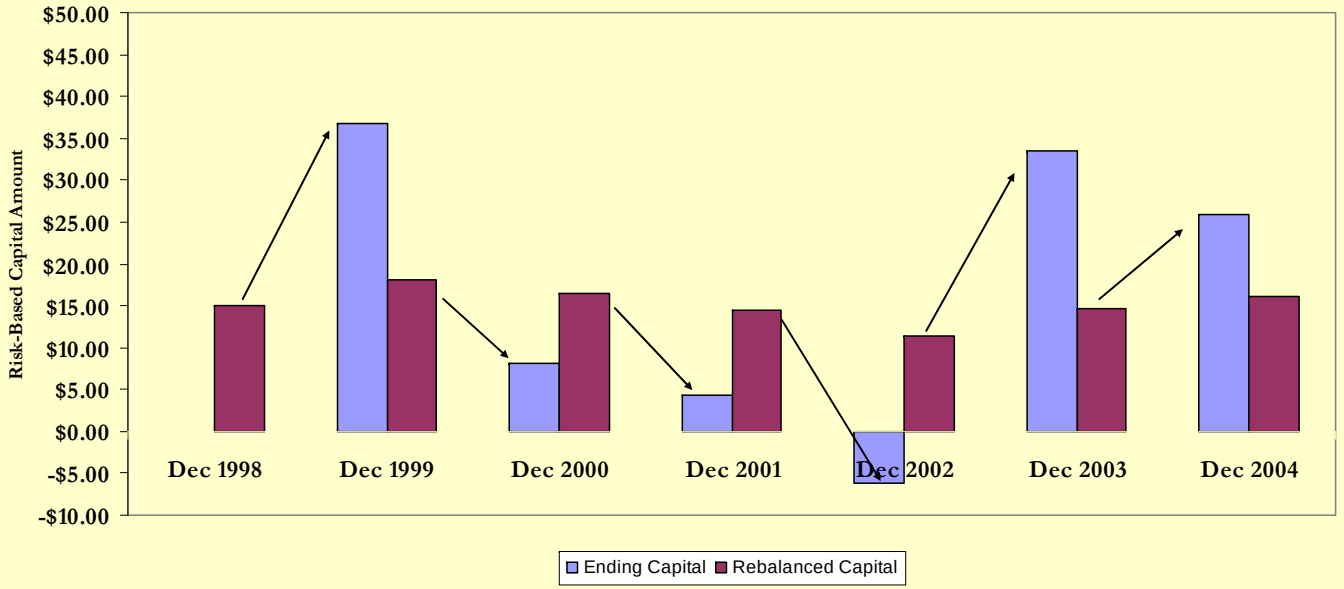
Excerpt A from Wacek Paper

FIGURE A
Actual S&P 500 Performance: 1999-2004
Within 95% Confidence Intervals for One Year Horizon
Total Return Including Dividends



