Overview of GEMS® Treasury Model

Dec. 3, 2020

Dan Finn, FCAS, ASA – Managing Director at Conning

Pat Allison, FSA, MAAA – NAIC Managing Life Actuary

www.conning.com

Agenda

1. Presentation Approach
2. Reference Materials and Documentation
3. GEMS® Treasury Model: Potential Goals
4. Next Steps

Presentation Approach

1. Potential goals relating to the GEMS® Treasury Model are outlined.
2. For each goal:
   a. Background information is provided for educational purposes, along with an underlying rationale
   b. Similarities and differences between the Academy ESG and GEMS® will be discussed
   c. Items requiring decisions are highlighted

Reference Materials and Documentation

The following materials are available on the LATF webpage (Related Documents tab):

https://content.naic.org/cmte_a_latf.htm

1. Treasury Model Overview: NAIC Technical Documentation - Interest Rates, DRAFT.pdf
2. Comparison of the AIRG and GEMS: GEMS vs AAA - Fan Chart.pdf

ESG Background Information:

Economic Scenario Generators: A Practical Guide

https://www.soa.org/resources/research-reports/2016/2016-economic-scenario-generators/

GEMS® TREASURY MODEL: POTENTIAL GOALS

Goals relating to the yield curve shape:

1. The model's starting yield curve should match the actual starting yield curve as closely as possible.

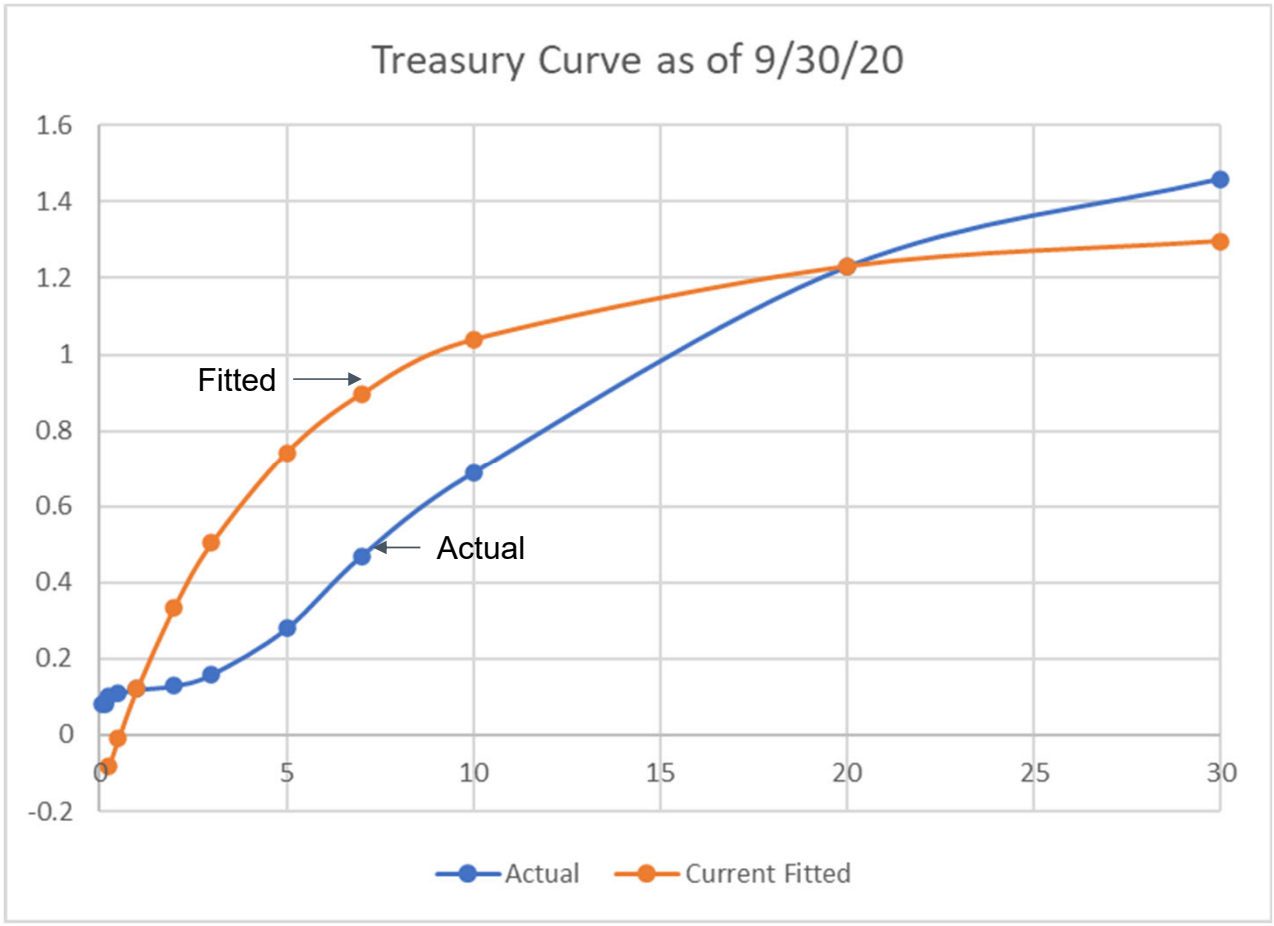
Rationale for this goal: The model should reflect accurate initial conditions.

Background: In the AIRG and GEMS® models, the projected interest rates don't start with the actual initial yield curve. A fitting process is used to create a representative initial yield curve.

AIRG compared to GEMS®:

