INTELLIGENT RISK MODELING FOR P/C INSURERS

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Agenda

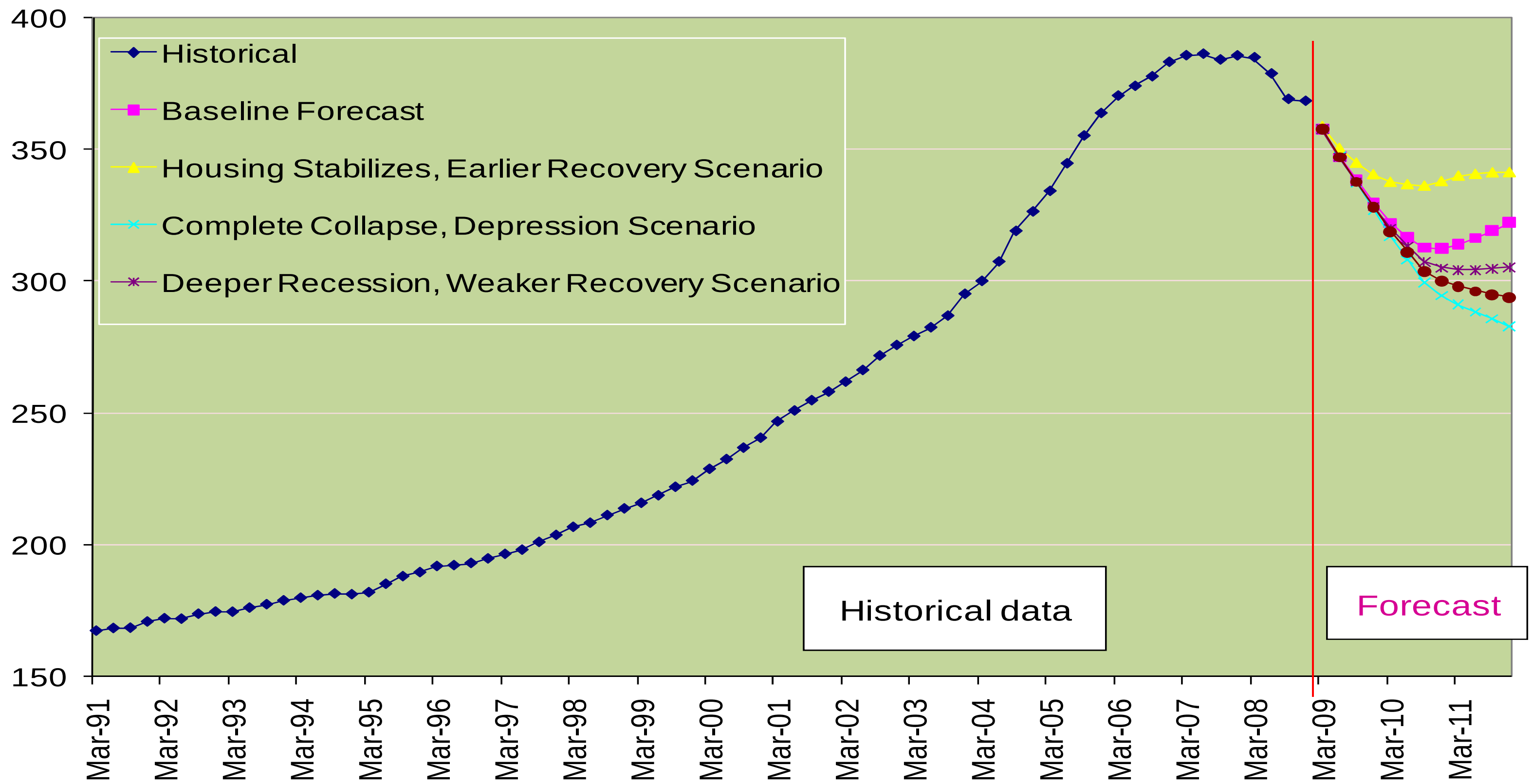
- Financial Crisis and Lessons for Insurers
- Re-develop our risk models
- Examples of Model Calibration
- Interactive Discussions on Risk Modeling

Financial Crisis and Lessons for Insurers

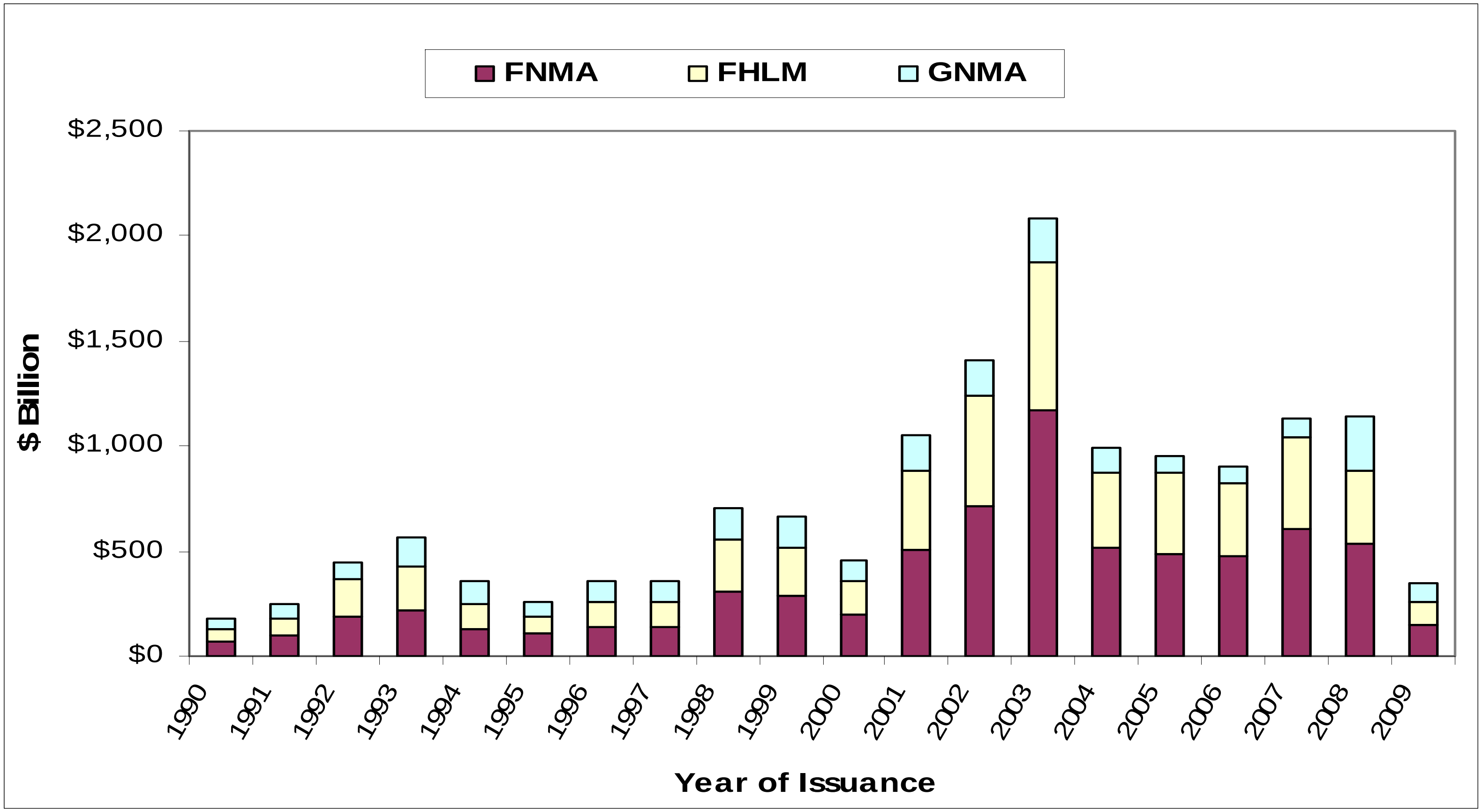
Big-pictures estimates (01-2008)