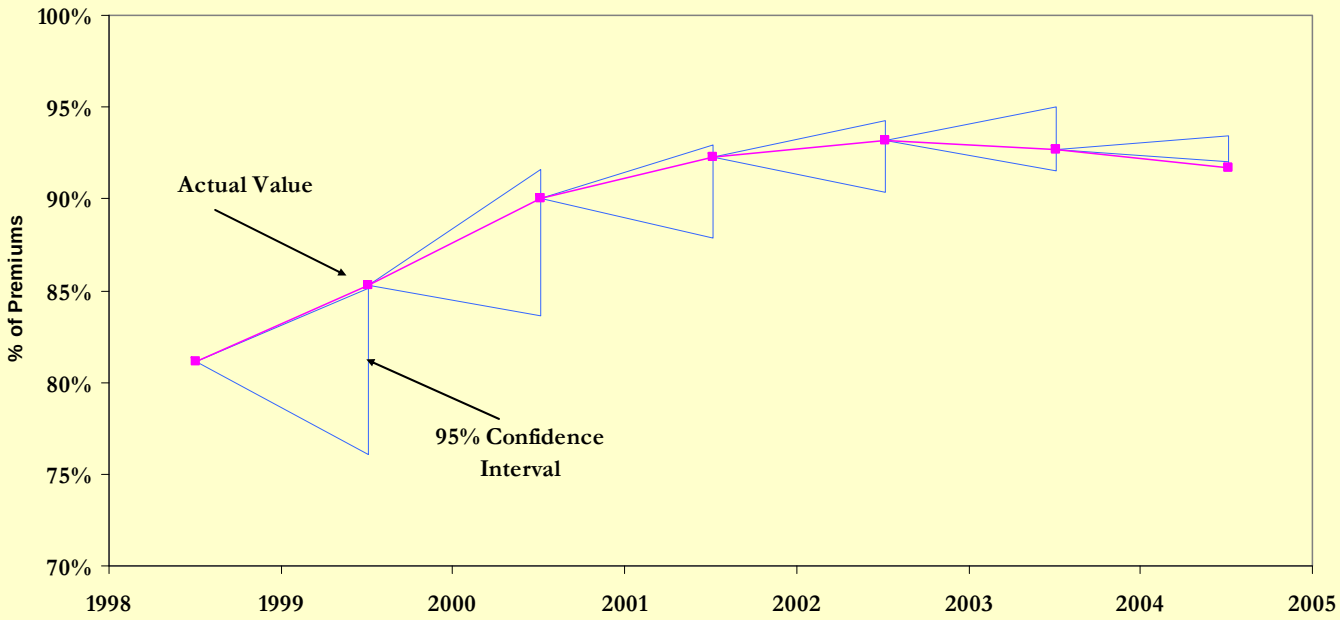
Excerpt B from Wacek Paper

FIGURE B
Risk-Based Capital for S&P 500 Investment: 1999-2004
Investment of $100 on January 1, 1999
Required Capital = 15% of Investment Market Value



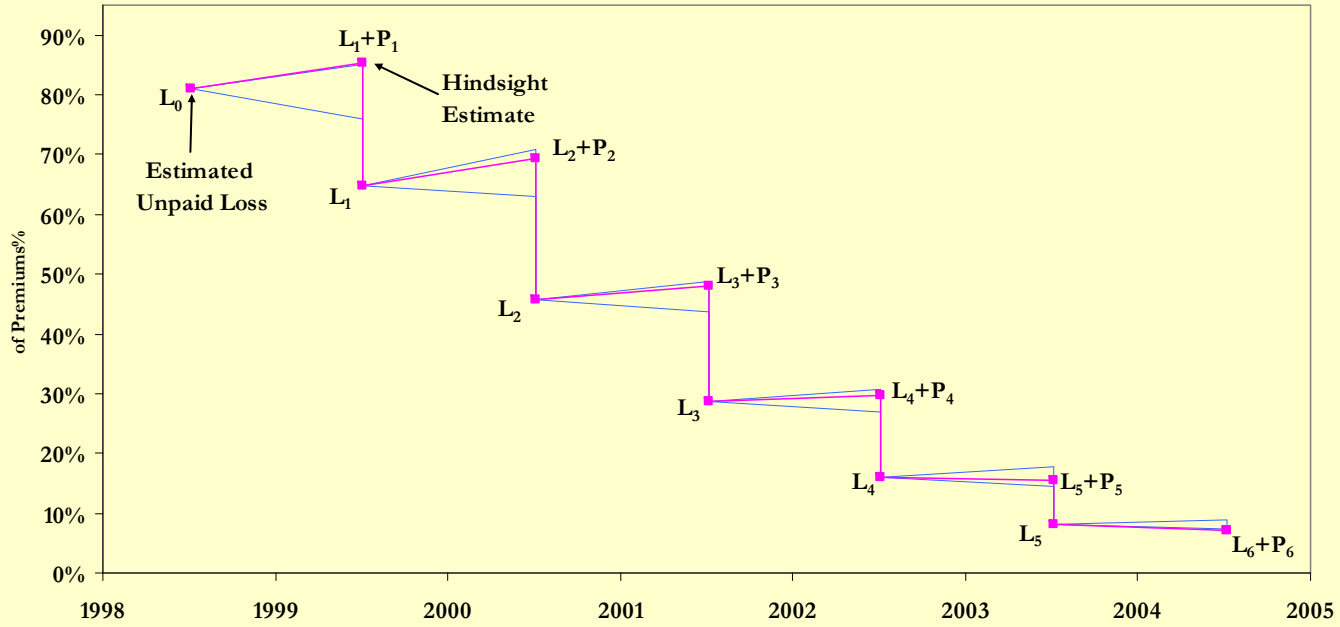
Excerpt C from Wacek Paper

FIGURE C
Path of Accident Year 1999 Ultimate Loss Ratio Estimate: 1999-2004
Within 95% Confidence Intervals for One Year Horizon
Commercial Auto Liability



