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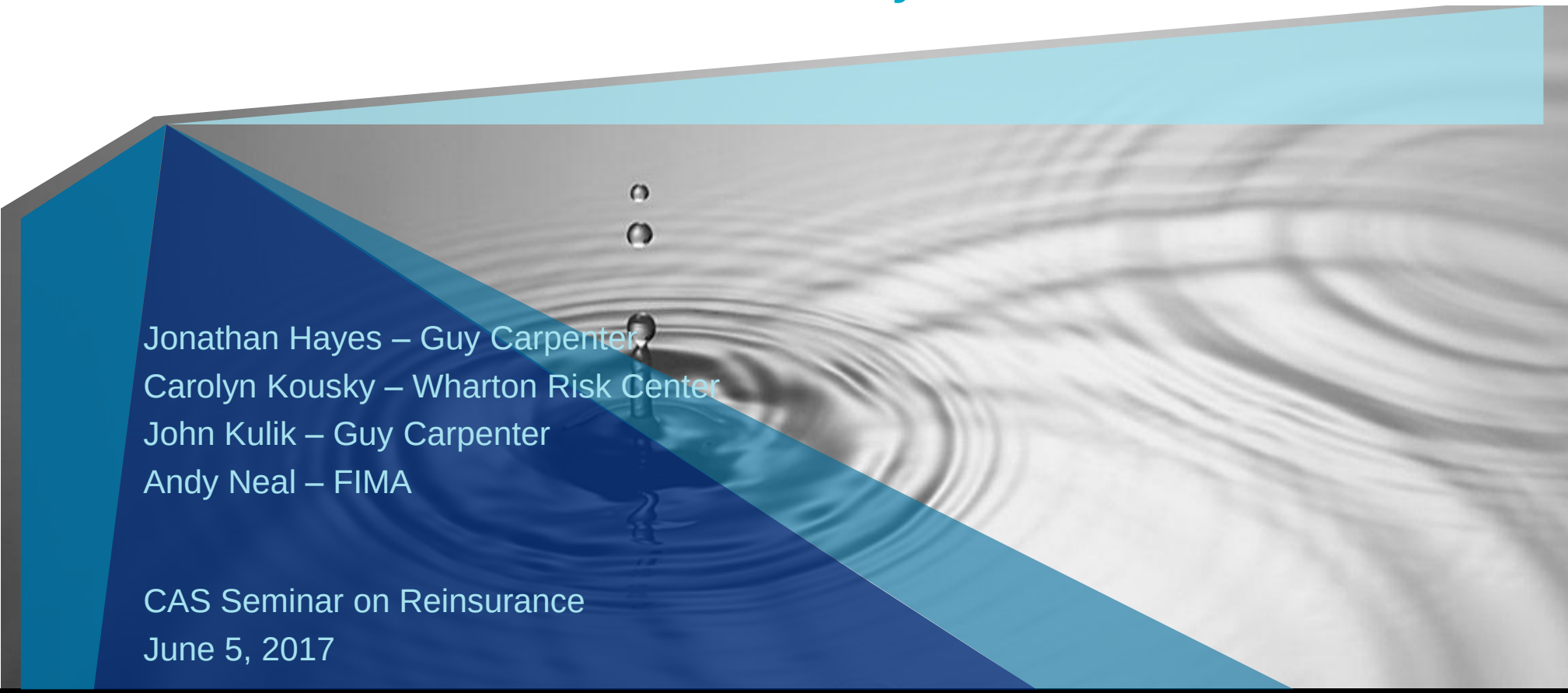
GUY CARPENTER

FEMA

NATIONAL FLOOD INSURANCE PROGRAM

US Flood Insurance:
Current NFIP and Public Policy Issues



Jonathan Hayes – Guy Carpenter
Carolyn Kousky – Wharton Risk Center
John Kulik – Guy Carpenter
Andy Neal – FIMA

CAS Seminar on Reinsurance
June 5, 2017

MARSH & McLENNAN COMPANIES

OUTLINE

1 LOSS MODELING

- Estimation of Non-Modeled Loss Distributions
- Modeled loss Distributions
- Ensemble Model: NFIP View of Risk

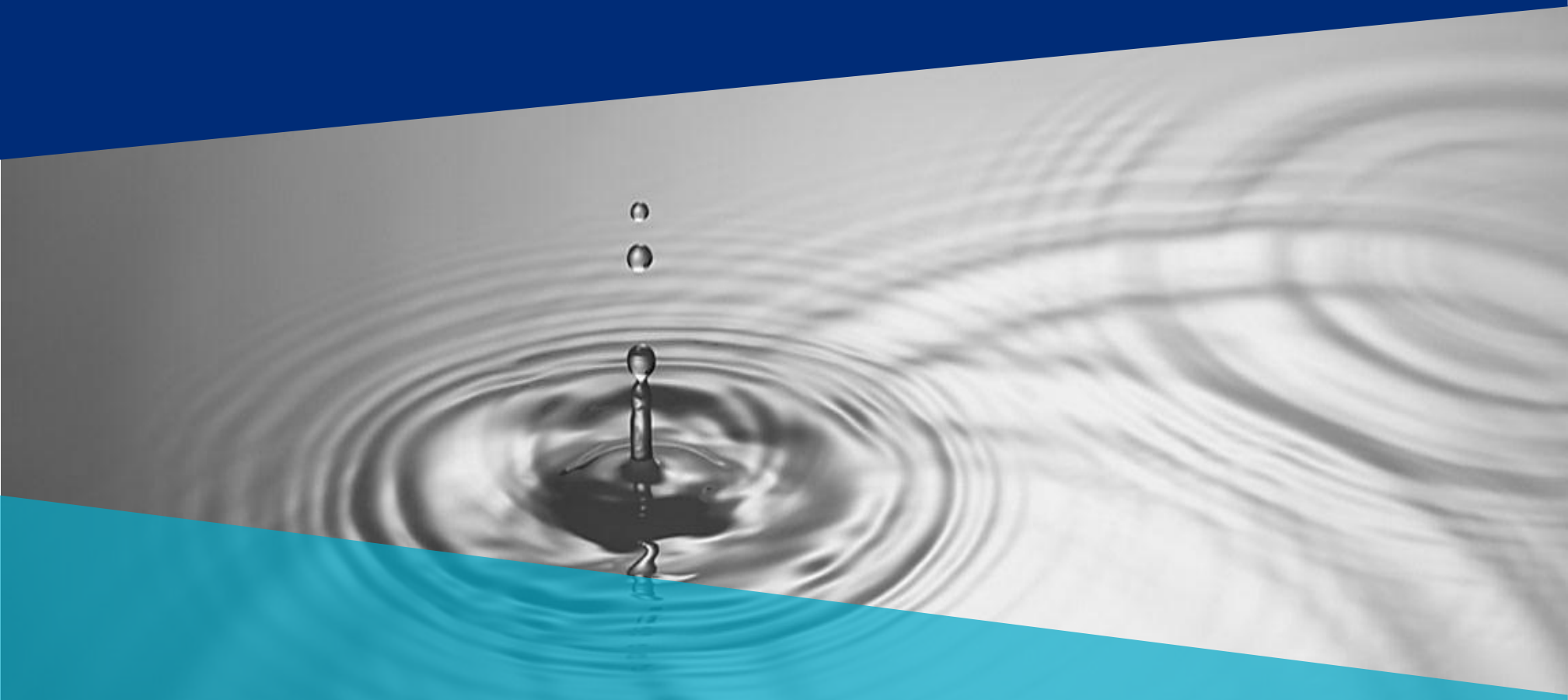
2 NFIP Financials: Stochastic Forecasts

- Revenue, Expense, and Loss Assumptions
- Projected Income Statement Means
- Projected Surplus Distributions