- Total value of the world's real estate
  - $75 trillion
- Total value of world's stock and bond markets
  - more than $100 trillion
  - Insurance companies hold over $4 trillion investments (nearly $3 trillion in rated bonds)
- Quiz: What is P&C Industry total capital?

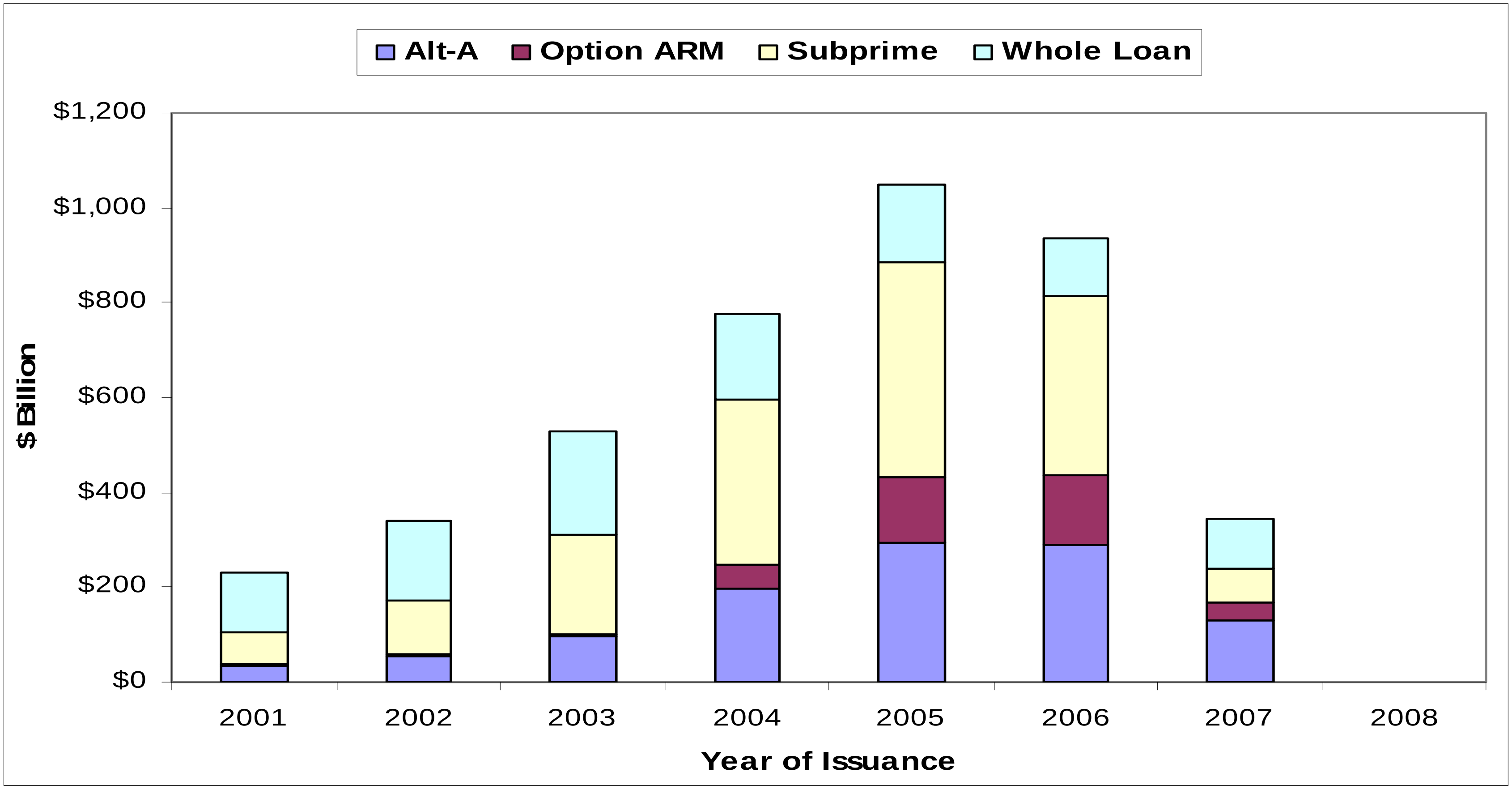
Historical and Predicted OFHEO House Price Index (Source: Moody's Economy.com)



