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2024 SOA VALUATION ACTUARY MEETING

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Session 2E:
Update on NAIC GOES Project

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Agenda

- NAIC GOES Update
- GOES Model Office Field Test Results
- An Alternative Model for Corporate Bond Fund Returns

NAIC GOES Update

Seong-Min Eom, MAAA, FSA

Economic Scenarios Used in NAIC Frameworks

NAIC Economic Scenarios

Treasury Scenarios

- Real-world US treasury yields for 1M, 3M, 6M, and 1-30Y maturities.
- Used to model asset sales, reinvestment, and discount rates

Equity Fund Scenarios

- US Large Cap, Mid Cap, Small Cap, and Aggressive Equity Funds
- International Diversified Equity and Aggressive Foreign Equity Funds
- Primarily used to model separate account investments

Bond Fund Scenarios

- Eight separate bond funds including Intermediate US Government, Long Investment Grade Corporate, and Money Market
- Primarily used to model separate account investments

NAIC Framework

Products	Life Insurance	Variable Annuities	Non-Variable Annuities	Prescribed?
Reserve Standards	VM-20	VM-21	VM-22**	Yes
	Asset Adequacy Analysis			No
Risk-Based Capital		C3 Phase II	C3 Phase I*	Yes
Risk Management	Own Risk and Solvency Assessment (ORSA)			No

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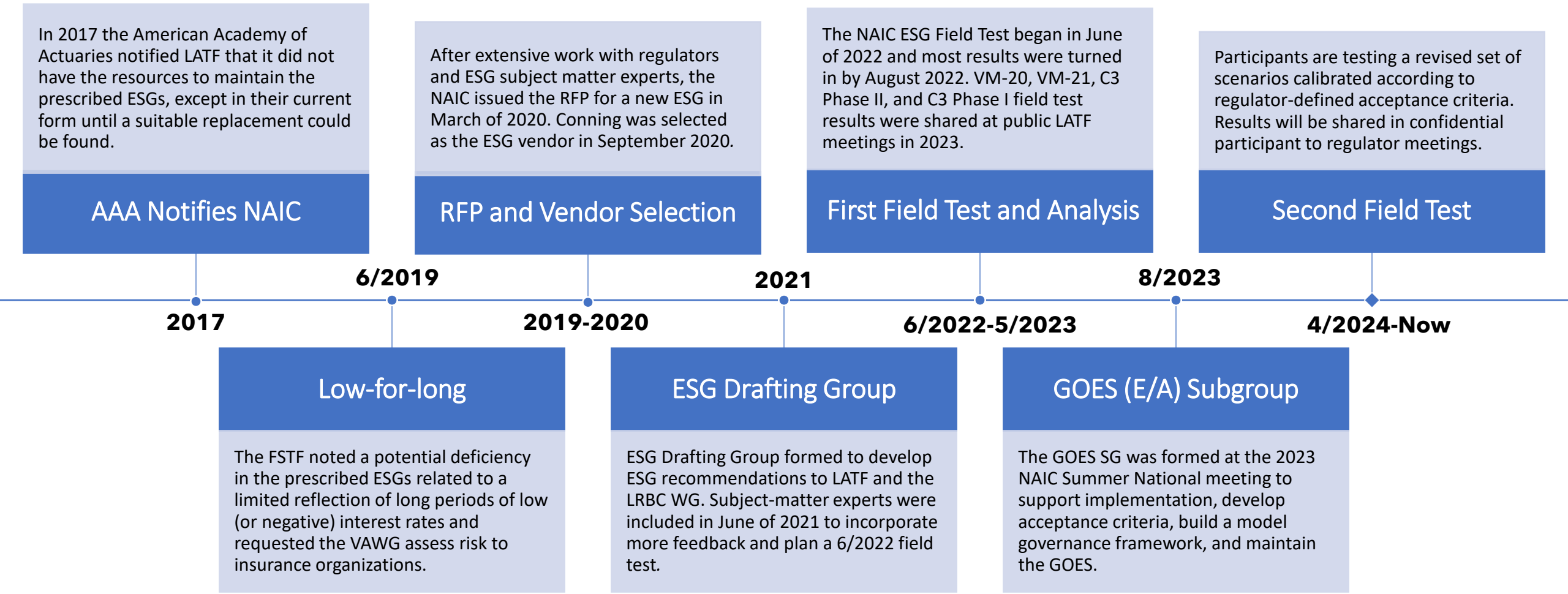
*The scope of C3 Phase I also includes products other than fixed annuities, such as single premium life insurance
**VM-22 is currently under development for non-variable annuities and was not included in the ESG Field Test

Project History

Life Actuarial (A) Task Force .....(LATF)
Valuation Analysis (E) Working Group ..... (VAWG)
Financial Stability (E) Task Force ..... (FSTF)
Life Risk-Based Capital (E) Working Group ..... (LRBC WG)
Generator of Economic Scenarios (E/A) Subgroup....(GOES SG)



Key Decisions Made Prior to 2024 GOES Field Test

Stylized Facts and Acceptance Criteria

- The Academy's Economic Scenario Generator Subcommittee developed a comprehensive set of stylized facts and acceptance criteria for the Treasury, equity and corporate models. GOES (E/A) Subgroup members had concerns that too many acceptance criteria could lead to more subjectivity on determining scenario suitability.
- The GOES (E/A) Subgroup decided to utilize a revised set of acceptance criteria separated into primary targeting criteria that serve as instructions for the GOES calibration and secondary evaluation statistics that provide additional information.

Equity-Treasury Linkage

- In GEMS® there is a functional linkage between the overnight Treasury yield and the drift factor for the equity fund price. Therefore, the expected equity fund total returns will rise and fall with changes to the starting short maturity interest rate levels. This is a departure from the currently prescribed Academy Interest Rate Generator (AIRG) that does not have this functional equity-Treasury linkage.
- The GOES (E/A) Subgroup elected to remove the structural linkage and modify the equity acceptance criteria developed by the Academy to use an average of the results of the reference models that were utilized in development of the criteria, rather than a “least-restrictive” approach. This change to the acceptance criteria helped ensure that an appropriate amount of low equity/low Treasury scenarios would be reflected.

Corporate Model

- The GEMS® Corporate Model captures the key dynamics that influence bond returns, including stochastic spreads, credit rating transitions, and defaults. However, due to the proprietary nature of the GEMS® Corporate model, there are limits to the extent of documentation that can be shared publicly. The Academy developed a simpler alternative model that is fully documented.
- The GOES (E/A) Subgroup elected to move forward with the GEMS® Corporate Model for the unaggregated field test primarily to take advantage of Conning’s ongoing research and development of their Corporate model.

Revised GOES Field Test Approach

Field Test 1

- **Participants submit field test results to NAIC to compile and share aggregated and anonymized data in public meetings**
- Advantages:
  - The aggregation of a sufficient amount of participant data allows for a proxy of the impact to the industry
  - Public disclosure of results
- Disadvantages:
  - Resource intensive for companies to participate and for NAIC to compile results
  - Lack of transparency into understanding individual company results
  - Limited participation for certain products/frameworks resulted in unknown applicability to overall industry

Field Test 2

- **Results are shared in confidential participant-to-regulator meetings. Model office testing is also employed for public disclosure of scenario impacts.**
- Advantages:
  - Model office testing allows for quicker feedback on candidate scenario sets
  - Regulators will get greater transparency into company-specific results
- Disadvantages:
  - Model office only a proxy for impact to industry and does not cover entire range of product- and company-specific impacts
  - No public disclosure of aggregated industry field test results

Status of Field and Model Office Testing

Participants:
37 Legal Entities
24 Groups

- There are five required runs using the new GOES field test scenario sets. The runs test the latest calibration of the GOES at of year-end 2023, other alternative Treasury starting conditions, and also include an equity market drop sensitivity.
- There are also seven optional field test runs that include additional Treasury, bond, and equity sensitivities along with a scenario set that uses an alternative initial yield curve fitting methodology.
- Confidential, participant-to-regulator discussions are being held and will continue through at least August. Seven groups have already presented.
- Variable annuity model office testing results were presented in early June and life model office results were presented at the Life Actuarial (A) Task Force session of the NAIC's Summer National Meeting.

Required Field Test Runs:

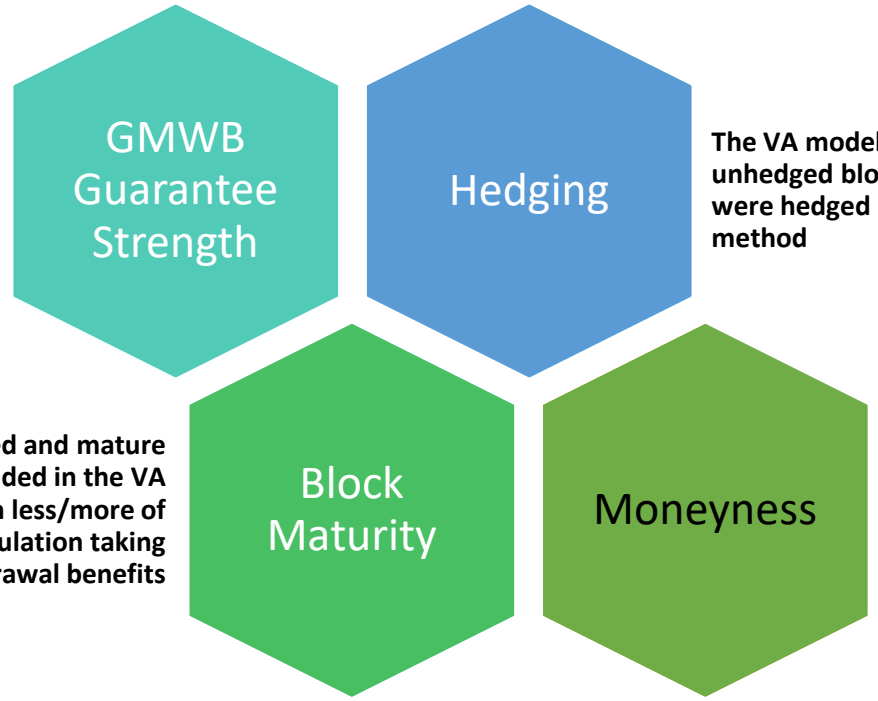
Field Test Run	Scenario Sets	Inforce
Baseline	Scenario set(s) the company used for 12/31/23 statutory reporting of reserves and RBC	As of 12/31/23
#1 - GOES	Conning scenarios as of 12/31/23	As of 12/31/23
#2 – Low Rate Shock	Conning scenarios with a starting UST yield curve as of 3/9/20 but with 12/31/23 starting credit spreads.	As of 12/31/23, but modified as necessary for a different starting UST yield curve.
#3 – Up Rate Shock	Conning scenarios with a starting UST yield curve as of 10/31/89 but with 12/31/23 starting credit spreads.	
#4 – Normal Yield Curve	Conning scenarios with a starting UST yield curve as of 12/31/04 but with 12/31/23 starting credit spreads.	
#5 – Down Equity Shock	Same as #1	As of 12/31/23, but modified for a 25% drop in equity markets.

