Brian Bayerle
Senior Actuary

April 12, 2022

Mike Boerner
Chair, NAIC Life Actuarial (A) Task Force (LATF)

Philip Barlow
Chair, NAIC Life Risk-Based Capital (E) Working Group (Life RBC)

Re: ESG PowerPoint Presentation

Dear Messrs. Boerner and Barlow:

The American Council of Life Insurers (ACLI) appreciates the opportunity to submit comments on the exposed PowerPoint Presentation on Recommended Models for ESG Field Testing (Presentation).

Economic scenarios are one of the most critical and foundational assumptions for principle-based reserves and capital for life insurance and annuity products. We support the NAIC's efforts to replace the existing economic scenario generator given the known limitations of the Academy interest rate model, and we are committed to helping the NAIC develop suitable scenarios which are both economically sound and include plausibly severe (worse-than-history) events.

In the sections below, we summarize our concerns regarding the exposed models, suggest improvements for the current field test, and identify areas for consideration in potential future field test exercises. It is our hope that this feedback will help to increase the likelihood that this resource intensive process will ultimately lead to successful implementation of a new Economic Scenario Generator by the NAIC and help preserve consumer access to important products that promote financial and retirement security.

Concerns remain regarding scenarios produced by the GEMS model

Industry continues to have significant concerns regarding the suitability of the Conning GEMS model for life and annuity statutory valuation, as pointed out in our March 24, 2021, comment letter (Attachment A) and more recently in our February 17, 2022, presentation to LATF (Attachment B). These concerns include the frequency, duration, and severity of negative interest rates; the assumed formulaic relationship of equity returns and interest rates, and term spread and volatility issues between different maturities. Underlying these issues is a lack of transparency and sufficient documentation about the workings of the model.

The American Council of Life Insurers (ACLI) is the leading trade association driving public policy and advocacy on behalf of the life insurance industry. 90 million American families rely on the life insurance industry for financial protection and retirement security. ACLI's member companies are dedicated to protecting consumers' financial wellbeing through life insurance, annuities, retirement plans, long-term care insurance, disability income insurance, reinsurance, and dental, vision and other supplemental benefits. ACLI's 280 member companies represent 94 percent of industry assets in the United States.

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Nevertheless, we recognize that regulators intend to proceed with an initial field test of the GEMS model, and ACLI wishes to participate constructively in the exercise. A well-designed field test may provide evidence that significant alternatives to the proposed model need to be considered in future field test exercises.

Recommendations for the field test and related processes

ACLI recommends including an alternative equity calibration for the model used in the field test. The American Academy of Actuaries (Academy) model office testing has shown some extreme results for variable annuities (VA) that are primarily attributable to the equity calibration. Without changes, ACLI would expect the field test to produce similarly extreme results which may distort scenario dynamics and interactions that we are trying to understand with the field test. ACLI wants to work with regulators on developing a different calibration of the equity model in the next few weeks (possibly to be tested alongside the revised calibration under development) that provides a more reasonable equity scenario distribution and will help address some of these extreme results we have seen in model office testing. As seen in the Academy's analysis of the VA model office results, equity returns are typically the primary driver of VA reserves and capital (hybrid scenarios using revised interest rates and current equities resulted in lower reserves / capital).

We also note that both the calibrations and flooring approaches described on slides 5 and 6 from the Presentation have significant limitations in terms of negative rates and other scenario properties. We suggest focusing on one approach for the field test (e.g., the Generalized Fractional Floor, the Academy Shadow alternative, or a revised version of the Academy Shadow alternative) or designating one as the baseline and the other as a sensitivity (instead of running both for every test).

We ask that regulators not underestimate the resource intensity placed on companies by field testing. In order to provide robust outcomes, we propose the following process recommendations:

1. Establish clear objectives for the field test. While these can be determined after the start of the field test, we believe that it would be a best practice to have these objectives in place prior to the analysis of field test results. Further, it would be helpful to have these objectives communicated so that we, and other interested parties, can properly align our efforts.

2. Develop a comprehensive set of interest rate, equity, and credit properties and acceptance criteria metrics across different economic conditions as a separate workstream running concurrently to the field test. Like mortality or policyholder behavior assumptions which are expected to satisfy certain relationships (e.g., mortality increasing by age, male rates > female rates), appropriate economic assumptions should follow a comprehensive set of relationships and properties regardless of model office and field test results. We would appreciate the opportunity to work with regulators to develop such metrics and note these are part of broader best practices outlined in a Conning/Society of Actuaries paper (select excerpts in Attachment C).

3. Incorporate a qualitative component of the field test in the form of a comprehensive survey. We believe the process is best served by opening the survey to all companies, not only the

companies participating in model runs. Such an approach casts a wider net and allows regulators to better understand the dynamics as they consider next steps in the development of the generator. ACLI stands ready to work with regulators to develop such a survey over the coming weeks.

4. Develop and follow a comprehensive and clearly defined assessment process. Developed concurrently with the field test, the process should include final acceptance criteria across all three model forms, quantitative assessments of the impacts, and qualitative assessments based on the survey.

Recommendations for potential future field tests

Based on the many challenges with the new model identified to date, ACLI expects that it may be necessary to conduct more than one field test. We highlight the following considerations for future reference:

1. We wish to work with regulators to finalize the requirements around the Academy's simplified model so it can be implemented for future testing.

2. ACLI has developed an alternative model (Attachments D-E) that could be used either as a comparative tool or an alternative path to a new generator. The interest rate portion of this model builds on the well-understood AIRG structure and applies straightforward and targeted refinements that a number of companies and other ESG practitioners have used to address the types of shortcomings encountered in the AIRG. A preliminary calibration shows this model meeting the regulators' low-for-long and other criteria while preserving other desirable scenario properties. In addition, by retaining the AIRG's existing rate / equity relationship, the ACLI model facilitates comparisons between this long-standing approach and GEMS's formulaic approach. The GEMS model assumes a constant mean expected equity risk premium in every month as a very material simplification. This simplification introduces volatility and potential procyclicality and has significant consequences and we suspect this effect may be magnified on existing business book given the distribution of equity return over projection time (Attachments F-J). The ACLI also intends to incorporate the Academy's simplified corporate model into this tool, which we view as preferable to the opaque Conning model.

   We wish to work with regulators so that regulators can gain sufficient comfort with this model so that it can be included in future field tests.

3. We support revisiting and confirming the methodology for the Stochastic Exclusion Ratio Test (SERT) and Deterministic Reserve (DR) scenarios given the change in ESG to ensure that the scenario properties still align with the original intention / risks they are intended to capture.

ACLI remains committed to the development of a replacement ESG that addresses the flaws in the AIRG and is appropriately "fit-for-purpose" for statutory valuation. ACLI is appreciative of your consideration of our comments and looks forward to a future discussion.

cc: Reggie Mazyck, NAIC, Dave Fleming, NAIC

Attached Files:
Attachment A: ACLI Comments on Economic Scenario Generator Exposure
Attachment B: ACLI Comments on ESG for LATF Discussion
Attachment C: Conning_Paper_Excerpts
Attachment D: Ref 1.3 Distributions
Attachment E: Reference Model and Stats DRAFT v1.3
Attachment F: ACLI_Equity_Model_Comments - 0820 Version
Attachment G: ACLI_ERP_Relationship_Summary
Attachment H: ERP_Excerpts
Attachment I: ACLI_StylizedFact_InitialConditions
Attachment J: ACLI_ERP_Modeling_Options

Brian Bayerle
Senior Actuary

March 24, 2021

Mr. Mike Boerner
Chair, NAIC Life Actuarial (A) Task Force (LATF)

Mr. Philip Barlow
Chair, NAIC Life-Risk Based Capital (E) Working Group

Re: ACLI Comments on Economic Scenario Generator Exposure

Dear Messrs. Boerner and Barlow:

The American Council of Life Insurers (ACLI) appreciates the opportunity to provide comments on the exposures related to the economic scenario generator (ESG) project. ACLI is committed to working with regulators on the modifications and implementation of Conning's GEMS as the replacement for the current Academy Interest Rate Generator (AIRG). We acknowledge that the current generator has clear shortcomings and further acknowledge the need to get an improved generator in place as soon as possible.

That said, our initial analysis of the scenario set has surfaced anomalies and scenario results that we consider inappropriate. These anomalies include significant and sustained negative interest rates, a large number of yield curve inversions, extreme equity returns, and low Sharpe ratios for certain equity indices, none of which is consistent with historical experience. The underlying causes of these issues are not currently clear due to the absence of detailed documentation and may be deeply rooted in the model. **For this reason, we request more thorough and comprehensive documentation which will aid in understanding of the model and make the decisioning and testing process more efficient.** While ACLI recognizes the need to get a better generator in place as soon as possible, our observations to date do not give us comfort in the current state of the proposed model which may indicate timeline issues. We believe that the implications of the collective set of decisions must be understood in order to avoid potential unintended consequences (i.e., addressing one concern but creating another). We support a timeline that ensures that the new generator is fit for purpose.

Our letter is organized as follows:

I. Overarching Comments
   A. Anomalies in Scenarios

The American Council of Life Insurers (ACLI) is the leading trade association driving public policy and advocacy on behalf of the life insurance industry. 90 million American families rely on the life insurance industry for financial protection and retirement security. ACLI's member companies are dedicated to protecting consumers' financial wellbeing through life insurance, annuities, retirement plans, long-term care insurance, disability income insurance, reinsurance, and dental, vision and other supplemental benefits. ACLI's 280 member companies represent 94 percent of industry assets in the United States.

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   B. Needed Additional Documentation
   C. Timeframe Considerations
II. Comments on Treasury, Corporate, and Equity ESG Goals and Proposed Recommendations
   A. Areas of Support
   B. Areas for Additional Dialogue/Documentation
   C. Areas of Significant Concern
III. Comments on ESG Scenario Statistics and Reports
IV. Comments on ESG Scenario Picker Tool, Stochastic Exclusion Ratio Test, and Data Formats
V. Comments on Other Related Topics

I. Overarching Comments

The Conning model represents a structural change relative to the current model, with interrelationships that should be vetted and understood. The components of GEMS (i.e., interest rate, equity, and corporate models) are linked, and their calibration (e.g., interest rate mean reversion level, volatility, and shift; equity risk premiums; jump parameters) should be evaluated holistically because a decision on one parameter or scenario property may have direct and indirect effects on scenario dynamics for multiple risk factors (e.g. changes to interest rate parameters will affect equity returns) both at a point in time and between reporting periods. In addition, the ESG has a complex relationship to the statutory requirements.

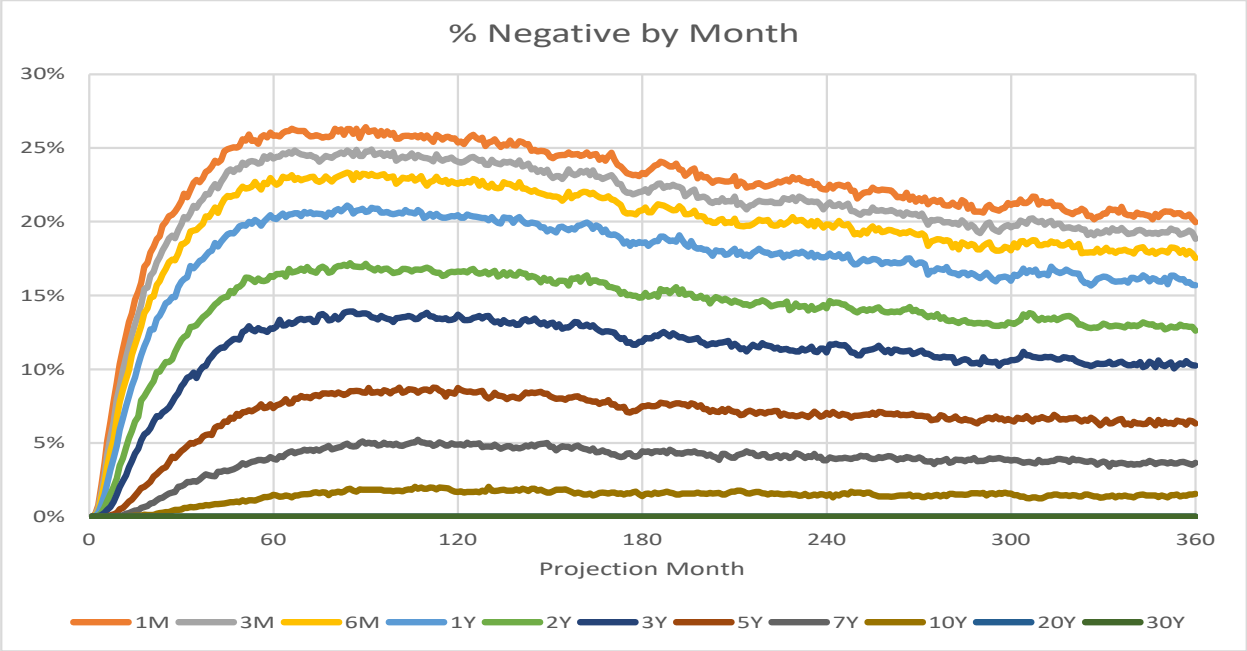
We believe that appropriate vetting and discussion of the key decision points is necessary so that regulators and industry can achieve the goal that the generator is fit for purpose in calculating reserves and capital. The discussion should go beyond individual technical decision points that, in a vacuum, may be reasonable but lead to an unreasonable scenario set. There should be a discussion of stylized facts and expectations around the results and their consistency with the relevant historical period. While the definition of the appropriate historical period can and should be debated, the results produced by the generator should be reasonable through the lens of that historical experience. As a reference to help assist in this discussion, Appendix One of our document outlines desirable attributes for the generator, which are further reflected in our specific comments on the exposures.

The focus of our following comments is the 12/31/2019 revised baseline scenario set and includes preliminary observations on the 12/31/2020 scenario set.

A. Anomalies in Scenarios

ACLI believes that the scenario generator should create a scenario set that reasonably reflects history, with some allowance for more extreme environments. Our initial analysis of the 12/31/2019 scenario set, however, has revealed several significant concerns. These concerns still appear to be present in the 12/31/2020 scenario set and may be generally exacerbated by lower initial interest rates.

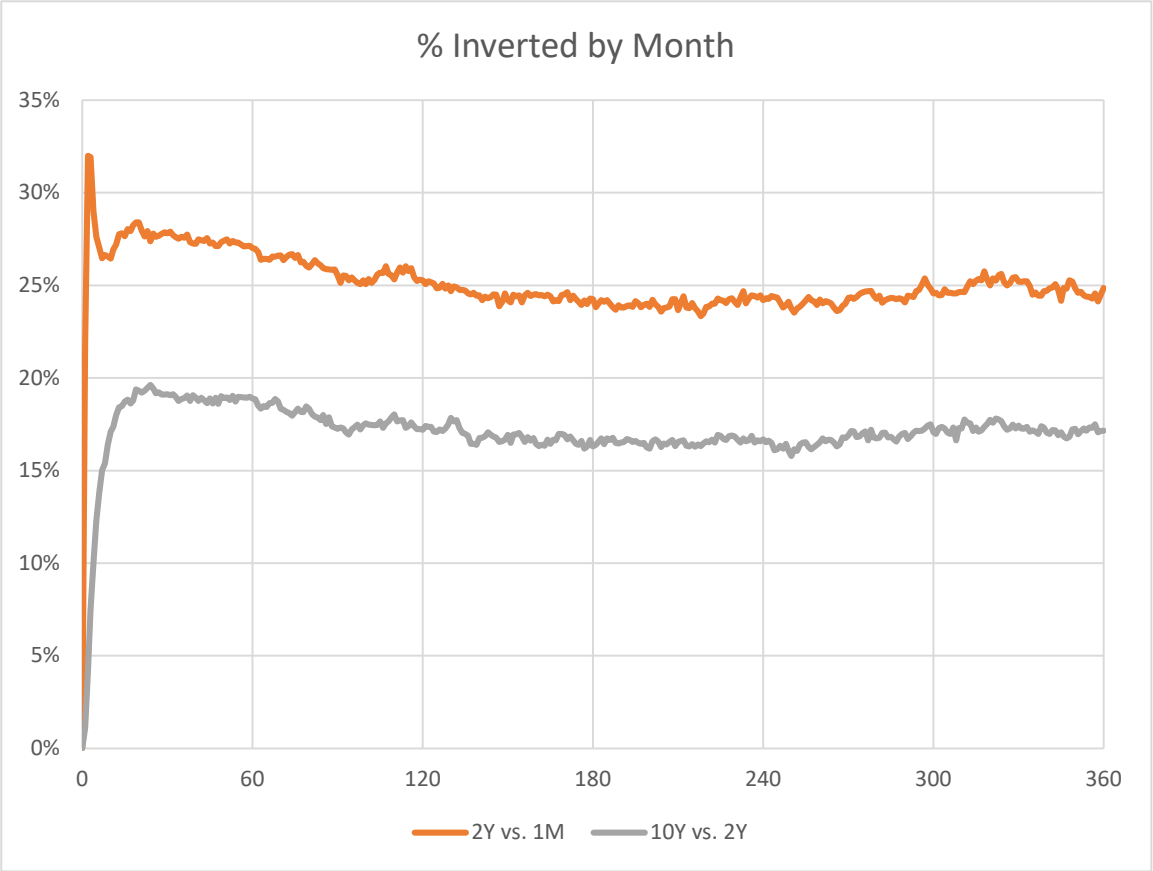
Negative Rates: The revised 12/31/19 scenario set is generating significant and sustained negative interest rates. Short-term yields fall as low as -6.2%. Yields for maturities shorter than 1Y are negative during roughly 20% to 25% of the scenarios in projection years 5-15. Those yields are negative in ~15% to 20% of scenarios in the long term as illustrated in the following graph:



The frequency of negative rates is even more extreme (e.g., over 45% of scenarios have negative short-term yields in the first year) in the 12/31/2020 scenarios.