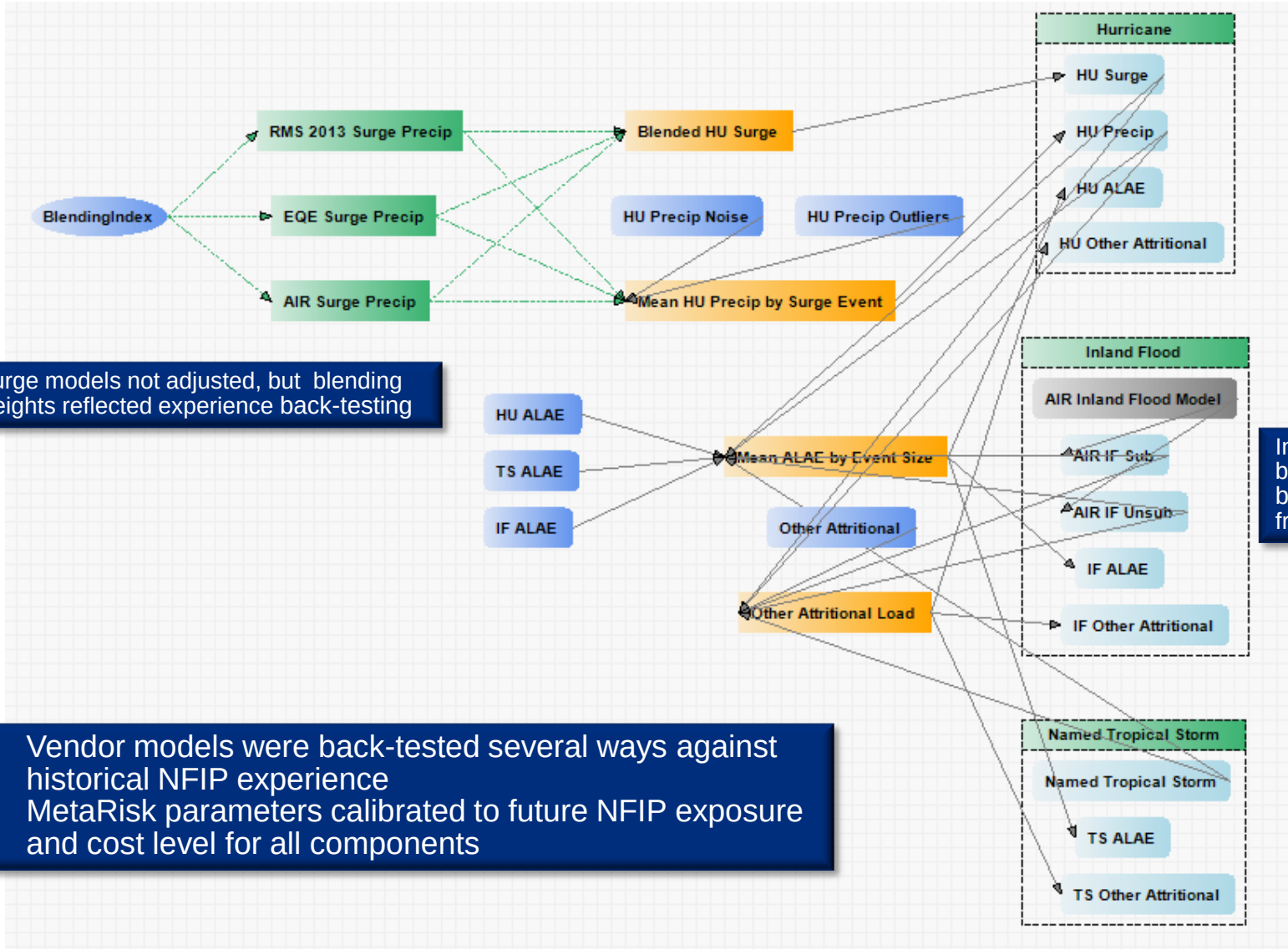
3 EVALUATING REINSURANCE

- Long Term Analysis
- Corporate Bond Market Comparisons

1 LOSS MODELING



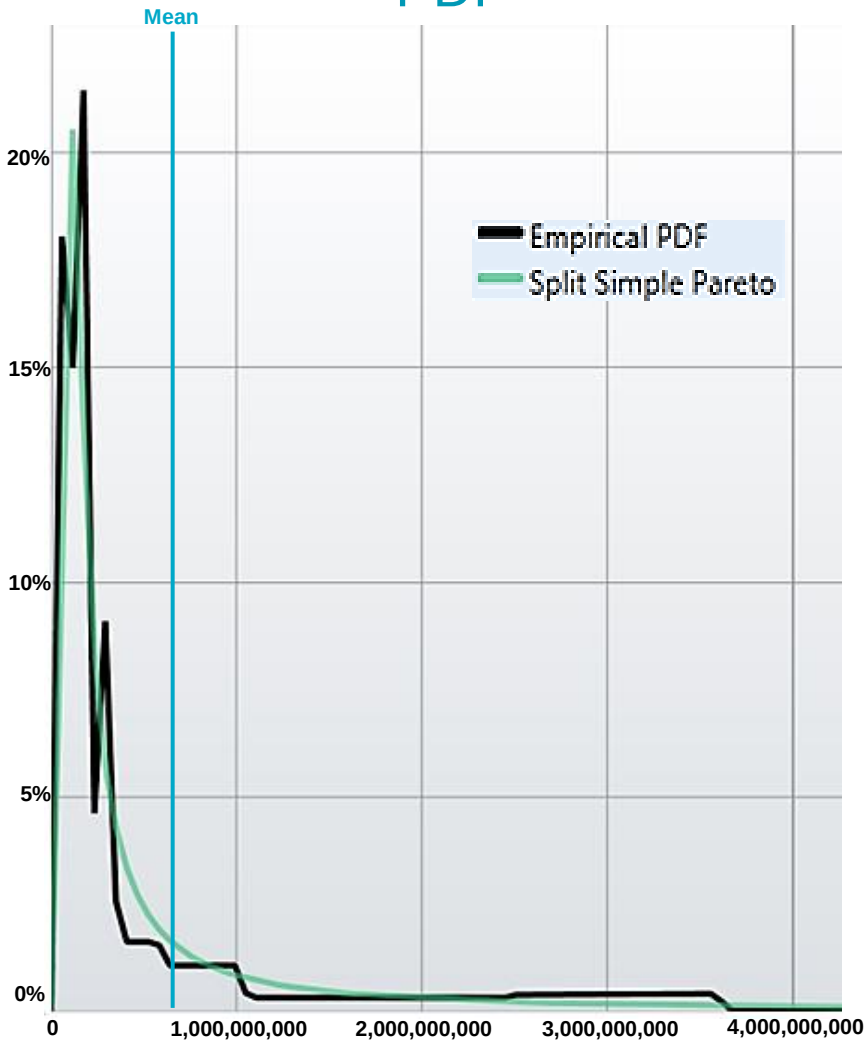
NFIP Ensemble Loss and ALAE Model
By Peril and All Combined



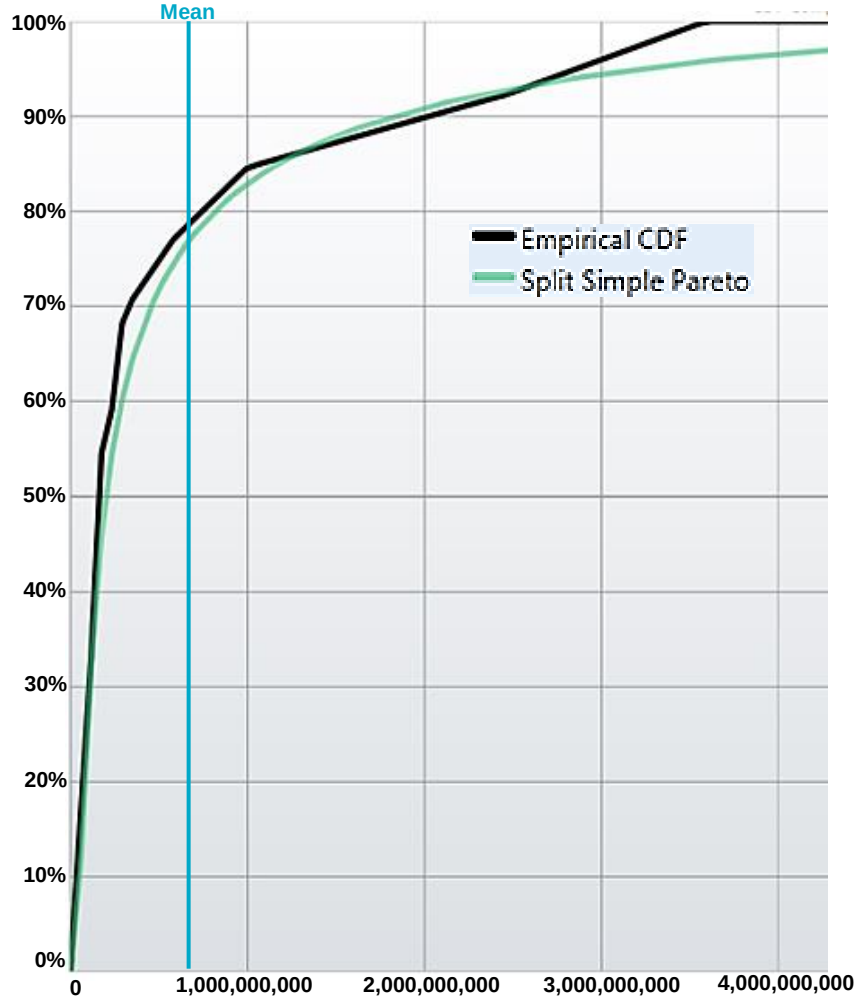
- Vendor models were back-tested several ways against historical NFIP experience
- MetaRisk parameters calibrated to future NFIP exposure and cost level for all components