Variable Annuity Model Office Insights

High-Level Overview

- Oliver Wyman was contracted by the NAIC to build out a Variable Annuity (VA) and Life model office analyze field test scenario sets.
- For the VA model office, results were produced for 16 different "archetypes" (model cohorts that reflected distinct risk drivers) and compared against the range of participant results from the first field test to ensure the model captured much of the range of results.
- For testing the 2024 GOES field test scenarios, three of the key archetypes were utilized:
  - Mature Business/Strong Guarantee/ATM
  - New Business/Strong Guarantee/OTM
  - New Business/Weak Guarantee/ITM

Variable Annuity Model Office "Archetypes"



The VA model office included unhedged blocks and blocks that were hedged using the implicit method

Newly issued and mature blocks were included in the VA model office with less/more of the model population taking withdrawal benefits

Variable Annuity Model Office Insights (continued)

Key Takeaways – Initial Analysis

- It is important to look at the change in the total reserve (cash surrender value + excess reserve).
- The relationship of the scenario reserves relative to the cash surrender value floor is a major driver in the change in the excess reserve.
- Distinct risk drivers have an impact on the relationship of the cash surrender value to the scenario reserves and the sensitivity to changes to underlying scenarios.

Key Takeaways – Analysis of Field Test 2 Scenarios

- GOES Field Test 2 scenario set #1 drove higher reserves compared to results produced using the Academy Interest Rate Generator (AIRG) due to lower tail equity gross wealth factors (GWFs) and lower early projection period treasury rates.
- The alternate Treasury or equity starting condition sensitivities (GOES Field Test 2 scenario sets #2-5) produced results that were consistent with expectations (e.g. lower reinvestment income driven by lower starting Treasury conditions in #2 produced higher reserves, higher in-the-moneyness from the equity down-shock in #5 saw increased reserves)

Next Steps

Conclude 2024 GOES Field Test

- Finish conducting participant-to-regulator discussions
- Summarize key findings for public discussion while preserving confidentiality
- Share results from the life model office analysis at Summer NAIC National Meeting
- Answer any remaining questions using model office

Continue Work of GOES (E/A) Subgroup

- Develop and approve GOES model governance framework*
- Streamline and enhance documentation*
- Refine GOES calibration, as needed, after incorporating lessons learned from field and model office testing
- Recommend final VM-20 Stochastic Exclusion Ratio Test methodology, scenario picking tool, and statistical reports

Adoption of GOES

- Once the GOES (E/A) Subgroup finalizes a recommendation, the Life Actuarial (A) Task Force and Life RBC (E) Working Group will adopt necessary changes into the Valuation Manual and RBC Instructions.
- **The GOES will not be required any sooner than 2026.** However, early adoption may be possible depending on the decisions of the GOES (E/A) Subgroup and parent groups in the NAIC Committee structure.

*Model governance program and documentation will be revised and enhanced on an ongoing basis

OliverWyman

GOES MODEL OFFICE Field TEST Results

Valuation Actuary Meeting 8/26/2024

Simon Gervais, FSA, MAAA

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agenda

1	Generator of economic scenarios (“GOES”) field test overview
2	VM-20 and VM-21 model office results
3	Takeaways

GOES Field Test overview

Field test scenario sets

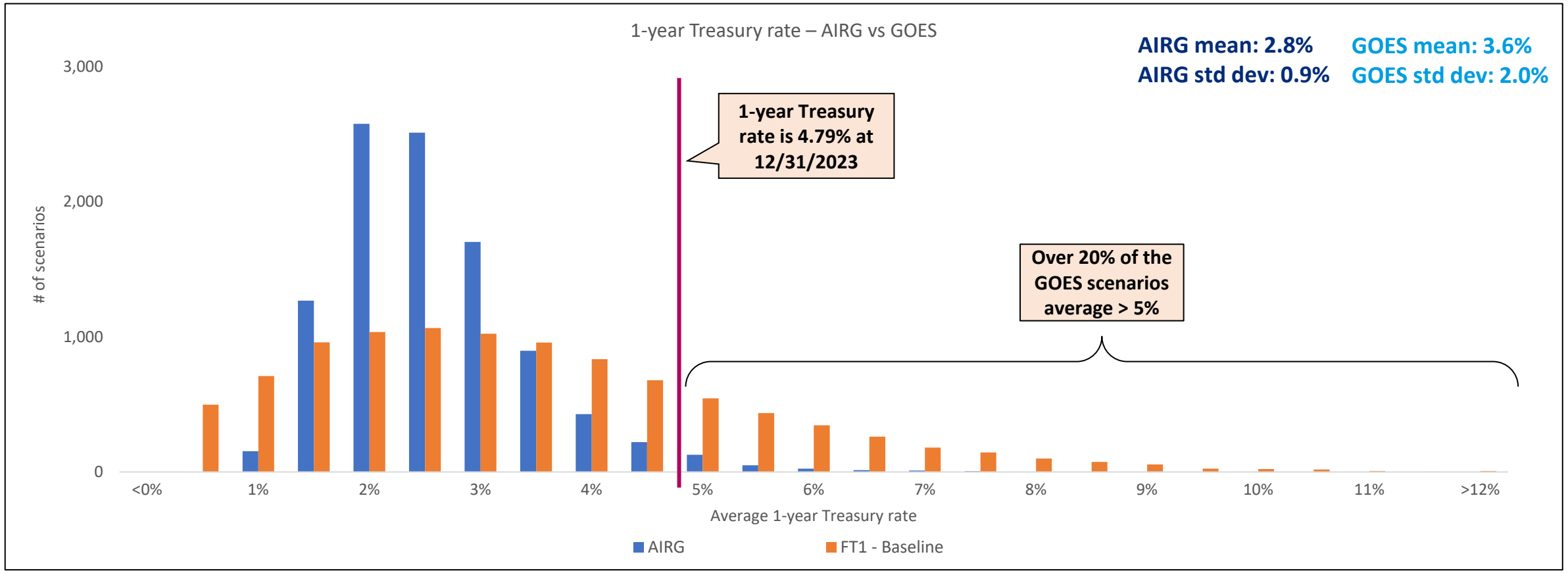
Model office testing was performed on the Academy Interest Rate Generator ("AIRG") scenario set, GOES Field Test scenario sets 1-5 as applicable, and the alternative baseline

Scenario Set	Description	Starting yield curve				
		3-mo	1-yr	10-yr	20-yr	30-yr
AIRG	AIRG as of 12/31/2023	5.40%	4.79%	3.88%	4.20%	4.03%
FT1 GOES Baseline	Conning scenarios as of 12/31/23	*Same as AIRG*				
FT2 Low Rate Shock	Conning scenarios with a starting UST yield curve as of 3/9/20 but with 12/31/23 starting credit spreads	0.33%	0.31%	0.54%	0.87%	0.99%
FT3 Up Rate Shock	Conning Scenarios with a starting UST yield curve as of 10/31/89 but with 12/31/23 starting credit spreads	8.61%	7.76%	7.93%	N/A	7.98%
FT4 Normal Yield Curve	Conning scenarios with a starting UST yield curve as of 12/31/04 but with 12/31/23 starting credit spreads	2.22%	2.75%	4.24%	4.85%	N/A
FT5 Down Equity Shock	Conning scenarios as of 12/31/23 (same as Field Test 1)	*Same as AIRG / baseline*				
FT6 Alternative Baseline	Conning scenarios as of 12/31/23 but with the alternative yield curve fitting proposed by ACLI	*Same as AIRG / baseline*				

Dispersion of average 1-year treasury rate over 30 years

The graph below plots the dispersion of the 1-year Treasury rates from the GOES baseline and AIRG 10,000 scenario sets

Dispersion of average 1-year Treasury rates over 30 years of projection[1]



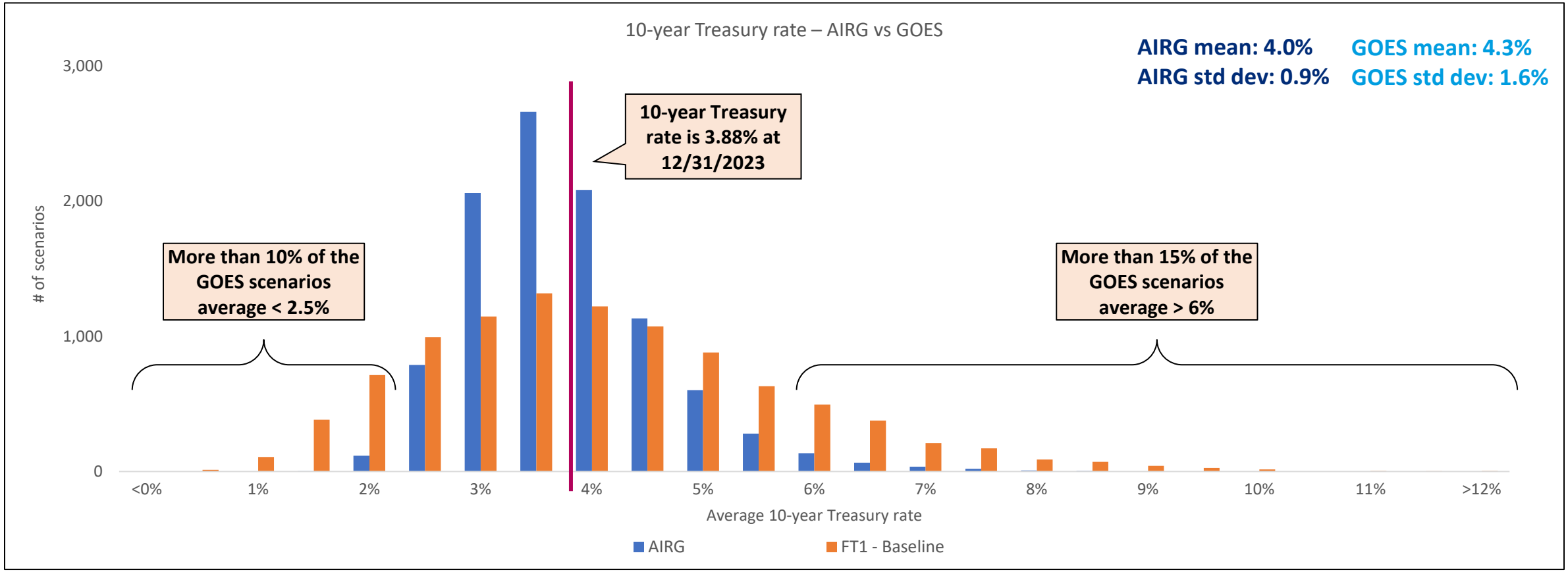
1. Geometric average over 360 months of projections, mean and standard deviation are calculated on the average returns