We believe that the projected frequency and severity of negative rates should be more consistent with historical US experience. Historically, no period of negative rates has lasted for a meaningful period of time in the US.

Yield Curve Inversions/Realized Volatilities: We are concerned by the number of inversions occurring within the scenarios. Based on our initial analysis of the revised 12/31/19 scenario set, the frequency of yield curve inversions appears elevated vs. history. While the revised baseline calibration addressed the 100% rate inversion problem in the initial set, inversions for short maturities are still relatively frequent (~25% of scenarios) as shown below:



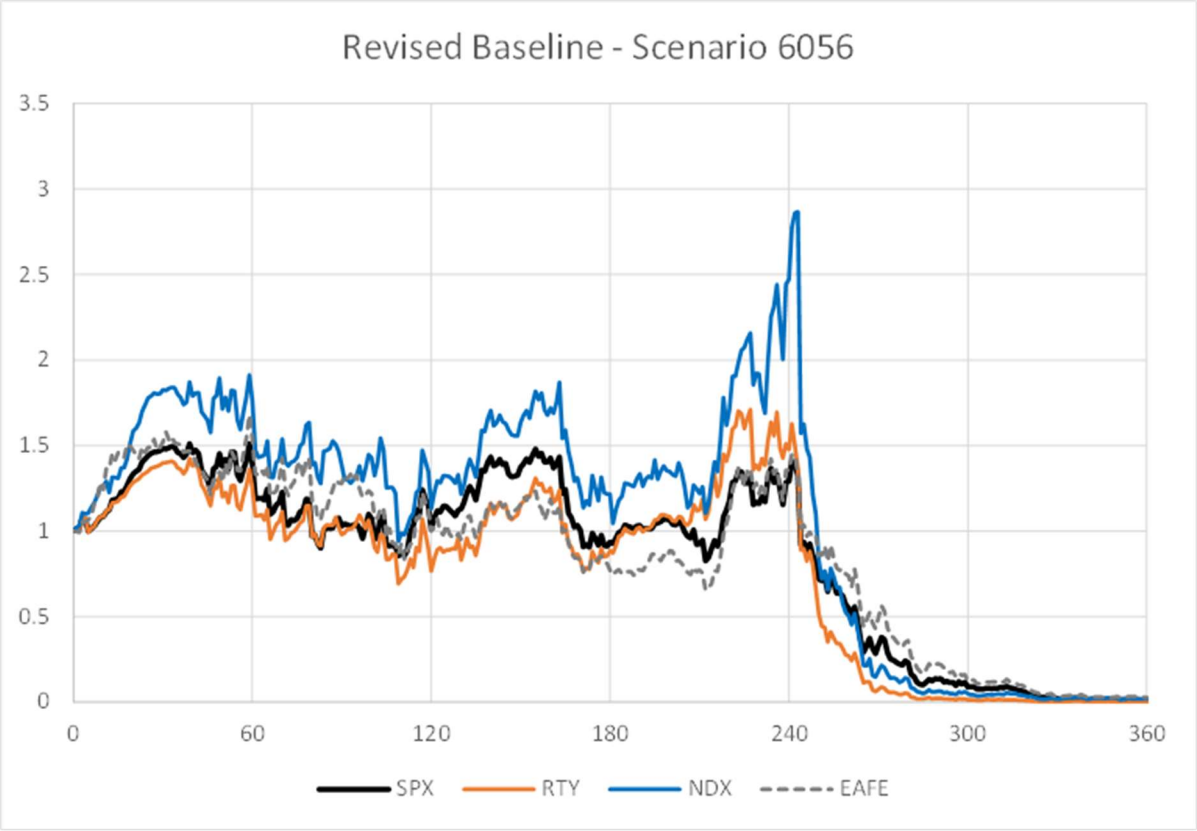
The frequency of short rate inversions also worsens dramatically in the first five years of the 12/31/2020 scenarios.

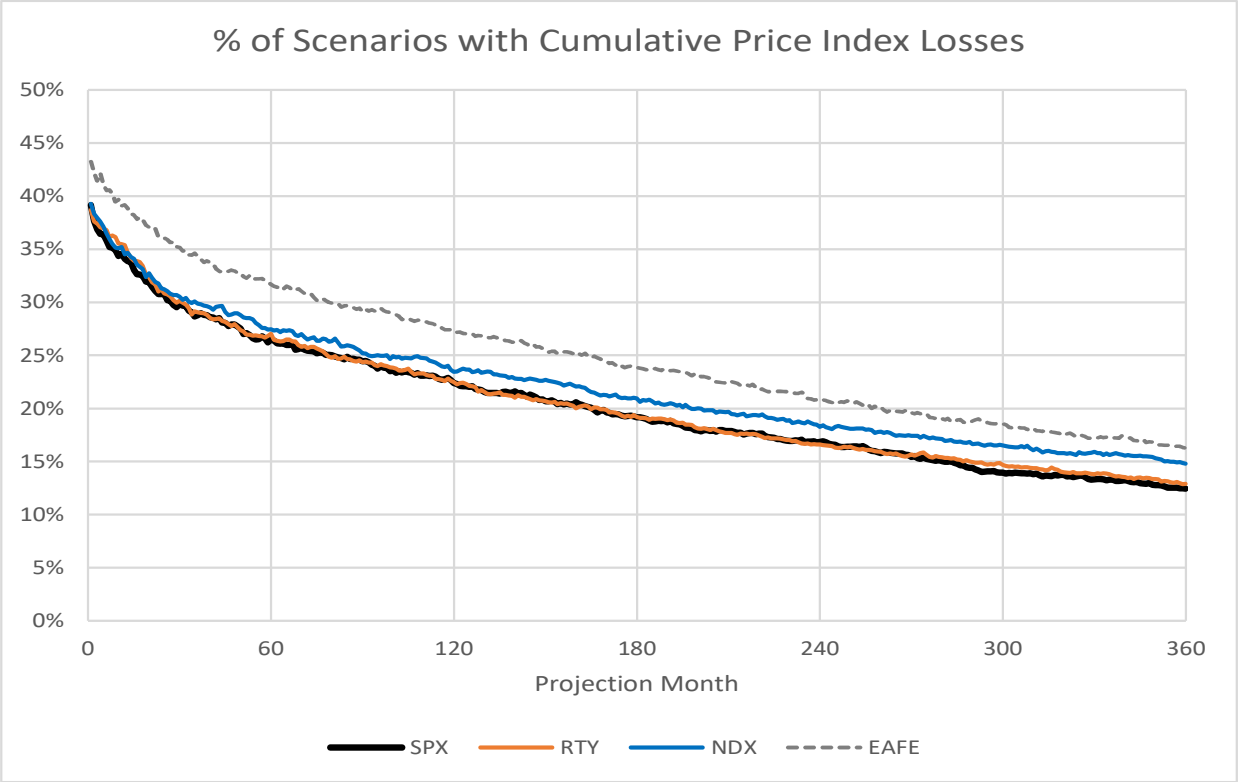
In addition, realized volatilities for short maturities (e.g., 1-year rates) are roughly double the realized volatilities for long maturities (20-year rates). This is inconsistent with the historical data set used in Conning's calibration and may also be contributing to other concerns with the scenario distribution we have observed (e.g., the ability to produce interest rate dynamics in recent history as well as the 1970s / 1980s, unintuitive long-term risk/reward relationships between bond funds).

We believe the yield inversions and realized volatilities should be more consistent with observable historical data.

Extreme Equity Returns: We have observed, as shown below, unusual distribution characteristics and jumps in the initial scenario set, the cause of which is unclear. At the extremes, there are scenarios that assume that equity indices essentially become worthless (see chart below for an example). The original baseline also includes indices that are 1000+ times (>100,000%) higher by year 30. We would like a better understanding of jump process / parameters & comparison of returns after jumps vs. history (which includes strong market recovery in a relatively short time period after jump down). The S&P 500 (price index) has negative returns over 30 years in 12% of scenarios even though this has never been observed in history. In the over 90 years of S&P 500 (SPX) data since 1928, monthly losses larger than

25% and 20% have only occurred once (Great Depression) and 3 times (1929, 1932, 2008), respectively. Monthly declines of more than 25% occur in over 14% of Conning's 30-year scenarios.





Mean Equity Returns / Return Relationships: Conning's recommended calibration has a significantly lower view of long-term equity returns relative both to history and the AIRG. The model returns should be calibrated similarly to the AIRG, with the addition of recent history. In particular, low EAFE returns and higher SPX/EAFE correlations may be contributing to inconsistencies in the risk return relationship between different equity indices. We observe that the average Sharpe Ratio over 30 years for EAFE is ~18% vs. ~33% for S&P 500 in revised baseline scenario set as of 12/31/2019.

B. Needed Additional Documentation

Additional documentation will help enable industry to provide more constructive insights for a higher quality generator and a more efficient process. There are gaps in the interest rate model documentation (e.g., determination of the state variables), with more significant gaps noted in the equity model documentation (e.g., EAFE model, distribution, and correlation of jump processes) and the corporate / credit model. We note that the corporate model drives bond fund returns in the Basic Data Set, so while companies may not need the granular credit output in the Robust Data Set on an ongoing basis, the information is needed to appropriately vet the Basic Data Set.

We request the following additional documentation to assist in our review, noting while some of this may have been included in the March 18th exposures, the materials do not appear to substantively address the issues outlined below:

- Explanations of model selection considerations and theoretical justification for model choices (e.g., 3-factor vs. 2-factor model, formulaic equity risk premium relationship) as

these decisions determine fundamental scenario properties and their suitability for purpose.

- Direct and indirect relationships (e.g., equity risk premium, equity/credit, rate/spread relationships), including formulas, correlations, and any relationships imposed via judgment
- Methodology and formulas used to determine fund returns, including the composition of bond indices and derivation of bond fund returns, use / modeling of exchange rates in international equity returns
- State process information, including all distributions and correlations
- Calibration information, including model parameters and calibration targets at multiple points in time, methodologies for setting initial values and long-term targets, how and where historical data is used and the benchmarks used, the process and judgment used when a calibration fails, and identification of the values that would be updated at each reporting period, regularly, or based only on triggering events
- The criteria for evaluating the reasonability of each published scenario distribution (beyond validating that targets are reproduced)

In addition to documentation for Conning's model and calibration, LATF should develop and document target scenario properties or stylized facts which can be done on a parallel track as documentation becomes available. Targets such as the original C-3 Phase 2 equity calibration points may be useful. It is important to confirm that the Conning generator and calibration can meet those targets under an appropriate range of market conditions and other sensitivities.

C. Timeframe Considerations

We encourage the Task Force to regularly assess the status of the timeline in light of the many steps to be completed prior to implementation. ACLI suggests the following considerations for additional milestones or adjustments for the expected timeframe of existing milestones:

- Additional time may be necessary to understand and confirm the suitability of the model and its calibration. Considerations include availability of documentation and adequate time to understand it, deliberation of key calibration decisions, adequate time to test impacts of changes, sensitivity testing and forecasting, and implementation to valuation systems and other processes. Additionally, smaller companies could be put at a disadvantage due to fewer resources to test and implement the change.
- Additional education sessions for regulators and interested parties may be necessary once more documentation is available to thoroughly understand the generator.
- The field testing start date may already be coming under pressure due to the lack of adequate documentation. There is currently no viable candidate for field testing as there are significant concerns with the revised baseline as noted in 'Anomalies in Scenarios'.
- The timeline should provide time for consideration of reassessing generator modification(s) and parameters after the assessment of the field study results.
- Consideration in the implementation timeline should also contemplate time for companies to evaluate the potential impact of the new ESG on statutory reporting, risk management & hedging (due to changes in economic sensitivities), and system implementation.

We encourage the regulators to regularly assess the status of the timeline since failure to meet current and suggested milestones may adversely impact the timeline.

II. Comments on Treasury, Corporate, and Equity ESG Goals and Proposed Recommendations

ACLI agrees with many of the stated goals for the generator and notes the importance of a holistic view of how these come together for a generator that is deemed to be fit for purpose. This holistic view of the exposed scenario sets (which are based on "mixing and matching" of the Conning Standard Calibration parameters with the selected adjustments and overrides presented in the list of "ESG Goals") gives us some concerns about the viability of these recommendations and may require a fundamental or first principles recalibration of Conning's model or selected model refinements to resolve these concerns. We have broken down our comments into three categories: areas of support, areas for improvement with additional dialogue or documentation, and areas of significant concerns:

A. Areas of Support

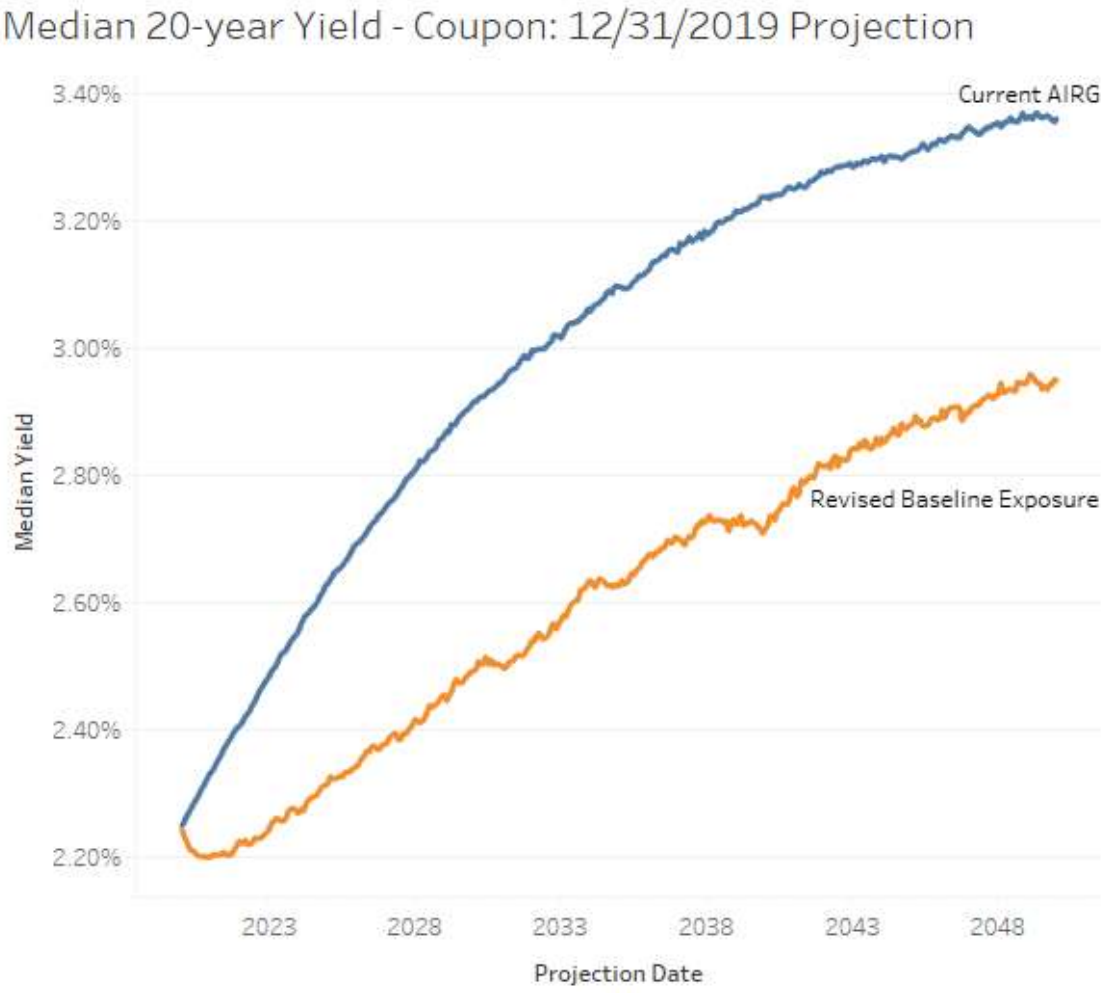
Treasury goal #1 (Initial Yield Curve): We support the goal that the model's starting yield curve should match the actual starting yield curve as closely as possible. Our initial analysis suggests that the model would have had difficulty fitting historical rate curves. Based on our analysis to date, adjustments to the model beyond the grading period recommendation may be needed to fulfill this objective.

Treasury goal #4 (Range of Results): We support the goal that the model should be capable of producing a reasonable range of results for very long simulations. Based on our analysis to date, adjustments to the recommendation may be needed to fulfill this objective.

Treasury goal #5 (Sustained Low Rates): We support the goal that the ESG should be capable of producing low interest rates for an extended period of time. The definition of "low for long" should be based on plausible expectations and should be considered in conjunction with the broader scenario distribution. We observe that lowering the mean reversion point alone is not sufficient to achieve this goal. The structure of the mean reversion point, the mean reversion speed or strength, and volatility need to come into play so that scenarios have the appropriate degree of dispersion.