Non-Modeled Perils – Loss Estimation
NFIP Named Tropical Storm – Fitted Severity

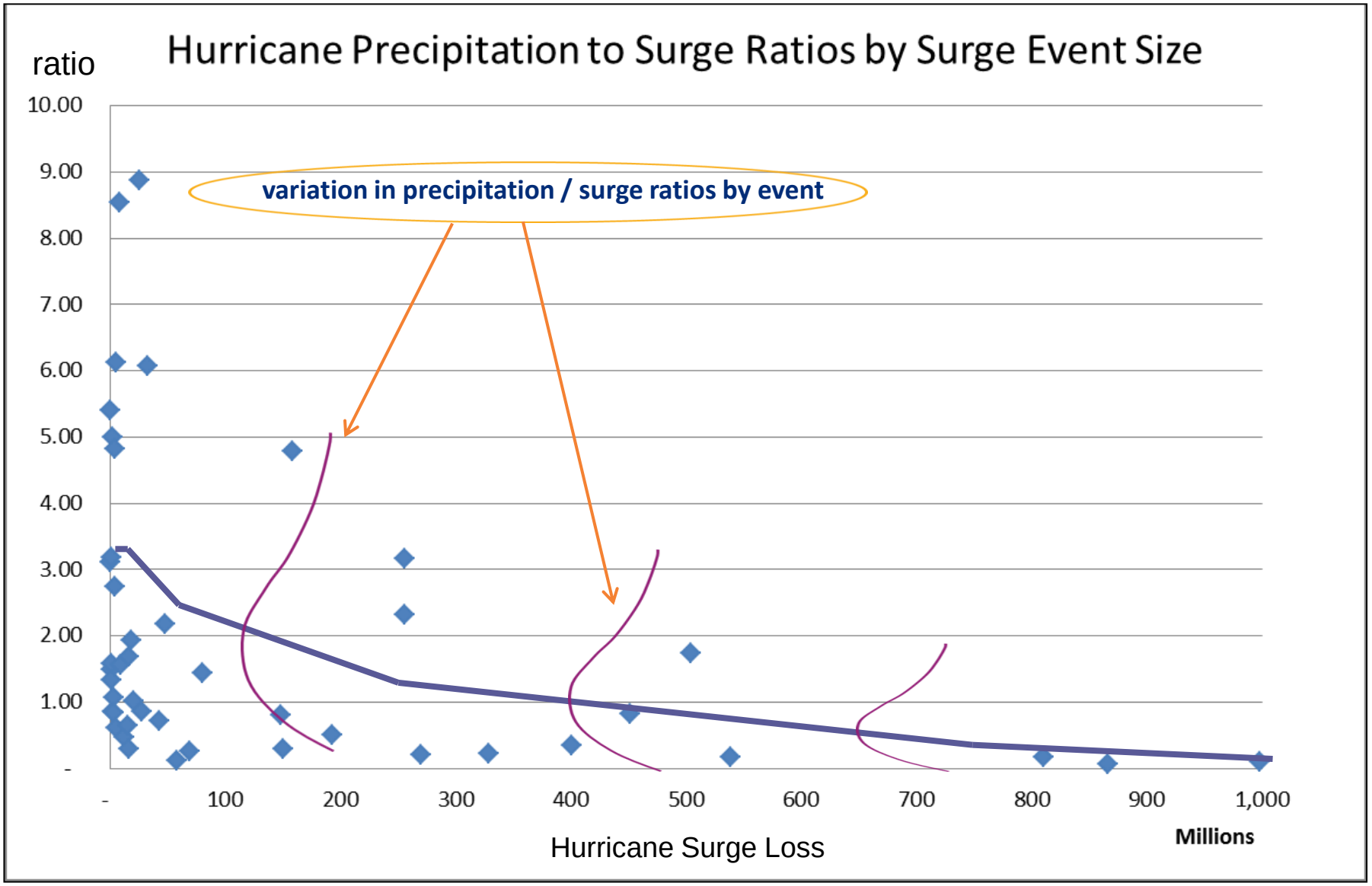
PDF



CDF



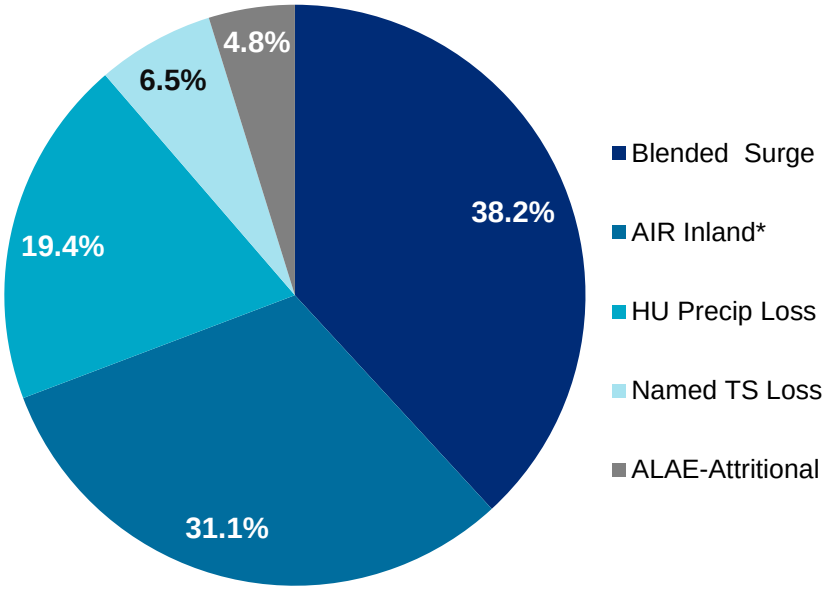
Non-Modeled Perils – Loss Estimation
NFIP Hurricane Precipitation