GOES scenarios are showing a much wider range of Treasury rates and are skewed towards significantly higher long-term averages

Dispersion of average 10-year treasury rate over 30 years

The graph below plots the dispersion of the 10-year Treasury rates from the GOES baseline and AIRG 10,000 scenario sets

Dispersion of average 10-year Treasury rates over 30 years of projection[1]



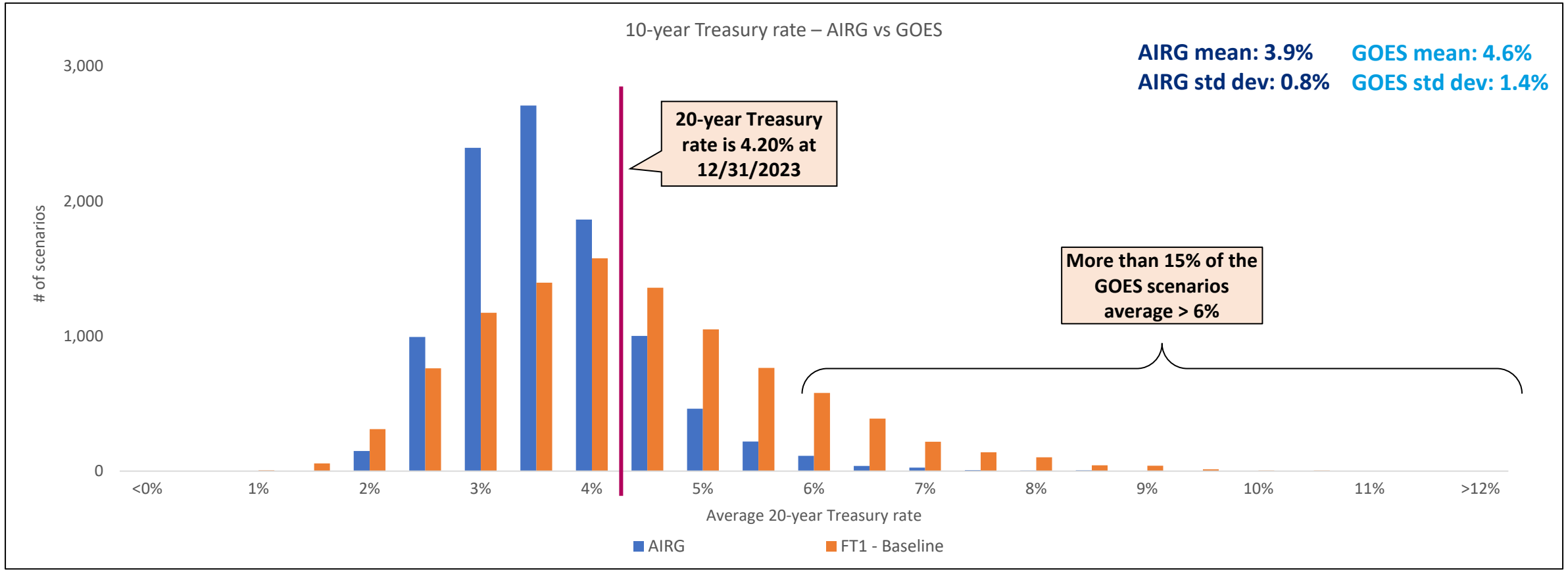
1. Geometric average over 360 months of projections, mean and standard deviation are calculated on the average returns

GOES scenarios are showing a much wider range of Treasury rates, exhibiting both significantly higher and lower rates than AIRG

Dispersion of average 20-year treasury rate over 30 years

The graph below plots the dispersion of the 20-year Treasury rates from the GOES baseline and AIRG 10,000 scenario sets

Dispersion of average 20-year Treasury rates over 30 years of projection[1]



1. Geometric average over 360 months of projections, mean and standard deviation are calculated on the average returns

GOES scenarios are showing a much wider range of Treasury rates and are skewed towards significantly higher long-term averages

comparison of cumulative equity returns over 50 years

The table below summarized the comparison of the accumulated value of $1 invested at time 0 between the GOES baseline and AIRG 10,000 scenarios sets

Comparison of gross wealth factor ("GWF") by percentile and year
Displayed data calculated as (GOES / AIRG) – 1

	1-yr	5-yr	10-yr	15-yr	20-yr	25-yr	30-yr	50-yr
Min	22%	-43%	-62%	-77%	-81%	-70%	-64%	-47%
1%	-2%	-10%	-20%	-21%	-30%	-24%	-24%	-33%
2.50%	-2%	-4%	-10%	-10%	-14%	-17%	-19%	-21%
5%	-1%	-1%	-4%	-4%	-8%	-12%	-12%	-14%
10%	0%	-1%	-1%	-3%	-3%	-6%	-5%	-10%
25%	1%	2%	3%	2%	1%	0%	-1%	-4%
50%	2%	3%	3%	3%	2%	2%	3%	2%
75%	1%	1%	2%	1%	2%	1%	1%	0%
90%	0%	-1%	-2%	-1%	-3%	-2%	-2%	-2%
95%	-1%	-3%	-2%	-6%	-5%	-6%	-7%	-4%
97.50%	-1%	-5%	-4%	-7%	-10%	-9%	-9%	-6%
99%	-3%	-7%	-9%	-10%	-13%	-11%	-14%	-3%
Max	-2%	-19%	-24%	-15%	-5%	-37%	-38%	82%

Commentary

- The GOES and AIRG GWFs are showing a **tight fit around the median** with a **relative difference of less than 5%**
- **Median scenarios** are generally producing slightly **higher GWFs under the GOES** than AIRG
- The **worst 5% of scenarios** are producing **lower equity returns** under the GOES and produce **more extreme results in the left tail**
- The **best 5% of scenarios** are producing **lower equity returns** under the GOES and produce **less favorable results in the right tail**
- The spread of cumulative returns between AIRG and GOES expands as the projection horizon increases and we move closer to the tail

The GOES baseline scenarios exhibit more extreme tail scenarios than the AIRG

VM-20 and VM-21 Model Office Results

VM-20 Model office description

Model assumptions and product features were selected based on industry benchmarks to be a simplified representation of products

Projection model details	▪ **Term:** 20-year term policies issued in 2018
	▪ **ULSG:** Universal life with shadow design lifetime secondary guarantee issued in 2020
	▪ Time 0 reserves held in cash and reinvested at the start date of projection
	▪ Reinvestment strategy uses 50% A/AA corporate bonds
	  ▪ **Term**: 2-year bonds
	  ▪ **ULSG**: 10-year bonds

Assumptions	▪ Prudent estimate ▪ VM-20 prescribed mortality margins based on credibility and sufficient data period ▪ **Term:** 100% shock lapse after level-term period ▪ **ULSG:** Minimal lapse when policy maintained in-force by NLG (i.e. CSV = 0)

VM-21 Model office description

Model assumptions and product features were selected based on industry benchmarks to be a simplified representation of products

Projection model details	• Liability cash flows for model office comprised of the following product features: – Base variable annuity contract and a variety of GMxB (GLWB, GMDB, GMIB) with typical features and charges • Modeled on a direct basis only (i.e., without reinsurance) • Guardrail VM-21 prescribed strategy: 10-year bonds with ratings A and AA consistent with the guardrail prescribed under VM-21 • Pre-tax asset and liability projections under input stochastic scenarios reflecting all cashflows under prudent best estimate and VM-21 prescribed assumptions • Inforce asset iteration at valuation date under input stochastic scenarios to achieve no GPVAD
Assumptions	• Prudent estimate • No hedging

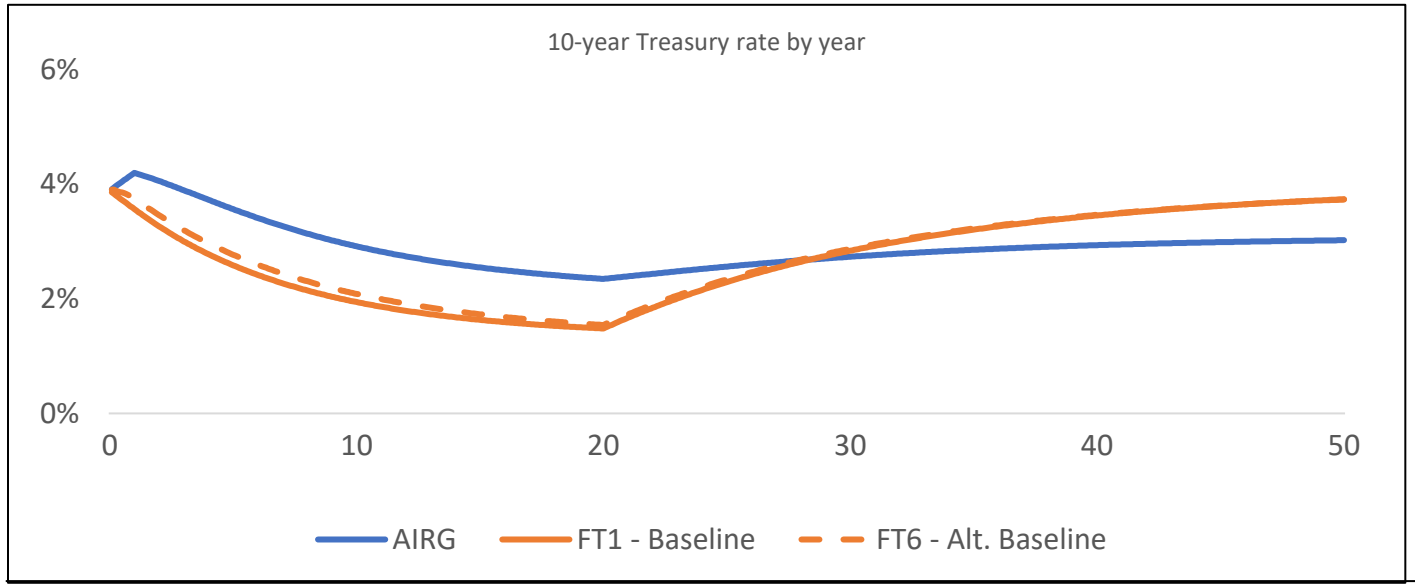
VM-20 Deterministic reserve ("DR")