Regarding the speed of mean reversion, we observe that the exposed scenarios do not appear to be consistent with the recommendation of alignment with the current Academy scenarios. The GEMS scenarios (both original and Revised Baseline exposures) have significantly slower median reversion than the current Academy scenarios (as observed in the following chart). This difference may reflect structural differences between GEMS and the AIRG. Starting from 12/31/2019 initial conditions, median long-term rates in the Conning generator are 40 basis points below the corresponding AIRG median after 30 years. When mean yields do not approach their target within a typical projection period, it effectively results in an inadvertently lower target in today's low-rate environment. Additionally, mean long-term yields decrease for

the first several months in the Conning generator. It is unclear if this is intended or an unintentional side effect of the model calibration.



Equity and corporate goal #1 (Returns are Representative): We support the goal that returns should be provided for the types of funds representative of those offered in U.S. insurance products.

B. Areas for Additional Dialogue/Documentation

Treasury goal #2 (Variety of Curve Shapes—also see above): We support the goal that the model should produce a variety of yield curve shapes, and they should change over time. We recommend additional review of the appropriateness of yield curve shapes and the acceptable frequency of specific shapes (e.g., frequency of yield curve inversions, consideration of limitation of time for inverted curves).

Treasury goal #6 (Sustained Volatility): We support the goal that the model should produce interest rate levels that fluctuate significantly over long periods. Currently, we do not yet support the recommendation to use the GEMS volatility estimate. The volatilities from the initial scenario

set do not look to be related to the relevant historical period and are not explained by the available documentation. The volatilities may also be a source of the anomalies described above.

Treasury goal #8 (Historical Data Period): We support the goal that the ESG should be calibrated using an appropriate historical period. We would support consistency with the Academy generator's historical period (starting in the 1950s), extended to include the most recent available data. Critical to this goal, the historical period should be consistently applied across the underlying calibration of state variables. Since Conning has effectively locked in significant aspects of their 1995+ based standard calibration (e.g., risk-neutral parameters, volatilities), it is unclear where they have reflected the data since 1953 in their calibration (other than when superimposing the mean reversion target). Using interest rate volatilities based on data since 1995 (generally a lower rate and lower volatility period) may lead to an insufficiently broad range of rates, which may not sufficiently capture disintermediation risk (from high-rate scenarios), and lead to other anomalies / inconsistencies.

Equity and Corporate Goals #2 (Calibrated to Historical Period): We support the goal that the ESG should be calibrated using an appropriate historical period. From the available documentation, it is not clear what historical period is currently being used by Conning. Consistent with Treasury goal #8, we believe the Academy generator's historical period extended to include more recent data would be an appropriate period. Further, the scenarios that are generated by the model should be reasonable compared to the historical period results. The examples illustrated previously suggest areas where the revised baseline scenarios may be unreasonable (such as severely negative cumulative returns).

Equity and Corporate Goals #3 (Stochastic Volatility): We do not oppose the goal that the equity model should have stochastic volatility and that the initial volatility should be updated periodically. However, realized equity volatility appears to be higher in the Conning scenarios than in the Academy scenarios, and we do not have sufficient documentation to opine on the underlying rationale for this observed higher volatility. Stochastic volatility, if it exists, needs to decline over time to avoid arbitrage within the scenario sets. While we believe that there should be a defined process for updating initial volatility, the frequency and basis for the updates will need to be considered in conjunction with Conning's jump process since the linkage between volatility and the jump process may increase the risk of procyclicality (e.g., higher likelihood of market stresses after a recent drop).

Equity and Corporate Goals #6 (Higher Correlation in Tail): We believe correlations between equity indices in stressed markets should be consistent with relevant historical data. We do not have sufficient documentation to opine on whether Conning's approach is reasonable. Given the complexity of Conning's model, we would like to understand Conning's theoretical approach rather than focus on the results from any given scenario set.

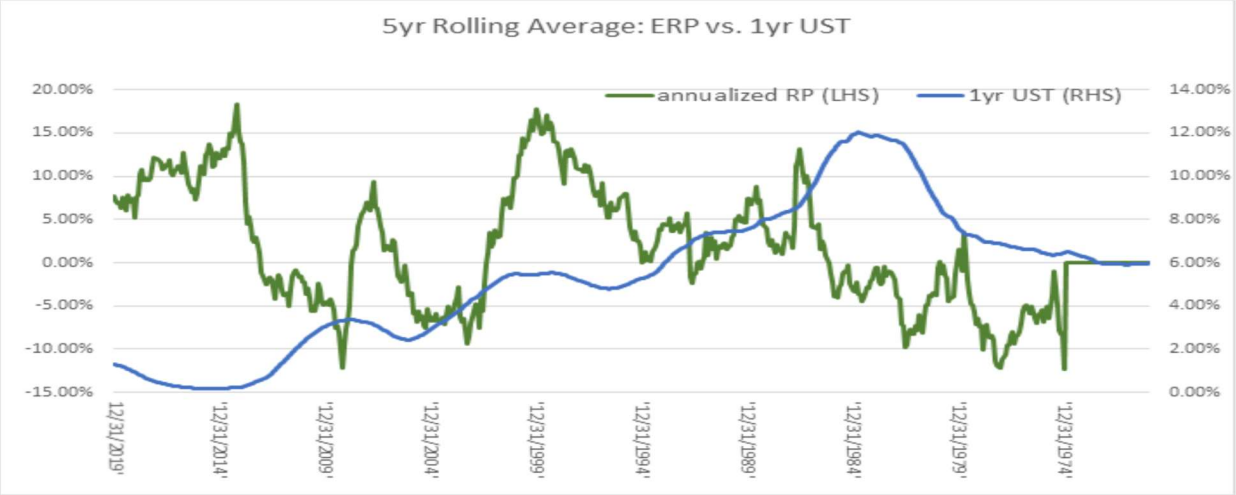
Equity and Corporate Goals #8-11 (Model for Returns, Separate Yield Curves by Rating, Stochastic Spreads, Dynamic Bond Credit Transitions): Conceptually, we support the goals to have stochastic spreads, credit migration, granular credit modeling, and consistency between basic and robust data sets. However, we have several concerns:

1. We lack sufficient documentation on GEMS' underlying credit model, assumptions, or existing calibration.
2. We would like to understand the basis and consequences of discrepancies between prescribed general account credit assumptions and Conning's assumptions and resulting credit scenarios.
3. It is unclear whether the tradeoff of a more sophisticated model is worthwhile relative to the increased complexity and lack of transparency (i.e., a significant amount of critical information only available in the Robust Data Set).

C. Areas of Significant Concern

Treasury goal #3 (Negative Rates—also see above): We do not inherently oppose the concept of negative interest rates. That said, we believe that the projected frequency and severity of negative rates should be similar to historical US experience and not be unduly influenced by experience in other economies outside the US. Historically, no period of negative rates in the US has lasted for a meaningful period of time. Negative rates are influenced by many model parameters, and each may entail different, potentially undesirable tradeoffs. In addition, the use of arbitrage-free scenarios may be contributing to the disconnect between the model and historical experience. While arbitrage-free scenarios are desirable (Treasury goal #7), a compromise may preferrable if necessary to prevent unrealistic scenario properties.

Equity and Corporate Goals #7 (Link between Equity and Treasury): We do not support the formulaic linkage between equity returns and Treasury yields given the lack of historical evidence. The existing approach in the AIRG allows for varying levels of correlation between rates and equities. At the same time, the correlations in the AIRG average close to zero across the entire distribution and have a historical basis. The selection of a strict formulaic relationship between equity returns and Treasury yields in every period appears to be driven by operational considerations (i.e., ability to simultaneously generate risk-neutral scenarios) unrelated to the NAIC's objective, fundamentally changes the nature of the scenarios, and is not supported by historical data. Intuitively, this relationship has not held in every period due to other macroeconomic factors. If it did, the late 70s and early 80s would have had high returns for equities, and the current low interest rate environment would have poor returns. Equity risk premium relationships have varied significantly over time in a manner that is unlikely to be well represented by the current recommendation.



The proposed relationship is also likely to be a source of non-economic volatility. Reserves and capital will be sensitive to changes in overnight interest rates even though the underlying insurance liabilities generally would not be. This relationship may create an incentive to hedge against changes to the overnight rate due to the artificial dependency in the ESG. We note how Conning's adjustment to target overnight rates in the revised baseline reduced equity returns by roughly 40% by year 30. Changes in actual overnight rates would also affect equity return paths in a manner that is unlikely to be offset by changes in other scenario parameters. For example, in the 2020 scenario set, equity index levels were approximately 10% lower at year 30 relative to the 2019 scenario set due to the lower initial overnight rates. However, the relationship varies at different periods, so any attempt to compensate for the change via high level adjustments to the equity risk premium would under/overcorrect depending on the product, introducing unintuitive results and volatility.

The revised baseline changes also illustrate how the explicit linkage may force unnecessary compromises between rate and equity distributions. The change to address a rate shortcoming in the original 12/31/19 baseline scenarios appears to have created or exacerbated inappropriate equity return distributions. Overall, we suggest an approach closer to the one used by the existing AIRG.

Equity and Corporate Goals #4 (Model Jumps): We do not oppose the goal of the ESG having the ability to generate very large losses and gains in short periods of time (i.e., jumps), but we have potential concerns about the recommendation to use Conning's existing calibration given the extreme results observed in the upside and downside tails previously noted and so cannot yet support this recommendation. Additional information will help us assess the appropriateness of the existing calibration.

Equity and Corporate Goals #5 (Long Recoveries): While we do not oppose the goal of having some equity scenarios reflect the possibility of a very long recovery after a period of losses, we have observed that a large portion of 30-year returns for indices in the revised baseline scenario set seemed highly adverse (see comments on extreme equity returns above). Additional

documentation may help us understand the drivers of these outcomes. We believe that recovery scenarios should be calibrated to appropriate history.

III. Comments on ESG Scenario Statistics and Reports

We suggest that the generator produce the following additional statistics. Note that we may request additional statistics once we have sufficient documentation to better understand the GEMS model.

- Additional percentiles, particularly in the tail in the fan charts (or supporting data tables)
- Period-over-period (i.e., between reporting date) comparisons in the fan charts
- A distribution (fan chart) of cumulative average interest rate paths
- A distribution (fan chart) of total and price return accumulation factors for all equity and bond funds
- A distribution (fan chart) of credit spreads and default losses driving the Basic Data Set bond fund returns
- A graph of the percentage of scenarios with negative rates (at the key 10-11 points on the yield curve) or inverted yield curves (for selected rate pairs) by projection month
- Information on the prevalence of other yield curve shapes (e.g., normal, steep, inverted, humped)
- Realized interest rate volatility statistics for short and long maturities
- Equity return volatility, skew, and kurtosis statistics
- A distribution (fan chart) of equity risk premiums
- A table showing the distribution of correlations between equity returns and bond funds, interest rates and equity returns, credit spreads and equity returns over the scenario projection (correlations should be over the scenario or meaningful periods, not individual years).

IV. Comments on ESG Scenario Picker Tool, Stochastic Exclusion Ratio Test, and Data Formats

We suggest deferring discussion of these items until the scenario set itself is determined. In the meantime, we offer the following considerations:

- Since scenario selection will only be available as posted files and not a tool, clarification on how scenario selection will be implemented for companies licensing the API should be provided.
- Documentation on how the new SERT percentiles are applied (e.g., to return vs. accumulation factor distributions, the conditional versions of those distributions based on the GEMS cascade structure (and therefore available only to Conning) and whether the approach captures the range of scenario outcomes intended for SERT (e.g., low rates/high equity leads to low rates/high equity given low rates (= lower equity)].

V. Comments on Other Related Topics

- Governance: We agree with Conning on the importance of appropriate governance in this process. We would encourage as much of the ESG specifications to be incorporated into the Valuation Manual as possible. Appropriate items to consider include the setting

of parameters, distribution properties, validation of results, and how the scenarios evolve through time. This will ensure appropriate controls of ESG changes and codify formulaic requirements and decision points that may be revisited over time. This work can begin while we are waiting on additional documentation.

- Scenario timing: We request assurance that the generator will be able to produce scenarios on the first day of each month, regardless of whether this falls on a weekend since many valuation processes commence based on a calendar day schedule.
- Projection Period: The projection period of the scenarios should be at least 70 years.
- Sensitivity testing and forecasting: It is unclear how scenarios for VM-20, VM-21, and VM-31 sensitivity testing requirements and potential attributions in Model Audit Rule key controls will be supported by the proposed process. For example, will additional scenario sets be generated and posted, or will companies be required to license the Conning API or full system to meet regulatory requirements or to understand and prudently manage their reserves and capital? The impact of changing economic conditions on the resulting scenario distribution will be vital for companies to understand for multiple reasons, including risk management & capital planning.
- C-3 Phase 1 (C3P1) RBC testing: Methodology clarifications will be needed if C3P1 is included in the ESG field study. Given the ongoing VM-22 discussions and their potential impact on C3P1 methodology, there are additional issues that may need to be addressed as part of the VM-22 field testing.
- C-3 Phase 2 (C3P2) CTE Level: We note that the revisions to C3P2 included the consideration of a scenario set with higher volatility, which was accompanied by a lower suggested CTE level (this is the CTE 95 vs CTE 98 discussion related to C3P2 TAR). Given that these decision points were contemplated as a package, the required CTE levels may need to be reconsidered in light of changes to the ESG.

We look forward to a discussion on this important initiative.

Sincerely,

cc: Reggie Mazyck, NAIC
Dave Fleming, NAIC

Desirable Properties of the Economic Scenario Generator

Stochastic Scenario Properties

- A single set of economic scenario requirements should apply to all products for which stochastic modeling is required.

- The prescribed scenario generator should be "fit for purpose" and produce a reasonable baseline set of economic scenarios. There should be a balance between complexity, transparency, and ease of use, and stability of scenario generator parameters.

- The scenario generator should have a sound fundamental basis. The generator parameterization should be based on relevant historical experience and produce a realistic distribution of real-world scenarios, including plausible and coherent tail stresses.

- The scenario generator should be based on best estimate assumptions to avoid unintended consequences between different products. For example, FIAs may have upside risk that would not be captured if the scenario parameters reflect additional margins geared towards products more sensitive to downside risk, such as VA GMxBs.

- The scenario generator should be viewed holistically, rather than focusing on narrow aspects of the generator. Refinements to the scenario generator should not be biased in one direction.

- Economic elements should be internally consistent. Bond fund returns should be consistent with the stochastic generator's interest rate and credit assumptions or guidance.

- Updated generator parameterizations and their impacts on scenarios and results should be intuitive/explainable. The parameterizations should be stable.

- The scenarios should reflect initial market conditions where applicable and should not be disproportionally impacted in the long-term by initial market conditions. For example, the generator starts at the initial actual treasury rate curve and credit spreads when projecting both interest rates and bond fund returns.

Stochastic Scenario Governance

- Governance rules should be established for both routine updates (i.e. updating starting yield curve with recent actual results, calibration criteria, etc.) and periodic holistic review/validation of the generator.
    - Reviews and updates should be performed by a third party, vetted for complex interactions between the parameters and potentially significant impacts, and documented in sufficient detail for independent review.
    - The initial development process of the scenario generator should allow adequate time and resources for field testing to ensure all intended stochastic scenario properties are met.
    - Updates should allow for attributions, and field testing should be considered for more substantial changes.

- Non-prescribed generators should be permitted, subject to appropriate governance. Calibration criteria should be developed by the vendor so that the prescribed generator and non-prescribed

generators can be validated based on scenarios produced rather than reserve and capital results. Different scenario generators and/or parameters may produce a materially similar distribution of scenarios and results.

- Other stochastic scenario uses (e.g., hedging, ALM, risk management) may require more sophisticated economic scenario modeling (e.g., explicit credit spread, default, and migration modeling). Allowing companies to use their risk management generators for stat valuation, provided the scenarios meet specific criteria for all elements included in the prescribed scenario generator, promotes better risk management without imposing unnecessary complexity on all statutory scenario stakeholders (i.e., companies and regulators).

Production Implementation Requirements

- The prescribed generator must automatically output prescribed scenarios in a common electronic format.

- The prescribed generator should be open source and sufficiently documented so that companies can call or otherwise implement the generator in their valuation, projections/forecasting, or risk management models. Providing just pre-generated scenarios on a quarterly basis is not sufficient to satisfy all of these purposes.

- Additional scenario tools should also be considered for development.
  - Representative scenario picking tool
  - Tool that generates the VM-21 Company-Specific Market Path method scenarios
  - Tool to generate scenarios for stochastic exclusion test
  - Tools to generate statistics on intermediate and final output of the generator.

ACLI
Financial Security for Life

Comments on Economic Scenario Generator Progress

February 17, 2022

ACLI Principles of ESG Effort

- NAIC prescribed scenario generator should be “fit for purpose” and produce a reasonable baseline set of economic scenarios.

- There should be a balance between complexity, transparency, ease of use, and stability of scenario generator parameters.

- Scenarios should reflect “history plus”: a reflection of economic dynamics from relevant history as well as an appropriate distribution of worse-than-history tail events, particularly around low-for-long interest rate conditions.

Concerns Surrounding the Models

1) General concerns
   - "Fit for Purpose"
   - Potential volatility
2) Treasury Model
   - Negative Interest Rates
   - Curve Shapes
3) Equity Model
   - Linkage to Interest Rates
   - Incomplete Recalibration of Equity Model Parameters
4) Corporate Model
   - Conning Simplified Model Limitations
   - Transparency

Treasury Model

Treasury Model – Negative Interest Rates

- GEMS-type models are known for producing excessively frequent and severe negative interest rates, particularly in low-rate environments.
- GEMS is producing an unreasonable number of negative interest rates.
  - Before including a floor, more than half the rates were negative in the near-term and up to 30% of rates were negative in the steady-state as of 12/31/20.
- Further, the model (without a floor) is producing rates near -9%.
- Floors are generally used to address outliers. ACLI has serious reservations about a floor that overrides rates at some point in nearly every scenario and will have significant implications elsewhere.