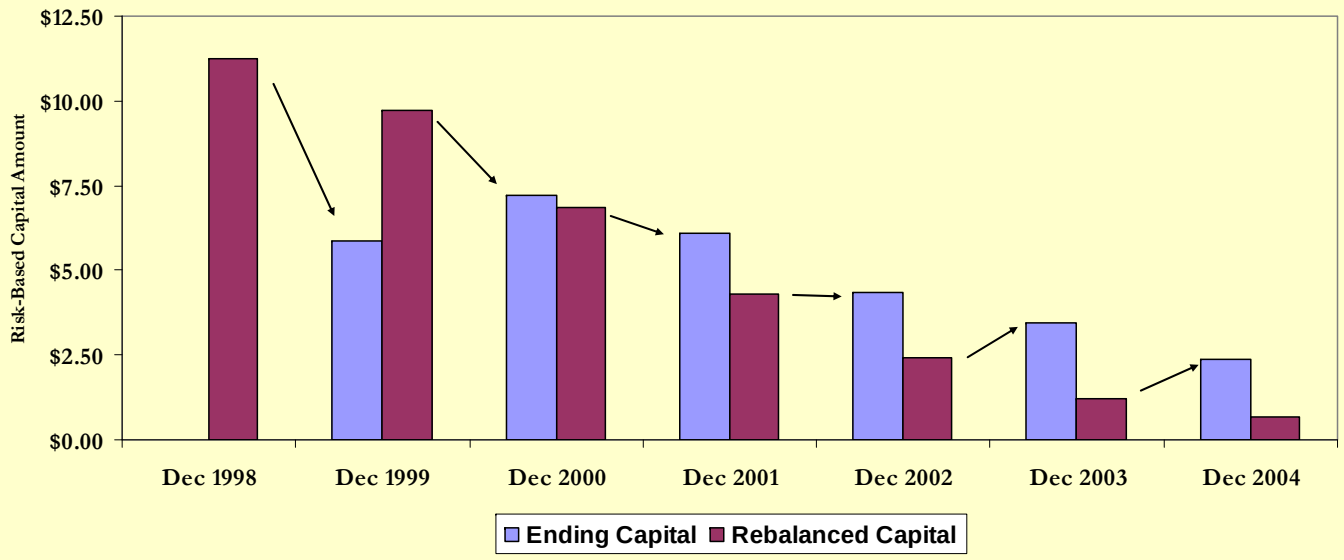
Excerpt D from Wacek Paper

FIGURE D
Accident Year 1999 Actual & Hindsight Unpaid Loss Ratio Estimates: 1999-2004
Within 95% Confidence Intervals for One Year Horizon
Commercial Auto Liability



Excerpt E from Wacek Paper

FIGURE E
Risk-Based Capital for Accident Year 1999 Unpaid Losses: 1999-2004
Commercial Auto Liability
1999 Premiums of $100
Required Capital = 15% of Unpaid Losses



Enterprise Risk Management / One Year Horizon

- ERM requires aggregation of risks from all sources
- Aggregation requires common time horizon
- One-year risk horizon fits with typical insurer planning horizon
- Example to follow

ERM Example – ABC Insurance Holdings, Inc.

- Hypothetical insurance holding company
- September 30, 2008 consolidated GAAP equity of $1 billion
- Key measure: One-year CHANGE IN GAAP EQUITY from 9/30/08
- Enterprise risks modeled separately and in combination

ERM Example – ABC Insurance Holdings, Inc.

- **ERM modeling date: 9/30/08**
- **Prospective Underwriting Risks through 9/30/09**
  - Accident year ending 9/30/09 as of 9/30/09
    - Underwriting result with expected catastrophe losses
    - "Unexpected" catastrophe losses (deviation from expected)
  - Prior accident year loss reserve development
  - Ceded reinsurance (change in reserve for uncollectibles)
- **Prospective Investment Risks through 9/30/09**
  - Bonds
  - Common stocks
  - Cash
  - Other invested assets and liabilities (e.g., credit default swaps)

ABC Insurance Holdings Value-at-Risk Table

Downside and Upside Potential (% of GAAP Equity) by Major Risk Source

One-Year GAAP Equity Gains & Losses by Return Time - Based on Portfolio Risks as of 9/30/08