The DR is produced using scenario 12 of the SERT scenario set

Term and ULSG Results (000s)

Scenario Set	Term DR	Change from AIRG	ULSG DR	Change from AIRG
AIRG	108		2,325	
FT1 Baseline	129	**+19%**	2,879	**+24%**
FT6 Alt. Baseline	134	**+24%**	2,765	**+19%**

SERT Scenario #12 (DR)



Commentary

- Per VM-20 Appendix 1 the DR scenario (#12) **shocks Treasury rates for years 1-20** and should be **one standard deviation** from the baseline scenario
- The **volatility of the GOES** scenarios result in a significantly **larger downward shock** than under AIRG
- **Long-term rates are higher** in the GOES scenario sets than in the AIRG
- There is minimal impact to results between the GOES FT1 baseline and FT6 alternative baseline
- **Starting assets are held in cash and reinvested at time 0.** The use of 2-year bonds for Term (10-year bonds for ULSG) allows the analysis to reflect the impact of differences in the yield curve at multiple durations; **more robust Asset-Liability Matching ("ALM") practices would mitigate impacts**
- As a result of the significantly lower rates in earlier durations, GOES baseline scenarios are producing a roughly **20% increase to the DR** for both Term and ULSG

The GOES DR scenario has significantly lower Treasury rates for years 1-20 and results in an increase to the DR for Term and ULSG

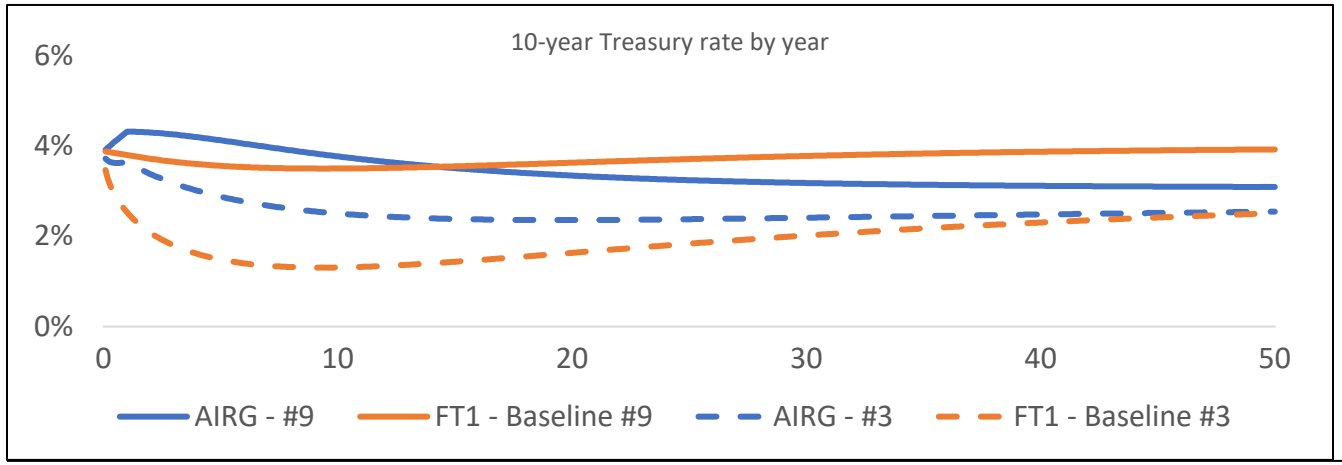
VM-20 Stochastic Exclusion Ratio Test ("SERT")

SERT results across the AIRG and GOES Field Test sensitivity scenarios are summarized in the table below, the passing threshold is 6%

Term and ULSG Results (000s)

	Term		ULSG	
Scenario Set	Max reserve (#3 pop down)	SERT ratio	Max reserve (#3 pop down)	SERT ratio
AIRG	95	**3.6%**	1,625	**8.6%**
FT1 Baseline	129	**6.3%**	2,281	**19.0%**
FT6 Alt. Baseline	136	**6.6%**	2,240	**20.2%**

SERT #9 – Baseline vs SERT #3 Pop Down



Commentary

- Under the GOES, the **baseline SERT scenario (#9)** which is an un-shocked yield curve, is showing slightly **lower Treasury rates in early projection years** and **higher Treasury rates in later years**, due to a higher mean reversion parameter
- Per VM-20 Appendix 1, the **pop down scenario** is described as having an **interest rate shock** selected to maintain the cumulative shock at the 10% level.
- The **wider dispersion** of Treasury rates under the GOES results in a **significantly larger shock to Treasury rates**
- The **maximum reserve** calculation for the SERT is **increased significantly** and results in **higher SERT ratios** than under the AIRG for the same liability profile
- The determination of the **SERT ratio may need to be reviewed** or the **scenario generation process may need to be further calibrated** to ensure the Exclusion Test's objectives are appropriately met

Similarly to the DR scenario, the SERT baseline (#9) and pop down (#3) scenario sets are showing a wider range of rates for the GOES

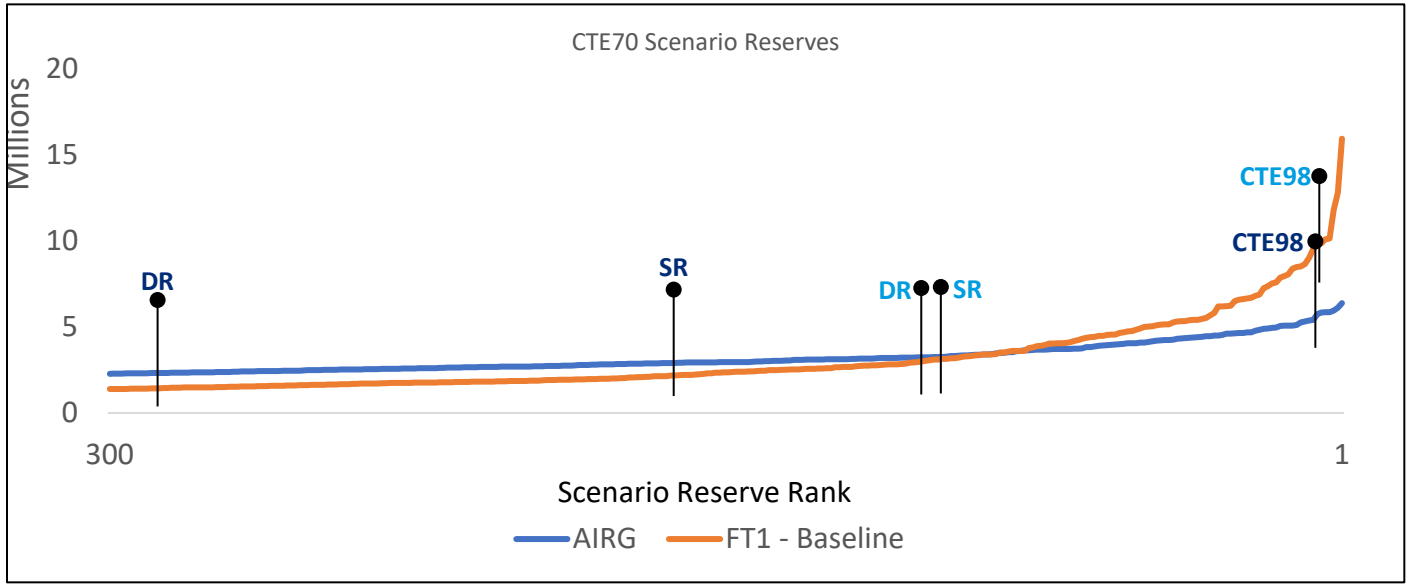
VM-20 Stochastic reserve ("SR")

The SR was produced using a 1,000 scenario subset of the AIRG and GOES scenario sets

ULSG Results (000s)

Scenario Set	DR	SR (CTE70)	Change from AIRG	CTE98	Change from AIRG
AIRG	2,325	3,229		5,417	
FT1 Baseline	2,879	3,167	-2%	9,336	+72%
FT6 Alt. Baseline	2,765	2,847	-12%	8,247	+52%

CTE70 Scenario Reserves



Commentary

- The GOES scenarios set are producing results that are **largely consistent with the AIRG at the CTE70 level**
- The **spread between the "worst" and "best" CTE70 scenario** is much **wider under the GOES**, explained by the broader range of yield curve paths
- For nearly **two thirds of the CTE70 scenarios**, the **AIRG is producing higher reserves than under the GOES**
- The deep **tail scenarios are significantly more severe under the GOES**. In comparison to the AIRG, the CTE98 increases over 70% for FT1 and 50% for FT6
- Given there is **no scenario reserve flooring under VM-20**, The sharp **increase in tail scenario reserves** is partially offset by the small **favorable impact from scenarios below VaR90** where AIRG produced higher reserves than GOES
- Under the GOES, the **SR is higher than the DR** by a significantly **smaller margin than under the AIRG**, driven by the strengthening of the DR

The impact of the sharp increase in deep tail scenarios is mitigated by the decrease in less adverse scenarios included in the CTE70