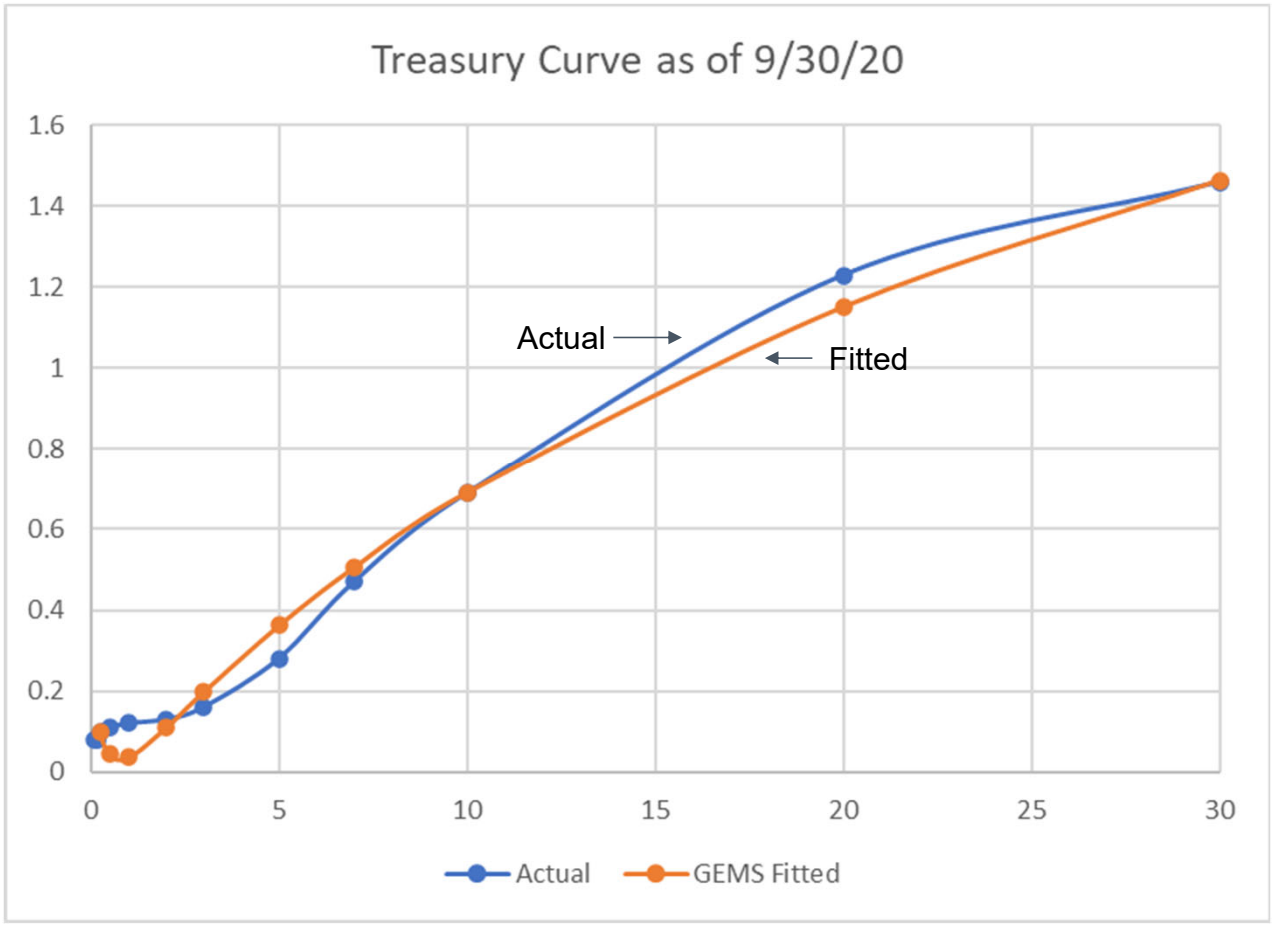
- AIRG model fits 1- and 20-year maturities; GEMS® fits 3-month maturity and 2 other selected maturities
  - GEMS® fitting procedure adjusts the 2 other points to minimize gap between actual and fitted
  - The 2 other points are chosen each period to optimize the fit of the curve
  - These changes do NOT impact underlying (i.e., fitted) model

Comparison of Fitting Results: AIRG Model fits 1- and 20-year maturities



Prepared by Conning. Source: American Academy Interest Rate Generator v 7.1.201905.

Comparison of Fitting Results: GEMS® fits 3-month and 2 other selected maturities



Prepared by Conning, Inc. Source: GEMS® Economic Scenario Generator scenarios.

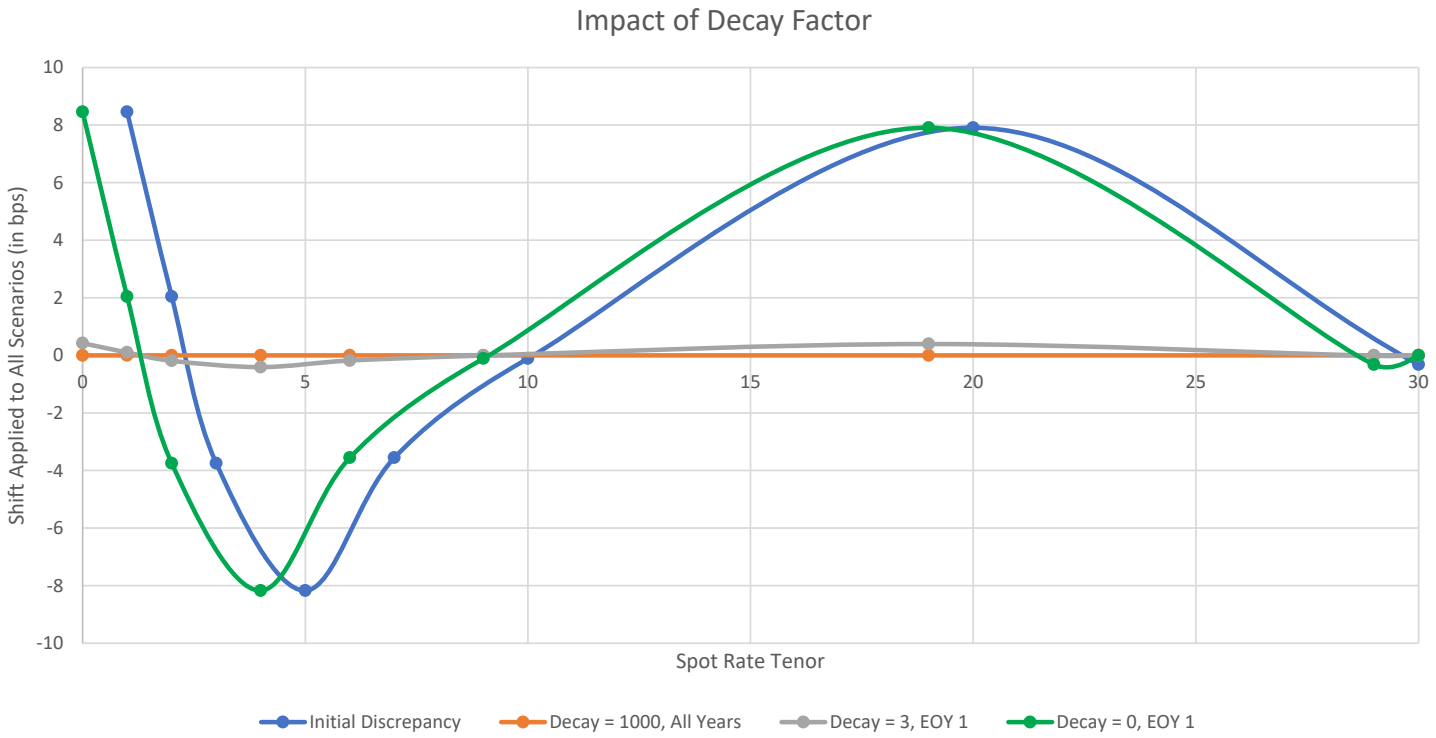
Add picture

CONNING

AIRG compared to GEMS® (cont.):

- Both models have adjustments to fit the actual initial yield curve
  - AIRG model's discrepancies go away linearly over 12 months
  - GEMS® has a decay parameter which controls the speed at which the discrepancies go away
    - Default value of 3 leads to 95% reduction during first 12 months
    - Range of from 0 (no decay) to 1000 (use fitted curve)
    - Remaining adjustments roll down the curve with passage of time. For example, the initial 10-year adjustment will impact the 8-year yield after 2 simulation years

GEMS® Initial Yield Curve Discrepancy Decay Factor Impact:

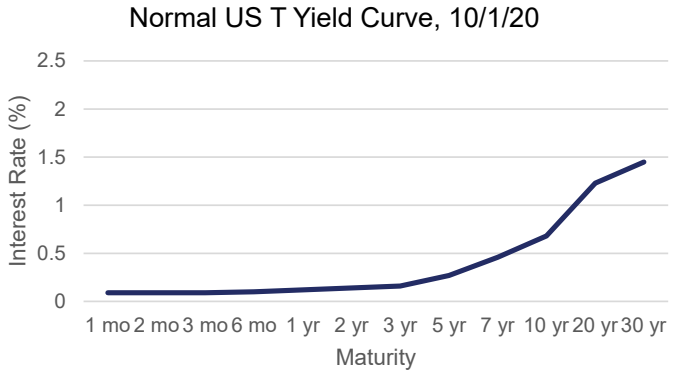


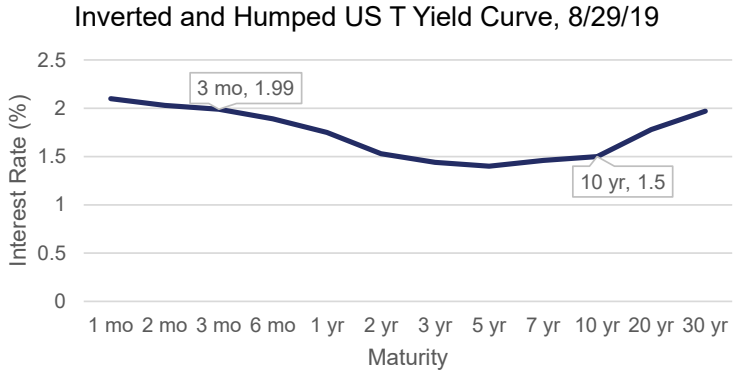
Decision to be made: How fast do regulators want the discrepancies to go away? Recommendation is to use the default value of 3.

Goals relating to the yield curve shape:

2. The model should produce a variety of yield curve shapes, and they should change over time.

Rationale for this goal: In the real world, a wide variety of yield curve shapes occur and evolve over time.





Background:

- Inversions of the yield curve occur when shorter-maturity yields are higher than longer-maturity yields
- Inverted yield curves occur approximately 10% of the time in the U.S. and in the standard calibration of the GEMS® treasury model. However, altering the GEMS® calibration could change the prevalence of yield curve inversions.

AIRG compared to GEMS® - Yield Curve Shapes: Both models produce normal and inverted yield curve shapes. However, the GEMS model is able to produce a wider variety of real world yield curve shapes, such as the humped curve shown in the 8/29/19 graph.

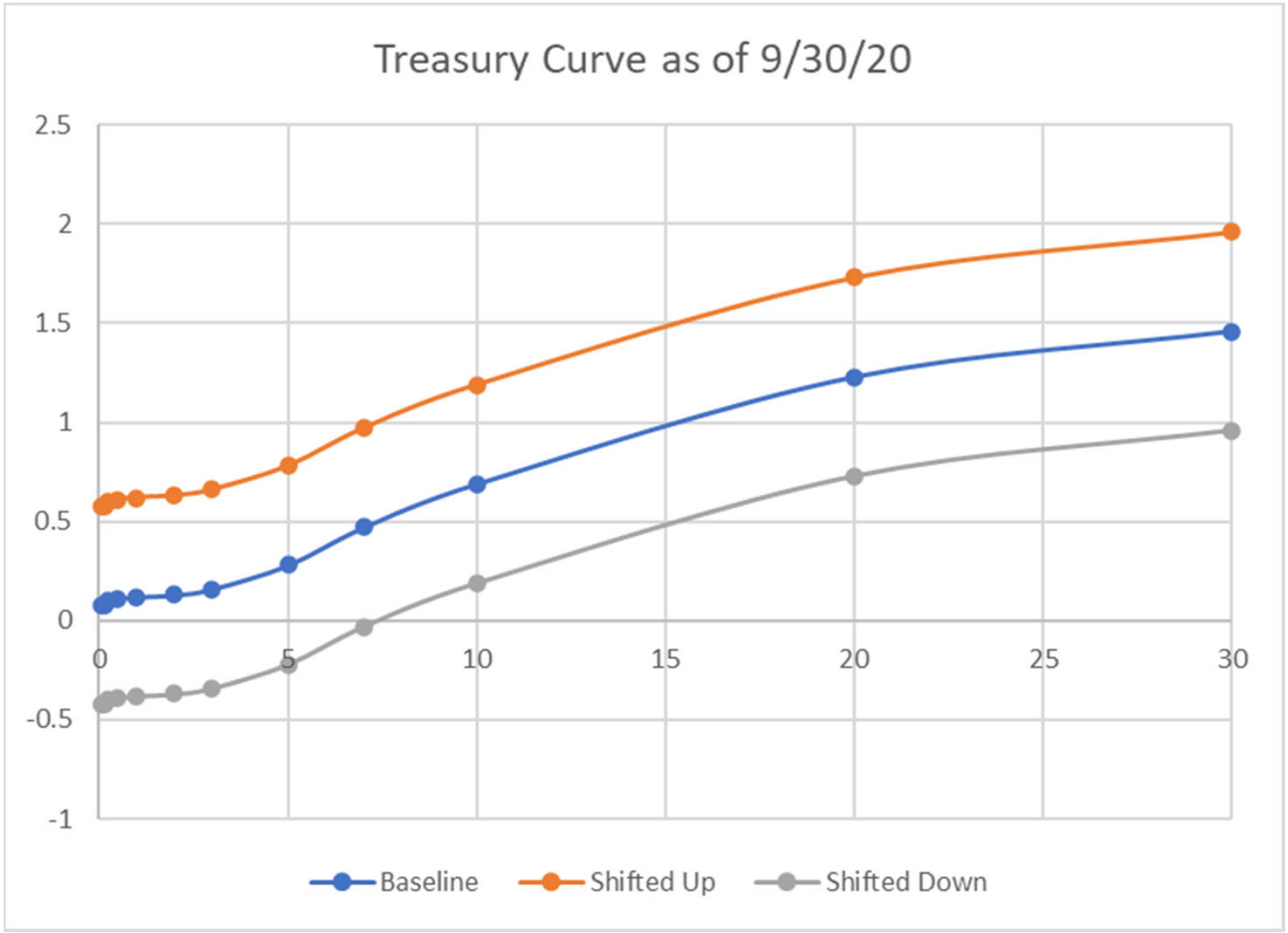
AIRG compared to GEMS® (cont.) – Yield Curve Movements:

- For the AIRG, yield curve movements are driven by the simulated values of the long maturity Treasury and the term premium (additional yield for long maturity Treasury assets vs. shorter maturities). These drivers can produce the following yield curve movements:
  - parallel shifts, which happen when the long maturity Treasury changes, but the term premium does not, and
  - changes to the slope of the yield curve, which happens any time the term premium changes.
- The GEMS® model goes about this differently. In addition to parallel shifts and slope changes, GEMS® is also able to produce changes in curvature.
  - Therefore, GEMS® can produce a broader set of yield curve shapes than the AIRG.
  - Changes in curvature affect the measurement of the convexity of assets and liabilities.

Decision to be made: None.