Downside Risks (Pre-Tax) — Return Time Legend: < 0% | 0% - 5% | 5% - 15% | 15% - 30% | > 30%

Major Risk Source	Actual 9/30/08 (1) Amount (Millions)	Actual 9/30/08 (1) % GAAP Equity	5-Year Return Time Pre-Tax Loss Amount (Millions)	5-Year Return Time Pre-Tax Loss % GAAP Equity	25-Year Return Time Pre-Tax Loss Amount (Millions)	25-Year Return Time Pre-Tax Loss % GAAP Equity	100-Year Return Time Pre-Tax Loss Amount (Millions)	100-Year Return Time Pre-Tax Loss % GAAP Equity	250-Year Return Time Pre-Tax Loss Amount (Millions)	250-Year Return Time Pre-Tax Loss % GAAP Equity
Fixed Income Investments	$2,250	225.0%	$60	6.0%	$214	21.4%	$306	30.6%	$340	34.0%
Net Common Stocks (at Mkt)	$200	20.0%	$32	3.2%	$61	6.1%	$74	7.4%	$82	8.2%
Common Stocks (at Equity)	$10	1.0%	($1)	-0.1%	($0)	0.0%	$0	0.0%	$0	0.0%
Cash / Short Term Investments	$300	30.0%	($3)	-0.3%	($3)	-0.3%	($3)	-0.3%	($3)	-0.3%
Other Invested Assets ex CDS Etc.	$5	0.5%	$1	0.1%	$2	0.2%	$3	0.3%	$3	0.3%
Credit Default Swaps (CDS) - Long	$10	1.0%	$9	0.9%	$9	0.9%	$9	0.9%	$9	0.9%
Ceded Recoverables / Contingencies	$400	40.0%	$13	1.3%	$24	2.4%	$31	3.1%	$35	3.5%
Net Foreign Currency (FX) Exposure	$100	10.0%	$5	0.5%	$11	1.1%	$14	1.4%	$16	1.6%
Net Loss Reserves	$1,600	160.0%	$70	7.0%	$171	17.1%	$247	24.7%	$306	30.6%
Abnormal Cat Losses (2)	$150	15.0%	$82	8.2%	$321	32.1%	$467	46.7%	$549	54.9%
Acc Yr U/W Result (Cat-Adjusted) (3)	$84	8.4%	($38)	-3.8%	$7	0.7%	$35	3.5%	$55	5.5%
All Risk Sources (Pre-Tax)	$1,000	100.0%	$40	4.0%	$281	28.1%	$471	47.1%	$568	56.8%
All Risk Sources (After-Tax)			$26	2.6%	$183	18.3%	$306	30.6%	$414	41.4%

Upside Opportunities (Pre-Tax) — Return Time Legend: < 0% | 0% - 5% | 5% - 15% | 15% -30% | > 30%