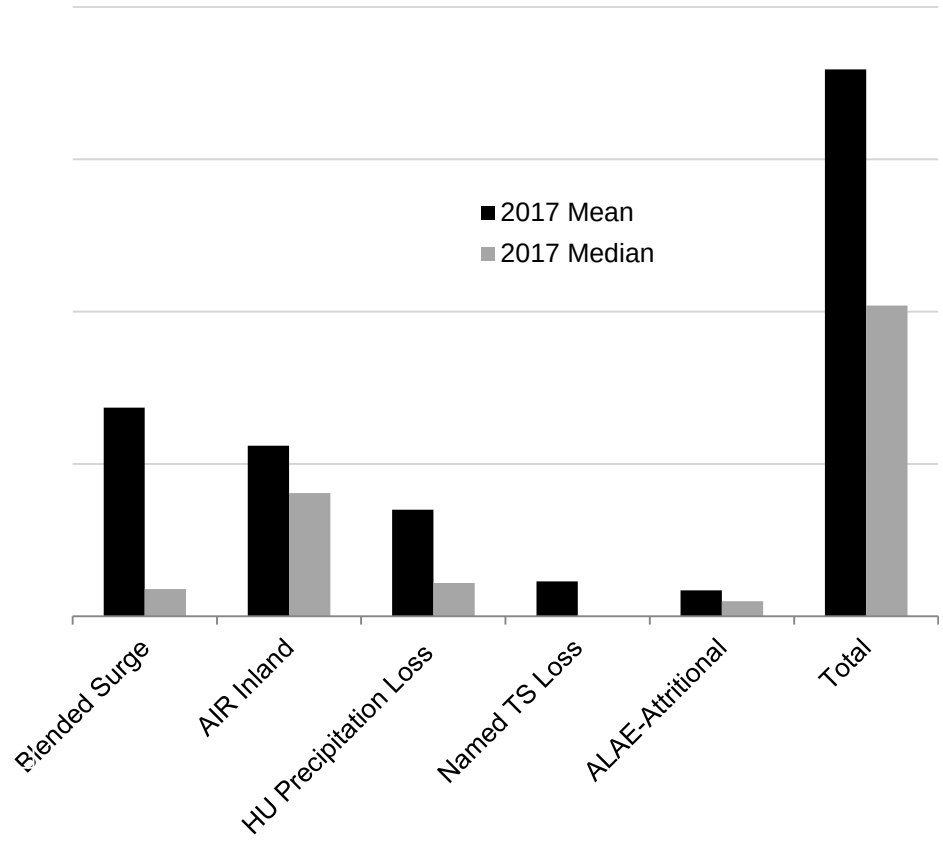


NFIP Ensemble Model
By Peril and All Combined

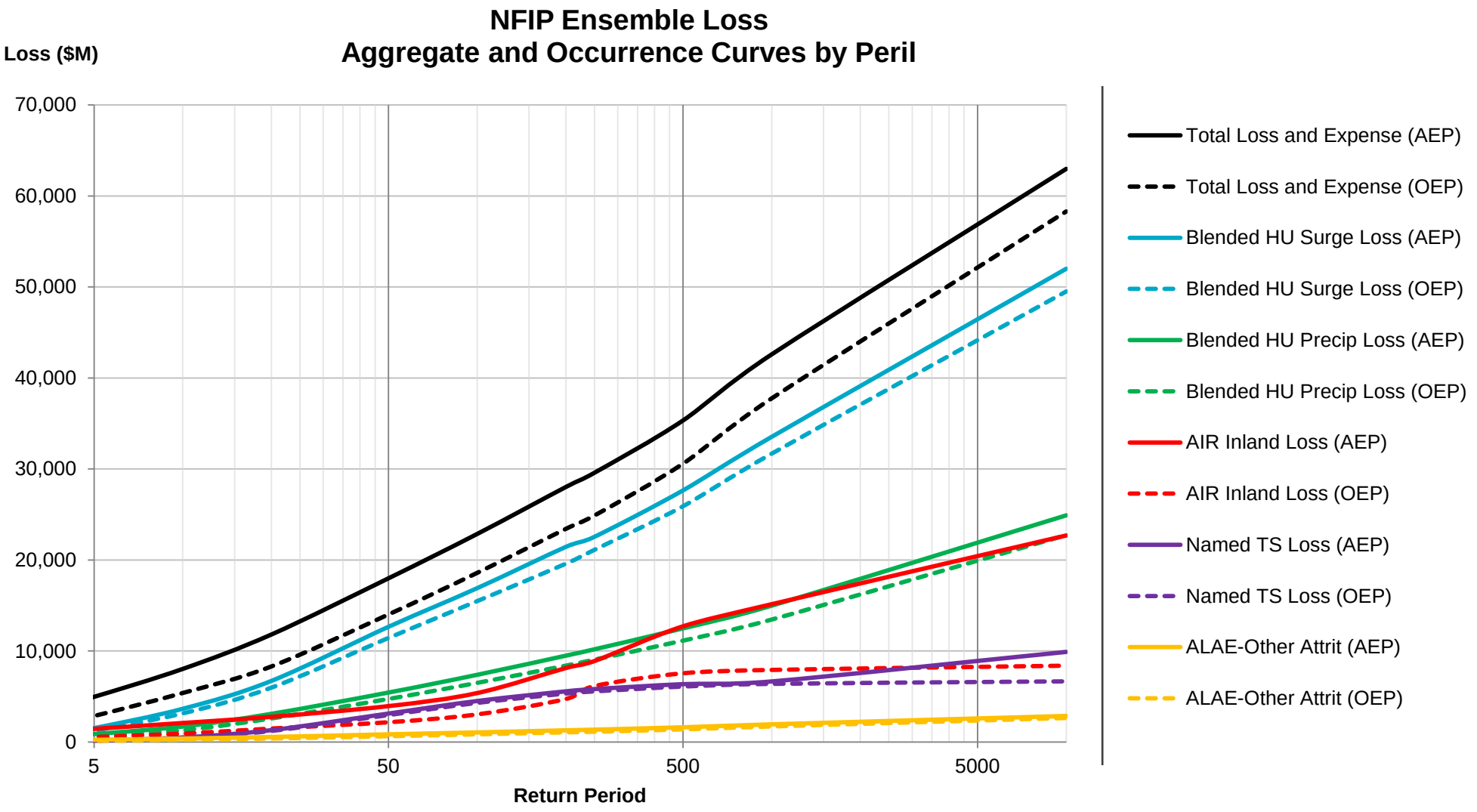
- model output reflects final weightings, adjustments, and recalibrations updated in 2016
- very significant reduction in AAL and entire ensemble CDF from FIRS completed in 2014
  - *remains a "work in progress" as US flood modeling continues to develop and improve*