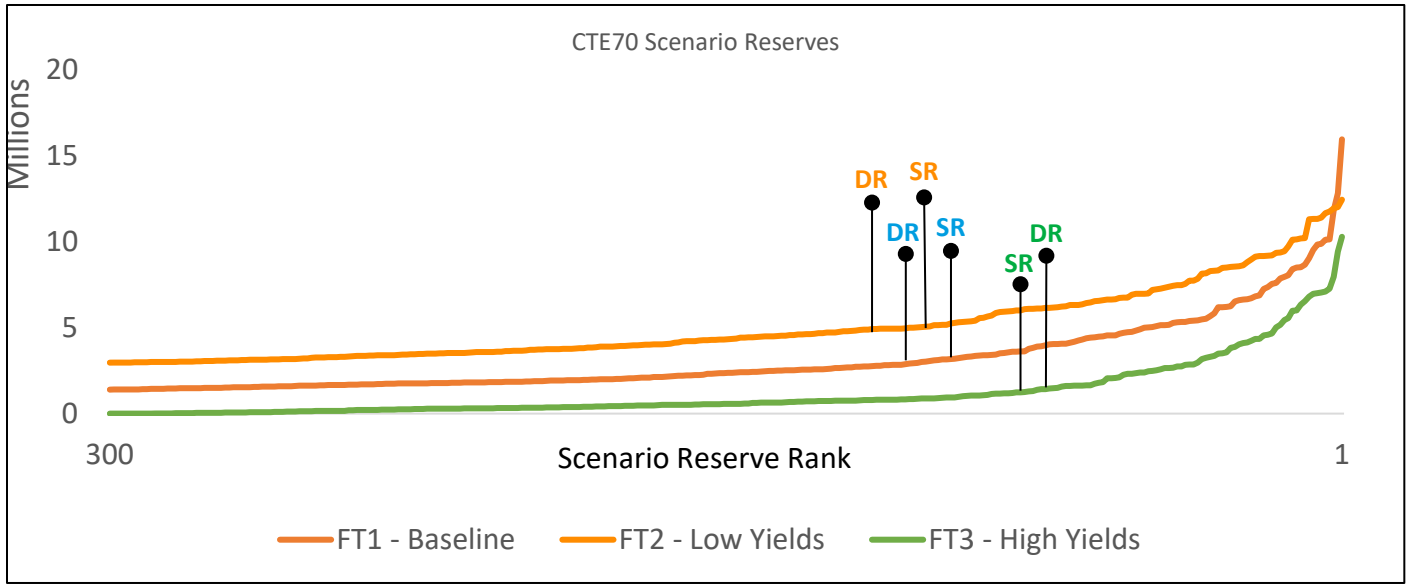
VM-20 Stochastic reserve ("SR") – Sensitivity testing

The SR was produced using the 1,000 scenario subset of the GOES low rate and high rate sensitivity scenario sets, and with a longer duration of reinvestment assets

ULSG Results (000s)

Scenario Set	DR	SR (CTE70)	Change from FT1	CTE98	Change from FT1
FT1 Baseline	2,879	3,167		9,336	
FT2 Low Yields	4,908	5,036	**+59%**	10,556	**+13%**
FT3 High Yields	1,438	1,237	**-61%**	6,482	**-31%**
FT1 Baseline (20Yr)	2,229	2,677	**-15%**	7,897	**-15%**

CTE70 Scenario Reserves



Commentary

- Under the GOES **baseline and low rate scenario sets**, the **SR is the dominant reserve** but the DR is producing a similar reserve
- Under the **high rate scenario set, the DR is the binding reserve** and some of the CTE70 scenarios produce a reserve of 0, indicating sufficiency of the DR
- The **severity of the deep tail** in the low rate scenario set is **mitigated by the increase in starting assets**
- The impact of shocks to the starting yield curve is significant at the CTE70 level but reduced at the CTE98 level
- Under an **alternate reinvestment strategy comprised of 20-year bonds**, results stayed largely consistent but the **gap between the DR and SR expanded** reflecting the broader dispersion of rates and impact of flooring

The relationship between the DR and SR is largely maintained across the GOES baseline and sensitivity scenario sets

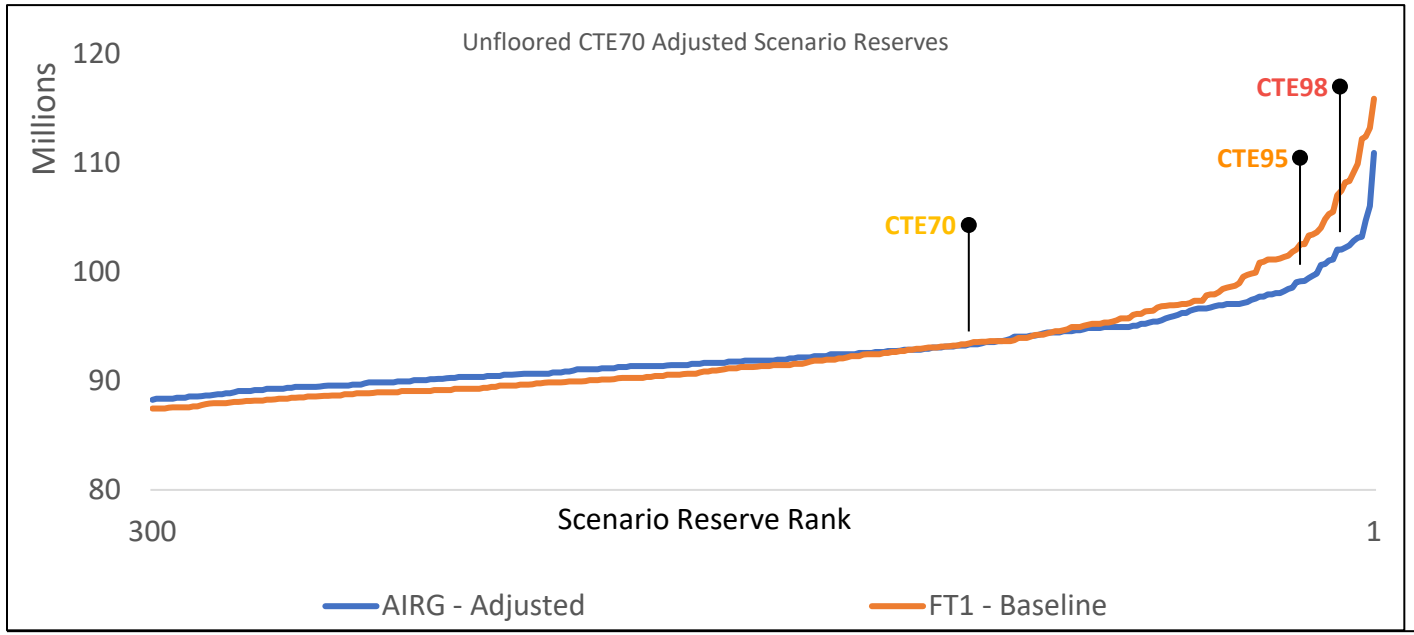
VM-21 CTE Adjusted reserve

The CTE adjusted scenario reserves from a sample in-force cohort with strong[1] guarantees and sitting at-the-money at the valuation date were calculated using both the AIRG and the GOES baseline scenario

CTE of Adjusted Scenario Reserves

Scenario Set	CTE70	CTE80	CTE90	CTE95	CTE98
AIRG	93	94	97	99	102
FT1 - Baseline	93	95	99	102	107

Unfloored CTE70 Adjusted Scenario Reserves



Commentary

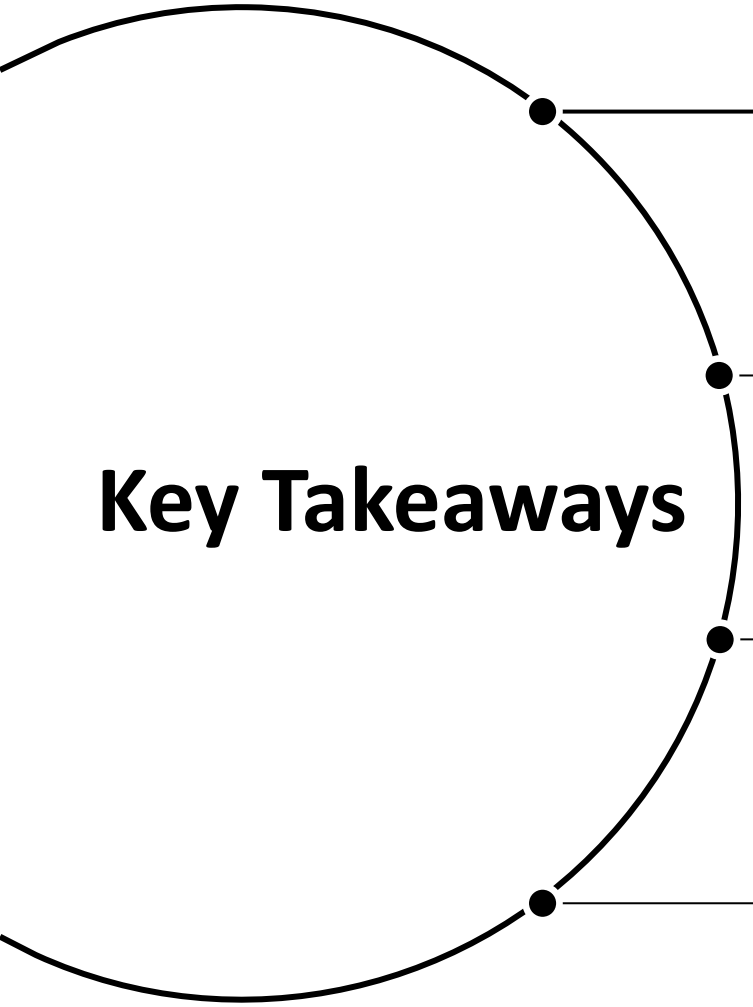
- The GOES scenarios are producing **larger adjusted scenario reserves than AIRG for tail scenarios**
- Severity of adverse impact to tail scenarios are the result of **increased volatility to equity returns and Treasury rates under the GOES**
  - **Equity returns in tail scenarios are lower** than under the AIRG, leading to increased claims and reduced fees
  - **Treasury rates in tail scenarios are lower than under AIRG and may go negative**, leading to lower investment income and higher discounted claims
- **CSV flooring at the scenario level has a significant impact under the GOES**, preventing impacts from less adverse scenarios from offsetting the increase to tail scenario reserves
- **The CTE95 under the GOES is similar to the CTE98 under the AIRG** due to more extreme tail scenarios

Results from the GOES are more adverse than AIRG the further we go in the tail, with a 5% increase to CTE98 adjusted

1. 7% roll-up GMWB and ROP GMDB

takeaways

The GOES provides a robust set of stochastic scenarios but may require further evaluation for deterministic use cases



1. The GOES is showing **increased rate volatility** compared to AIRG and produces **more adverse tail scenarios**

2. **Deterministic uses of the ESG are more impacted** by the GOES, resulting in adverse impacts to the DR and SERT

3. The presence of **CSV flooring can have a significant impact** at the CTE70 level

4. **Significant conservatism at the CTE98 level** reflective of extremely adverse economic conditions in the most extreme scenarios

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An Alternative Model for Corporate Bond Fund Returns