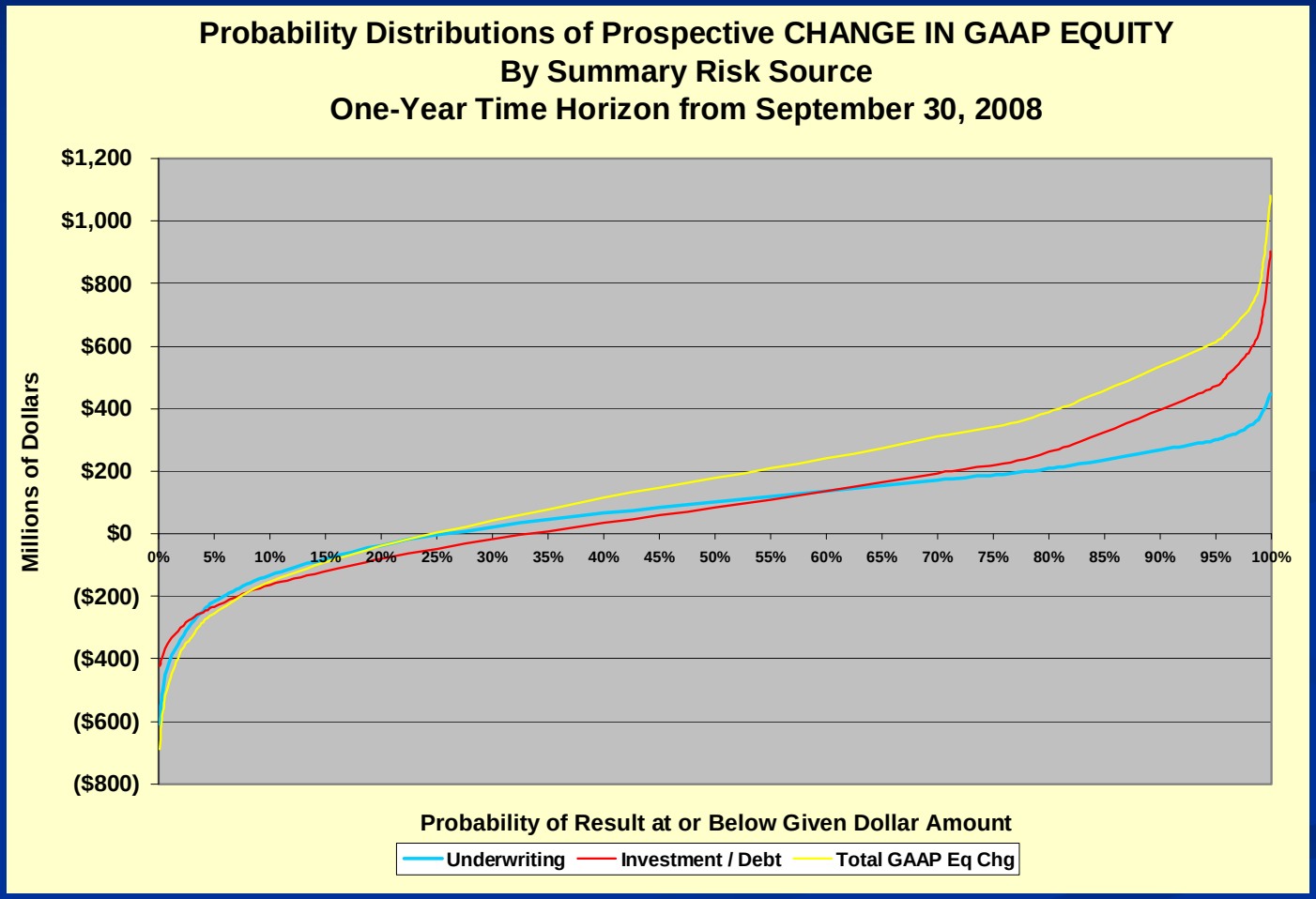
Major Risk Source	Actual 9/30/08 (1) Amount (Millions)	Actual 9/30/08 (1) % GAAP Equity	5-Year Return Time Pre-Tax Gain Amount (Millions)	5-Year Return Time Pre-Tax Gain % GAAP Equity	25-Year Return Time Pre-Tax Gain Amount (Millions)	25-Year Return Time Pre-Tax Gain % GAAP Equity	100-Year Return Time Pre-Tax Gain Amount (Millions)	100-Year Return Time Pre-Tax Gain % GAAP Equity	250-Year Return Time Pre-Tax Gain Amount (Millions)	250-Year Return Time Pre-Tax Gain % GAAP Equity
Fixed Income Investments	$2,250	225.0%	$270	27.0%	$514	51.4%	657	65.7%	$756	75.6%
Net Common Stocks (at Mkt)	$200	20.0%	$53	5.3%	$117	11.7%	163	16.3%	190	19.0%
Common Stocks (at Equity)	$10	1.0%	$1	0.1%	$2	0.2%	2	0.2%	$3	0.3%
Cash / Short Term Investments	$300	30.0%	$9	0.9%	$13	1.3%	15	1.5%	$17	1.7%
Other Invested Assets ex CDS Etc.	$5	0.5%	$2	0.2%	$4	0.4%	5	0.5%	$6	0.6%
Credit Default Swaps (CDS) - Long	$10	1.0%	($2)	-0.2%	$9	0.9%	23	2.3%	$35	3.5%
Ceded Recoverables / Contingencies	$400	40.0%	$4	0.4%	$4	0.4%	4	0.4%	$4	0.4%
Net Foreign Currency (FX) Exposure	$100	10.0%	$5	0.5%	$11	1.1%	15	1.5%	$17	1.7%
Net Loss Reserves	$1,600	160.0%	$76	7.6%	$142	14.2%	177	17.7%	$205	20.5%
Abnormal Cat Losses (2)	$150	15.0%	$98	9.8%	$126	12.6%	135	13.5%	$138	13.8%
Acc Yr U/W Result (Cat-Adjusted) (3)	$84	8.4%	$130	13.0%	184	18.4%	225	22.5%	245	24.5%
All Risk Sources (Pre-Tax)	$1,000	100.0%	$389	38.9%	$644	64.4%	810	81.0%	$945	94.5%
All Risk Sources (After-Tax)			$253	25.3%	418	41.8%	526	52.6%	$615	61.5%