Treasury Model – Negative Interest Rates (Unfloored)

- Direct flooring approaches are likely to affect all scenarios and override up to half of the rates in a given month.
- Approaches that start with a "shadow" rate curve would generate even more negative scenarios to floor.
- The choice of floor is likely to be a key driver of rate levels used to calculate reserves and capital.

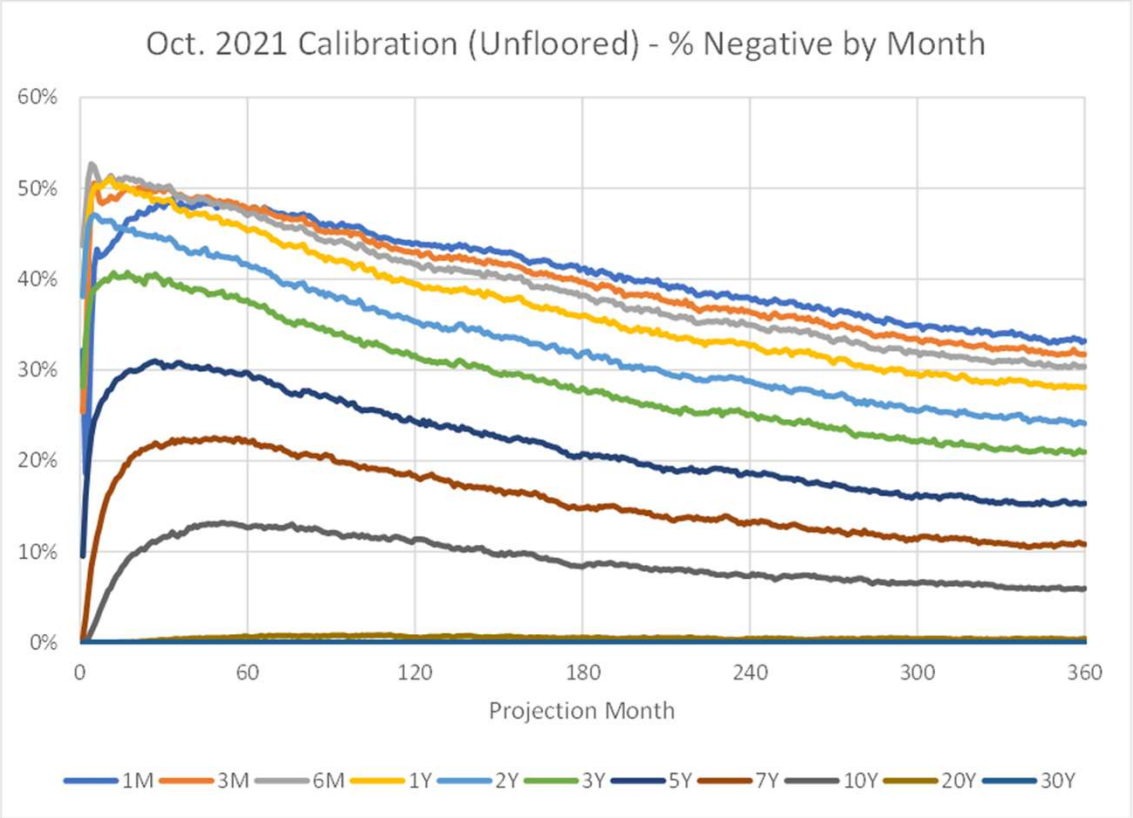
360 month minimum	1M	3M	6M	1Y	2Y	3Y	5Y	7Y	10Y	20Y	30Y
YE2020	-8.6%	-7.9%	-7.4%	-6.8%	-6.1%	-5.4%	-4.4%	-3.5%	-2.6%	-0.8%	0.1%

% of Scenarios with Negative Rates in											
	1M	3M	6M	1Y	2Y	3Y	5Y	7Y	10Y	20Y	30Y
at least 1 month	98%	99%	99%	98%	98%	96%	91%	83%	66%	11%	0%
>= 12 months	94%	94%	93%	93%	90%	87%	78%	66%	47%	5%	0%
>= 24 months	90%	89%	89%	88%	84%	80%	68%	56%	37%	3%	0%
>= 36 months	86%	85%	85%	83%	78%	73%	61%	48%	30%	1%	0%
>= 48 months	81%	81%	80%	78%	72%	67%	54%	41%	25%	1%	0%
>= 60 months	77%	77%	75%	73%	67%	61%	48%	35%	20%	0%	0%
>= 120 months	56%	55%	53%	50%	44%	38%	26%	16%	7%	0%	0%
>= 180 months	36%	35%	34%	31%	25%	20%	12%	6%	2%	0%	0%
>= 240 months	20%	19%	18%	16%	12%	9%	4%	2%	0%	0%	0%
Max neg months	360	360	360	360	360	360	357	352	347	115	-

Treasury Model – Negative Interest Rates

- In the unfloored scenarios, about 50% of rates are negative in the initial months and 30% of rates are negative in the steady state.

- In the subset of available Conning floored scenarios, up to 60% of rates are negative in the initial months, 30% of rates are negative in the early years, and 20% of rates are negative in the steady state.



Treasury Model – Yield Curve Shapes

- Curve shapes, including frequency and severity of inversions, are inconsistent with historical dynamics and economics.

- This is problematic as it could:
  - Create significant non-economic costs to companies whose investment and hedging strategies are sound in real world applications but might generate significant reserves due to the differences.

  - Incent ALM mismatches.

Treasury Model – Yield Curve Shapes

- The frequency of yield curve inversions generally varies by rate levels. Controlling for rate level differences, inversions may be roughly twice as frequent in the 10/2021 scenarios as in historical data.
- Conning floored results show similar inversion frequencies.

Inversions: 10Y vs. 2Y (Rate buckets are for the 2Y UST)

% Inverted

	<-1%	[-1%, 0%)	[0%, 1%)	[1%, 2%)	[2%, 3%)	[3%, 4%)	[4%, 5%)	[5%, 6%)	[6%, 7%)	[7%, 8%)	[8%, 9%)	[9%, 10%	>=10%	All Yields
Years 1-5	0%	0%	0%	6%	32%	59%	75%	86%	92%	96%	99%	99%	100%	10%
Years 6-10	0%	0%	0%	5%	20%	38%	54%	67%	77%	85%	89%	91%	93%	16%
Years 11-15	0%	0%	0%	3%	13%	26%	40%	52%	61%	70%	73%	79%	87%	16%
Years 16-20	0%	0%	0%	2%	10%	21%	31%	41%	50%	57%	64%	69%	80%	16%
Years 21-25	0%	0%	0%	2%	8%	17%	27%	36%	45%	52%	56%	63%	73%	16%
Years 26-30	0%	0%	0%	2%	7%	16%	25%	33%	41%	47%	53%	58%	69%	17%
Years 1-30	0%	0%	0%	3%	15%	26%	37%	45%	53%	59%	63%	67%	75%	15%
Hist %			0%	0%	0%	9%	28%	27%	20%	28%	39%	54%	46%	7%

Treasury Model – Yield Curve Shapes

- The magnitude of yield curve inversions also appears to be significantly higher than history when reflecting rate levels.
- Conning floored results show similar magnitudes of inversions.

10Y vs. 2Y - Inverted Spread Distribution (Years 1-30)													
	< -1%	[-1%, 0%)	[0%, 1%)	[1%, 2%)	[2%, 3%)	[3%, 4%)	[4%, 5%)	[5%, 6%)	[6%, 7%)	[7%, 8%)	[8%, 9%)	[9%, 10%)	>=10%	All Yields
Min			-0.1%	-0.6%	-1.1%	-1.5%	-2.0%	-2.4%	-2.9%	-3.3%	-3.7%	-4.1%	-7.2%	-7.2%
1%			-0.1%	-0.4%	-0.8%	-1.2%	-1.6%	-2.0%	-2.3%	-2.7%	-3.1%	-3.4%	-4.9%	-3.5%
5%			-0.1%	-0.4%	-0.6%	-1.0%	-1.3%	-1.6%	-2.0%	-2.3%	-2.6%	-2.9%	-3.8%	-2.4%
10%			-0.1%	-0.3%	-0.5%	-0.8%	-1.1%	-1.4%	-1.7%	-2.0%	-2.3%	-2.6%	-3.3%	-1.9%
25%			-0.1%	-0.2%	-0.4%	-0.6%	-0.8%	-1.1%	-1.3%	-1.5%	-1.7%	-1.9%	-2.5%	-1.2%
50%			0.0%	-0.1%	-0.2%	-0.4%	-0.5%	-0.7%	-0.8%	-1.0%	-1.1%	-1.2%	-1.6%	-0.6%
75%			0.0%	0.0%	-0.1%	-0.2%	-0.2%	-0.3%	-0.4%	-0.5%	-0.5%	-0.6%	-0.8%	-0.3%
90%			0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%	-0.2%	-0.2%	-0.3%	-0.1%
95%			0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.2%	0.0%
99%			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Max			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Avg			0.0%	-0.1%	-0.3%	-0.4%	-0.6%	-0.7%	-0.9%	-1.0%	-1.2%	-1.3%	-1.7%	-0.8%
Hist Min			0.0%	0.0%	0.0%	-0.2%	-0.3%	-0.6%	-0.5%	-0.9%	-1.1%	-1.2%	-2.0%	
Hist Median			0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.2%	-0.3%	-0.4%	-0.6%	-0.6%	-0.7%	
Hist Average			0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.2%	-0.3%	-0.4%	-0.6%	-0.5%	-0.7%	

Worst inversions are ~3 to 5+ *times* larger than history

Median inversions are more than double historical relationships

Equity Model

Equity Model – Concerns with the Linkage to Interest Rates

- Conning assumes a constant mean relationship between equities and interest rates in each individual month (i.e., Expected equity return = Expected short-term interest rate + a random component).
  - This simplification is not supported by historical data or economic research.

- This simplification results in counterintuitive results and creates:
  1. "Mark to Model" relationships that can result in artificial volatility
  2. Procyclical results
  3. Scenario distributions that vary in their level of conservatism/aggressiveness from reporting period to period

Equity Model – Concerns with the Incomplete Recalibration of Equity Model Parameters

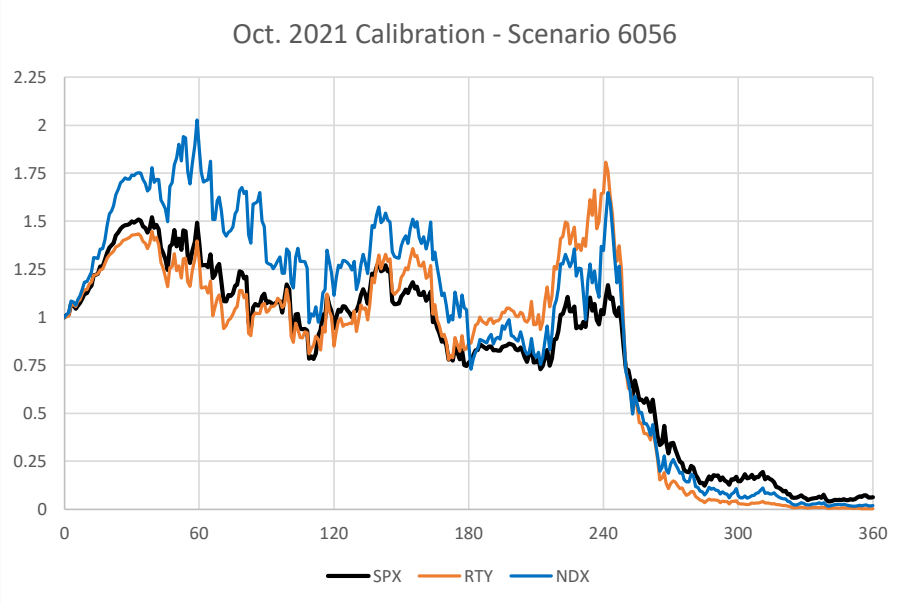
- Interest rates are a key input in Conning's equity model.
  - Current interest rate models under consideration have significant differences vs. Conning's standard calibration.

- Defaulting to Conning's calibration for other parameters (after changing the underpinnings of the model) has led to an unsupported ~45% decrease in median 30-year cumulative equity returns (and more extreme decreases in lower percentiles) based on 12/31/20 conditions.

- Conning's incomplete recalibration also includes scenarios where broad equity indices become worthless.

Equity Model – Concerns with the Incomplete Recalibration of Equity Model Parameters

- While theoretically possible, projecting that equity indices become essentially worthless in some scenarios is extreme for reserve and capital projections and may cause operational issues (e.g., scenario selection).



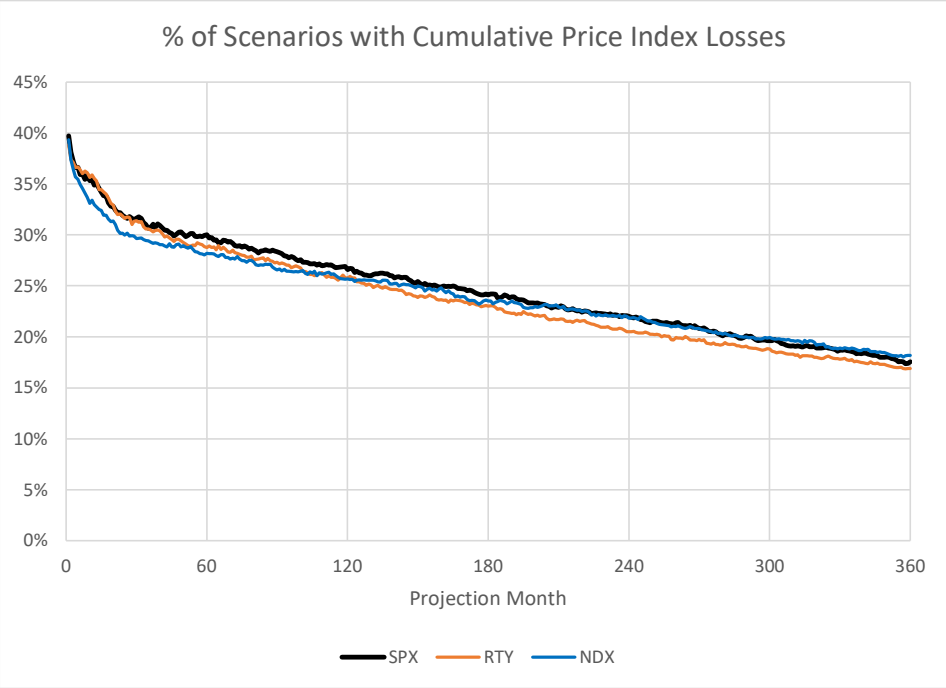
Scen 6056	Cumulative Return - 30 years
SPX	-93.7%
RTY	-99.7%
NDX	-98.1%

Equity Model – Concerns with the Incomplete Recalibration of Equity Model Parameters

- The S&P 500 (price index) has negative returns over 30 years in ~18% scenarios even though this has never been observed in history, even using data since 1928.

Longest Negative cumulative return period

Index	Duration	
	Months	Years
S&P 500	164	13.67
Russell	140	11.67
Mid	108	9.00
Nasdaq	193	16.08
EAFE	149	12.42



Corporate Model

Corporate Model – Concerns

- Limited substantive documentation is currently available for the GEMS corporate model, and there are structural issues with the Conning proposed simplified model (including contradictions with prescribed VM credit assumptions and credit market dynamics and excessive cumulative credit related returns).

- Experts have offered a transparent and understandable alternative that appears to track closely with the GEMS corporate model.

- Since we are unaware of a meaningful implementation limitation on such a model, we would favor the transparent approach.

Recommendations

- Develop appropriate acceptance criteria (including contemplation of reference models) to facilitate an industry field study for maximal return on effort. Current criteria are not sufficient to assess economic scenarios, including potential non-economic behavior.

- Engage in a substantive discussion of model limitations and consider structural modifications (interest rates, corporate) and calibration refinements (equity) in the existing model form once more robust criteria are established.

- If continued analysis suggests untenable characteristics of the model remain, we believe it is critical that LATF begin contemplating alternatives.

Appendix: Equity Result Comparison YE2019 to YE2020

- 141 bp decrease in initial overnight rates ~10% lower price index levels though 30 years (= -0.4% annualized)
  - Patterns are similar for total return accumulation factors and for other indices.
  - Differences in the extreme tails may be from differences in the # of scenarios with multiple large jumps (e.g., ±20% or 25%).