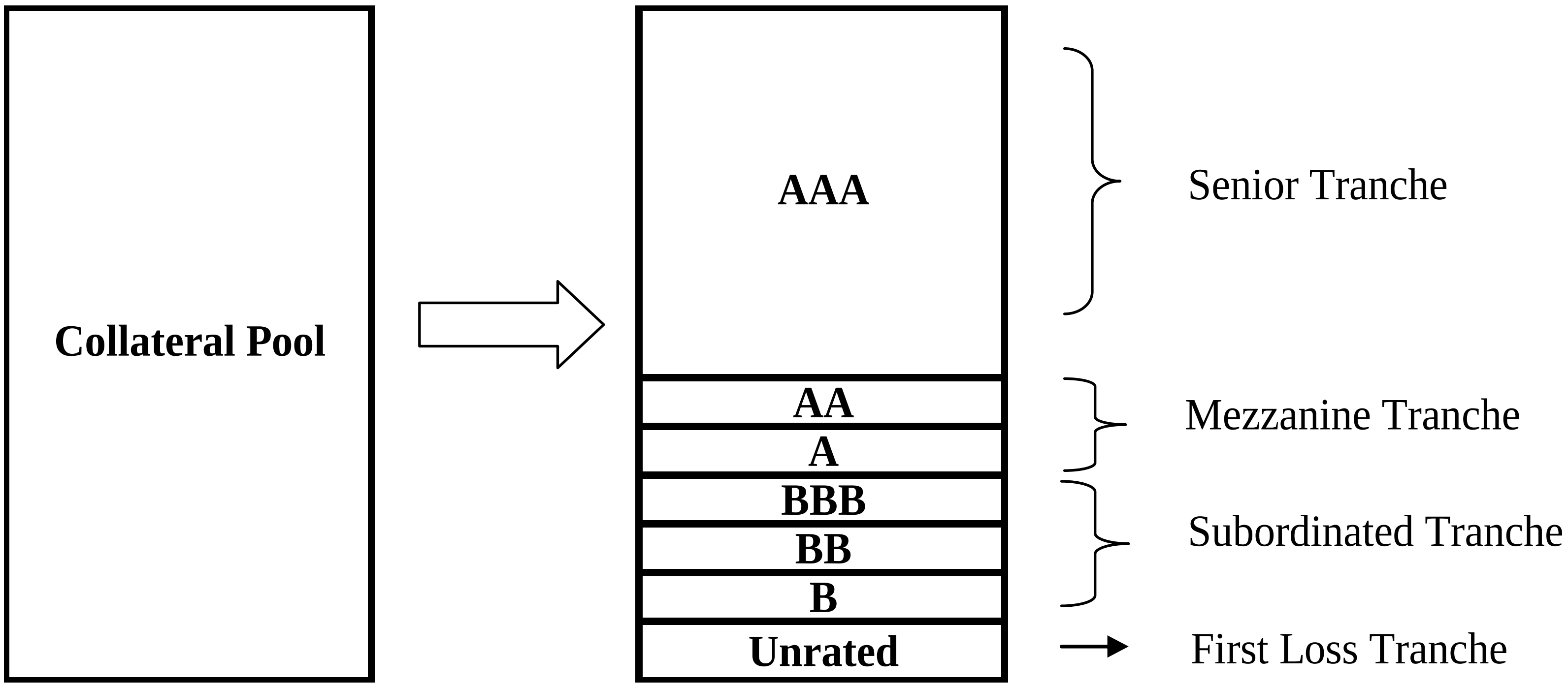
Trend of Agency Issuance and Breakdown by GSE



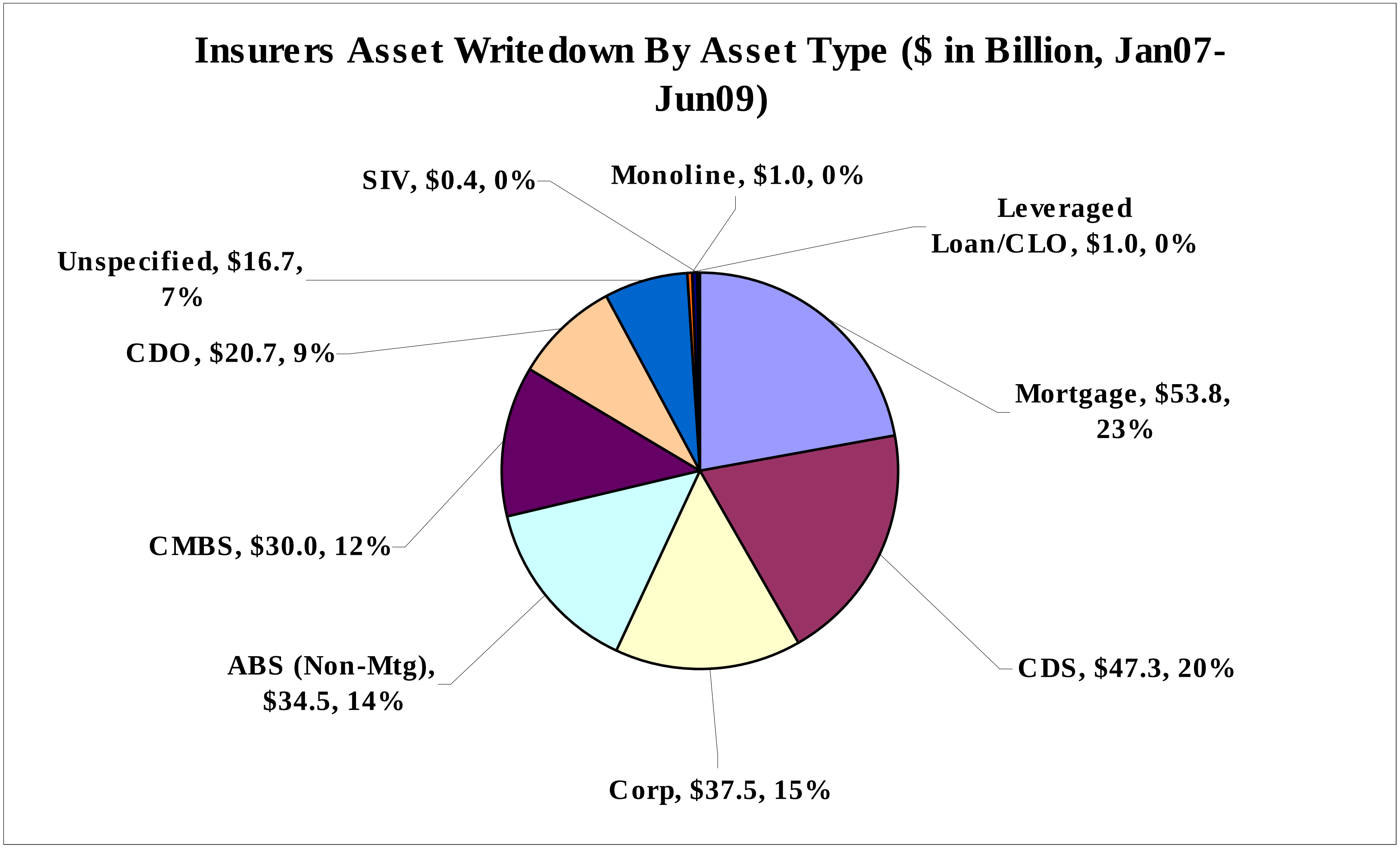
Trend of Non-Agency Issuance and Breakdown by Type



CDO (collateralized debt obligation)



Breakdown of Worldwide Insurer Asset Write-Downs Since 2007 through June 2009



Asset Allocation and Performance -- U.S. Life Insurers and Non-Life Insurers

Table III.7
Life and P&C Insurers 2007 Allocation and 2008 Total Return

	2007 Allocation		2008 Total Return	
	Life	**P&C**	**Index**	**Index used**
Inv. Grade Corp Bond	41.0%	13.9%	-11.9%	Barclays US Investment Grade Corporate Index
High Yield Corp Bond	4.6%	1.7%	-45.3%	Barclays US High Yield Corporate Index
ABS	4.3%	1.7%	-10.2%	US Aggregate ABS Index
CMBS	6.7%	2.3%	-38.1%	CMBS Index
Mortgage Loans	12.6%	0.3%	-36.9%	CMBS: Whole Loan Index
Equities	1.3%	17.8%	-48.6%	S&P500 Index

Source: Barclays Capital: "Impact of the financial crisis on the insurance industry"

Recent crisis was due to collective intelligence failure

- "Intelligence is quickness in seeing things as they are" -- George Santayana (1863-1952).
- What led to *collective* intelligence failure?
  - Too much noise or misinformation in the system
  - Narrow focus due to professional experience (division of labor)
  - Illusion about one's own capability
  - Lack of will-power and mechanism to respond

Complex math models failed

Risk Intelligence succeeded

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Why?