Notes

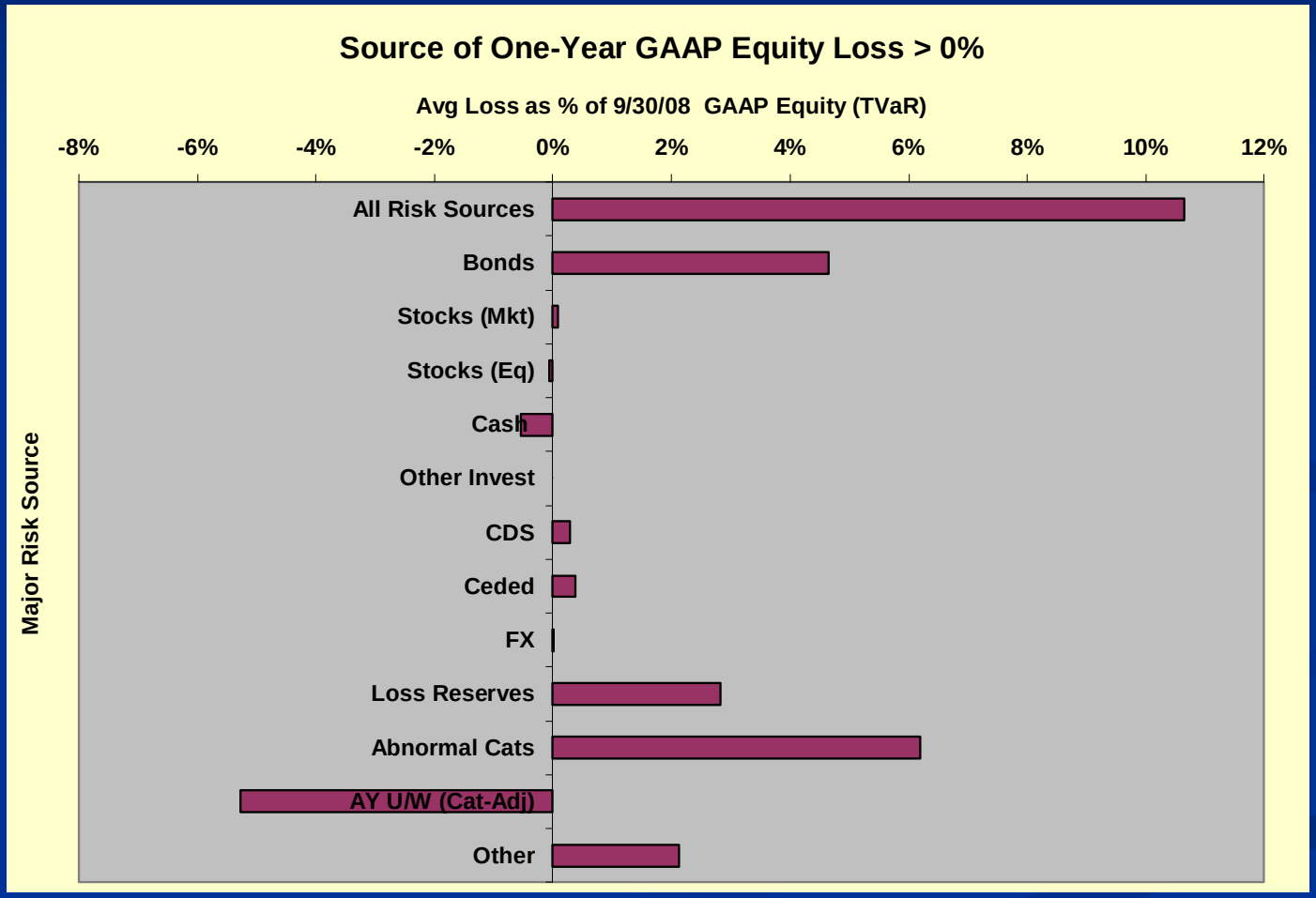
1. Balance Sheet Amounts and % of GAAP Equity, except Cat Losses and Underwriting
2. Actual 9/30/08 Amount is Expected ("Normal") Cat Loss
3. Actual 9/30/08 Amount is Expected Underwriting Margin at 12 Months with Expected Cat Losses