Possible Yield Curve Movements: Parallel

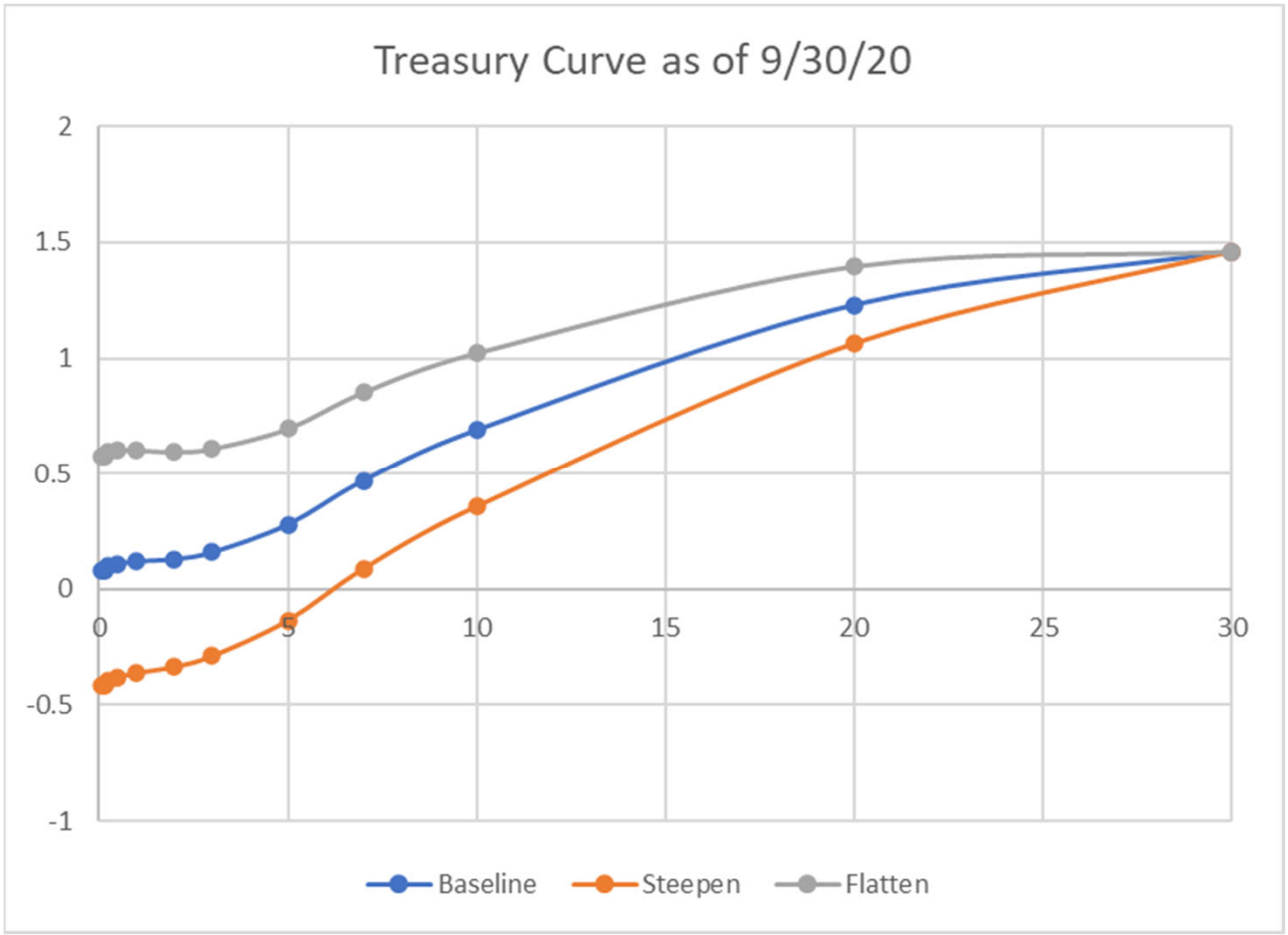
AIRG and GEMS® both produce this type of movement.



Prepared by Conning. Source: U.S. Department of the Treasury (2020)

Possible Yield Curve Movements: Change in Slope

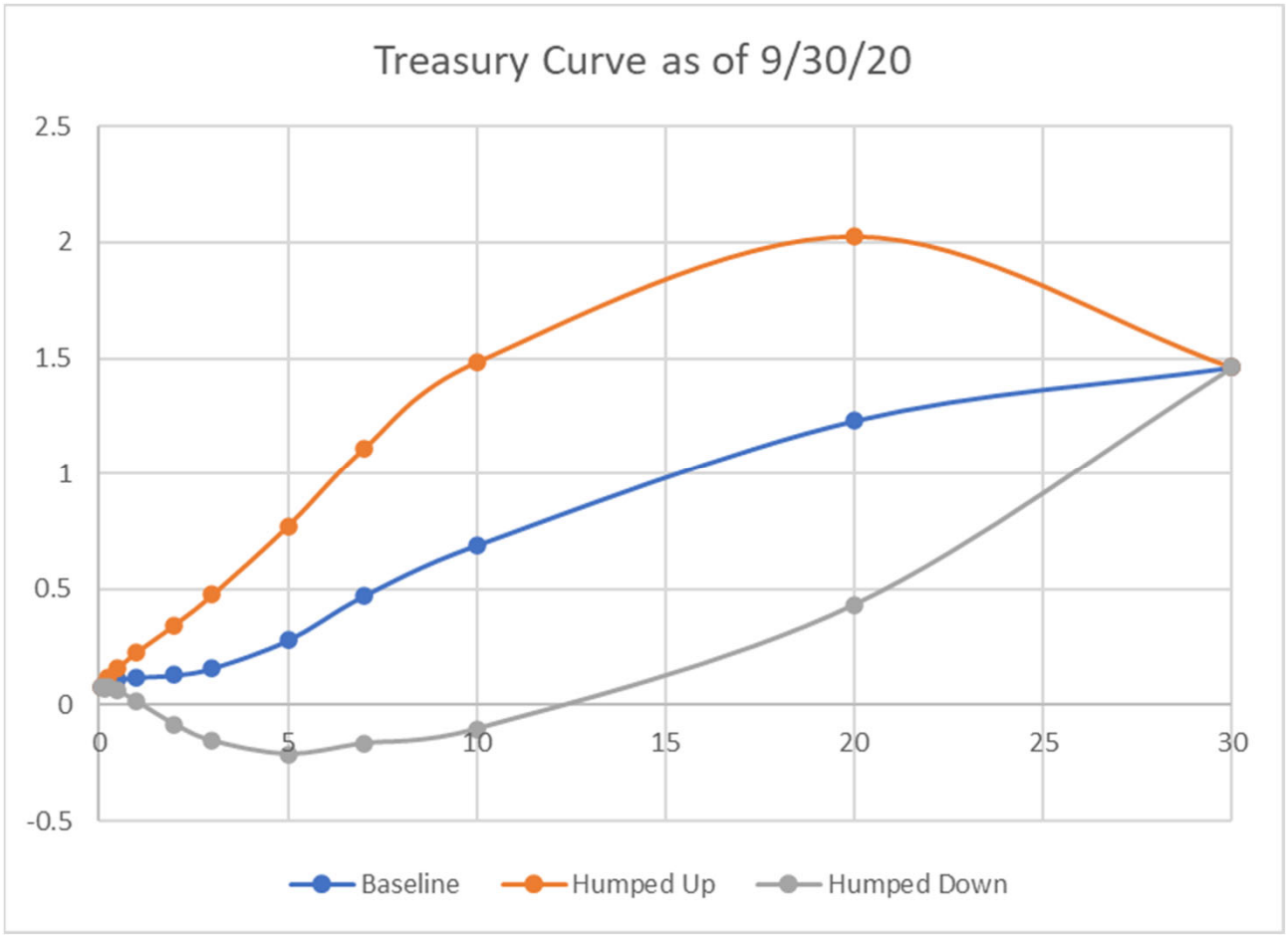
AIRG and GEMS® both produce this type of movement.



Prepared by Conning. Source: U.S. Department of the Treasury (2020)

Possible Yield Curve Movements: Change in Curvature

GEMS® Treasury Model produces these types of movements. The AIRG does not.



Prepared by Conning. Source: U.S. Department of the Treasury (2020)

Goals relating to the yield curve shape:

3. Interest rates can be negative.

Rationale for this goal: Interest rates in the U.S. have been trending lower, and negative interest rates have occurred in the past.