- Not enough attention to the whole system
- Focused on short-term
- Relies on superficial data equations, not paying regard to structural issues

Why?

- Paid attention to the big picture
- Looked at long-term trends
- Focusing on structural issues, incentives and business models

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Re-develop our Risk Models

Objectives/Goals of Risk Modeling

1. Allow for analysis of broad range of P&C ***RISK*** related issues including:
   - Pricing risk
   - Reserving risk
   - Asset side risk
   - Catastrophe risk
   - Impact of changes in reinsurance structures (for reinsurance users)
   - Liquidity/cash flow

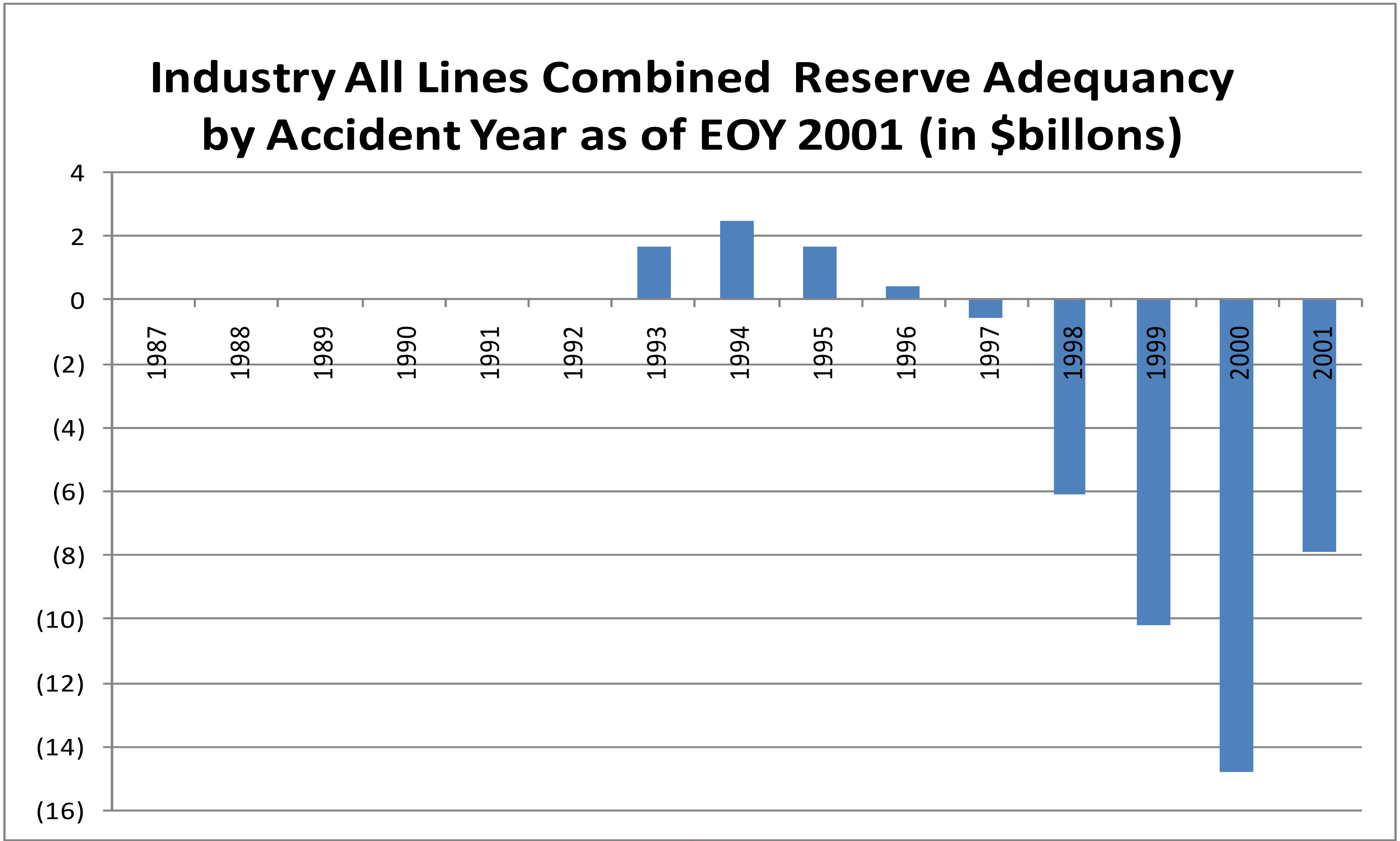
Objectives/Goals (cont'd)

2. Allow for more fundamental modeling of inter-relationships of risks/dependence without resorting to correlations
3. Allow for multi-year time horizon
4. Allow framework to be open enough to include systemic risk drivers including:
   - P&C U/W cycle and its drivers
     - Industry catastrophes, pricing cycle (competition), industry capital/reserve position, industry asset performance, underwriting standards