Iouri Karpov, MAAA, FSA

Background: Academy's Model for Corporate Excess Return

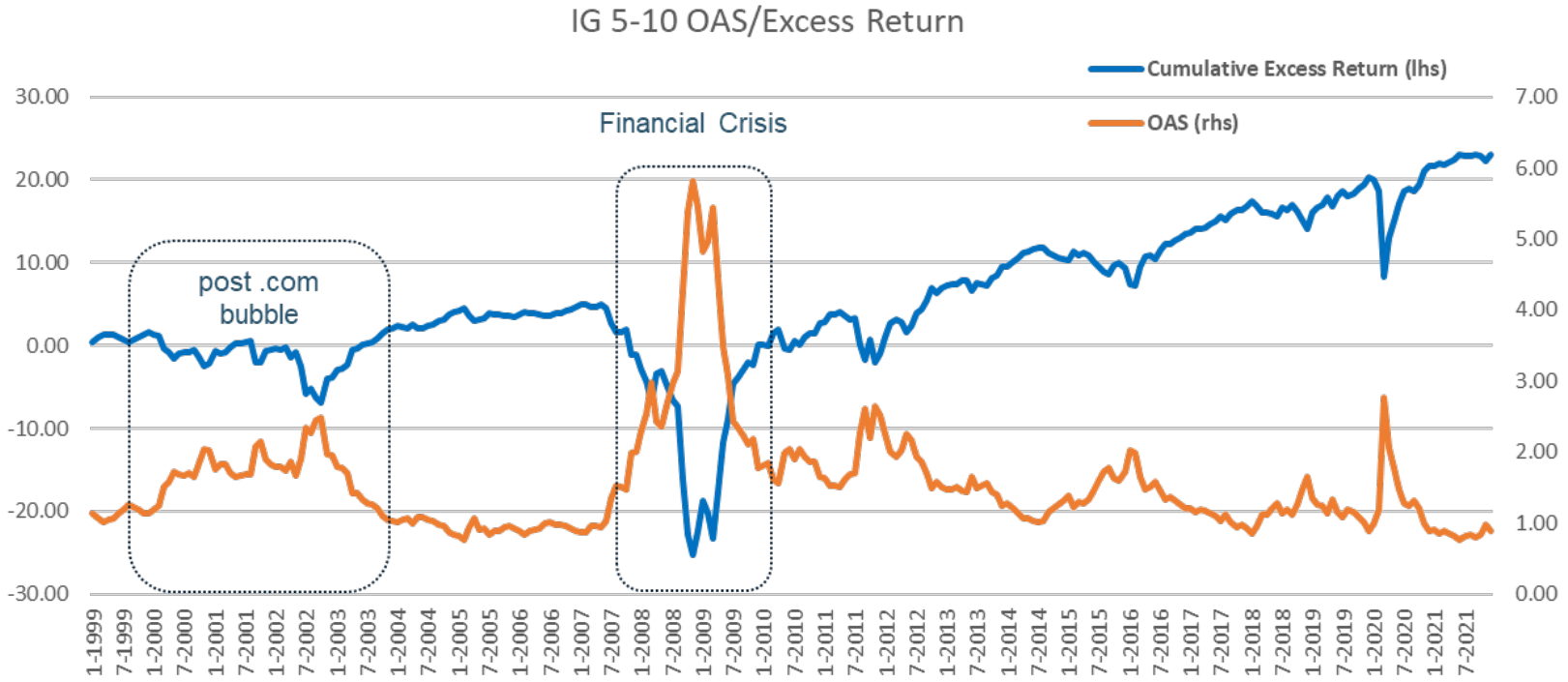
- **Academy's Model for Corporate Excess Return:**
  - Intended to simulate excess/credit return of key corporate bond indices, applicable to Separate Account funds
  - Developed by the members of Academy's ESGS group for purposes of GOES initiative, as a fully transparent and documented alternative suitable for PBR reserves and capital
  - Can be easily modified and added to any existing Scenario Generator
  - Captures key drivers of corporate excess return and its relationships with other market variables
  - Based on available historical data from Bloomberg:

Index	Bloomberg Ticker	Data Period	Avg. Quality
U.S. Corp. IG 1-5	BUC1TRUU	1/1990 - 12/2021	A2 - Baa1
U.S. Corp. IG 5-10	BCR5TRUU	1/1999 - 12/2021	A2 - Baa1
U.S .Corp. IG Long (10-30)	LD07TRUU	1/1990 - 12/2021	A2 - Baa1
U.S. Corp. HY	LF98TRUU	11/1995 - 12/2021	Ba3 – B2

General nature of a Corporate bond index

- A corporate bond index tracks the performance of thousands of eligible corporate bonds typically aggregated by quality and maturity (e.g. investment grade 5-10 year). Metrics available from Bloomberg include:
  - market value, total return, and excess (credit) return
  - key portfolio characteristics such as coupon, quality, maturity, and duration.
- Corporate bond indices are often used to benchmark actively managed bond funds, and as basis for funds that seek to replicate the return of published indices.
- Corporate bond indices are subject to periodic rebalancing to stay within quality and maturity targets (individual bonds are traded in and out of the index).
- Corporate bond prices are subject to credit risk:
  - day-to-day fluctuation in credit spread/OAS
  - defaults and migrations
- In credit stress, increased downgrades can result in meaningful permanent loss, as bonds are traded out of the index .

Historical Excess Return and OAS: IG 5-10yr



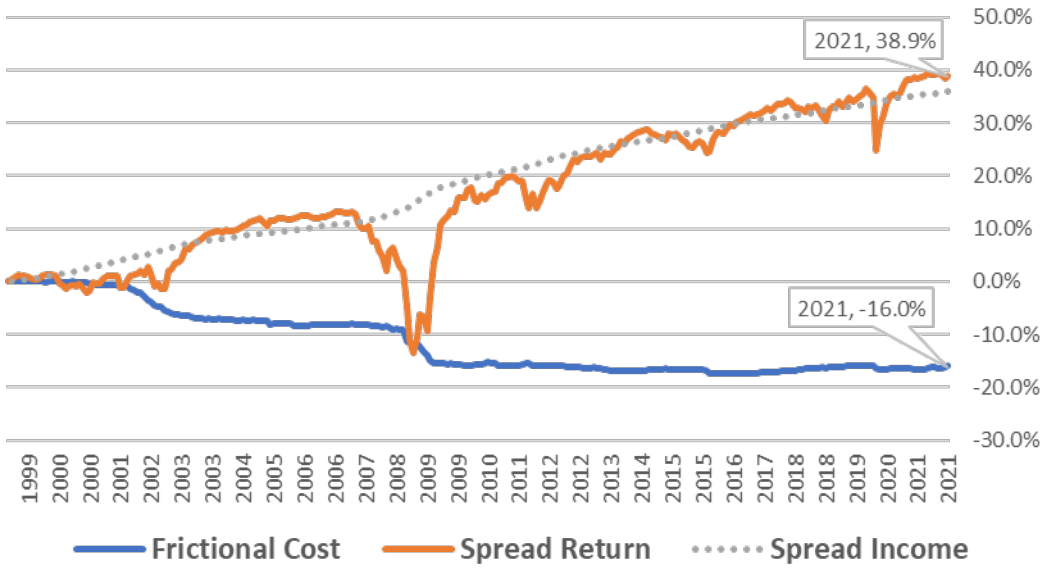
- Historical Excess return is sensitive to the level of OAS spreads
- Over the long term, from 1999 to 2021, OAS spread averages 170bps while Excess Return is only 100bps, implying annual frictional losses of 70bps.

Decomposing Excess Return into Spread and Frictional Cost

$\boldsymbol{Excess\ Return = Spread\ Return - Frictional\ Cost}$, where:

- $\boldsymbol{Spread\ Return_t} = Spread_{t-1}\Delta t - Duration_{t-1}(Spread_t - Spread_{t-1})$ reflects the earned credit spread as well as the change in market price due to spread movement.
- ***Frictional Cost*** reflects the effects of defaults, migrations, and otherwise forced rebalancing that occurs within the index fund.
- $\boldsymbol{Spread\ Income_t} = Spread_{t-1}\Delta t$ is the stable/asymptotic portion of the *Spread Return* which only reflects earned credit spread

Components of Cumulative Excess Returns: IG 5-10



- Spread Return was calculated using Bloomberg OAS and duration time series, while the implied Frictional Cost is simply: Excess Return less Spread Return.
- Spread Return varies with level of spreads, but ultimately reverts to earned spread income.
- Implied Frictional Cost tends to be relatively stable, with costs accruing aggressively in early 1990s, 2000s (.com bubble) and in 2008 (financial crisis) as defaults and migrations punctuate the end of a credit cycle.

A simplified model for returns on corporate bond fund indices

- The model simulates excess returns on the same four corporate bond fund indices.
  - Excess return = Spread-based return – Frictional costs.
  - Total return (Treasury return + Excess return) can be simulated by
    - Extending the model form to incorporate the treasury portion of the return, or
    - Adding excess returns to appropriately calculated and internally consistent returns on government bond funds of similar maturity.
- The model implicitly reflects the impact of credit migration and defaults.
  - For each of the modeled funds, the simplified model derives excess credit-related returns using stochastic credit spreads by rating/maturity and reflects the impact of credit migration, defaults, and recoveries as simplified frictional costs.
  - The historically implied frictional cost is fitted using a linear functional relationship between the trailing OAS and the costs to rebalance the fund. This fitting approach ensures the frictional cost is positive and increases with the spread.

A simplified model for returns on corporate bond fund indices (cont.)

- Steady-state credit spread targets and mean reversion speeds are consistent with VM-20 general account fixed income spreads.
- Duration is estimated as a function of bond maturity and bond yield.
  - The model captures fluctuations in long maturity fund durations observed when the level of yield changes.
- Modeled relationship between credit spreads
  - We propose a single random driver for all the indices to ensure rational behavior of credit spreads and capture 90% of spread variation across the indices.
- Relationship to Equity and Interest Rates
  - Using a simplified correlation matrix, the model captures relationships between credit spreads, equity volatility, equity return, interest rate level, and interest rate volatility.
  - This correlation matrix approach can be used to generate stochastic bond index fund excess returns which are consistent with any underlying stochastic interest rate and/or equity model.

Modeling Excess Return: Spread and Frictional Cost

Credit Spreads: Simplified model based on mean reverting stochastic processes for each credit rating.

$ls_t = \min(ls_{t-1} + \beta(\ln(\tau) - ls_{t-1}) + \sigma Z_{ls,t}, max\_spread)$ where $spread_t = e^{ls_t}$ subject to reasonable cap, $ls_0 = \ln(init\_spread)$,
tau (τ) = Target OAS (adj), and *beta* (β) = mean reversion.

Frictional Cost: Simplified model based on trailing 3-month credit spreads.