Background:

- Negative yields have rarely happened in the US
  - Less than 0.4% of the time for the 3-month yield
  - Never for the 5- or 10-year yields

AIRG compared to GEMS®:

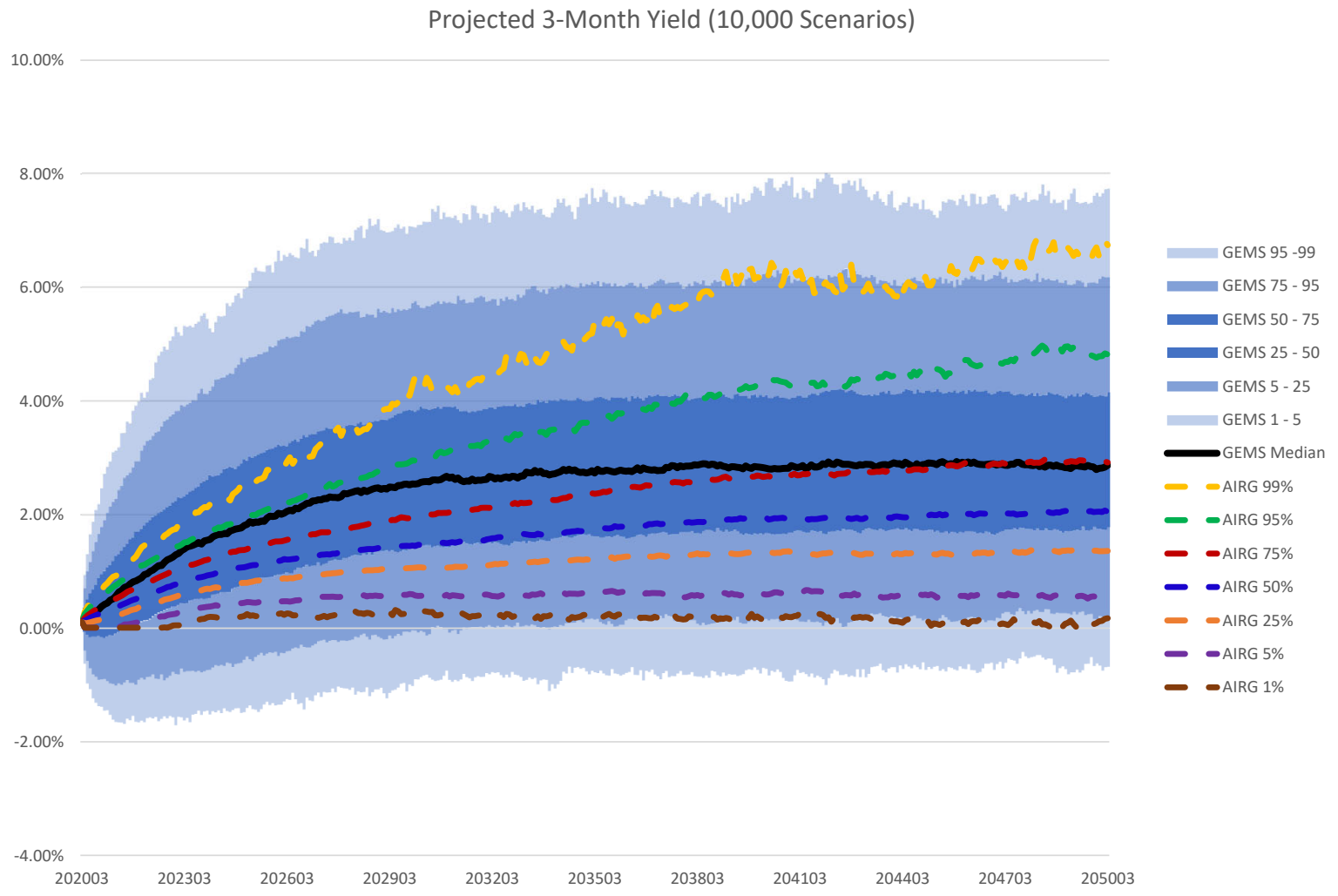
- Negative yields happen roughly 5% of the time for the 3-month yield using the current GEMS® Treasury Model calibration. This can be customized.

- AIRG does not produce negative interest rates.

Decisions to be made:

- Should the model produce negative interest rates?
  - If so, how low should rates be allowed to go, and how frequently should negative rates occur?
  - If not, how absolute is this? Should there be a floor?

AIRG compared to GEMS® current calibration



CONNING

Prepared by Conning. Sources: Academy Interest Rate Generator v 7.1.201905 and GEMS® Economic Scenario Generator scenarios

Goals relating to interest rate mean reversion:

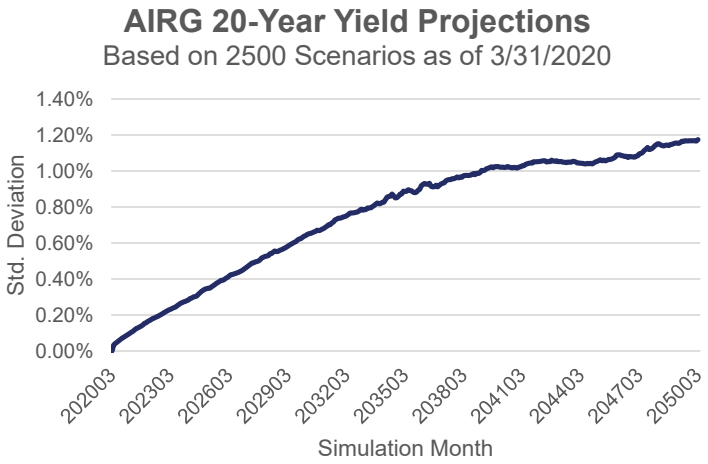
4. The model should be capable of producing a reasonable range of results for very long simulations.

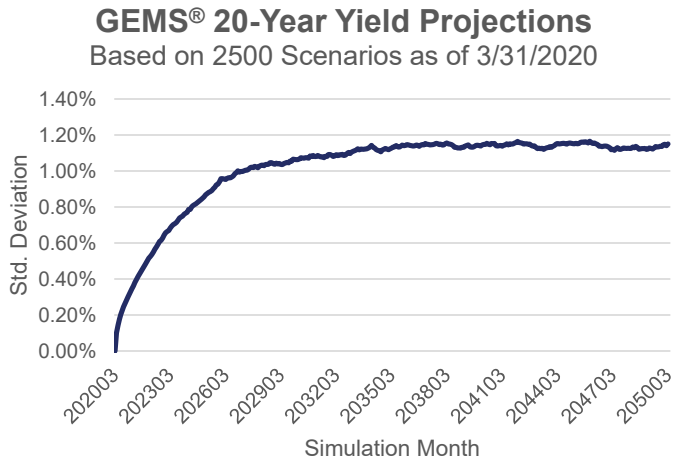
Rationale for this goal: A reasonable range is needed, given the long-term nature of life insurance and annuity liabilities.

Background:

- Without mean reversion in an interest rate model, the yields will "explode" over long-term simulations.
- It is important to consider both the speed of mean reversion and the level of mean reversion.
  - The following slide will provide information about speed of mean reversion.
  - See goal #5 to find information about the level of mean reversion.