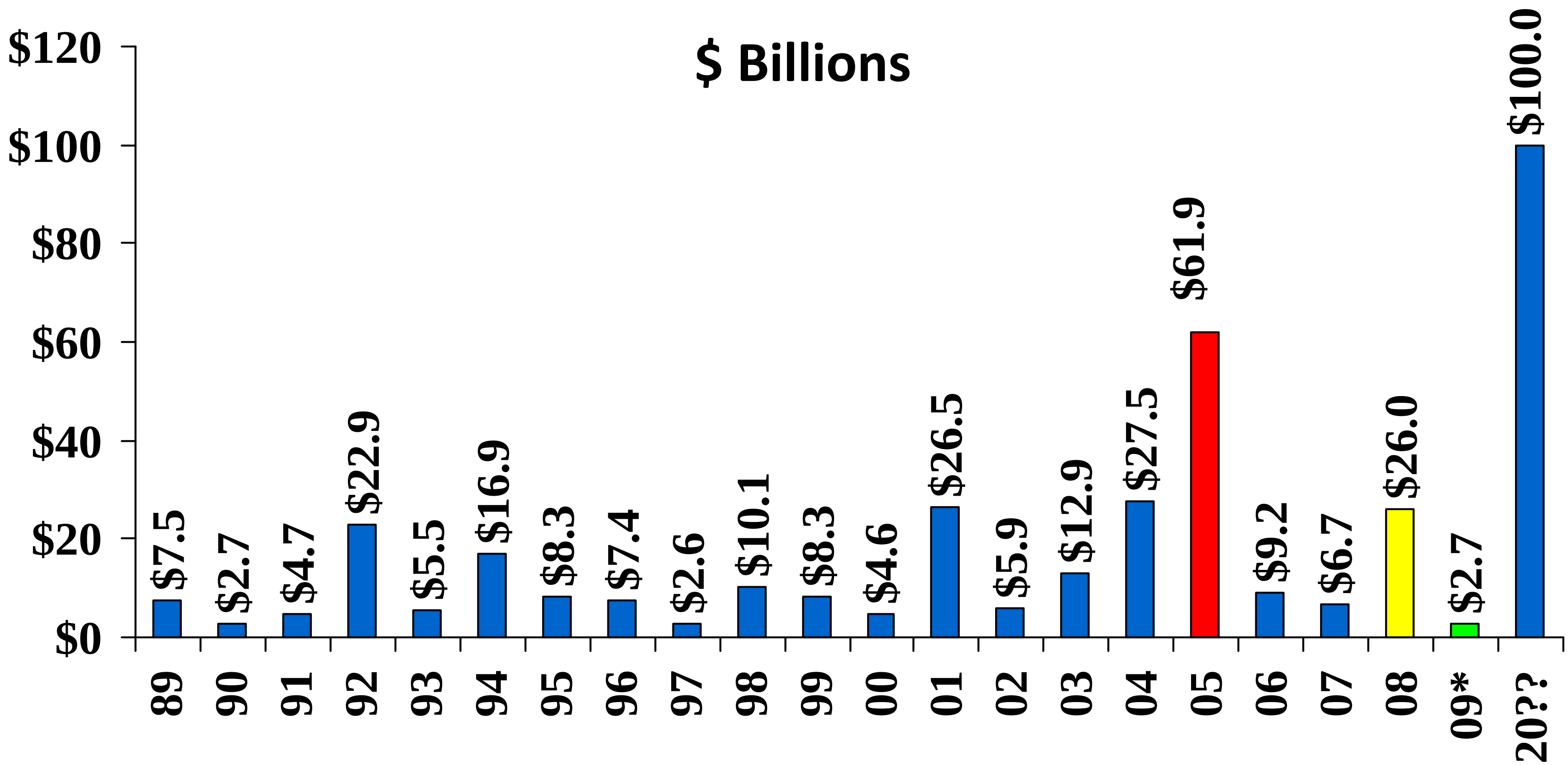
Objectives/Goals (cont'd)

4. Allow some ability to test/quantify hypothetical scenarios/stress tests
   - Historical scenarios
   - Interest or Inflation rates changing significantly
   - Other changes in included economic factors:
     - Equity returns
     - Default/recovery rates
     - Credit spreads

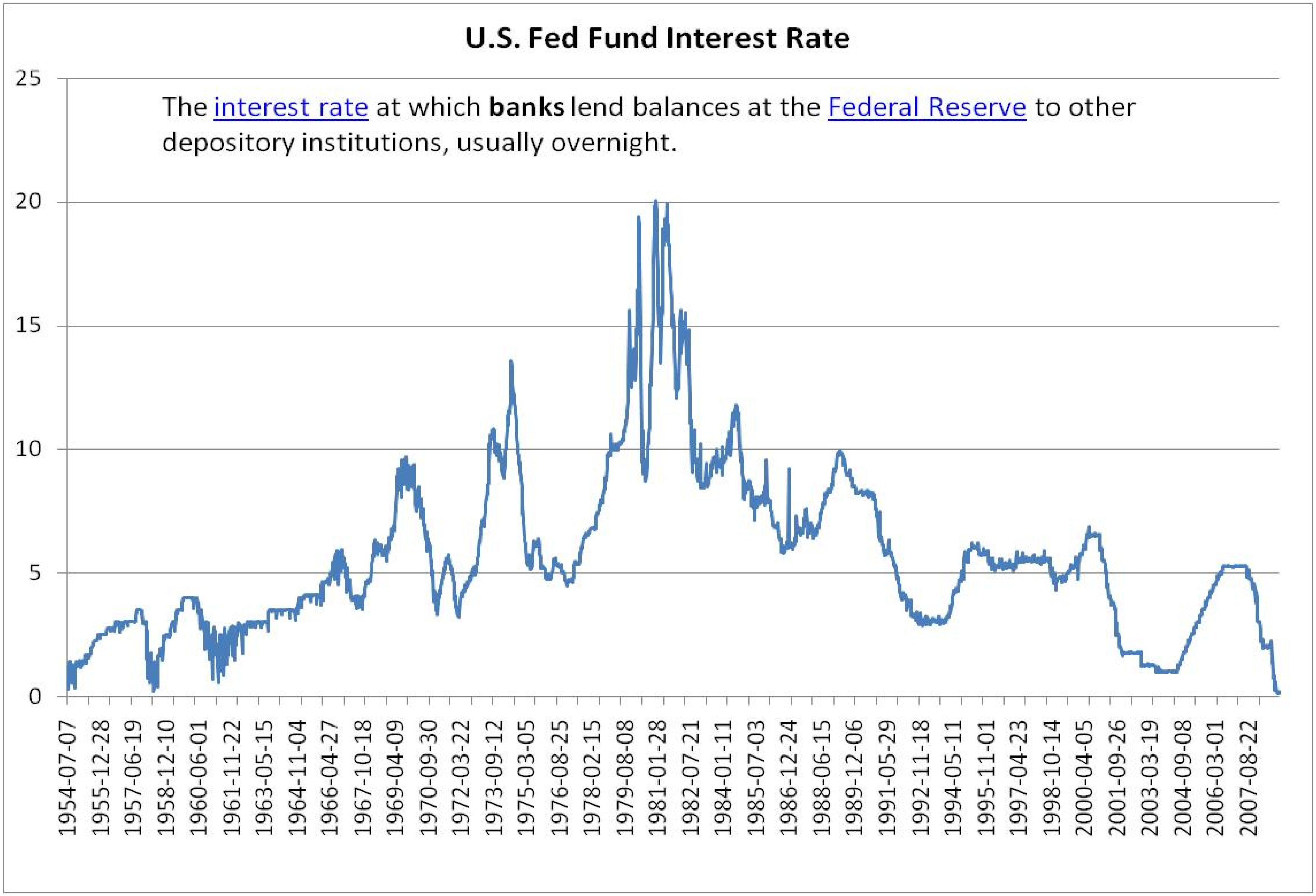
Reserve Adequacy/Deficiency



U.S. Insured Catastrophe Losses



***Based on PCS data through March 31 = $2.7 billion.**
Source: Property Claims Service/ISO; Insurance Information Institute