$cost_t = a + m_1 \min(\bar{s}_t, \kappa) + m_2 \max(\bar{s}_t - \kappa, 0)$ where $\bar{s}_t = \frac{1}{3}\sum_{i=1..3} spread_{t-i}$ is the 3-month trailing avg spread, and a = drift.

Excess Return: Simplified model based on Excess Return = Spread Return – Frictional Cost.

$Excess\ Return_t = [spread_{t-1}\ \Delta t - \frac{1}{2}(Dur_t + Dur_{t-1})\ (spread_t - spread_{t-1})] - cost_t$ where:

Dur_t is duration of the underlying fund based on its assumed maturity and semi-annual coupon determined as $coup_t = UST_{t,mat} + spread_t$.

Dur_t is determined using the closed-form approximation $Dur_t = .5\ (cS_n + nx^n)$ where c $= \max\left(\frac{1}{2}coup_t, .000001\right), n = 2 \times maturity, x = \frac{1}{1+c}$,
and $S_n = \frac{x-(n+1)x^{n+1}+nx^{n+2}}{(1-x)^2}$ is the partial sum representing par-coupon durations, while nx^n represents the duration of the principal payment.

Proposed parameter values

Parameters for the simplified model of excess returns on bond index funds

Spread Model

	IG 1-5	IG 5-10	IG Long	HY
tau (τ, spread target)	0.00920	0.01298	0.01493	0.04134
beta (β, mean rev.)	0.03	0.03	0.03	0.03
sigma (σ, volatility)	0.13557	0.09756	0.10181	0.09565
maturity	3.0	7.0	23.0	7.0
max_spread	0.06900	0.05900	0.05000	0.18329
init_spread (12/31/20)	Market based inputs			
VM-20 spread target	0.01069	0.01408	0.01627	0.04475

Frictional Cost Model

	IG 1-5	IG 5-10	IG Long	HY
drift (a)	0.00012	0.00018	0.00019	0.00034
kappa (κ)	0.01239	0.01362	0.01556	0.03650
mult1 (m_1)	0.00000	0.00000	0.00448	0.00100
mult2 (m_2)	0.06265	0.13773	0.18706	0.12111

Parameters (correlations) for implementing the simplified model alongside existing interest and equity models.

Simplified Corr. Matrix based on ACLI v1.3 & SLV Equity

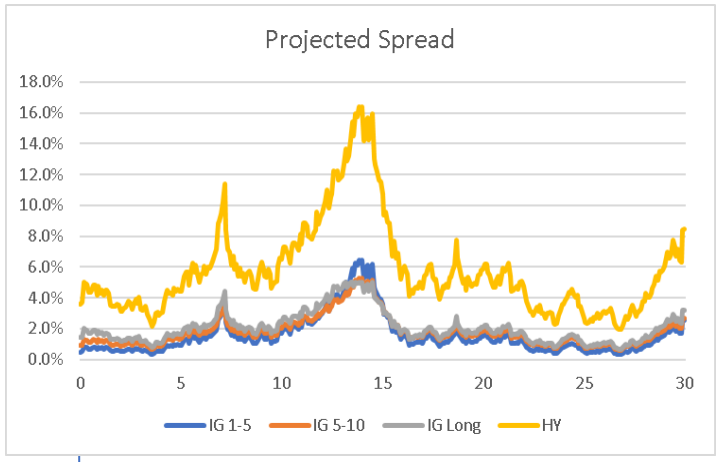
	Rate Log Vol	Log Long Rate	SPX Log Vol	SPX Return	Credit Spread
Rate Log Vol	1.00				
Log Long Rate	0.00	1.00			
SPX Log Vol	0.00	0.00	1.00		
SPX Return	0.00	0.00	-0.63	1.00	
Credit Spread	0.20	-0.35	-0.55	-0.60	1.00

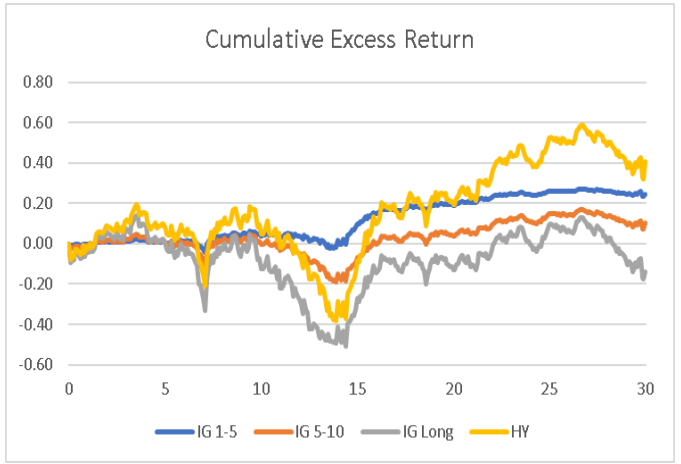
Simplified Corr. Matrix based on GEMS GFF rates & Heston Equity

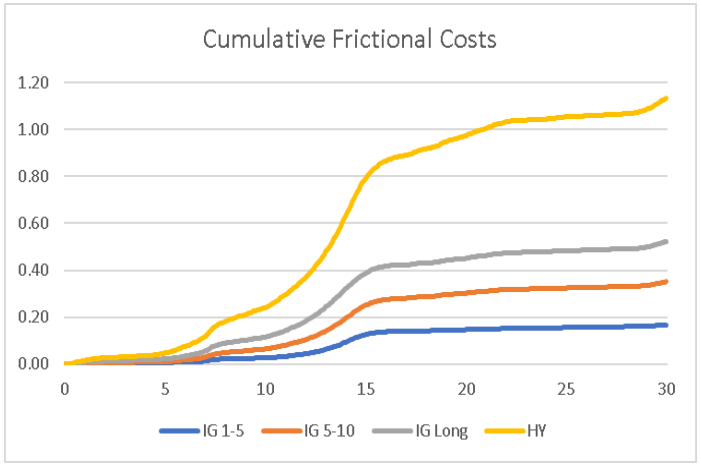
	CIR ("level")	SPX Variance	SPX Return	Credit Spread
CIR ("level")	1.00			
SPX Variance	0.00	1.00		
SPX Return	0.00	-0.68	1.00	
Credit Spread	-0.25	0.60	-0.60	1.00

Illustrative scenarios: Tail 1% and Median

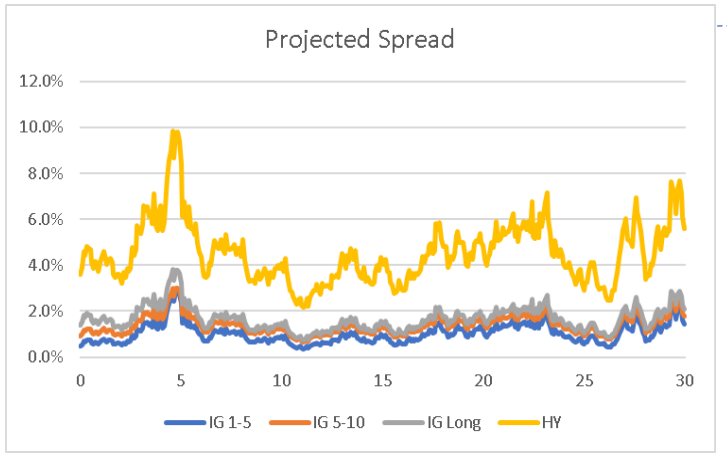
Tail 1% Scen #6187

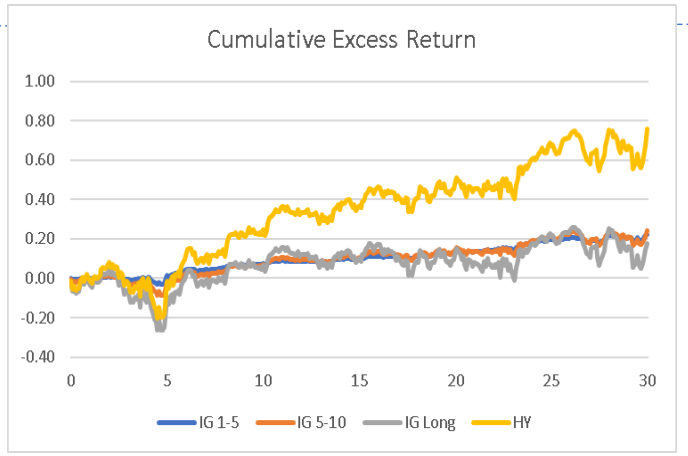


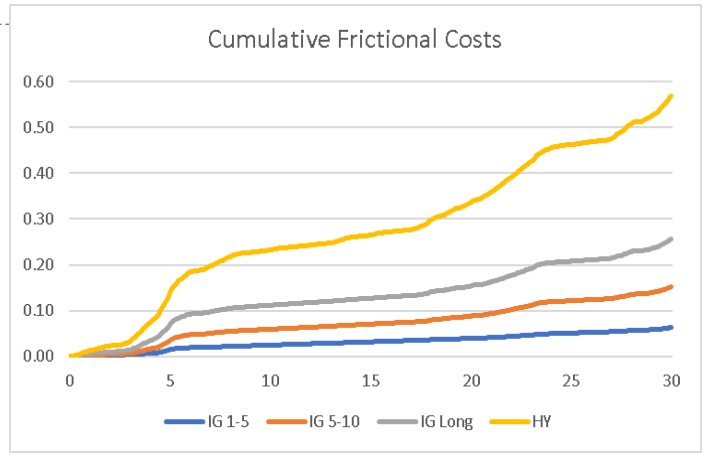




Median Scen #6731







Excess Return—comparison to GEMS

Conning's GEMS corporate model explicitly considers default and migration dynamics on the underlying securities.

Conning's GEMS results were readily available, and as an additional reasonableness check, the next four slides provide a comparison to GEMS.

- GEMS excess returns were determined by taking total returns from the four corporate bond fund indices and subtracting total returns from government bond fund indices with similar maturity profiles.
- The distributional comparison is based on cumulative Gross Wealth Factors across the projected scenarios

Summary

- **IG 1-5** and **IG 5-10**: Simplified model and GEMS cumulative excess return distributions are relatively close.
- **IG Long**: Simplified model cumulative excess return distribution is generally lower than GEMS.
- **HY**: Simplified model cumulative excess returns are significantly lower than GEMS in the right tail of the distribution.