S&P 500 Price Accumulation Factors

YE2020	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.46	0.10	0.04	0.02	0.02
1.0%	0.70	0.42	0.28	0.24	0.20
2.5%	**0.75**	**0.52**	**0.39**	0.34	0.34
5.0%	**0.81**	**0.62**	**0.51**	**0.48**	0.49
10.0%	**0.87**	**0.74**	**0.68**	**0.68**	0.77
25.0%	0.96	0.94	1.00	1.21	1.57
50.0%	1.05	1.20	1.42	2.07	3.09
75.0%	1.13	1.47	1.96	3.36	5.80
90.0%	**1.21**	**1.74**	**2.55**	**5.06**	9.98
95.0%	**1.25**	**1.91**	**2.95**	**6.38**	13.68
97.5%	**1.29**	**2.11**	**3.35**	7.90	18.06
99.0%	1.34	2.35	3.93	9.90	24.43
Max	1.67	3.55	7.88	21.70	129.38

YE2019	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.45	0.15	0.06	0.05	0.01
1.0%	0.69	0.43	0.30	0.26	0.23
2.5%	**0.75**	**0.53**	**0.42**	0.38	0.35
5.0%	**0.80**	**0.63**	**0.55**	**0.52**	0.54
10.0%	**0.87**	**0.76**	**0.72**	**0.73**	0.86
25.0%	0.96	0.98	1.05	1.31	1.74
50.0%	1.06	1.25	1.52	2.26	3.44
75.0%	1.15	1.54	2.09	3.71	6.55
90.0%	**1.23**	**1.83**	**2.74**	**5.56**	11.30
95.0%	**1.28**	**2.03**	**3.17**	**7.11**	15.73
97.5%	**1.33**	**2.23**	**3.62**	8.74	20.79
99.0%	1.37	2.46	4.24	11.33	28.39
Max	1.72	3.63	7.62	26.61	101.61

YE2020 / YE2019	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	101%	71%	75%	44%	183%
1.0%	103%	97%	94%	91%	88%
2.5%	100%	99%	92%	88%	96%
5.0%	101%	98%	93%	91%	91%
10.0%	100%	97%	95%	93%	90%
25.0%	100%	96%	95%	92%	90%
50.0%	99%	96%	93%	92%	90%
75.0%	98%	95%	94%	90%	89%
90.0%	98%	95%	93%	91%	88%
95.0%	98%	94%	93%	90%	87%
97.5%	98%	95%	93%	90%	87%
99.0%	98%	96%	93%	87%	86%
Max	97%	98%	103%	82%	127%

S&P 500 Annualized Cumulative Returns

YE2020	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	-54.3%	-36.3%	-27.0%	-17.1%	-11.9%
1.0%	-29.6%	-16.1%	-11.9%	-7.0%	-5.2%
2.5%	**-25.0%**	**-12.1%**	**-9.0%**	-5.3%	-3.6%
5.0%	**-19.1%**	**-9.2%**	**-6.5%**	**-3.6%**	-2.3%
10.0%	**-13.3%**	**-5.9%**	**-3.8%**	**-1.9%**	-0.9%
25.0%	-4.5%	-1.1%	0.0%	0.9%	1.5%
50.0%	4.8%	3.7%	3.5%	3.7%	3.8%
75.0%	13.4%	8.0%	6.9%	6.2%	6.0%
90.0%	**20.7%**	**11.7%**	**9.8%**	**8.4%**	8.0%
95.0%	**25.3%**	**13.9%**	**11.4%**	**9.7%**	9.1%
97.5%	**29.5%**	**16.1%**	**12.9%**	10.9%	10.1%
99.0%	34.4%	18.7%	14.7%	12.1%	11.2%
Max	66.8%	28.8%	22.9%	16.6%	17.6%

YE2019	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	-54.6%	-31.8%	-24.8%	-13.6%	-13.7%
1.0%	-31.5%	-15.5%	-11.3%	-6.5%	-4.8%
2.5%	**-25.0%**	**-11.9%**	**-8.3%**	-4.7%	-3.4%
5.0%	**-19.5%**	**-8.9%**	**-5.9%**	**-3.2%**	-2.0%
10.0%	**-13.5%**	**-5.4%**	**-3.2%**	**-1.5%**	-0.5%
25.0%	-4.1%	-0.3%	0.5%	1.4%	1.9%
50.0%	5.8%	4.6%	4.3%	4.2%	4.2%
75.0%	15.3%	9.0%	7.6%	6.8%	6.5%
90.0%	**23.3%**	**12.8%**	**10.6%**	**9.0%**	8.4%
95.0%	**28.0%**	**15.2%**	**12.2%**	**10.3%**	9.6%
97.5%	**32.5%**	**17.4%**	**13.7%**	11.4%	10.6%
99.0%	37.4%	19.7%	15.5%	12.9%	11.8%
Max	72.4%	29.4%	22.5%	17.8%	16.7%

YE2020 - YE2019	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.3%	-4.5%	-2.1%	-3.4%	1.8%
1.0%	1.9%	-0.6%	-0.6%	-0.5%	-0.4%
2.5%	0.0%	-0.2%	-0.8%	-0.6%	-0.1%
5.0%	0.5%	-0.3%	-0.7%	-0.4%	-0.3%
10.0%	0.1%	-0.5%	-0.5%	-0.4%	-0.4%
25.0%	-0.4%	-0.8%	-0.5%	-0.4%	-0.4%
50.0%	-1.0%	-0.9%	-0.8%	-0.5%	-0.4%
75.0%	-2.0%	-1.0%	-0.7%	-0.5%	-0.4%
90.0%	-2.5%	-1.2%	-0.8%	-0.5%	-0.4%
95.0%	-2.7%	-1.4%	-0.8%	-0.6%	-0.5%
97.5%	-3.0%	-1.3%	-0.9%	-0.6%	-0.5%
99.0%	-3.0%	-1.0%	-0.9%	-0.8%	-0.6%
Max	-5.5%	-0.6%	0.4%	-1.2%	0.9%

Process Considerations from Conning's Paper

- https://www.soa.org/globalassets/assets/files/research/projects/research-2016-economic-scenario-generators.pdf
- p.10: CONSIDERATIONS OF MODEL SPECIFICATION AND STYLIZED FACTS

  Stylized facts refer to generalized interpretations of empirical findings that provide a basis for consistent understanding of markets or economic drivers across a wide range of instruments, markets and time periods. Analysis of historical data is commonly used as the basis for determining stylized facts and setting calibration targets; however, stylized facts can also be based on expert judgement. Stylized facts are important in guiding the design of an ESG in that they help establish and prioritize the properties that the ESG model must have to be useful for a given application. The historical record of economic and financial markets is an indispensable guide to the dynamics that govern ESG model simulations. Detailed knowledge of these dynamics is essential for setting ESG model calibration targets and understanding strengths and weaknesses of various ESG model frameworks.

  It is natural to summarize financial market variables in terms of their averages, standard deviations and correlations such as in a mean-variance framework. These summary statistics tell a good bit of the story, but they do not inform the subtle but important aspects of how markets are experienced through time. More advanced applications such as those used for pricing and risk management typically require additional specifications that may include information related to distributional shapes (fat tails), pathwise behavior (how variables move over time) and the ways characteristics of modeled variables change under different economic environments.

- pp. 11-12: VALIDATION

  Validation ensures that the estimation of an ESG's parameters results in simulated behavior that is a good representation of the variable or market under consideration. Effective validation of an ESG requires comparing simulated output data with some predefined benchmark of acceptance criteria.

  For a typical insurance or pension undertaking, the list of financial and economic variables that may be of interest is typically quite large. For this reason, the validation system and validation environment require careful design at inception, in order to organize the various data elements in an ordered fashion.

  An automated validation system is preferable to manual validation. Validation should be repeatable and consistent through time. Before any data are analyzed or validation performed, it is helpful to form the acceptance criteria upon which the model output will be judged. This type of approach to validation, whereby the particular desirable features of an ESG are based on analysis of a firm's risk exposures, is preferable to what might be called a "problem discovery" approach. In a problem discovery approach, a user first runs the ESG, creating a large output data set, and then tries to discover problems with the output.

Process Considerations from Conning's Paper

- p. 89: ACCEPTANCE CRITERIA

  Before any data are analyzed or validation performed, it is helpful to form the acceptance criteria upon which the model output will be judged. These acceptance criteria should be based on what the end user expects the model to do. An idealized process for forming acceptance criteria might be as follows:

  > *1. Select a person or persons to formulate acceptance criteria. Ideally, this would be a group made up of the direct users of the system, the end user of the scenarios or derived data, participants in the market to be validated and risk model experts, as well as individuals who are independent of the system usage to provide oversight.*
  >
  > *2. Decide which economic variables are to be validated, and determine the materiality of these variables.*
  >
  > *3. Formulate concrete acceptance criteria, which should be based on a combination of analysis of market data, expert judgment and an understanding of the sensitivities to and materiality of particular risk factors of a firm. Acceptance criteria should not be arbitrary but instead justifiable and based on data analysis and informed judgment.*
  >
  > *4. Define when a model is accepted and when rejected. This is usually best dealt with by scoring the ESG output against particular acceptance criteria and holistically considering the extent to which it matches all the acceptance criteria. For all but the most simplistic uses of an ESG, it is likely that some areas will perform better than other areas; therefore, it is better to answer the question "How well does the ESG as a whole perform?" than to reject a model because a single acceptance criterion is not adequately met.*

  …

  Therefore, it is recommended that the validation process start with acceptance criteria and then move on to the validation stage. Chapter 6 discussed the model specification process and the development of stylized facts that form the basis of the acceptance criteria.

  With the acceptance criteria in place, the next stage is to actually validate the ESG and determine its appropriateness to the application for which it is intended. Usually, validation entails comparing the output of the ESG with market data, and finally with the acceptance criteria, which may be based on market data or a combination of market data and expert judgment. In this process, there are several considerations to take into account.

Key Model Features

Proposed IR model extends the legacy AIRG in order to better capture IR dynamics in the low-rate environment, and model realistic severity and frequency of negative rates in the tail of the distribution

- ***Heston stochastic variance*** follows CIR process, and helps capture market cycles and generate clustered high market volatility in stress, as well as periods of low volatility. Helps generate a rich distribution of rates and hedge costs.
- ***2-factor model of the term structure*** projects level (UST20 rate) as well as slope (UST20/UST1) to capture the main dynamics of the yield curve, explaining over 88% of the variation in historical curve shapes.
- Term structure is completed using abbreviated ***Nelson-Siegel applied in "spot" space***, which ensures physical and smooth term structures for any modeled combination of modeled UST20 and UST1 rates.
- Model has been extended for ***shifted rates and volatility scaling*** to ensure realistic rate/volatility relationship when rates are low (or negative) and dispersion in order to generate high and low tails
- ***Shadow Mapping*** has been added to directly specify the severity and frequency of negative short rates, and otherwise compress the distribution of the short rate in tail low-rate scenarios. Shadow Mapping allows for generation of realistic near zero and negative rate scenarios such as observed in US, Europe and Japan markets. The mapping can also be used to achieve desirable short rate high tails that are otherwise constrained by the base model form.

The proposed model form is sufficiently flexible to allow for:

- Historical dynamics/relationship by calibrating core parameters to history
- Forward-looking views/targets suitable for general Risk/ALM and regulatory purposes by adjusting target and floor model parameters

Brief Description of the Model: Stochastic Volatility and Shifted Long Rate

- Heston Volatility models IR variance as a CIR process:

  $dv = \beta_3(\tau_3 - v)dt + \sigma_3\sqrt{v}\, dW_{t,v}$, reimagined in discretized form as:

  $v_{t+1} = \tau_3\left(1 - e^{-\beta_3}\right) + e^{-\beta_3}v_t + \sigma_v\sqrt{{}^{\tau_3}/_{2\beta_3}(1 - e^{-\beta_3})^2 + {}^{1}/_{\beta_3}(e^{-\beta_3} - e^{-2\beta_3})v_t}\; Z_{t,v}$

  $\sigma_{heston} = \sqrt{v}$ $(v\ is\ the\ variance\ based\ on\ CIR\ process\ above)$

- Generalized form for modeling log-rates:

  $lr_{t+1} = \beta_1 \log(\tau_1 + shift) + (1 - \beta_1)\, lr_t + \sigma_{LN}Z_{t,lr}$, where:

  $$\sigma_{LN} = \frac{\sigma_{heston}\,(rate + shift + diff_shift)^{cev}}{(rate + shift)}$$

  $lr_t = \log(rate_t + shift)$ or $rate_t = e^{lr_t} - shift$, where $rate_t$ represents modeled UST20 yield

  $lr_{t+1} = \beta_1 \log(\tau_1) + (1 - \beta_1)\, lr_t + \sigma_{LN}Z_t$

  - τ_1 represent the long term target rate for UST20, and β_1 is the mean reversion speed
  - shift parameter allows for modeling of near 0 or negative rates as low as –shift levels
  - cev parameter controls how IR volatility is scaled relative to the level of rates, and can be vary between 0 (effectively normal rates) to 1 (pure lognormal rates)
  - Note that setting $shift = 0$ and $cev = 1$ results in the basic lognormal rate process such as the one used in AIRG, with $\sigma_{LN} = \sigma_{heston}$

Brief Description of the Model: Slope and Shadow Mapping the Short Rate

- Slope Process represents the difference between modeled UST20 and a shadow UST1 rate, and follows an OU process:

$$slope_{t+1} = \beta_2\,\tau_2 + (1-\beta_2)\,slope_t + \varphi\,min\left(r_t^{shadow} - shadow_{max}, 0\right) + \sigma_2 e^{\theta lr_t} Z_{t,slope}$$

  - τ_2 is the long term target for the slope, and β_2 is the mean reversion speed
  - $\sigma_2 e^{\theta lr_t}$ is the diffusion term that is scaled relative to the level of shifted long rate
  - φ adjusts the slope drift in the even the modeled shadow rate is subject to mapping adjustment (below 75bps in below mapping)

- Shadow and Modeled Short Rate:

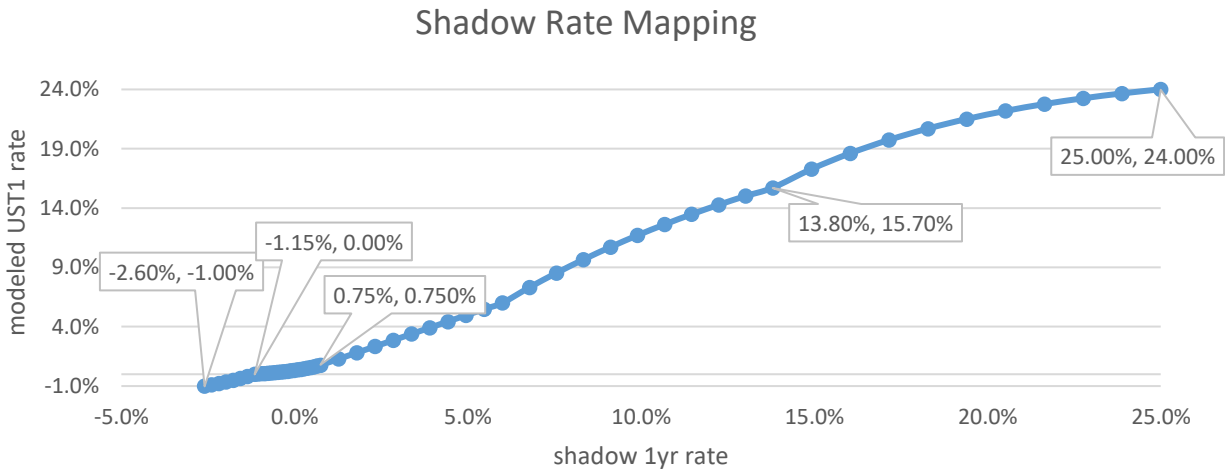
$$shadow\ rate_t = rate_t - slope_t$$

$short\ rate_t$ is derived via an explicit mapping: $shadow\ rate_t \rightarrow short\ rate_t$, specified to manage the distribution of the tail low rates

  - Mechanically, the mapping can be specified on a percentile basis, and use interpolation to map any value from the shadow rate process to the ultimate short rate value, and vice versa.
  - Setting of the initial $shadow\ rate_0$ and the corresponding $slope_0 = rate_0 - shadow\ rate_0$, is accomplished via the inverse mapping: $short\ rate \rightarrow shadow\ rate$

Shadow Mapping is Used To:

- Floor the level of negative rates
- Reduce the frequency of negative rates by remapping some of the negative rates to low-positive levels, emulating the "line-in-the-sand" ZLB associated with the current monetary policy
- The re-scaling/compression lowers the effective volatility of the short rates at low levels
- Achieve target high tail levels



Completing and Stripping the Curve

- Spot curve is defined using abbreviated Nelson-Siegel form:

  $$continuous\ cumulative\ spot_t = \beta_0 t + \beta_1 \lambda \left(1 - e^{-t/\lambda}\right)$$

  - β_0 is the ultimate rate level
  - β_1 is the distance between the ultimate rate and the short rate
  - λ is a scalar that controls the curvature of the term structure

- Fitting to UST yields using optimization:

  - Discount factor for a given tenor, t, can be expressed as: $D_t = e^{-continuous\ cumulative\ spot_t}$
  - Par (BE semi-annual) UST yield: $UST_t = \frac{2(1 - D_t)}{\sum_{.5,1,1.5 \ldots t} D_i}$ can be expressed in terms of the NS parameters
  - Assuming λ=2.5, based on historical analysis, optimization techniques are used to fit β_0 and β_1 to any combination of UST1 and UST20

  - The fitted NS curve is used to complete an entire term structure consistent with modeled UST20 and UST1. The fitted curve is guaranteed to be smooth, and physical, avoiding some of the numerical and arbitrage issues associated with interpolating the term structure in UST space and then stripping to produce the zero curve.