U.S. Fed Fund Interest Rate
The interest rate at which banks lend balances at the Federal Reserve to other depository institutions, usually overnight.
25
20
15
10
5
0
1954-07-07
1955-12-28
1957-06-19
1958-12-10
1960-06-01
1961-11-22
1963-05-15
1964-11-04
1966-04-27
1967-10-18
1969-04-09
1970-09-30
1972-03-22
1973-09-12
1975-03-05
1976-08-25
1978-02-15
1979-08-08
1981-01-28
1982-07-21
1984-01-11
1985-07-03
1986-12-24
1988-06-15
1989-12-06
1991-05-29
1992-11-18
1994-05-11
1995-11-01
1997-04-23
1998-10-14
2000-04-05
2001-09-26
2003-03-19
2004-09-08
2006-03-01
2007-08-22

Historical Relationship between Interest Rates and Stock Market

- Dynamic Yield Curve

http://stockcharts.com/charts/YieldCurve.html

Examples of model calibration

An Interest Rates Model

- (Nominal) Interest rates are at the heart of the economic scenarios
  - Other variables are driven by underlying interest rates
- Model:
  - 2-factor model of short rate (2nd factor is a stochastic mean reverting level for short rate)

$$dr(t) = [\theta(t) + u(t) - \bar{a}' r(t)]dt + \sigma_1 dZ_1(t), \quad r(0) = r_0,$$

$$du(t) = -\bar{b}' u(t)dt + \sigma_2 dZ_2(t), \quad u(0) = 0,$$

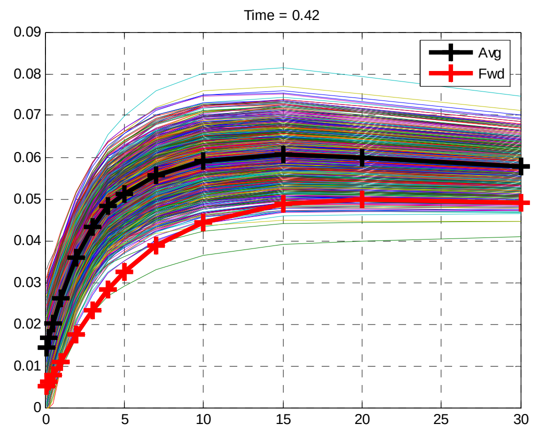
Desirable features of this model

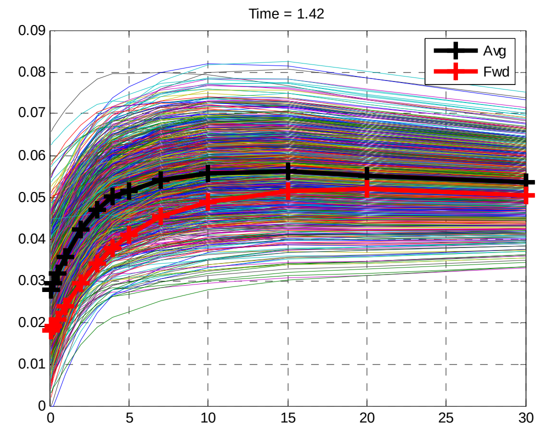
- Intuitive parameters (can modify to account for expectations (e.g., Fed rate increases))
- Economic basis/underlying rationale
- Consistent real-world and risk-neutral possible
- Tractable, closed form formula for basics (e.g., zero coupon bond valuation)
- Scalable, can be built upon (e.g., inflation, more than one interest rate curve/multi-national support)
- As simple as possible and no simpler (2 factors: parallel shift, slope changes)

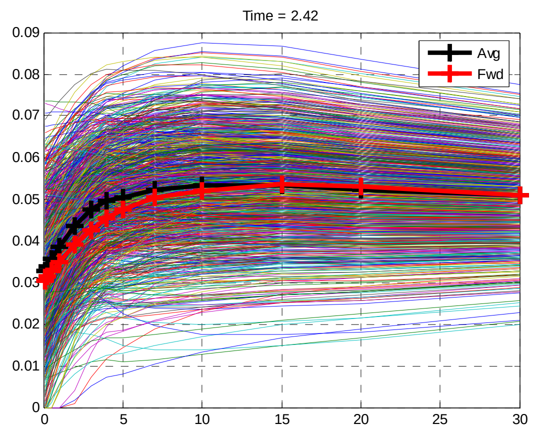
Interest Rates – Simulation Procedure

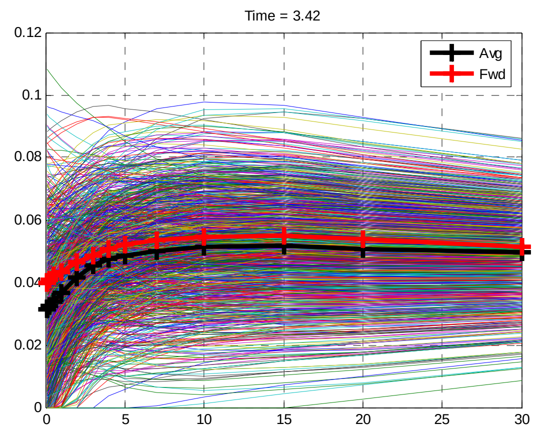
- Use real-world parameters to generate simulated daily rates for 5 years starting with the current yield curve
- Use risk-neutral parameters to imply zero coupon bond prices and in turn the yield curve
- Do this N times where N =1,000 or 10,000
- Then grab the year-end values for each of the next 5 years for the N simulations