AIRG compared to GEMS®: The speed of mean reversion in the AIRG is slower than in GEMS®





Mean Reversion Speeds (in Years)

Description	AIRG Target	GEMS Target
Long End Mean Reversion Speed	16.8	4.1
Short End Mean Reversion Speed	3.6	3.1

Impact of Target

- Impacts expected trajectory
  - Lower value = steeper slope given today's low initial yields
- Impacts ratio between volatility of changes and volatility of steady state Yields
  - Higher value = more growth from Year 1 to Year 30
  - So, if we have a target for long-term volatility of Yields, a Higher value will result in lower volatility of changes

Prepared by Conning. Sources: Academy Interest Rate Generator v 7.1.201905 and GEMS® Economic Scenario Generator scenarios

CONNING

Goals relating to interest rate mean reversion:

5. The ESG should be capable of producing low interest rates for an extended period of time.

Rationale for this goal: To reflect the possibility that rates will continue to remain low, since that has been the pattern for some time now.

Background:

- Since 2012, the 10-year U.S. Treasury has averaged approximately 2%
- The 10-year U.S. Treasury has been below 1% since 3/19/2020
- Producing low for long scenarios will involve changing multiple targets, including the mean reversion speed, mean reversion level, and the interest rate volatility

AIRG compared to GEMS®:

- See previous slide for information on speed of mean reversion.
- See next slide for information on level of mean reversion.

AIRG compared to GEMS® (cont.):

- The mean reversion target in the AIRG is lower than the GEMS® target.

Mean Reversion Levels

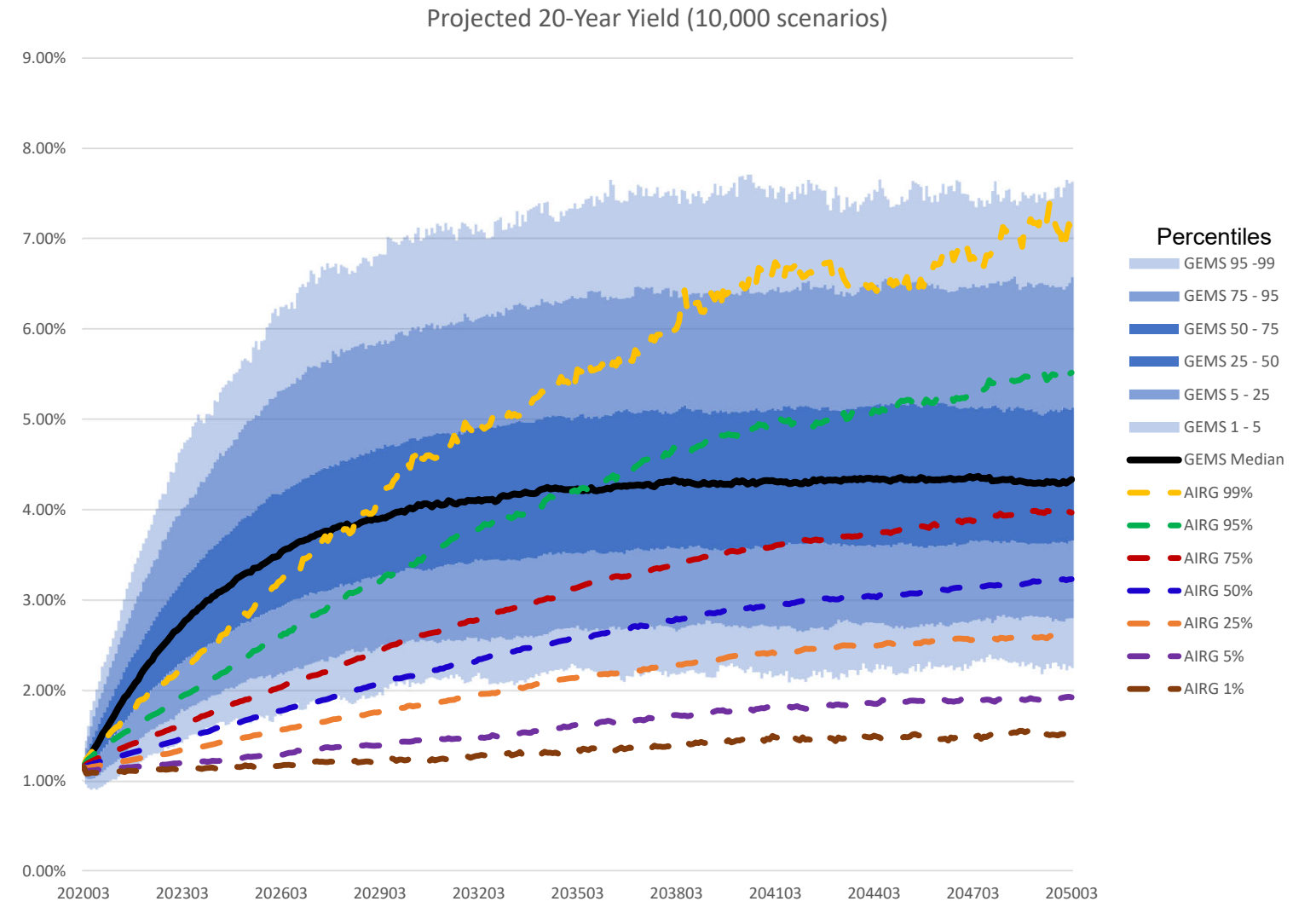
Description	AIRG Target	GEMS Target
20-Year Yield Mean Level	3.50%	4.48%
1-Year Yield Mean Level	2.50%	2.93%

Methodology used to Set Targets

- AIRG Model uses a weighted average of values from the last 36-, 120- and 600-months. The mean reversion target is automatically updated annually by this formula.
- GEMS® targets are based on Central Bank inflation targets and observed Treasury Yields since 1995
- There are other options
  - Yields stay at their current level
  - Yields follow the market's implied expectations

Prepared by Conning. Sources: Academy Interest Rate Generator v 7.1.201905 and GEMS® Economic Scenario Generator scenarios