Model Calibration: Core Parameters and Target Setting

- Core model parameters, are calibrated to monthly UST data from 4/1953 to 12/2021 using generalized MLE
  1. Informs base model parameters
  2. Subsequent adjustments are made to shape the projected distribution consistent with calibration targets/criteria:
     - Low-for-long targeting at least 5% cumulative average UST20 rate below 1.45% over 30 years in projection
     - Historical PEWs criteria developed to inform the targets/dispersion in the steady state (see slide 7)

- The rate volatility related parameters are set to ensure reasonable historical relationships (see Appendix):
  - *cev = 1 and diffusion shift = .015* in order to ensure sufficient volatility in low rates and reasonable dispersion in high rates
  - *shift = .005* in order to model UST20 as low as -50bps and ensure stability in low rate scenarios
  - $\tau_3 = .0001633$, targeting rate volatility of 70bps per annum at 3% UST20 level

- Log-rate target level, τ_1, was set to 5.95% to reflect historical average and to stabilize the calibration. However, τ_1 is set to 4.35% for purposes of scenario generation, reflecting a lower forward looking view for UST20. Slope mean, τ_2 was set to historical 1.22% for calibration and adjusted to 1.6% for purposes of projection.

- Log-rate mean reversion speed, β_1 , was set to .00425 (~5.0% per annum or half-life of 13.56yrs).

- Finally, slope φ parameter, in combination with shadow mapping (based on exponential interpolation) was set to produce reasonable steady state probability of negative rates (~1-2%) as well as peak frequency below 10% and maximum severity of -100bps.

Summary of the Interest Rate Scenario Dynamics and Parameters

Stochastic log-volatility of long rate (20yr tenor):

$$v_t = \max\left\langle \tau_3\left(1-e^{-\beta_3}\right) + e^{-\beta_3} v_{t-1} + \sigma_v \sqrt{{}^{\tau_3}\!/_{2\beta_3}\,(1-e^{-\beta_3})^2 + {}^{1}\!/_{\beta_3}\,(e^{-\beta_3}-e^{-2\beta_3}) v_{t-1}},\ 10^{-8} \right\rangle$$

Log-long-rate process (e.g. observed 20 year treasury):

$lr_t = \max\langle \min[lr_{t-1} + \beta_1(\ln(\tau_1 + shift) - lr_{t-1}), lr_{max}], lr_{min}\rangle + \sigma_{lr,t}\, Z_{lr,t}$

where:

$\sigma_{lr,t} = \min(\max(\sqrt{v_t}\,(r_t^{long} + shift + diff_shift)^{cev}, \min_irv), \max_irv)\, e^{-lr_t}$

$lr_t = ln(r_t^{long} + shift)$ and the 20yr rate is recovered as $r_t^{long} = e^{lr_t} - shift$, and

$lr_{min} = \ln(r_{min}^{long} + shift)$ and $lr_{max} = \ln(r_{max}^{long} + shift)$

Slope process (distance between 1yr and 20yr rates):

$\alpha_t = min\langle \alpha_{t-1}, \alpha_{max}\rangle(1-\beta_2) + \beta_2\tau_2 + \varphi\, min(r_{t-1}^{shadow} - shadow_{max}, 0) + \sigma_\alpha e^{\theta lr_{t-1}} Z_{\alpha,t}$ and α_t is subject to caps and floors:

$\alpha_t = \max\langle \min[\alpha_t, r_t^{long} - r_{min}^{short}], -r_t^{long}/3, \alpha_{min}\rangle$

$shadow_{max}$ is the threshold rate level below which short rate is being floored/re-mapped

Short Rate is a difference between Long Rate and Slope, subject to shadow mapping:

$r_t^{shadow} = r_t^{long} - \alpha_t,\ r_t^{shadow} \xrightarrow[mapping]{} r_t^{short}$

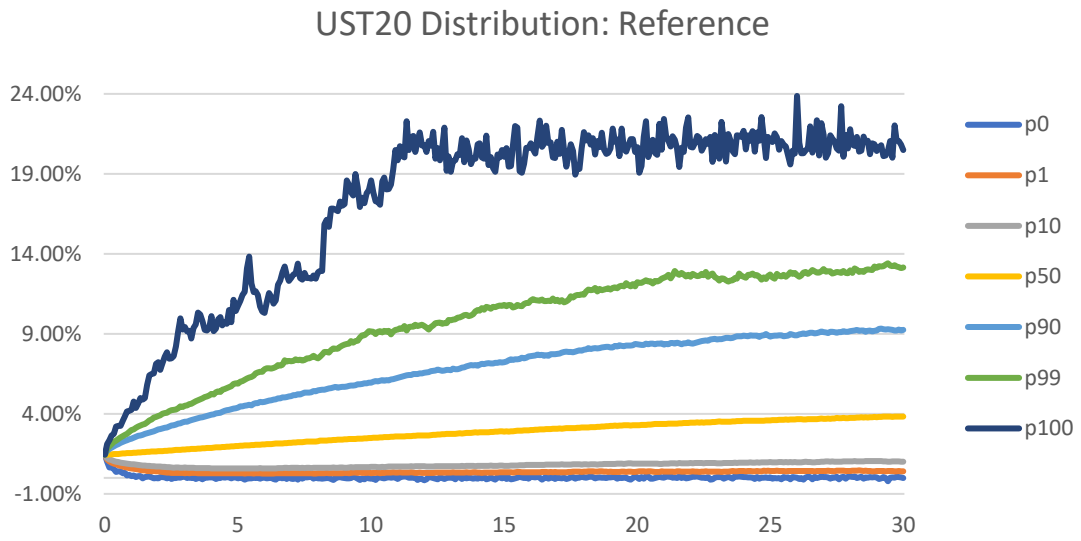
Note: all BE rates are subject to r_{min}^{short} floor , which double sup as a global floor

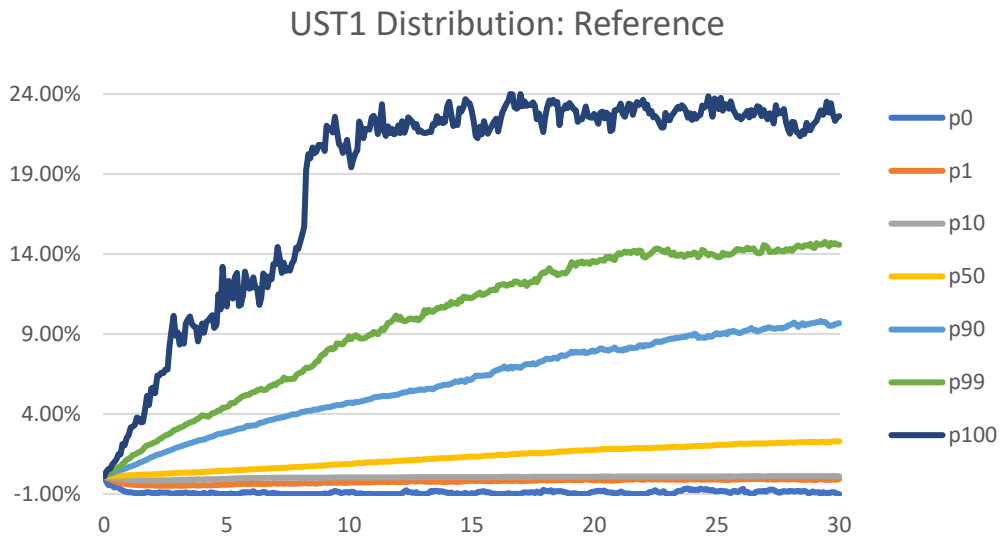
The min_irv volatility floor was set to ensure that the annualized volatility of the long rate is at least 10bp (.001/sqrt(12)), while the cap, max_irv, set to limit rate volatility at 3.5% to ensure stability

Parameter	Calibrated Value
β_3	0.017000
τ_3	0.001633
σ_v	0.005023
β_1	0.00425
τ_1	0.0435
cev	1.000
$shift$	0.0050
$diff_shift$	.01500
β_2	0.0177
τ_2	0.0160
σ_α	0.0246
θ	0.7687
φ	.00250
ρ_{12}	.1219
ρ_{13}	0
ρ_{23}	0
Initial variance	.001633

Cap/Floor	*Value*
r_{min}^{long}	0.002500
r_{max}^{long}	0.200000
r_{min}^{short}	-0.1000000
min_irv	0.0002887
max_irv	.01010
α_{min}	-0.04000
α_{max}	0.04000

Key Statistics across 10k scenarios

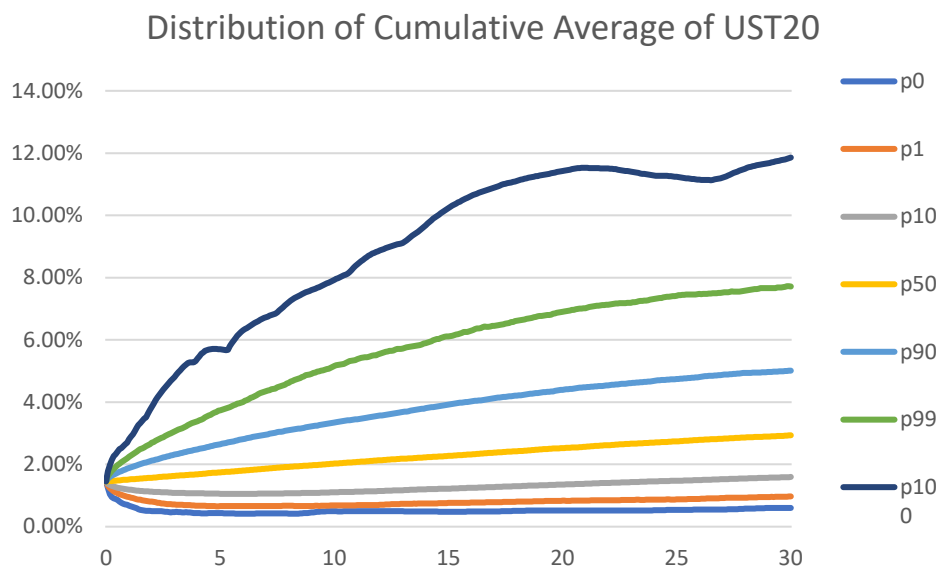


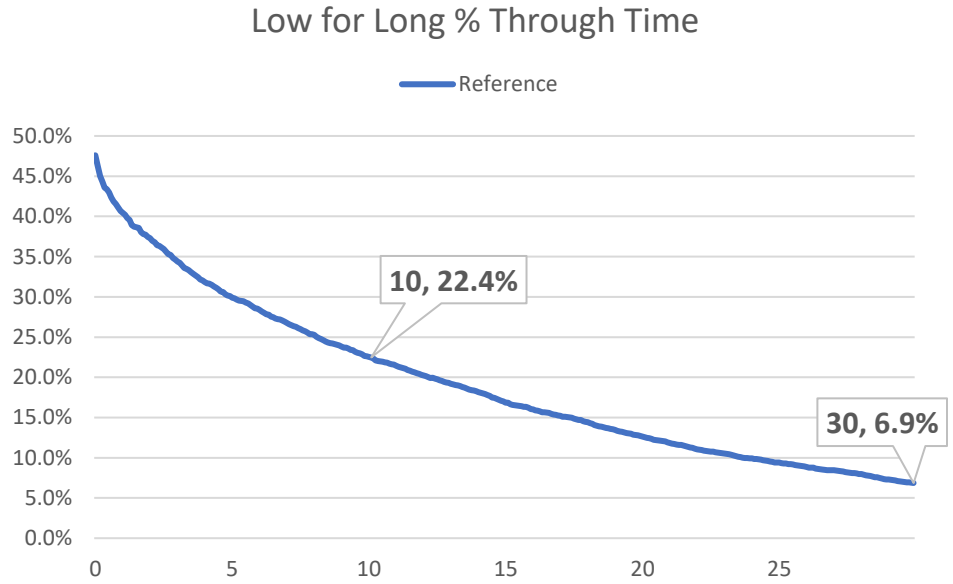


UST20 Compare (year 50)				UST1 Compare (year 50)		
	Ref 1.3	PEWs			Ref 1.3	PEWs
min	-0.13%	-0.52%		**min**	-1.00%	-1.41%
1%	0.58%	-0.18%		**1%**	-0.01%	-1.11%
5%	1.33%	1.18%		**5%**	0.16%	0.10%
50%	4.41%	4.49%		**50%**	2.70%	2.30%
95%	10.59%	11.73%		**95%**	10.97%	10.59%
99%	14.70%	14.44%		**99%**	15.61%	15.40%
max	22.45%	18.52%		**max**	24.00%	19.97%

- Overall dispersion of rates goes well beyond historically observed range and allows for robust tails.
- Steady-state distributions snapshot in year 50 of the projection is compared to historically based PEWs:
  - Reference scenarios are aligned with blended PEWs on the high end of the distribution, as well as median
  - Reference scenarios produce higher rates relative to low tail PEW levels, but are within reasonable range

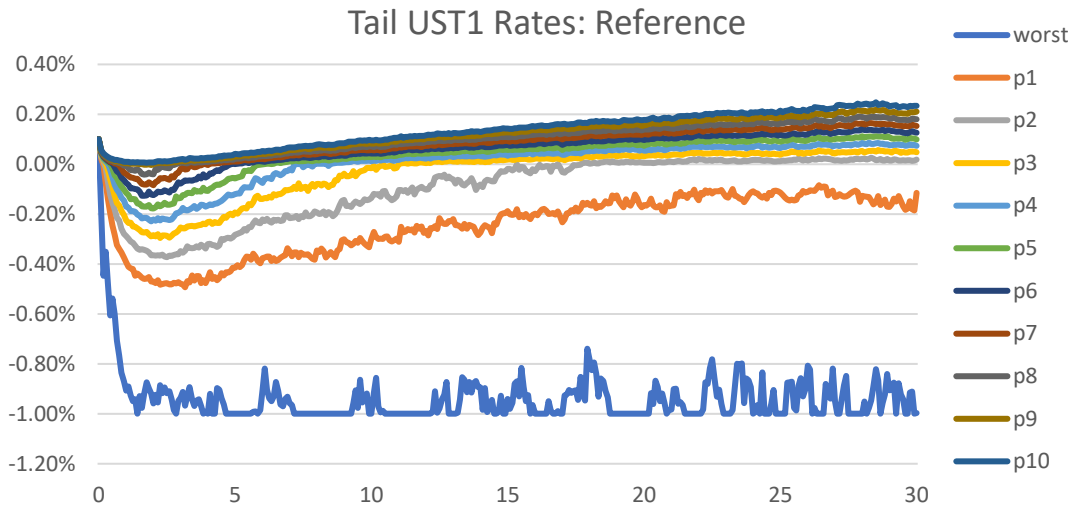
Low for Long: Average Cumulative UST20 Rate below Current (1.45%)

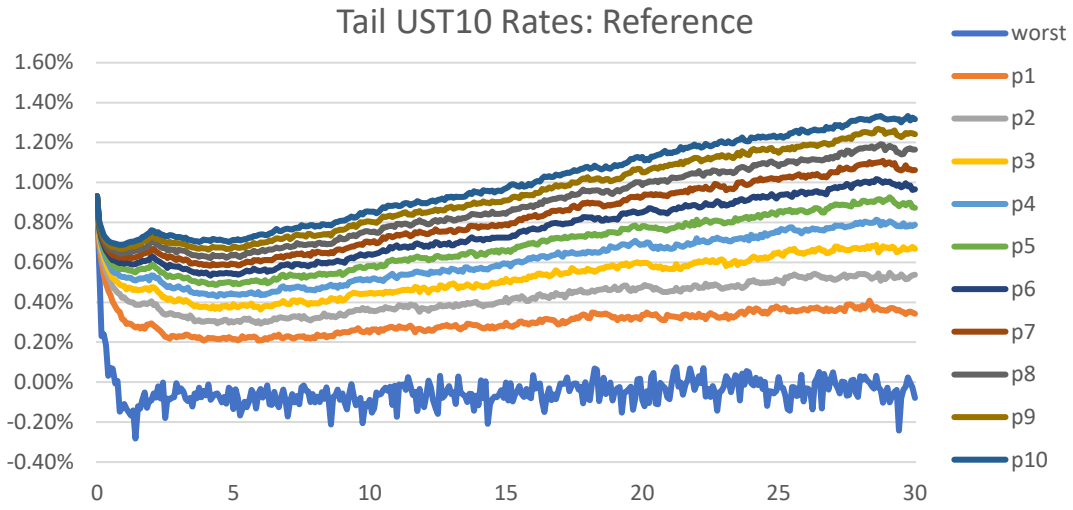


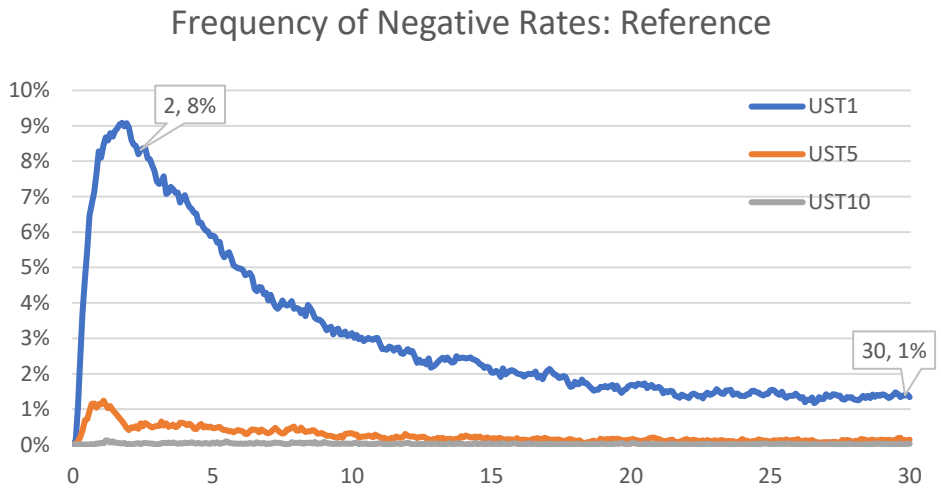


- Reflects the distribution of geometric average of projected UST20 rate across 10k scenarios
- Low for long metric measures % of scenarios where the cumulative average of UST20 falls below current (12/2020) level of 1.45%