A set of simulated interest rates









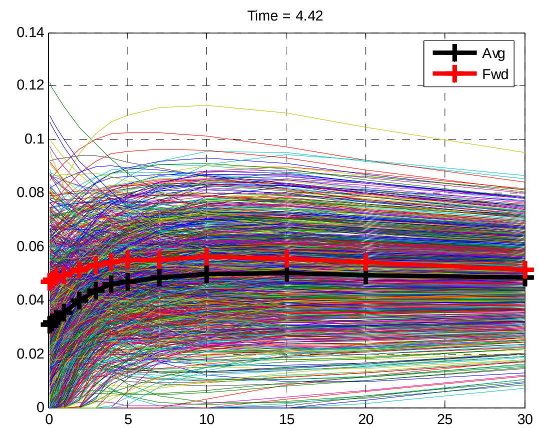
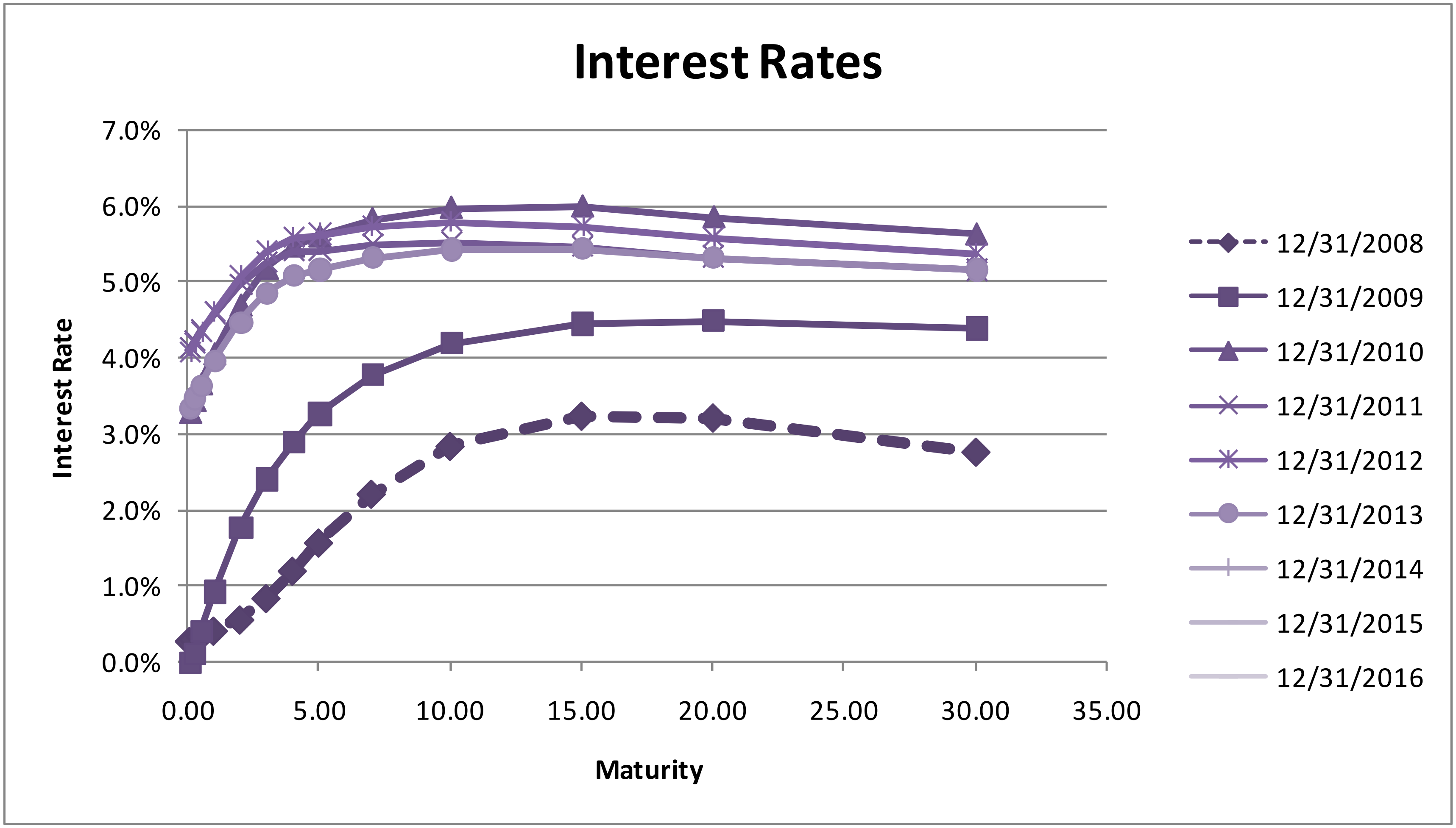