Contribution to NFIP Ensemble Gross AAL



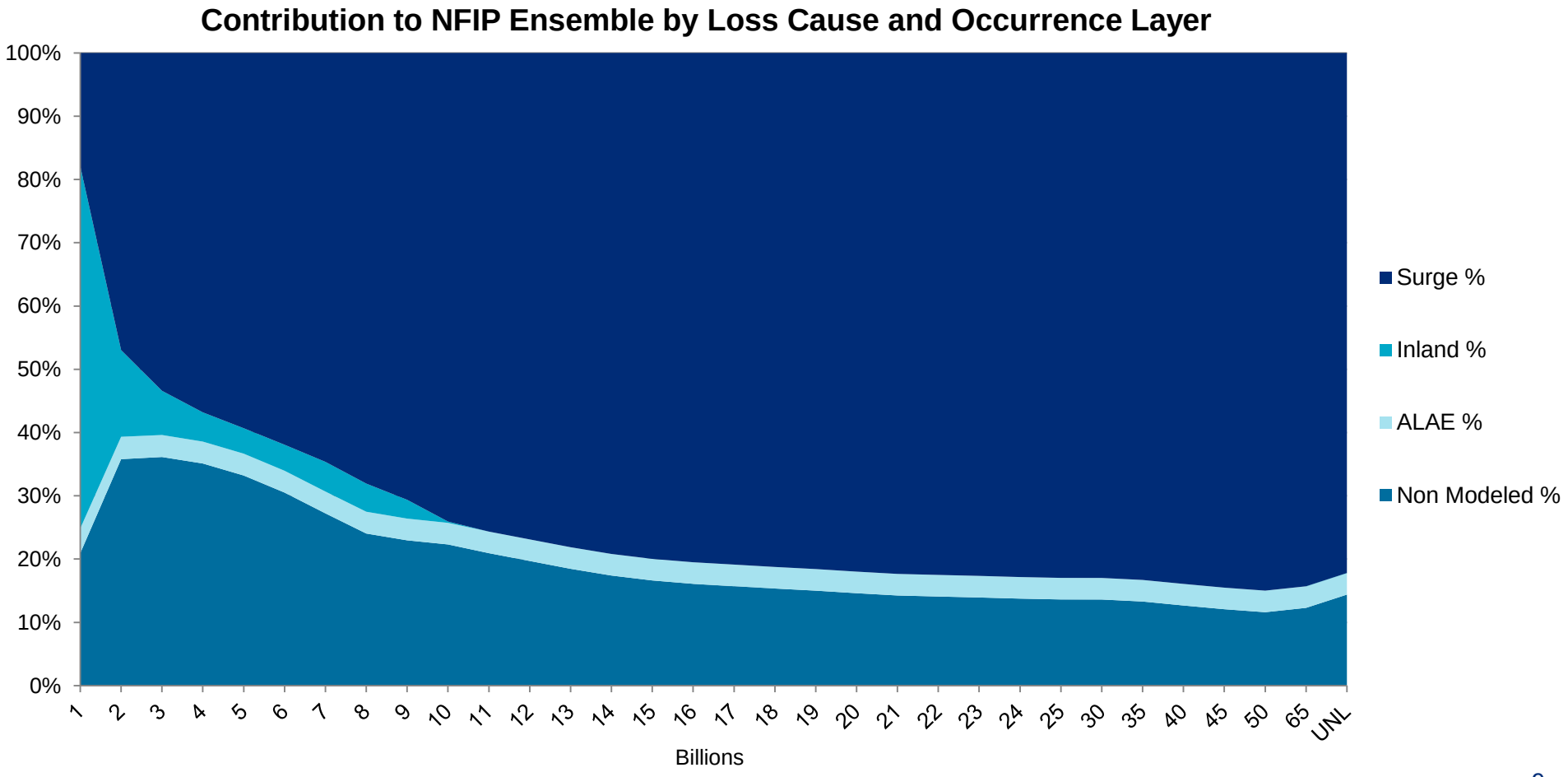


NFIP Ensemble Model
AEP and OEP by Peril and Combined

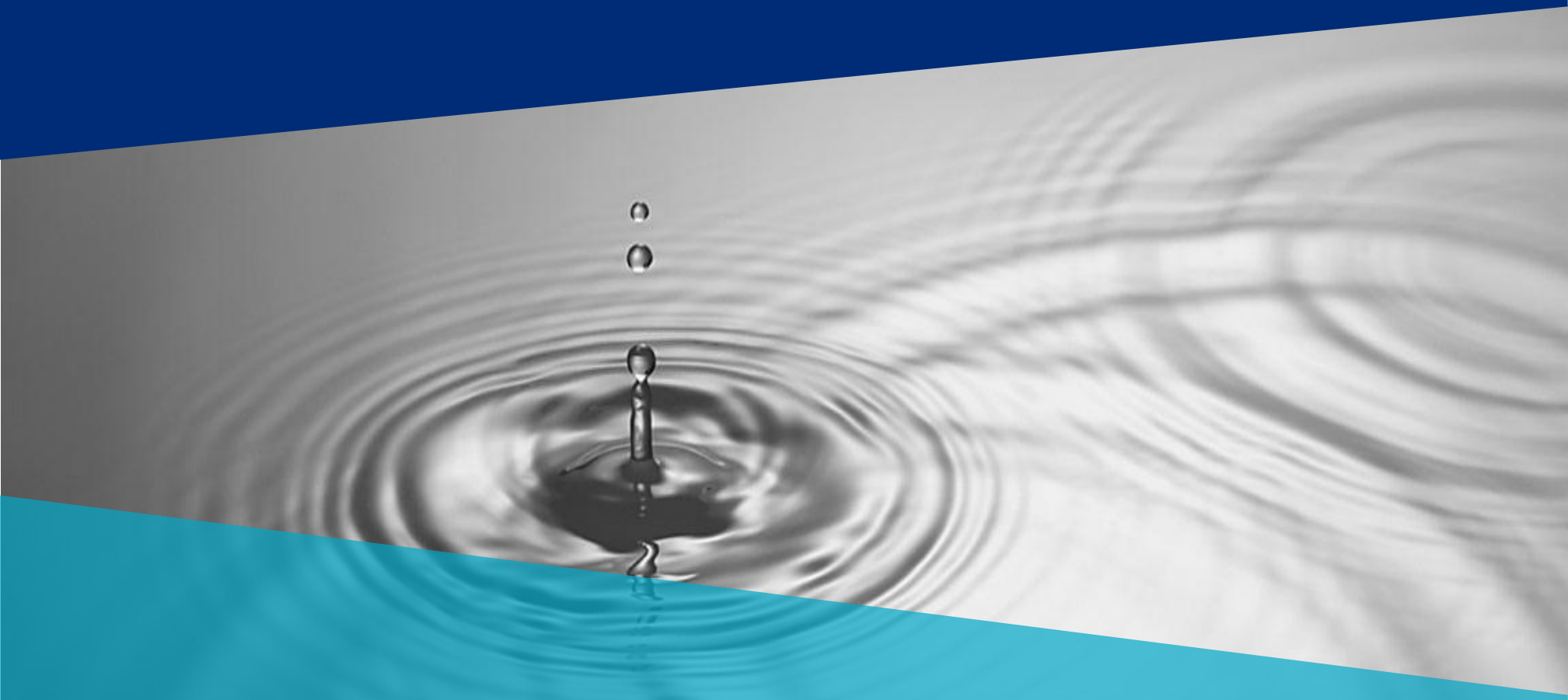


NFIP Ensemble Model
By Peril and Incremental Occurrence Layers

- inland and non-modeled exposure diminish significantly as occurrence layer attachment increases
- thus beyond lower attachments, occurrence layers can be more confidently priced in the near term



2 NFIP Financials: Stochastic Forecasts



NFIP Financials
Stochastic Forecasts

REVENUE

Surcharges – flat $ charges by occupancy

Assessments – flat % charges

Unsubsidized rate increases = inflation

Subsidized rate increases > inflation
(until full risk level reached)

Newly mapped policy additions each year

FORECASTING VARIABLES and ASSUMPTIONS

EXPOSURE

Added newly mapped policies annually

- no other exposure increases assumed

Demand elasticity formula applied to:

- Premium + surcharges + assessments increases > inflation by segment
- Losses - overall average exposure reduction with a newly mapped offset