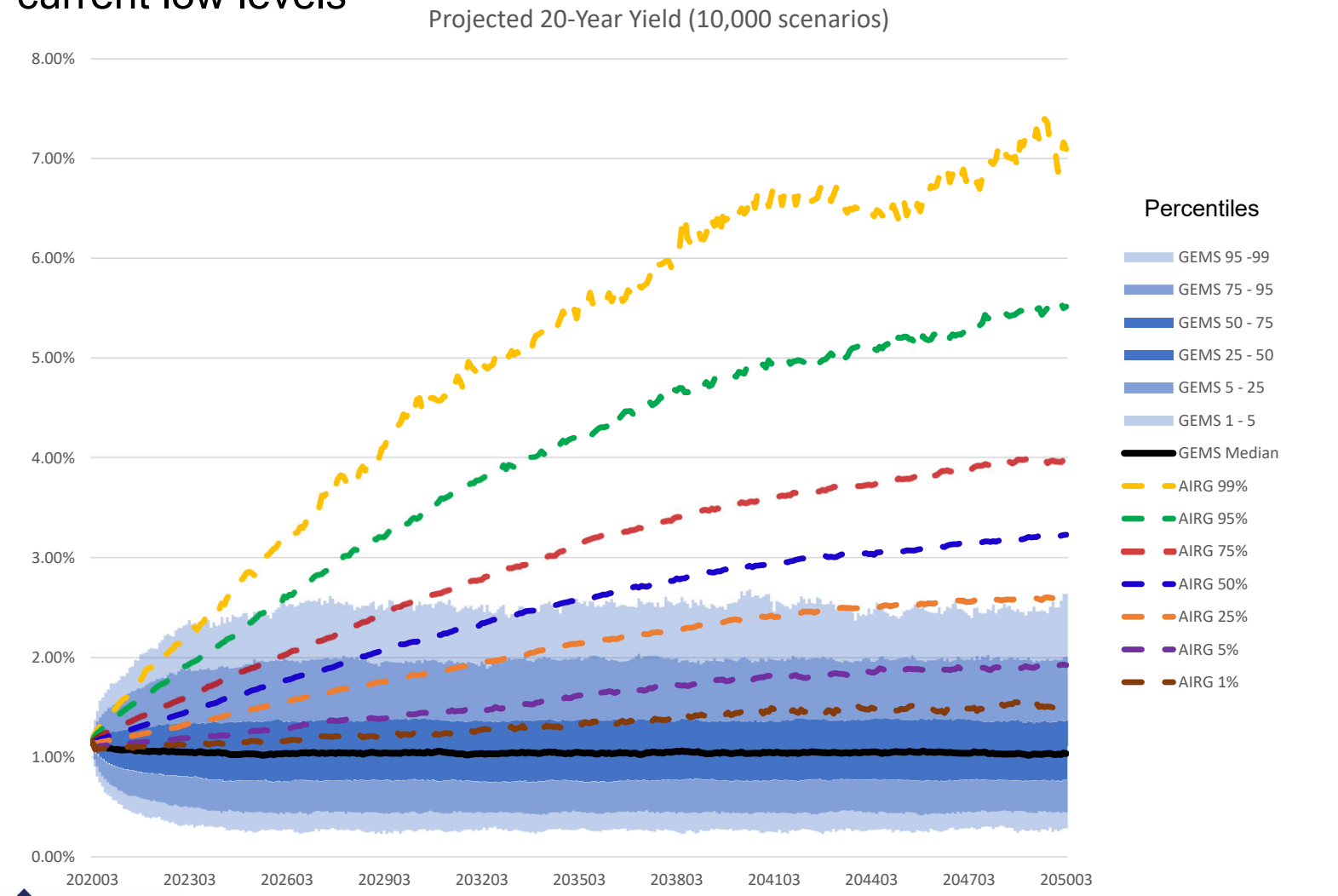
AIRG compared to GEMS® current calibration



CONNING

Prepared by Conning. Sources: Academy Interest Rate Generator v 7.1.201905 and GEMS® Economic Scenario Generator scenarios

AIRG compared to GEMS® calibration adjusted to maintain today's current low levels



CONNING

Prepared by Conning. Sources: Academy Interest Rate Generator v 7.1.201905 and GEMS® Economic Scenario Generator scenarios

Decisions to be made:

- What is the mean reversion target, and what methodology will be used to determine it? Conning can solve for implied parameters for each update
- What mean reversion speed is desired?
- How many low for long scenarios are desired?
- What sensitivities should be tested prior to field testing, and how should they be determined?

Goals relating to interest rate volatility:

6. The model should produce interest rate levels that fluctuate significantly over long periods.

Rationale for this goal: This follows the historical pattern of interest rates in the U.S.

Background:

AIRG compared to GEMS®:

Volatility

Description	AIRG Target	GEMS Target
Long End 1-Year Volatility	11 bps	37 bps
Short End 1-Year Volatility	20 bps	94 bps
Absolute Minimum (3-Month Yield)	0.0%	-12.7%
Achieved Minimum (3-Month Yield)	0.0%	~ -2.0%

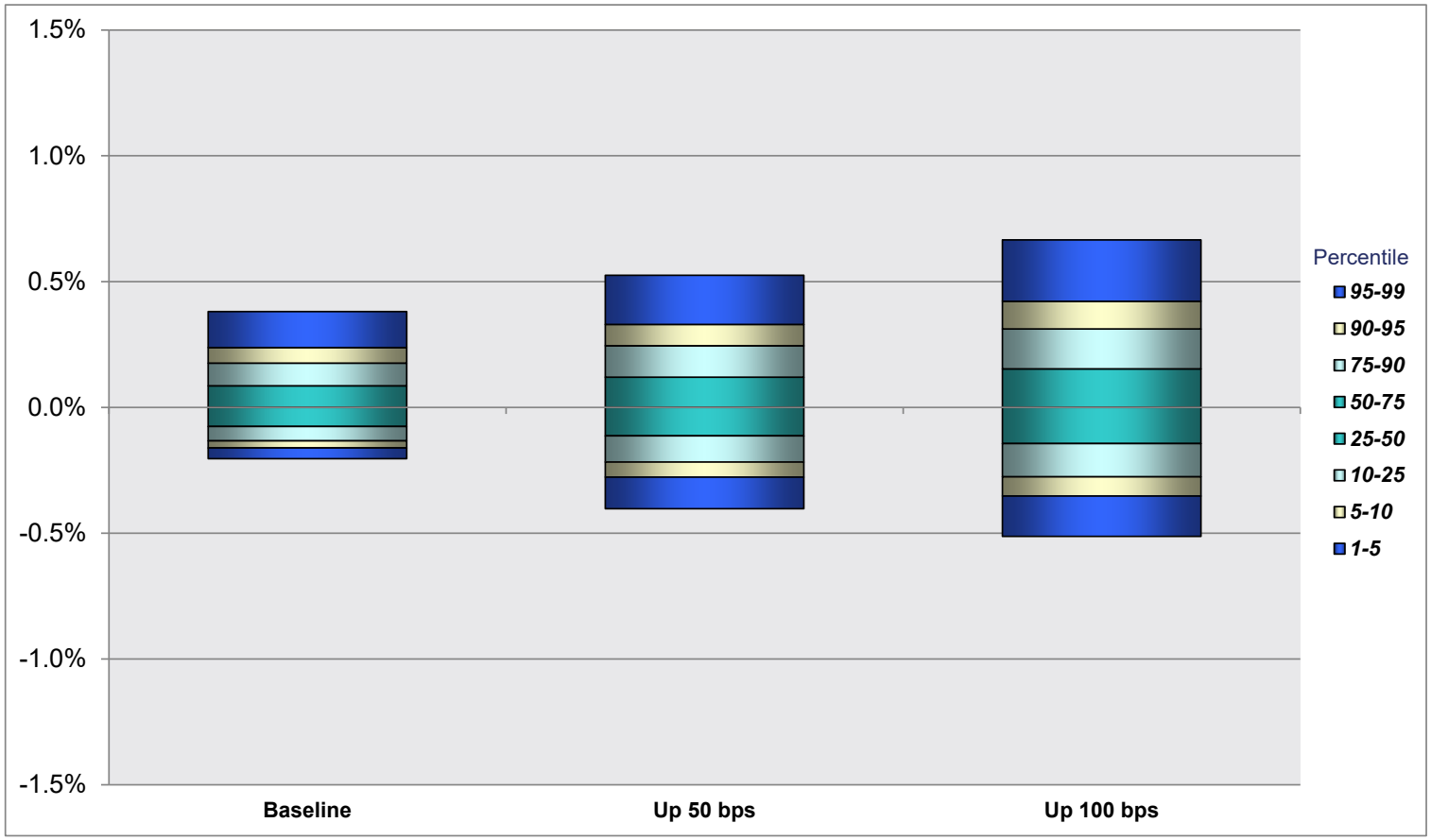
Impact of Target

- Impacts range of possible results
  - For comparison, actual 20-Year Treasury was down about 90 bps from 1/1/20 through 9/30/20
  - Had been down over 130 bps (3/9/20)
  - Applies to the upside, as well
- Volatility is also linked to minimum possible and observable Yields
  - More volatility leads to lower simulated Yields
  - The volatility in the AIRG is proportional to the rate level, where the lower the yield, the lower the volatility (i.e. Yields = 0 => no volatility)
  - GEMS® also has volatility proportional to the rate level, but the volatility would decline to zero at the Initial Shift level instead of at 0%