Illustration: one simulated scenario



Re-price bonds using scenarios

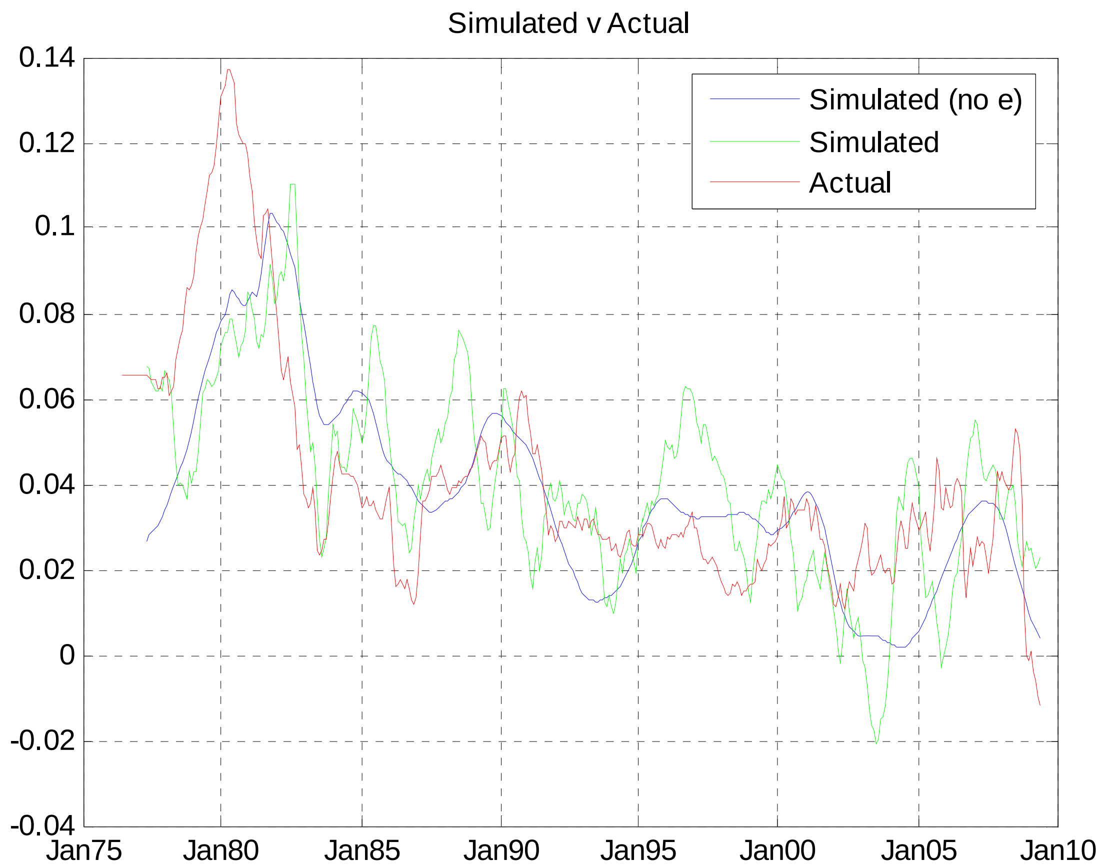
Valuation Date:	12/31/2008

				Maturity Information						
Portfolio Name	Disc. Spread Key	Floating Ref Rate Spread Key	Bond Type	Bucketed Maturity	Low	High	Avg (WAM)	Notional	Cost	BV
US Government Bond			Fixed	Y	20	30	30	10,000,000	10,000,000	10,000,000
US Government Bond			Fixed	Y	10	20	15	5,000,000	5,000,000	5,000,000
US Government Bond			Fixed	Y	5	10	8	5,000,000	5,000,000	5,000,000
US Government Bond			Fixed	Y	1	5	3	5,000,000	5,100,000	5,000,000
US Government Bond			Fixed	Y	0	1	1	1,000,000	1,000,000	1,000,000
Municipal	Muni		Fixed	Y	20	30	30	10,000,000	10,000,000	10,000,000
Municipal	Muni		Fixed	Y	10	20	15	10,000,000	9,900,000	10,000,000
Municipal	Muni		Fixed	Y	5	10	8	7,500,000	7,500,000	7,500,000
Municipal	Muni		Fixed	Y	1	5	3	5,000,000	5,100,000	5,000,000
Municipal	Muni		Fixed	Y	0	1	1	1,000,000	1,000,000	1,000,000
Unaffiliated	Corp-BBB		Fixed	Y	20	30	30	10,000,000	10,100,000	10,000,000
Unaffiliated	Corp-BBB		Fixed	Y	10	20	15	10,000,000	10,000,000	10,000,000
Unaffiliated	Corp-BBB		Fixed	Y	5	10	8	7,500,000	7,400,000	7,500,000
Unaffiliated	Corp-BBB		Fixed	Y	1	5	3	5,000,000	5,000,000	5,000,000
Unaffiliated	Corp-BBB		Fixed	Y	0	1	1	1,000,000	1,100,000	1,000,000
Collateral Loans	Corp-BBB	LIBOR-1Y	Float	N	0	3	3	100,000	100,000	100,000
Mortgage Loans	RMBS		MBS	N	0	30	30	100,000	100,000	100,000

Inflation Rates - Model

- Inflation is driven by interest rates
  - Nominal interest rates implicitly have an inflation expectation
  - Goal: make inflation rates consistent with nominal interest rate scenario
  - Method I chose:
    1. Regress inflation rates on interest rate factors and model residual risk
    2. Residuals look like an AR model after simple regression so I've chosen an ARX model (Autoregressive with Exogenous factors)

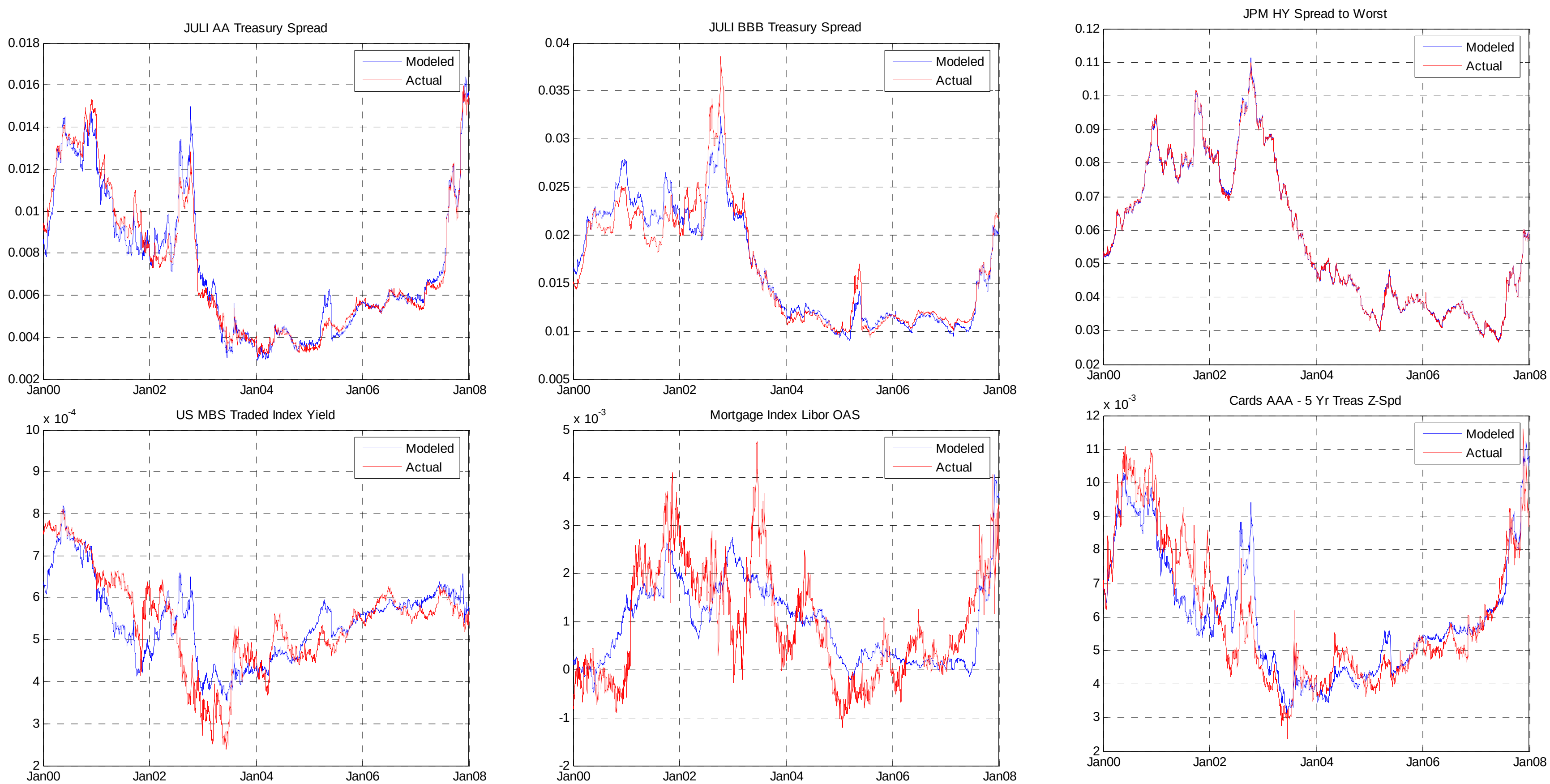
Inflation Rates - Simulation



Credit Spreads - Modeling

- To reduce dimensionality issues we use PCA (Principal Component Analysis) to boil the many spreads down to a more manageable set of factors
  - Similar to interest rate movements being composed of 3 main factors (i.e., level, slope, curvature)
  - For the set of spreads graphed above we end up with the following from PCA

Credit Spreads – Using 3 factors



Inflation Rates – Modeling choices

- What inflation rates do we model (e.g., CPI-All, CPI-Core, CPI-Medical)?
- Which are most relevant for liabilities and assets?
  - Obviously this depends on the assets and liabilities
- Are they the same? If not, do we need to model multiple inflation rates? If so, what is the best model for multiple rates?

Apply Scenarios to Exposure Data

- Use industry and company Sch. P data to estimate payout patterns
- Use Sch. D data to get investment holdings
- Apply integrated scenarios to asset and liability exposure data
  - Intelligence embedded in such scenarios

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Interactive Discussions on Risk Modeling

Hurdles to risk modeling?

- Complex math (lack of intuitive understanding)?
- What level/type of data?

Questions for Interactive Discussions

1. How to link between (i) high-level risk models and (ii) pricing & reserving models?
2. How can actuaries get more involved in high-level asset risk modeling?
3. How to test and validate risk models, for what purposes?