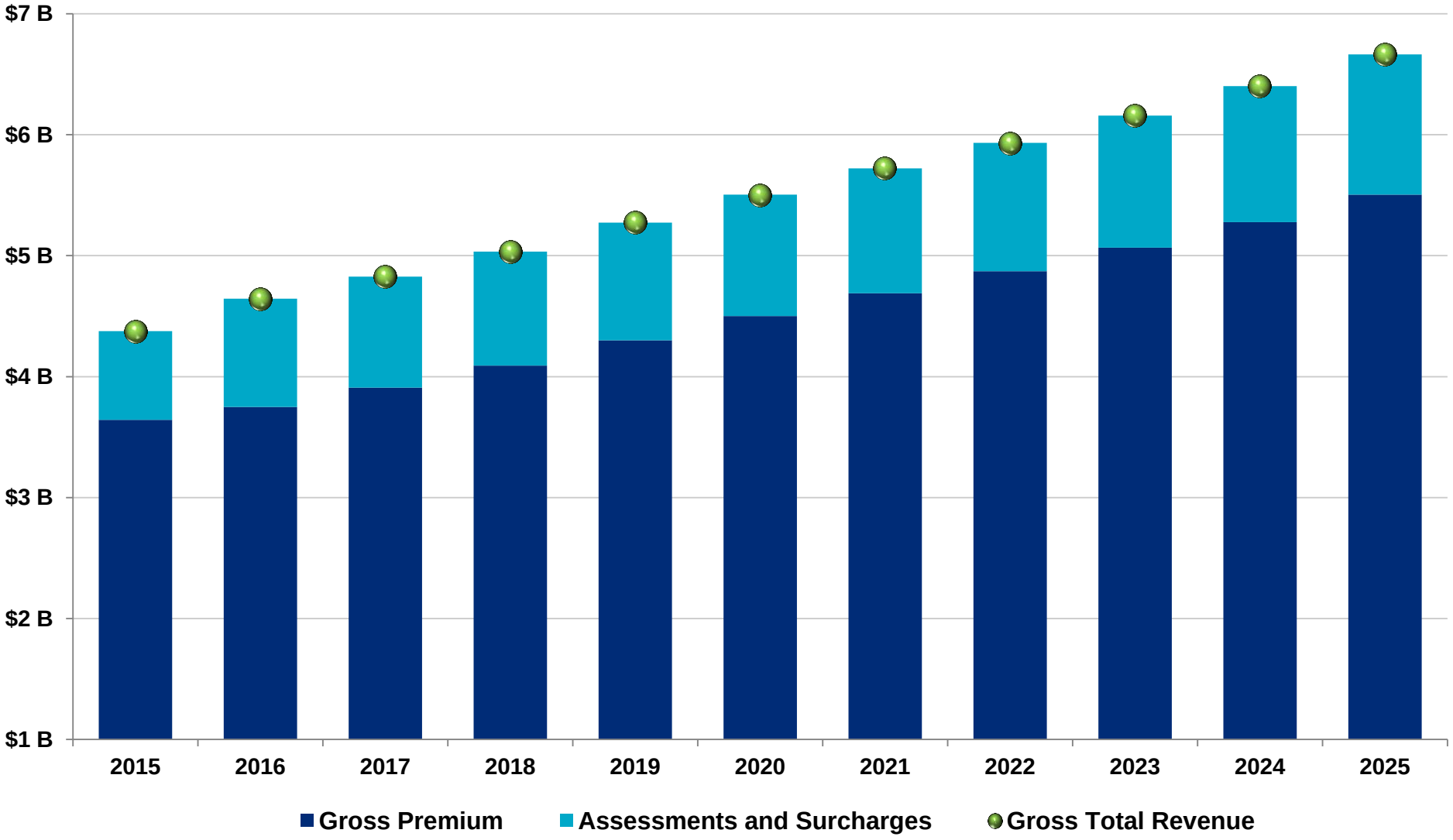
LOSSES, EXPENSES, and INTEREST RATES

Losses per exposure increased by stochastic CPI inflation annually

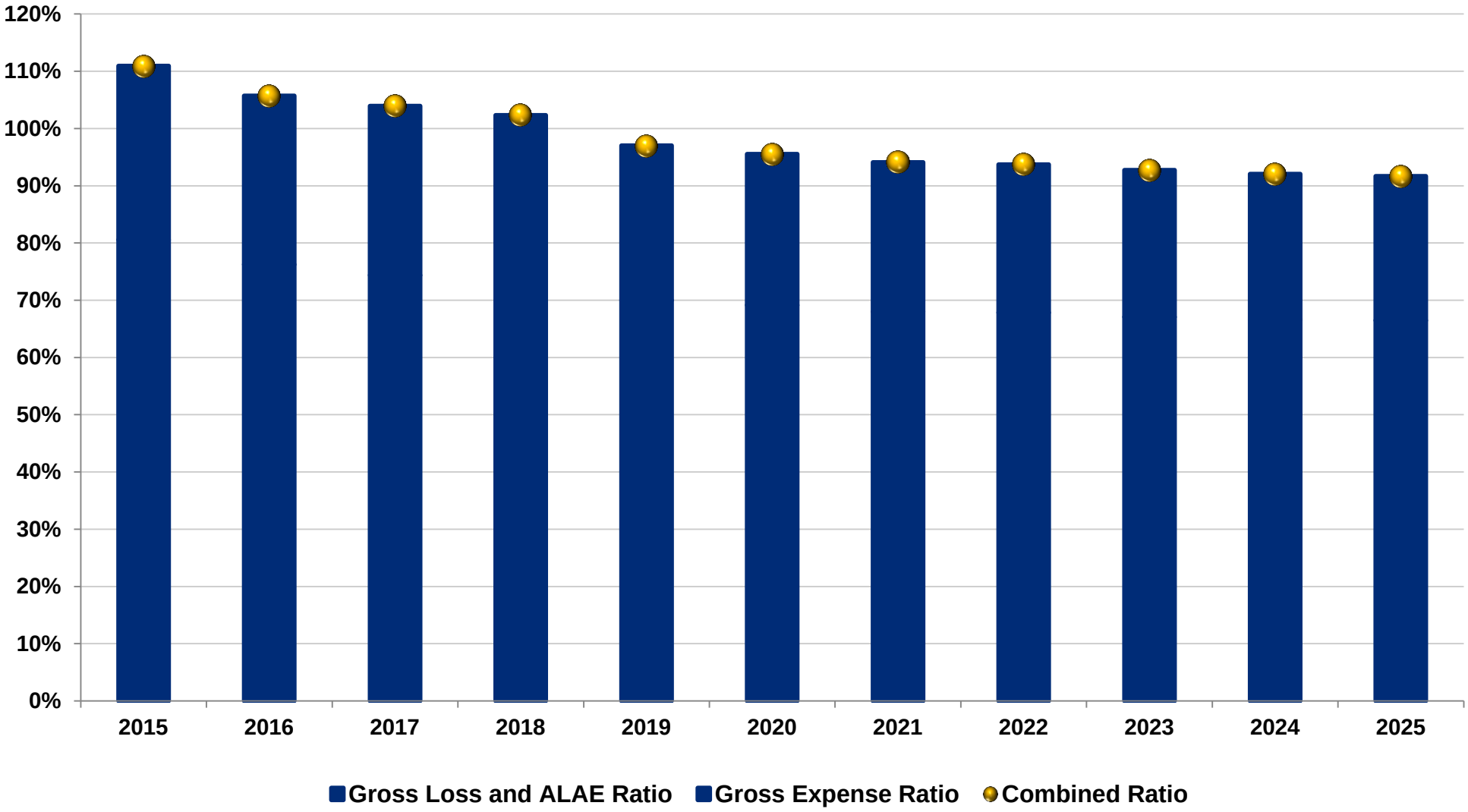
Planned expense ratio reductions to subsidized policies beginning 2019

Stochastic yield rates applied annually to investment income/debt accrual

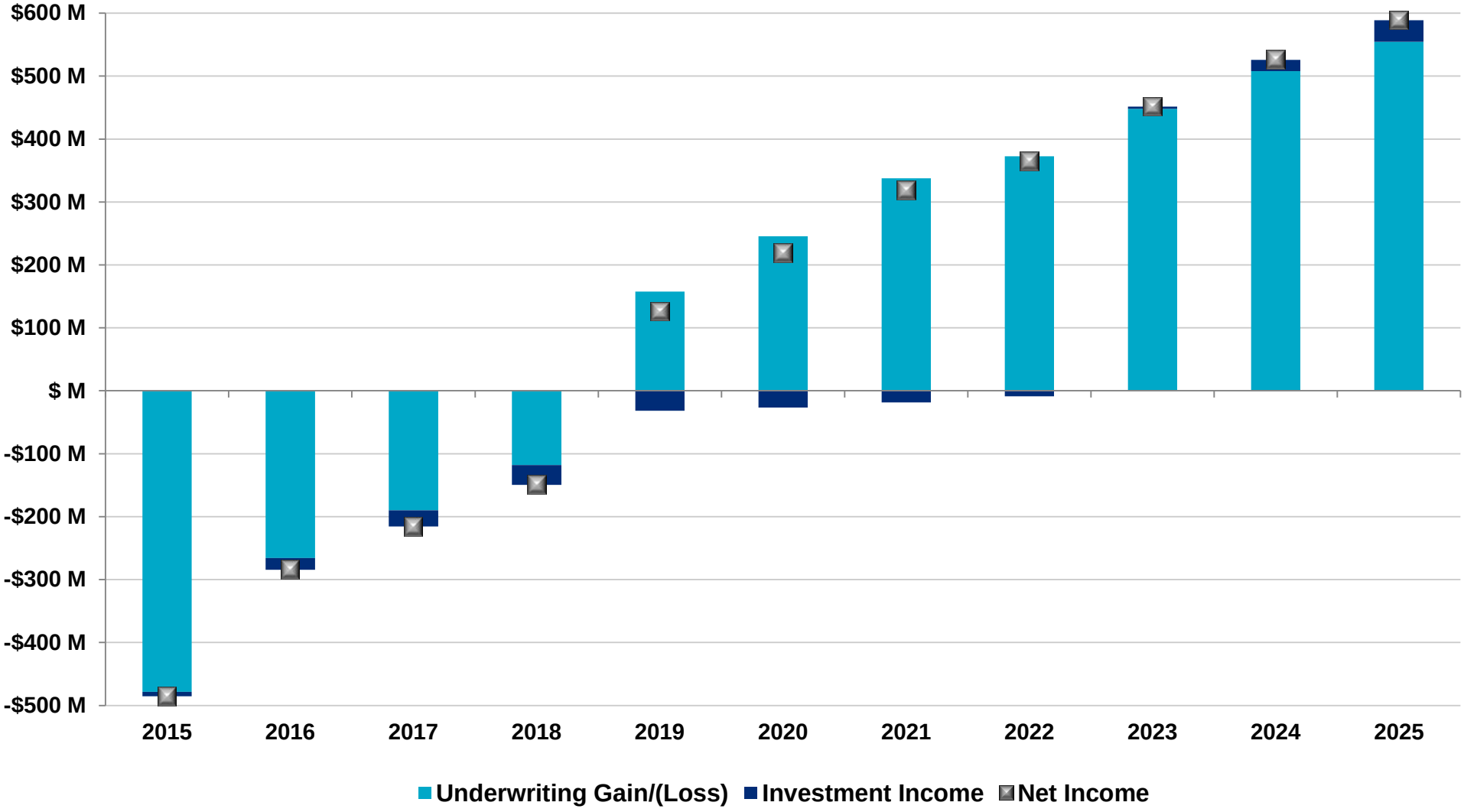
NFIP Revenue Projections
Premium, Assessments, and Surcharges