9/30/08 GAAP Equity	$1,000.0	Avg Change
Average 9/30/08 GAAP Equity	$1,114.4	11.44%

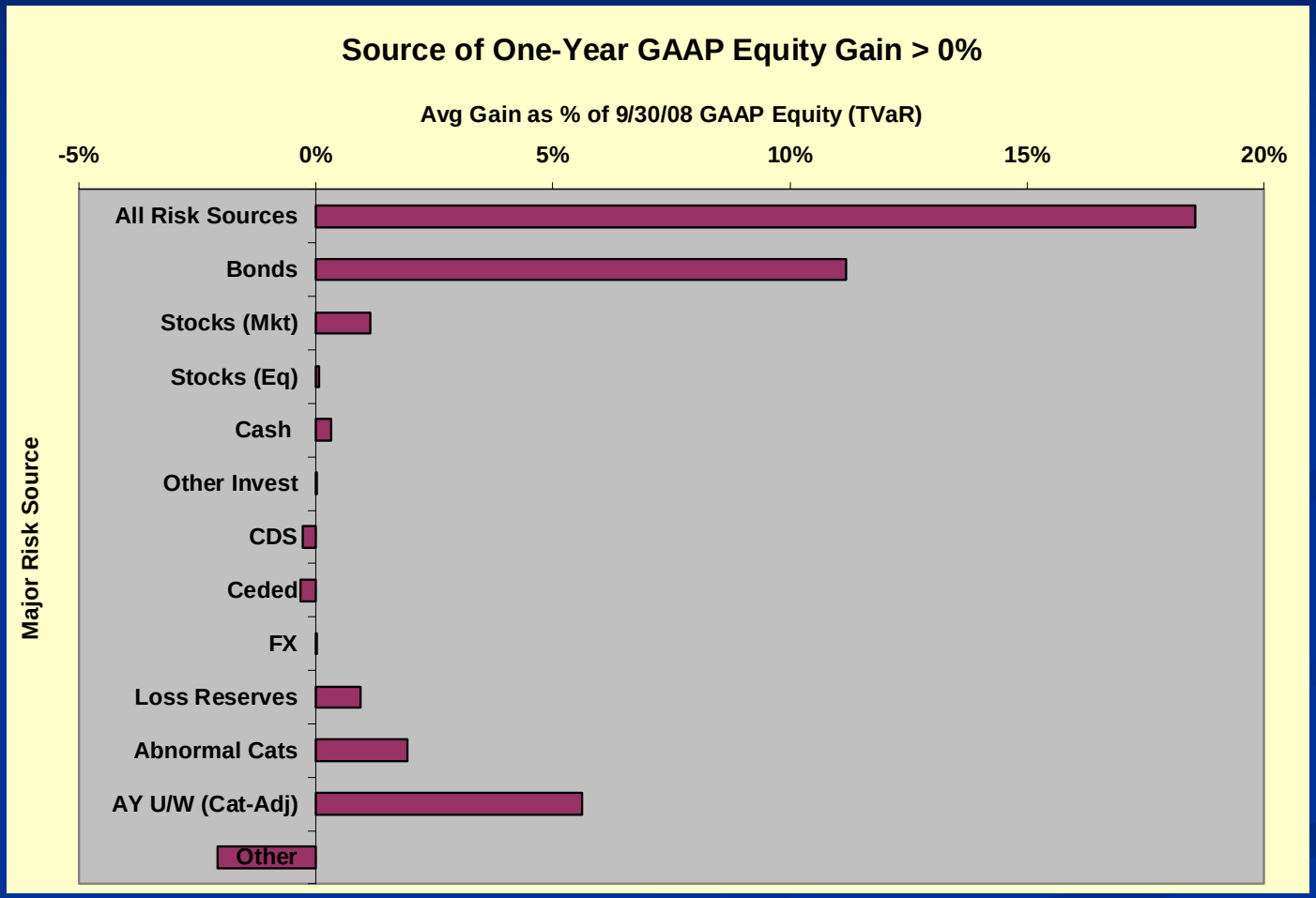
ABC Insurance Holdings Downside / Upside Profile



ABC Insurance Holdings – TVaR Loss Profile



ABC Insurance Company – TVaR Gain Profile



Q & A