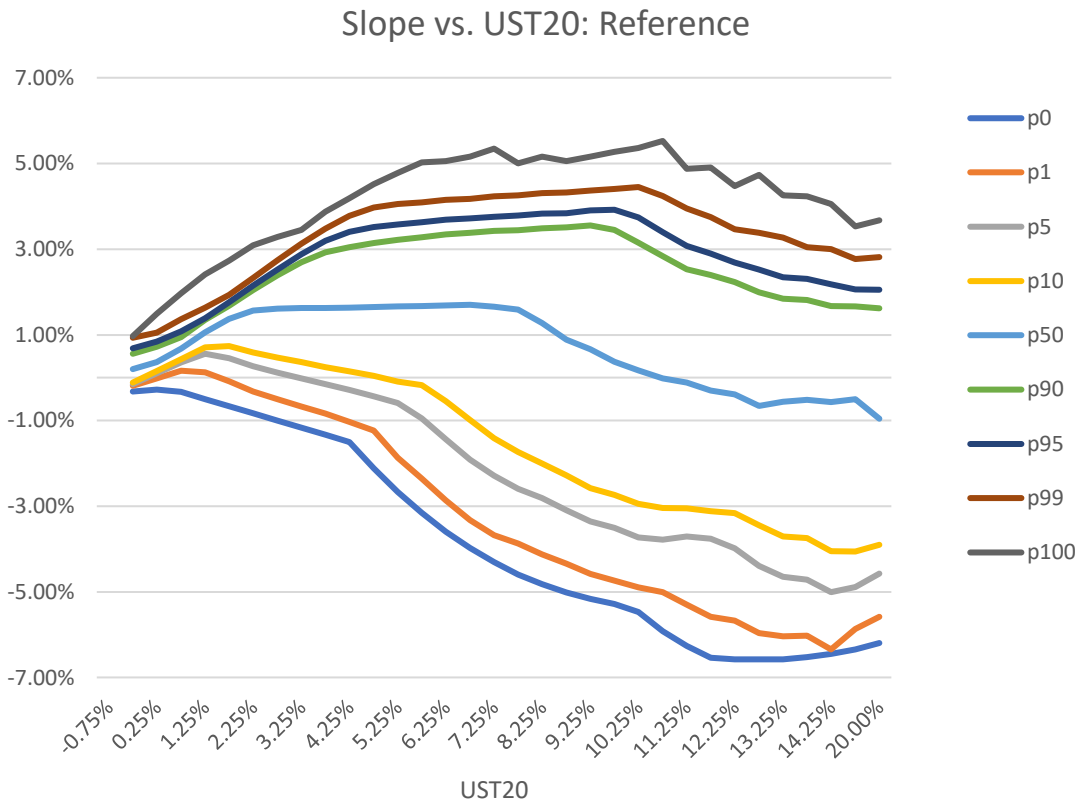
Tail UST1 and UST10 Distribution, and Frequency of Negative Rates

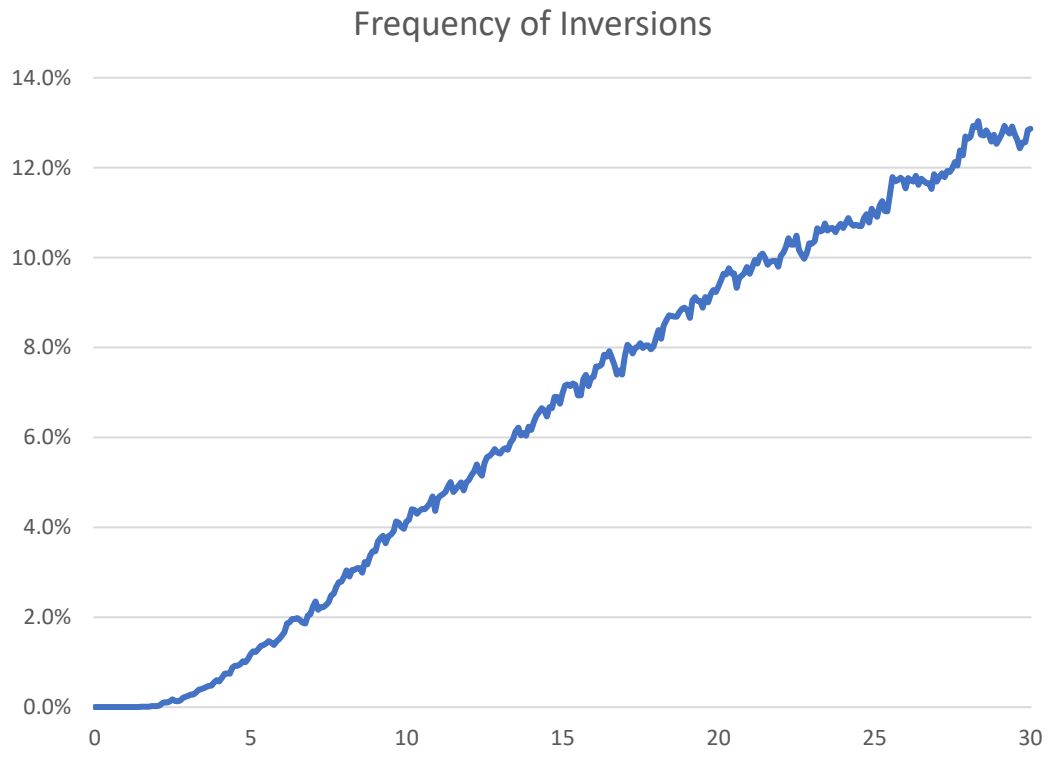




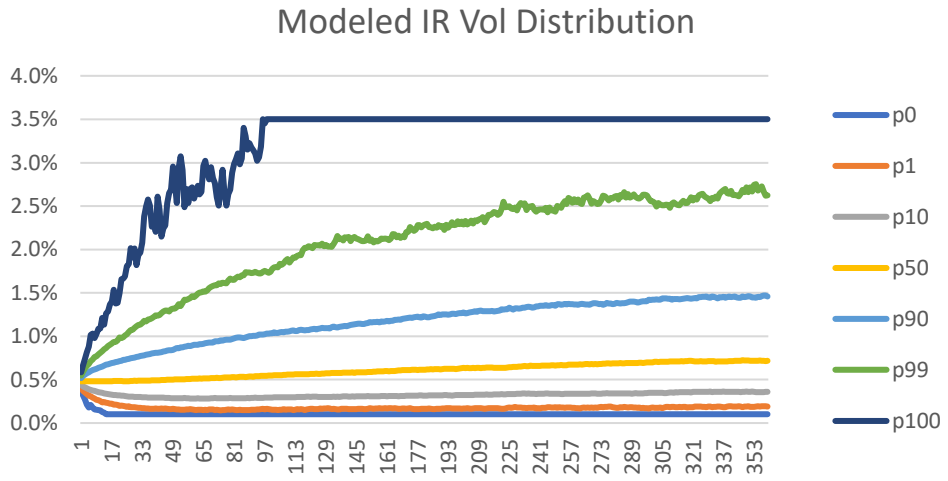


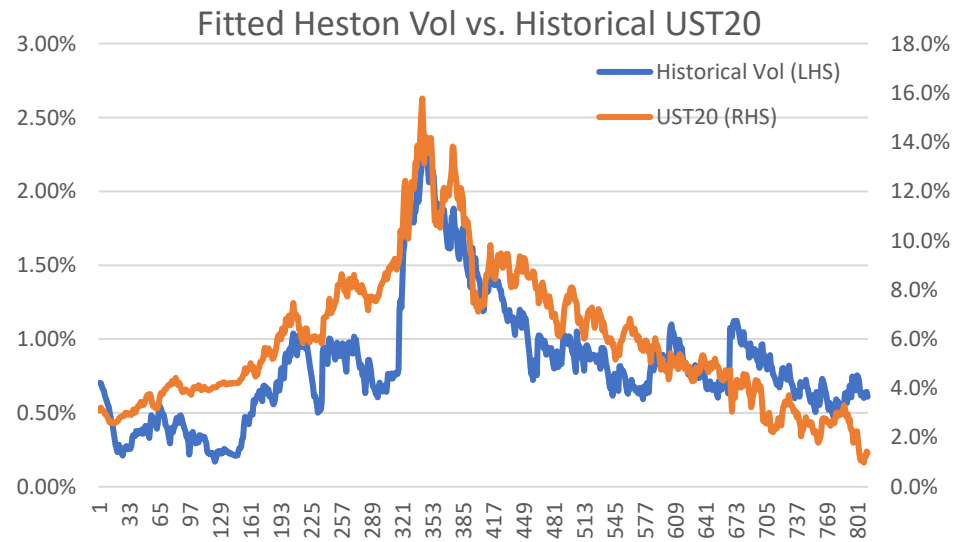
Distribution of Slope vs. UST20, and Inversion Frequency

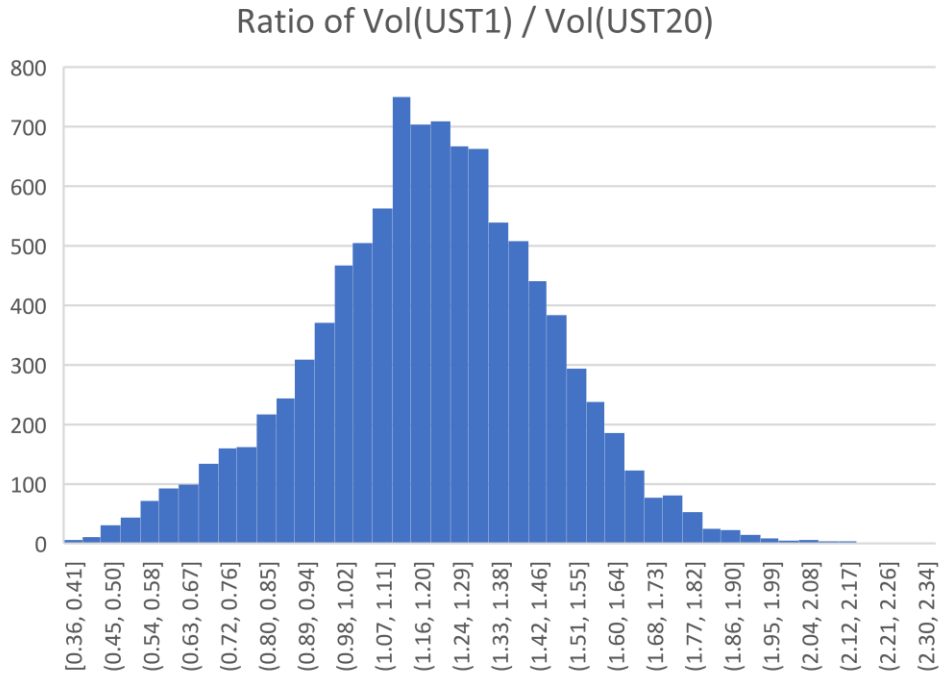




Distribution of UST20 Volatility and Relative UST1/UST20 Vol Comparison

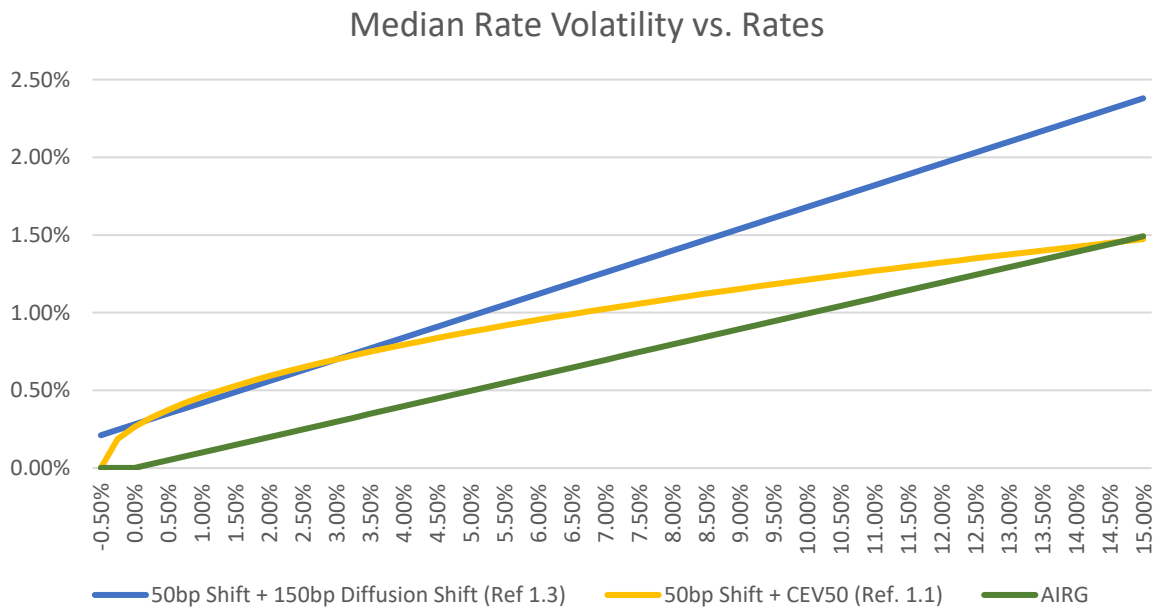


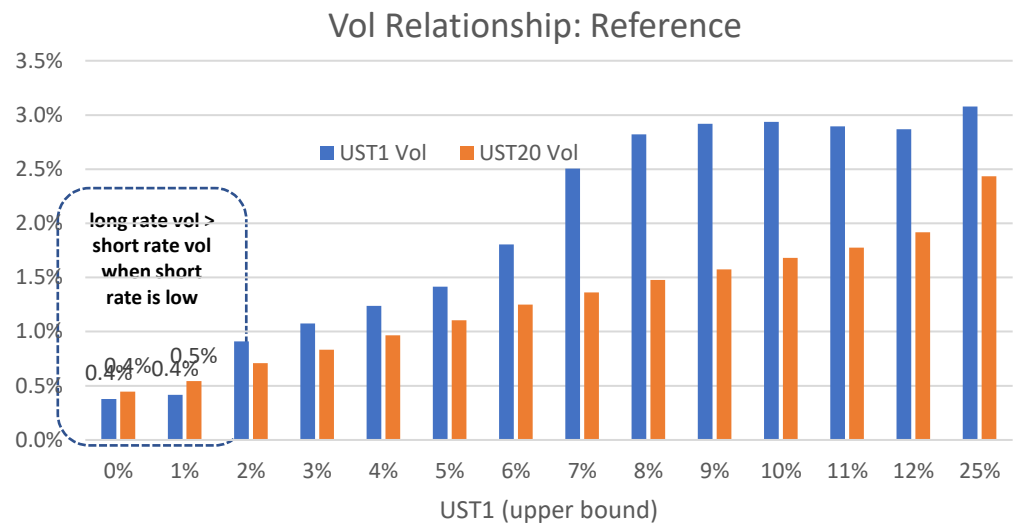


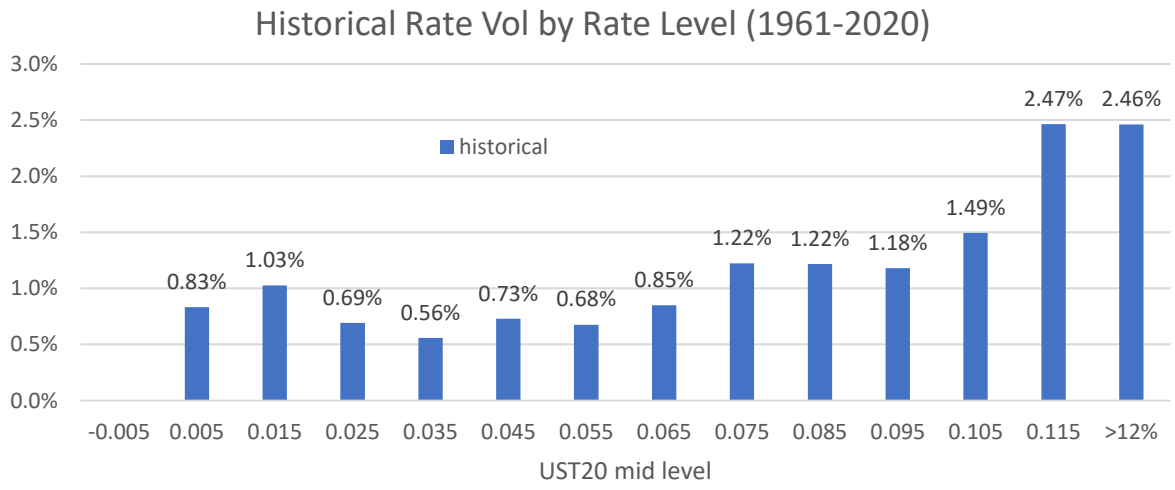


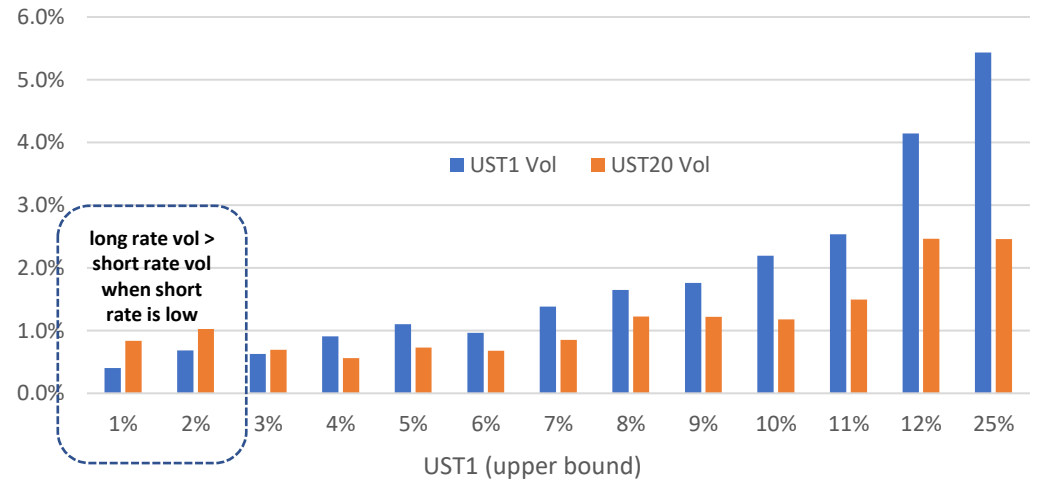
UST20 volatility, as measured over 30 years on monthly basis, exceeds that of UST1 in 21% of scenarios