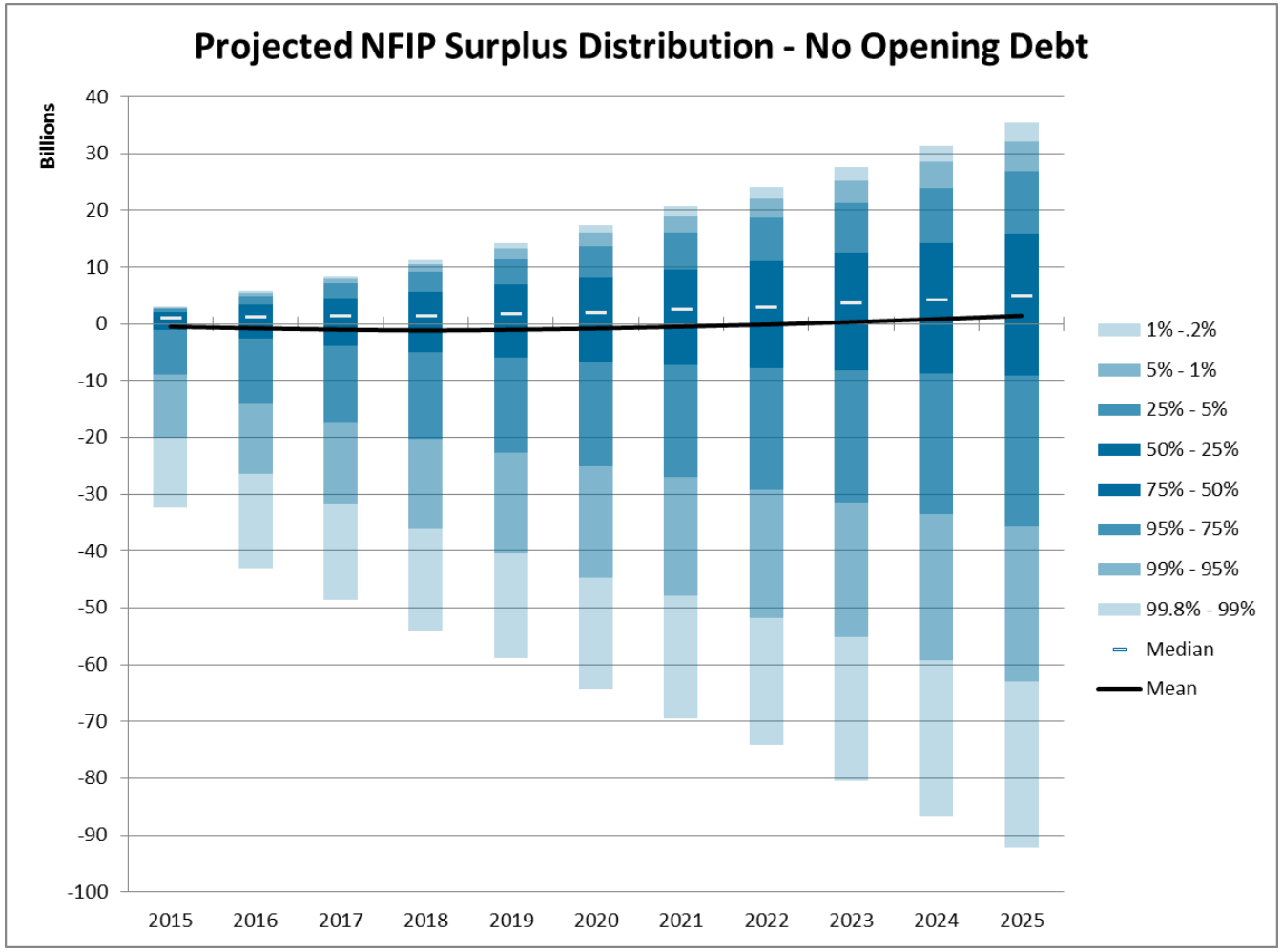
Projected NFIP Mean Underwriting Results
Combined Ratios



Projected NFIP Mean Operating Income
Underwriting Gain/(Loss), Investment Income, and Net Income

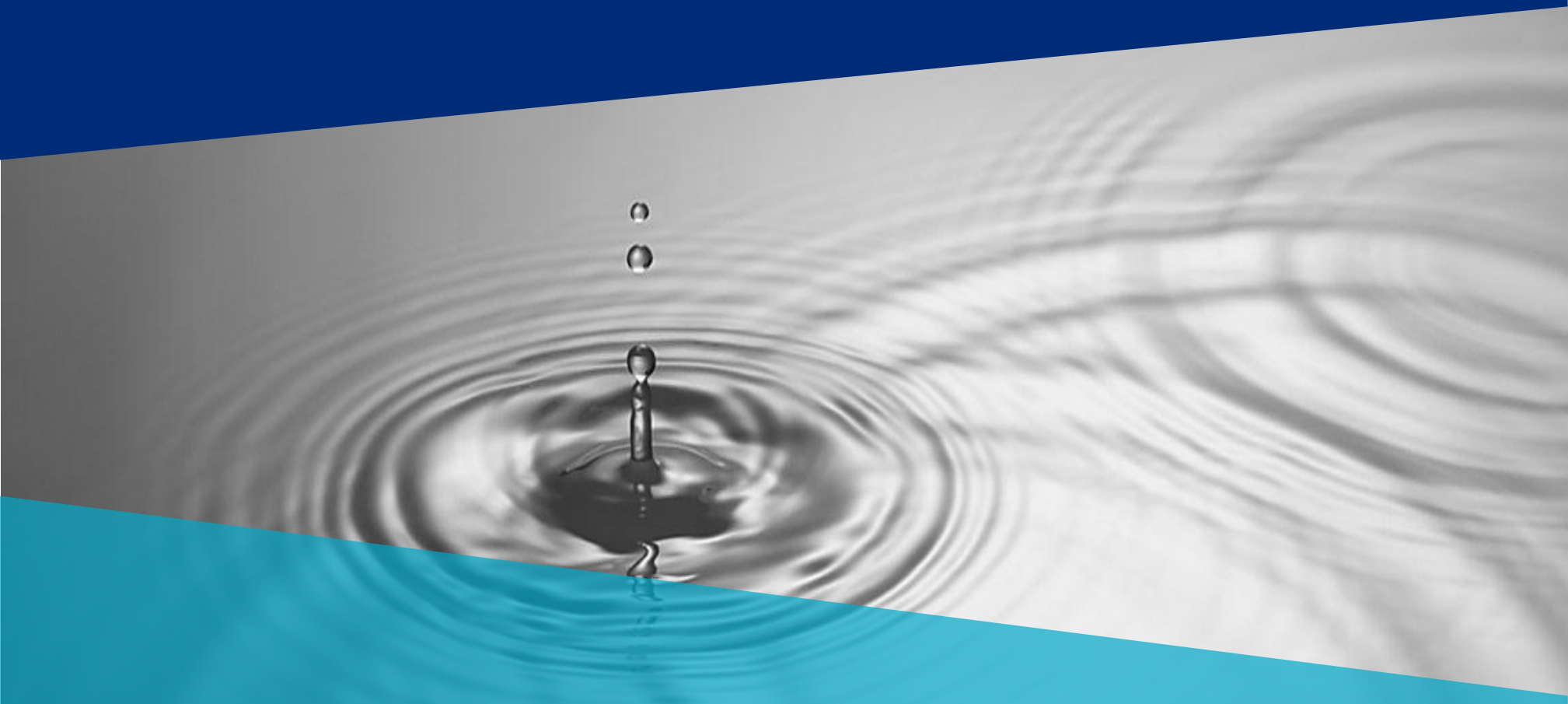


Projected NFIP Surplus Distribution – Cone of Uncertainty
Excluding Current Debt



The possibility of deficits is still significant despite mean surplus turning positive

3 EVALUATING REINSURANCE



Evaluating Reinsurance
Long Term Value – Summary

Reinsurance is a **cost efficient** source of non-subsidized capital with **~$60m savings per $1B** issued over corporate bond market

REINSURANCE IS CAPITAL

$8-16B of immediately accessible reinsurance is **real capital relief,** and the $2-4B initial program is **significant move towards stability**

Assuming adequate premiums, attainable reinsurance equates to a **~40% reduction** in the probability of having to raise NFIP's debt ceiling and a **73% reduction** in the probability of having to do this at least twice over a 10 year timeframe

NFIP – Evaluating Reinsurance
Long Term View – Analytical Approach

- view several straightforward reinsurance structures and estimated market pricing
- generate 10 years of financials at adequate rate level
  - *establish adequacy of revenue to support reinsurance purchase, add any shortfall*
  - *replenish capital when the existing debt ceiling is exhausted*
  - *compare probabilities of exhausting debt ceiling and replenishment $s*
- while comparisons between structures are interesting, the primary purpose of this analysis is to analyze reinsurance value across a range of common types and terms
- long-term $ amounts are 2025 projections, thus limited accuracy
  - *the loss and expense ratios are less inaccurate and more relevant to the analysis*
  - *indications are sensitive to the level of rate adequacy*

Evaluating Reinsurance – Long Term View
10 Year Value Metrics with Capital Replenishment