Prepared by Conning. Sources: Academy Interest Rate Generator v 7.1.201905 and GEMS® Economic Scenario Generator scenarios

Impact of Initial Yield Level on 20-year Treasury volatility – AIRG Model as of 9/30/2020

Dispersion from Median in first 12 months of Projection



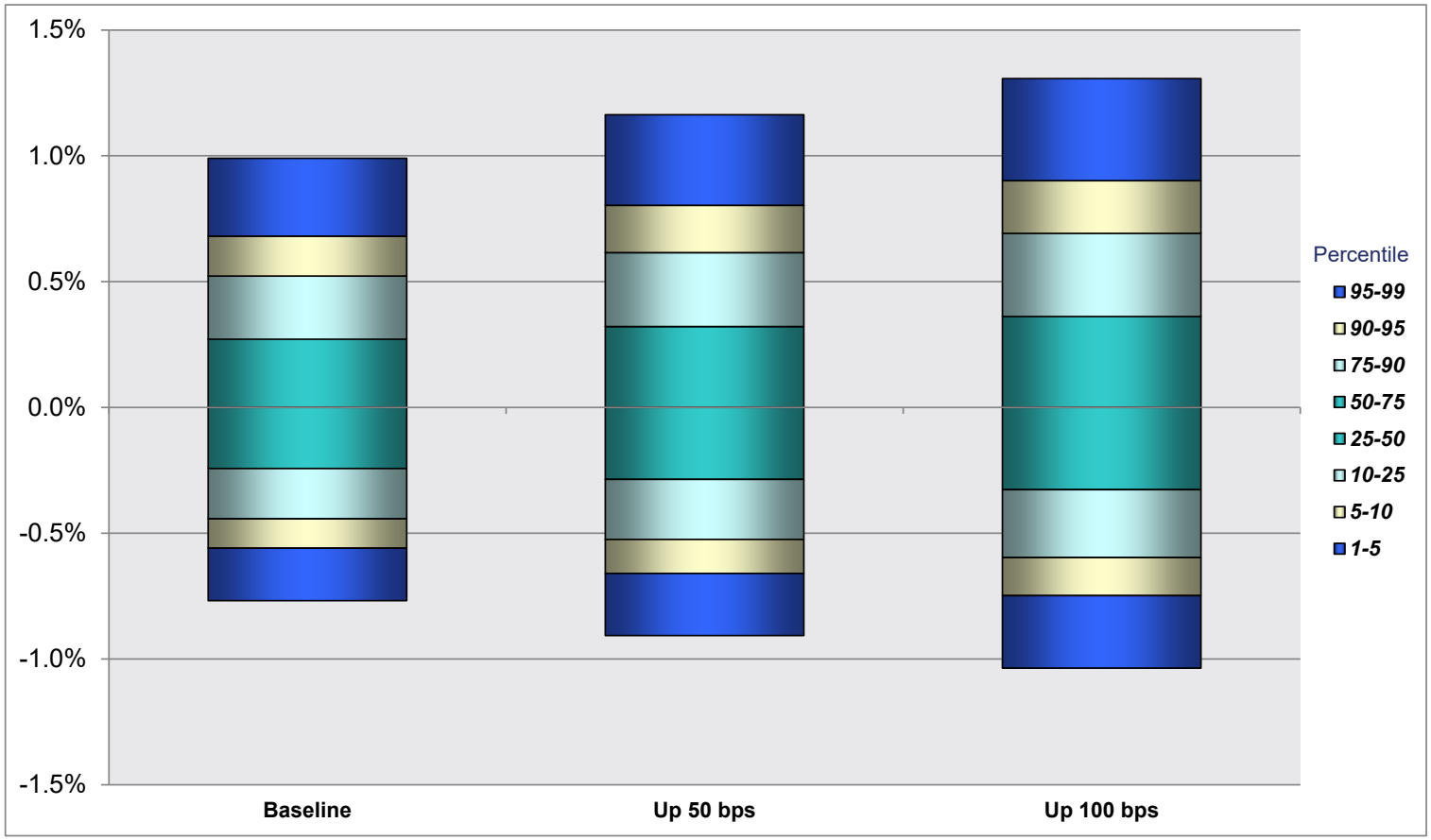
20-year Treasury = 1.23%

Prepared by Conning. Source: Academy Interest Rate Generator v 7.1.201905

CONNING

Impact of Initial Yield Level on 20-year Treasury volatility – GEMS® Model as of 9/30/2020

Dispersion from Median in first 12 months of Projection



20-year Treasury = 1.23%

Prepared by Conning. Source: GEMS® Economic Scenario Generator scenarios

CONNING

Other goals:

7. The interest rate generator should be arbitrage free.

Rationale for this goal: If a model is not arbitrage free, then there is some ability to create a risk-free profit

AIRG compared to GEMS®:

- The AIRG model is not arbitrage free. When the short end of the curve hits the minimum, the arbitrage free framework is violated
  - Consider a scenario where the 1- and 2-Month Yields are at their minimum (i.e. 1 bps). Then, over the next month, the return on a 1-Month Treasury will be 1 / 12 bps in all scenarios. On the other hand, that will be the maximum return over that period on a 2-Month Treasury. If Yields increase, then the 2-Month Treasury's return will be less than that. So, one can lock in a profit by buying the 1-Month Treasury and selling the 2-Month Treasury in that scenario.
- The GEMS® Treasury Model is arbitrage free.
- Why is this important: This is particularly important for life insurers because they are valuing not only their assets with these scenarios, but also their liabilities. So, in certain circumstances, it is possible for a company to create an asset strategy that will always outperform its liabilities despite the two having the same initial market value.

Decision to be made: No decision to be made. The GEMS model is arbitrage free. However, if a floor is introduced, it will no longer be arbitrage free.

Other goals:

8. The ESG should be calibrated using an appropriate historical period.

Rationale for this goal: It is important to incorporate a historical period that captures an appropriate range of market dynamics while also being careful not to introduce bias into the generated scenarios

AIRG compared to GEMS®:

- The AIRG is calibrated using historical Treasury data going back to 1953.
- GEMS® is calibrated using data from 1995 to 2019. The historical period used for calibration can be customized. For example, see the customization illustrated on slide 22.

Decision to made: What historical period would regulators like to use?

Summary of Goals

Goals relating to the yield curve shape:

1. The model's starting yield curve should match the actual yield curve as closely as possible.
2. The model should produce a variety of yield curve shapes, and they should change over time.
3. Interest rates can be negative.

Goals relating to interest rate mean reversion:

4. The model should be capable of producing a reasonable range of results for very long simulations.
5. The ESG should be capable of producing low interest rates for an extended period of time.

Goals relating to interest rate volatility:

6. The model should produce interest rate levels that fluctuate significantly over long periods.

Other goals:

7. The interest rate generator should be arbitrage free.
8. The ESG should be calibrated using an appropriate historical period.

Next Steps

1. Please send questions and comments regarding the GEMS® treasury model to Reggie Mazyck (Rmazyck@naic.org)

2. Next topics for discussion

    1. Corporate Model

    2. Equity Model