Excess return cumulative wealth factors—IG 1-5

IG 1-5: Academy

	Proj. year						
	1	5	10	15	20	25	30
Min	0.93	0.91	0.93	0.94	0.98	1.01	1.07
0.5%	0.97	0.96	0.99	1.01	1.04	1.08	1.11
1.0%	0.98	0.97	1.00	1.02	1.05	1.08	1.12
2.5%	0.98	0.98	1.01	1.04	1.06	1.10	1.13
5.0%	0.99	0.99	1.02	1.04	1.08	1.11	1.15
10.0%	0.99	1.00	1.03	1.05	1.09	1.13	1.17
25.0%	1.00	1.01	1.04	1.07	1.11	1.15	1.20
50.0%	1.00	1.02	1.05	1.09	1.14	1.19	1.23
75.0%	1.00	1.02	1.07	1.11	1.17	1.22	1.27
90.0%	1.01	1.03	1.08	1.13	1.19	1.25	1.30
95.0%	1.01	1.03	1.09	1.15	1.20	1.26	1.33
97.5%	1.01	1.04	1.09	1.16	1.22	1.28	1.34
99.0%	1.01	1.04	1.10	1.17	1.24	1.30	1.36
99.5%	1.01	1.04	1.11	1.17	1.25	1.31	1.38
Max	1.01	1.06	1.14	1.23	1.29	1.38	1.46

IG 1-5: GEMS

	Proj. year						
	1	5	10	15	20	25	30
Min	0.92	0.91	0.93	0.96	0.98	1.00	1.03
0.5%	0.96	0.96	0.99	1.02	1.04	1.07	1.10
1.0%	0.97	0.97	1.00	1.03	1.05	1.08	1.12
2.5%	0.97	0.98	1.01	1.04	1.07	1.10	1.13
5.0%	0.98	0.99	1.02	1.05	1.08	1.11	1.14
10.0%	0.99	1.00	1.03	1.06	1.09	1.12	1.16
25.0%	1.00	1.01	1.04	1.07	1.11	1.14	1.18
50.0%	1.00	1.02	1.05	1.09	1.12	1.16	1.20
75.0%	1.00	1.03	1.06	1.10	1.14	1.19	1.23
90.0%	1.01	1.03	1.07	1.11	1.16	1.21	1.27
95.0%	1.01	1.03	1.07	1.12	1.17	1.23	1.29
97.5%	1.01	1.03	1.08	1.13	1.19	1.25	1.32
99.0%	1.01	1.04	1.08	1.14	1.20	1.28	1.35
99.5%	1.01	1.04	1.09	1.15	1.22	1.30	1.38
Max	1.01	1.05	1.11	1.21	1.33	1.53	1.75

Excess return cumulative wealth factors—IG 5-10

IG 5-10: Academy

	Proj. year						
	1	5	10	15	20	25	30
Min	0.85	0.76	0.75	0.80	0.84	0.92	0.93
0.5%	0.93	0.88	0.91	0.93	0.96	1.00	1.06
1.0%	0.94	0.90	0.93	0.95	0.99	1.03	1.08
2.5%	0.95	0.93	0.95	0.99	1.02	1.06	1.10
5.0%	0.96	0.95	0.97	1.01	1.05	1.09	1.13
10.0%	0.97	0.97	1.00	1.03	1.07	1.12	1.16
25.0%	0.99	1.00	1.03	1.07	1.11	1.15	1.20
50.0%	1.00	1.02	1.06	1.10	1.14	1.19	1.23
75.0%	1.01	1.04	1.08	1.12	1.17	1.21	1.26
90.0%	1.02	1.05	1.09	1.13	1.18	1.23	1.28
95.0%	1.02	1.05	1.10	1.14	1.19	1.24	1.30
97.5%	1.03	1.06	1.10	1.15	1.20	1.25	1.31
99.0%	1.03	1.06	1.11	1.16	1.21	1.26	1.32
99.5%	1.03	1.07	1.11	1.16	1.21	1.27	1.33
Max	1.04	1.08	1.13	1.18	1.24	1.29	1.37

IG 5-10: GEMS

	Proj. year						
	1	5	10	15	20	25	30
Min	0.86	0.81	0.78	0.83	0.87	0.89	0.91
0.5%	0.91	0.88	0.92	0.95	0.98	1.02	1.06
1.0%	0.92	0.91	0.94	0.97	1.00	1.04	1.08
2.5%	0.94	0.93	0.96	1.00	1.03	1.07	1.12
5.0%	0.95	0.95	0.98	1.02	1.06	1.10	1.14
10.0%	0.97	0.97	1.01	1.04	1.08	1.13	1.17
25.0%	0.99	1.00	1.04	1.08	1.13	1.17	1.22
50.0%	1.00	1.03	1.07	1.12	1.17	1.22	1.28
75.0%	1.01	1.04	1.09	1.14	1.20	1.26	1.32
90.0%	1.02	1.05	1.10	1.16	1.22	1.29	1.36
95.0%	1.02	1.06	1.11	1.17	1.24	1.31	1.38
97.5%	1.02	1.06	1.12	1.18	1.25	1.32	1.40
99.0%	1.02	1.06	1.12	1.19	1.26	1.34	1.43
99.5%	1.02	1.06	1.13	1.20	1.27	1.36	1.45
Max	1.02	1.07	1.16	1.25	1.36	1.45	1.62

Excess return cumulative wealth factors—IG Long

IG Long: Academy

	Proj. year						
	1	5	10	15	20	25	30
Min	0.61	0.57	0.56	0.59	0.55	0.65	0.63
0.5%	0.77	0.68	0.70	0.71	0.74	0.76	0.81
1.0%	0.80	0.71	0.73	0.75	0.78	0.80	0.84
2.5%	0.84	0.76	0.79	0.81	0.84	0.87	0.90
5.0%	0.87	0.82	0.84	0.86	0.89	0.92	0.95
10.0%	0.90	0.87	0.89	0.92	0.95	0.99	1.02
25.0%	0.95	0.96	0.98	1.01	1.04	1.08	1.11
50.0%	1.01	1.03	1.07	1.10	1.13	1.17	1.21
75.0%	1.05	1.09	1.13	1.16	1.21	1.25	1.29
90.0%	1.09	1.14	1.18	1.21	1.26	1.31	1.36
95.0%	1.11	1.16	1.20	1.24	1.29	1.34	1.39
97.5%	1.12	1.18	1.22	1.26	1.32	1.36	1.42
99.0%	1.14	1.20	1.25	1.29	1.34	1.39	1.45
99.5%	1.15	1.21	1.26	1.30	1.36	1.41	1.48
Max	1.19	1.27	1.31	1.39	1.43	1.49	1.58

IG Long: GEMS

	Proj. year						
	1	5	10	15	20	25	30
Min	0.73	0.63	0.60	0.68	0.71	0.78	0.78
0.5%	0.82	0.77	0.81	0.86	0.88	0.93	0.97
1.0%	0.84	0.80	0.84	0.89	0.92	0.98	1.02
2.5%	0.87	0.85	0.89	0.94	0.98	1.03	1.08
5.0%	0.90	0.88	0.93	0.98	1.03	1.08	1.13
10.0%	0.93	0.93	0.97	1.03	1.08	1.13	1.19
25.0%	0.97	0.99	1.04	1.10	1.15	1.22	1.28
50.0%	1.00	1.04	1.10	1.17	1.23	1.30	1.38
75.0%	1.03	1.08	1.15	1.22	1.30	1.38	1.46
90.0%	1.04	1.11	1.19	1.27	1.36	1.44	1.53
95.0%	1.05	1.12	1.21	1.29	1.38	1.48	1.57
97.5%	1.06	1.13	1.22	1.31	1.40	1.50	1.60
99.0%	1.06	1.14	1.24	1.33	1.43	1.54	1.64
99.5%	1.07	1.16	1.25	1.35	1.45	1.56	1.66
Max	1.08	1.19	1.30	1.41	1.55	1.63	1.80

Excess return cumulative wealth factors—HY

HY: Academy

	Proj. year						
	1	5	10	15	20	25	30
Min	0.62	0.52	0.53	0.65	0.72	0.94	0.96
0.5%	0.81	0.74	0.82	0.90	1.00	1.13	1.33
1.0%	0.83	0.78	0.87	0.96	1.08	1.20	1.39
2.5%	0.87	0.84	0.94	1.04	1.17	1.32	1.49
5.0%	0.90	0.90	0.99	1.11	1.25	1.40	1.58
10.0%	0.92	0.95	1.06	1.19	1.34	1.50	1.69
25.0%	0.97	1.04	1.16	1.30	1.46	1.65	1.85
50.0%	1.02	1.12	1.25	1.40	1.59	1.79	2.01
75.0%	1.06	1.18	1.33	1.49	1.69	1.91	2.15
90.0%	1.09	1.22	1.38	1.55	1.76	2.00	2.26
95.0%	1.11	1.24	1.40	1.59	1.80	2.05	2.31
97.5%	1.12	1.26	1.43	1.61	1.83	2.08	2.36
99.0%	1.14	1.27	1.45	1.64	1.87	2.12	2.41
99.5%	1.14	1.28	1.46	1.66	1.89	2.15	2.44
Max	1.18	1.33	1.51	1.73	1.98	2.24	2.60

HY: GEMS

	Proj. year						
	1	5	10	15	20	25	30
Min	0.81	0.88	0.96	1.07	1.20	1.40	1.58
0.5%	0.90	0.97	1.10	1.22	1.36	1.53	1.72
1.0%	0.92	0.99	1.11	1.24	1.40	1.57	1.76
2.5%	0.94	1.02	1.15	1.29	1.44	1.63	1.83
5.0%	0.97	1.04	1.17	1.32	1.48	1.68	1.90
10.0%	0.99	1.07	1.20	1.35	1.54	1.74	1.98
25.0%	1.02	1.11	1.25	1.42	1.62	1.86	2.13
50.0%	1.05	1.14	1.30	1.50	1.74	2.02	2.35
75.0%	1.06	1.17	1.37	1.62	1.91	2.25	2.64
90.0%	1.07	1.21	1.46	1.77	2.12	2.52	2.99
95.0%	1.07	1.24	1.54	1.89	2.28	2.74	3.26
97.5%	1.08	1.27	1.63	2.04	2.44	2.98	3.59
99.0%	1.08	1.33	1.76	2.19	2.70	3.28	4.02
99.5%	1.08	1.38	1.87	2.35	2.92	3.57	4.38
Max	1.09	1.66	2.41	3.19	4.13	5.63	7.16

Questions?

For more information, please contact Amanda Barry-Moilanen (barrymoilanen@actuary.org)

- Add Evaluation link