Figures in $Billions

Metric	Gross	Agg 16x7	Agg 8x7	Occ 16x7	Occ 12x5
Reinsurance Deposit	0	2.4	1.7	1.4	1.5
Annual Net Margin	1.8	.40	.80	1.0	1.0
Pr (1+ replenishment)	18.6%	11.5%	13.8%	16.5%	14.8%
Pr (2+ replenishment)	2.9%	0.8%	1.4%	2.0%	1.5%
Capital Replenishment:					
Avg per 10 year string	4.0	1.9	2.7	2.3	2.0
Avg per replenishment	21.3	16.1	19.5	13.9	13.2
Change over Gross					
Pr (1 + replenishment)		**-38%**	**-26%**	**-11%**	**-21%**
Pr (2+ replenishment)		**-73%**	**-53%**	**-32%**	**-50%**
Capital per 10 year string		**-53%**	**-32%**	**-42%**	**-51%**
Capital per replenishment		**-24%**	**-8%**	**-34%**	**-38%**

- Reinsurance reduces frequency of need to increase debt ceiling
- Reinsurance also reduces severity of the debt ceiling increase (when increased)
- Must have revenue margin sufficient to support reinsurance purchase
  - *this example adds more revenue than projected 2025 rate levels*
  - *reinsurance saves $1.5b in revenue increase needed for comparable protection*

Reinsurance is Cost-efficient Capital
Corporate Bond Market Comparisons

PROCESS

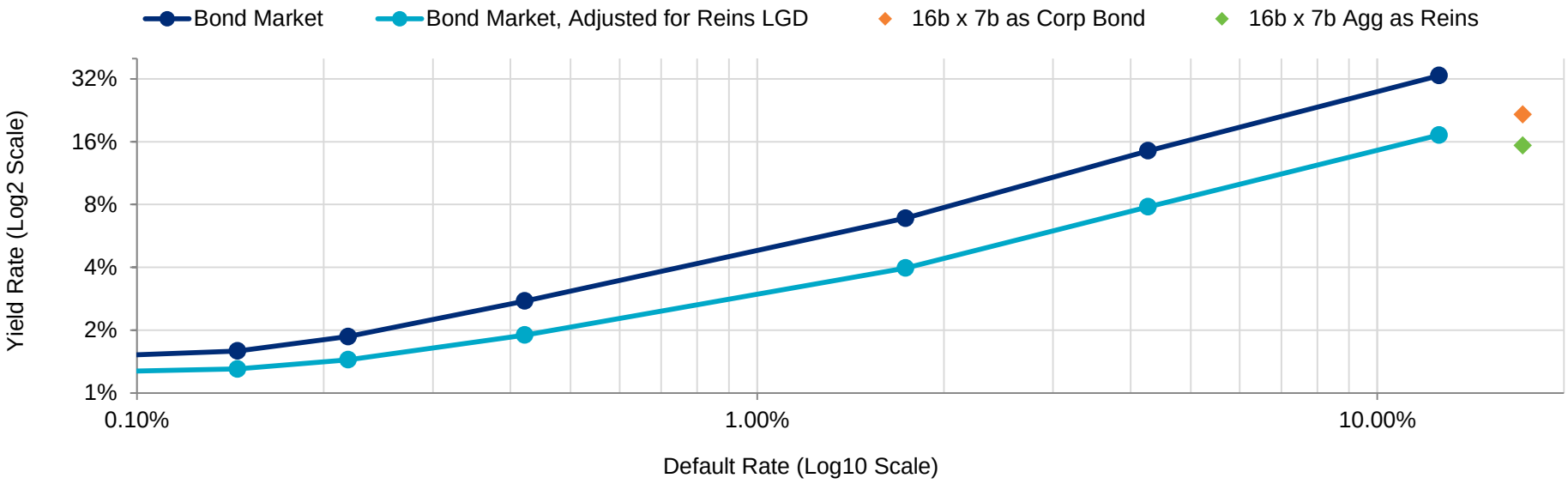
1. Start with Corporate Bond Yields (~$10 trillion market, ~$27b daily trading volume)
   – James Carville: *I used to think if there was reincarnation, I wanted to come back as the president or the pope or a .400 baseball hitter.* ***But now I want to come back as the bond market. You can intimidate everybody.***
2. Adjust for differential recovery rate
3. Interpolate on log-log scale
4. Inferred yield for corp bond with similar default probability

RESULT

Save $40-$100m per $1b issued

- Adjusting for credit cliff, tail correlation, bond fees increases savings
- Key assumption: Treasury has limit to risk-free financing
  - But borrowing at risk-free rate is subsidization

Reinsurance is Cost-efficient Capital
Bond Market Comparison - Math



Tranche	p(default)	rtn pd	Yield	LGD	Risky RoR[2]	Adj RoR[3]
Bond_Govt_USD	0.0000%	n.a.	1.0143%	0.0%	n.a.	1.014%
Bond_AAA_Corp_USD	0.0052%	19,230.8	1.1026%	70.9%	1.139%	1.059%
Bond_AA_Corp_USD	0.1452%	688.7	1.5899%	70.9%	1.826%	1.304%
Bond_A_Corp_USD	0.2190%	456.6	1.8650%	70.9%	2.214%	1.443%
Bond_BBB_Corp_USD	0.4220%	237.0	2.7615%	70.9%	3.479%	1.894%
Bond_BB_Corp_USD	1.7348%	57.6	6.8827%	70.9%	9.291%	3.970%
Bond_B_Corp_USD	4.2706%	23.4	14.4820%	70.9%	20.010%	7.798%
Bond_CCC_Corp_USD[4]	12.5842%	7.9	33.2066%	70.9%	46.420%	17.230%
Log-linear extrapolation	25.1684%	4.0				28.648%

Reinsurance LGD: 35.7%

LGD = Loss Given Default

Reinsurance Discussion
Bond Market Comparison - Math

Option	Occ/Agg	p(attach)	LGD	Yield	Dep RoL	Adj RoL	Accept Reins?	Save Per $1b
16 x 7	Agg	17.16%	35.71%	**21.63%**	15.33%	**15.33%**	Yes	63
8 x 7	Agg	17.16%	53.69%	**32.10%**	21.54%	**21.54%**	Yes	106
16 x 7	Occ	9.36%	36.22%	**14.04%**	8.98%	**9.82%**	Yes	42
12 x 5	Occ	14.29%	41.01%	**21.58%**	12.76%	**14.58%**	Yes	70

Notes:

1. Key is to see Adj RoL<I, then reinsurance is mathematically cost-effective.
2. Save per $1b is in millions
3. LGD = Loss Given Default.

OBSERVATIONS

- $40m-$100m cost advantage per $1b issued
- Reinsurance market more comfortable with default
- As default probability increases, reinsurance cost advantage goes up
- Correction for credit cliff and correlation would increase savings
- Correlation increases for tail events (lower default probabilities)

NFIP – Value of Reinsurance
Recap

Macro – Debt Matters

- Aggregate federal debt & debt to GDP ratio stress economy
- $8-16b is a significant transfer
- Is reinsurance a core federal function?
- Some unexpected social spending has no private market solution

Micro – Reinsurance Can Help NFIP

- Use to justify actuarially sound rates
- Annual volatility compressed
- Reduce probability of debt ceiling increase
  - Reduce overall probability 38%
    - If Treasury used for extreme tail, reduction % is even more
- Reinsurance costs less than corporate debt
  - As much as $40-100m+ per $1b issued

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As with any actuarial analysis, the results presented herein are subject to significant variability. While these estimates represent our best professional judgment, it is probable that the actual results will differ from those projected. The degree of such variability could be substantial and could be in either direction from our estimates.

The estimated cash flows may vary significantly from amounts actually collected, particularly in the event that a reinsurer is unwilling or unable to perform in accordance with the terms of the reinsurance contract.

In performing this analysis, we relied on FEMA for historical NFIP claims data, current financial data and information, and information and assumptions regarding future NFIP revenue and expense levels. We did not perform an independent review of these estimates.

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In performing this analysis, we relied on AIR for estimates regarding claim inflation and exposure trend of historical NFIP claims and exposures to current cost and exposure levels, as well as the amount of historical NFIP losses for subperils for which their current software models do not provide estimates. We did not perform an independent review of these estimates.

In performing this analysis, we relied on Moody's for estimates regarding economic scenarios of future interest rates and inflation rates. We did not perform an independent review of these estimates.

The results in this report are generated with software models provided by Risk Management Solutions, Inc.
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