Rate/Volatility Relationship



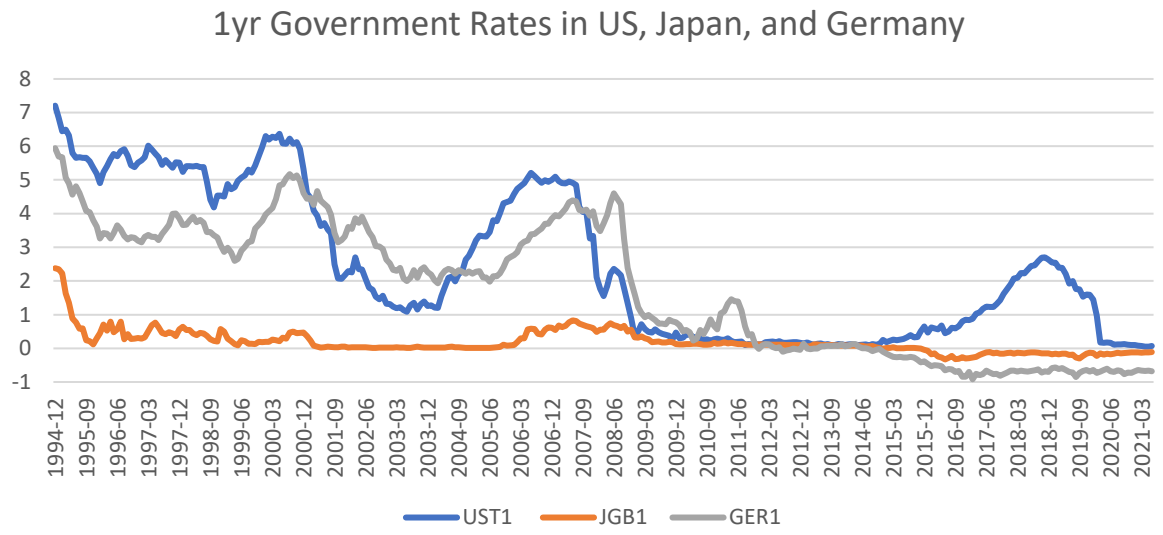


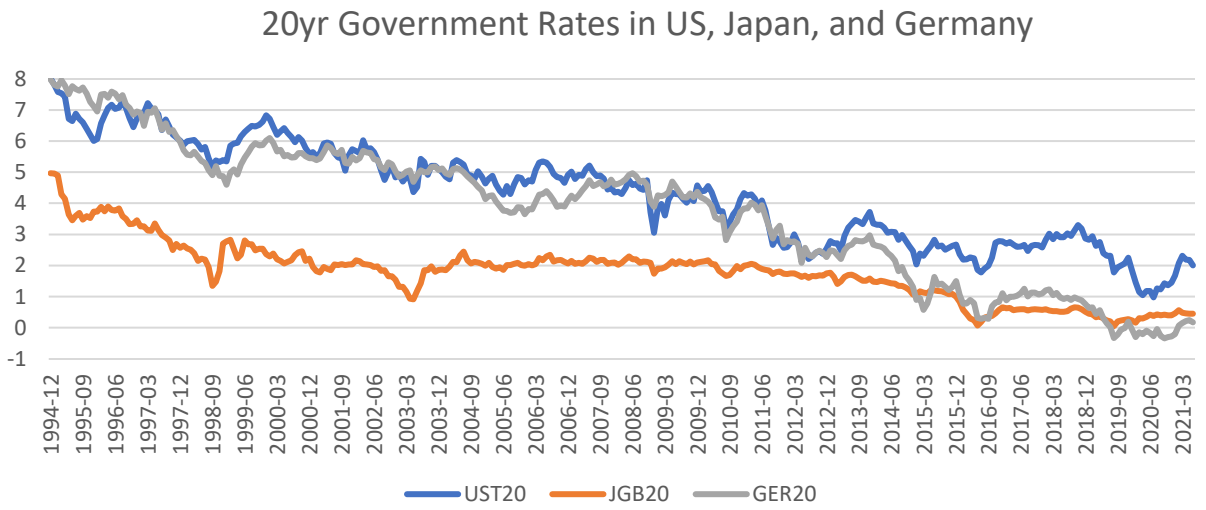




Low for Long: Short Rates are Rangebound and Exhibit Reduced Volatility

DRAFT





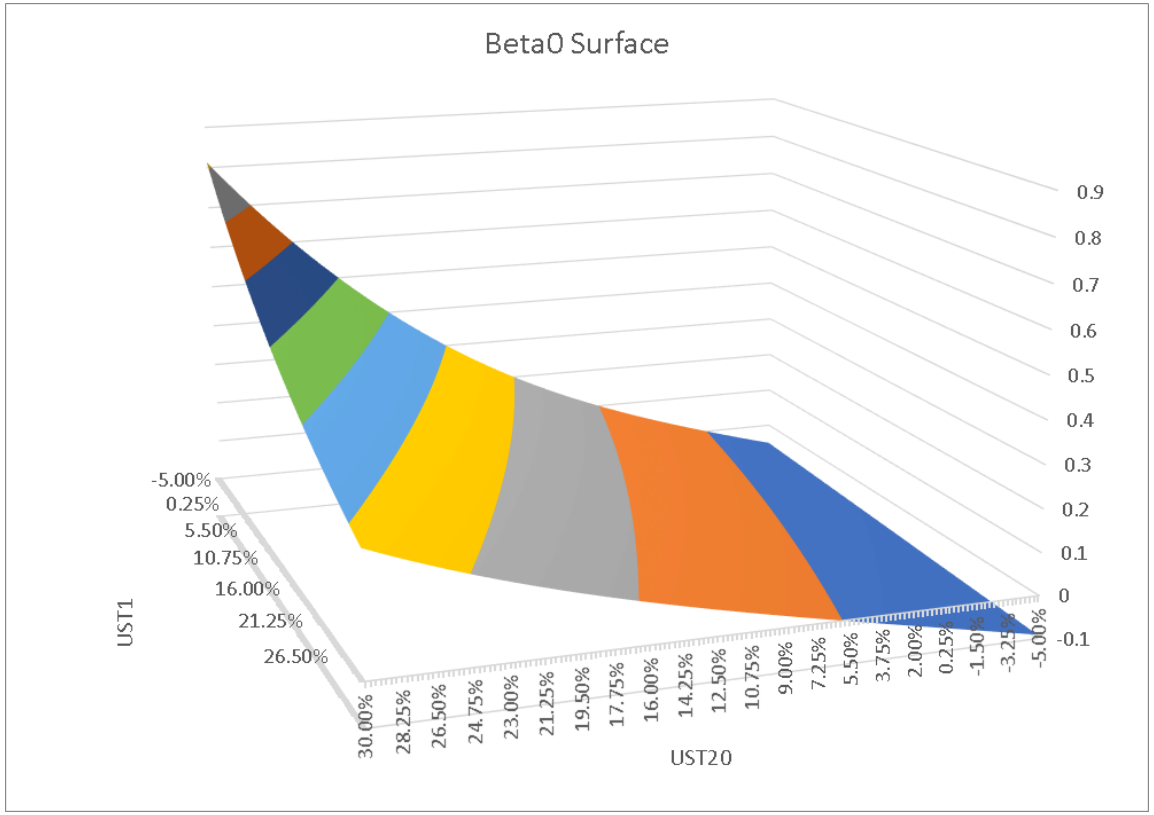
Historical Period	1yr Rate Range	Duration in months	Volatility of 1yr Rate	Volatility of 20yr Rate
US: 11/2008 to 2/2017	0 to 100bp	100 months	31bp	85bp
Japan: 5/1995 to 10/2015	0 to 100bp	246 months	30bp	44bp
Japan: 11/2015 to present	-33bp to 0	68 months	14bp	33bp
Germany: 6/2014 to present	-92bp to 0	85 months	13bp	92bp

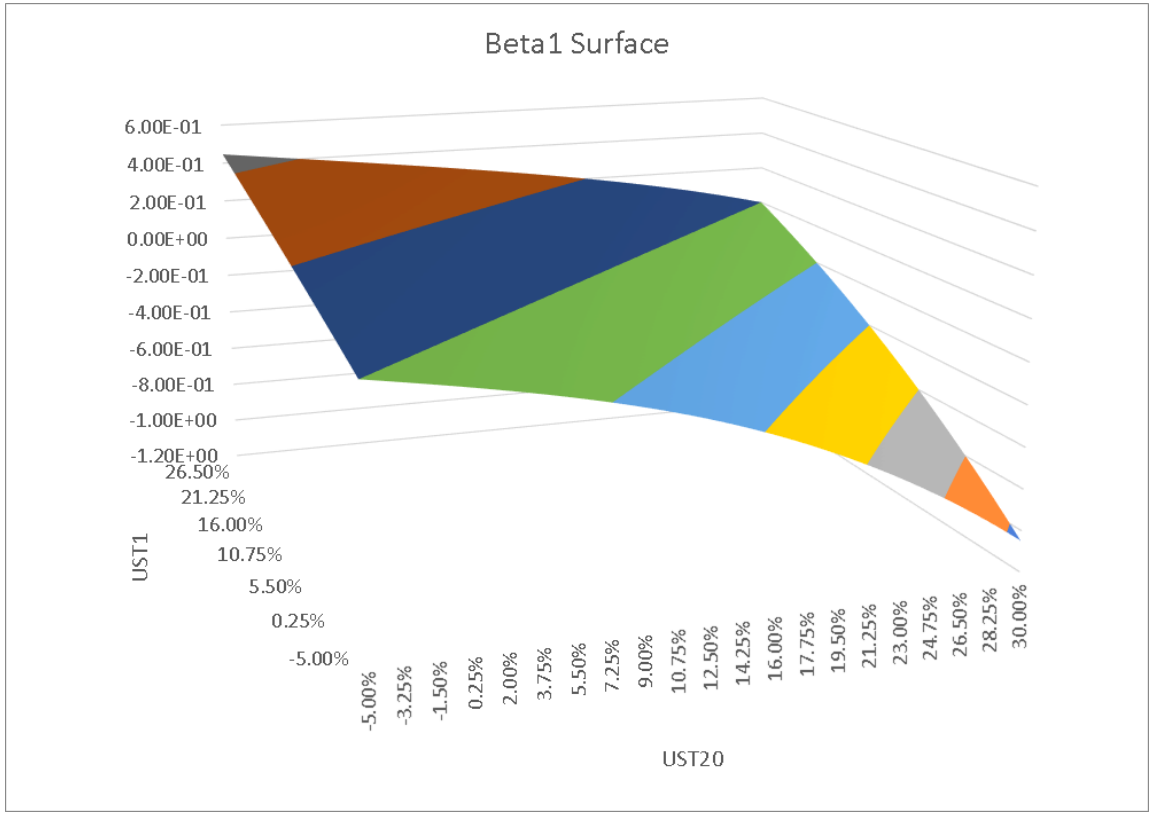
Key Historical Characteristics of Low-for-Long Rates:

- Low rates are often motivated by central bank policy, and become pinned to lower bound on the short end of the curve
- Short rates are range-bound and exhibit reduced volatility
- Inversions between 1yr and 20yr rate are rare – do not occur in illustrated periods
- Long rate exhibits much higher volatility as they are more exposed to market expectation vs. central bank action

While the international experience can be useful in understanding key characteristics in low rate environment, the levels & duration of low rates may not be directly relevant to the US given structural economic differences

Appendix: Precomputing NS parameter Surfaces

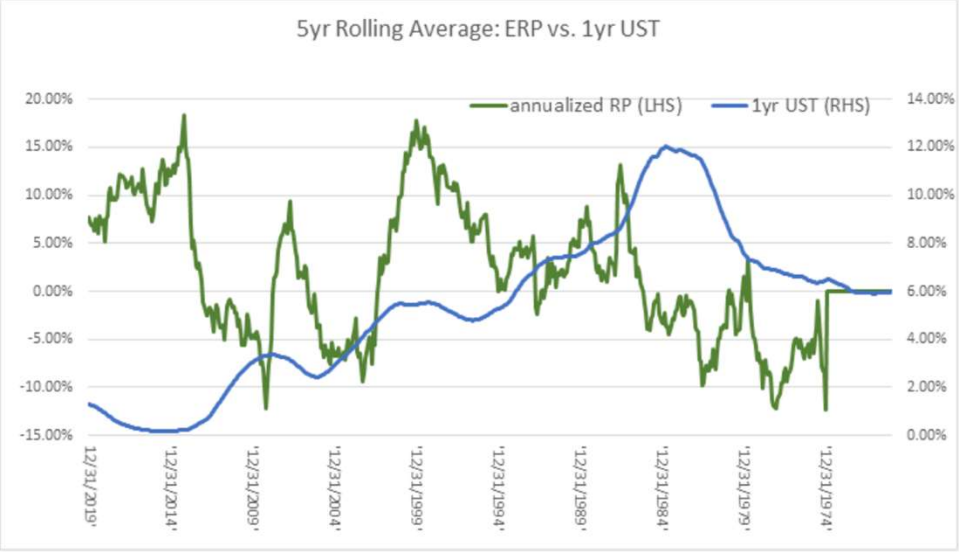




- Fitted SN parameters produce surfaces that are smooth and amenable to interpolation.
- Pre-computed parameter grids can be used to construct a term structure that fits any combination of UST1/UST20 with great precision: eg a grid using 25bp increments can fit any historical UST1/UST20 yields to within 5e-6

Equity Model – Structural Considerations

- Different approaches linking rates and equities will produce different reserve/capital dynamics (i.e., level and sensitivity to market changes from reporting period to reporting period). Sample approaches include:
  - Correlation between equity returns and changes in rates
    - Historical data include periods of positive and negative correlation – averaging to zero over the long-term. (Note: An ESG that assumes zero correlation on average will still have a range of positive and negative correlations across scenarios.)
  - Linking long-term equity return targets to long-term interest rate targets through a long-term equity risk premium assumption
    - May be conceptually consistent with economic theory
    - May consider reasonable ranges (not necessarily 1:1, and not necessarily static as it can change over time)
  - Strict formulaic relationship (ERP) between equity returns & interest rates in every period
    - No structural relationship between equity and rates is apparent.
    - Errors in fitting the independent model are imported into the dependent model during simulation



Equity Model – Structural Considerations (continued)

- Using a strict formulaic relationship between equity returns and overnight rates is a model simplification that can place substantial burden on governance process
    - Makes reserves / capital sensitive to changes in actual or expected overnight rates even if the long-term liabilities are not inherently dependent on overnight rates
        - Introduces artificial sensitivity in financial results from the selected ESG and not liability characteristics or actual equity return experience
        - Potentially creates a need to hedge the ESG's (and not the liability's) interest rate dependency
        - Linking returns to a less volatile longer maturity may reduce but not eliminate interest rate distortions
    - Frequent, possibly time consuming, recalibrations will likely be needed to ensure a reasonable distribution of results, particularly in the tails of the distribution. If cumulative returns at a particular time horizon are targeted, liabilities with shorter or longer product lifetimes would still experience unintended volatility. Path dependent liabilities would also be affected.
        - Targeting the distribution at many time points & extreme percentiles may be needed but be practically infeasible
        - Approach may cause governance and interpretation challenges for regulators and companies
    - Prioritizes the ability to simultaneously generate risk neutral and real world scenarios (a feature that will not be used)
        - Resulting tradeoffs on real world scenario behavior may not be consistent with LATF's objective of producing the appropriate real world scenarios for reserve / capital
    - In the absence of compelling evidence of structural linkage, a simpler model should be preferred (Occam's Razor).
- International equities
    - Assuming that international equities have lower returns and higher volatility than domestic equities may be inconsistent with VM-21 guidance (e.g., consideration of Sharpe Ratios) and/or have unintended consequences.
        - For example, it could be interpreted as an NAIC view that rational insurers should not offer these funds.
    - Using a regression line instead of an equity generator is highly unusual, and linear regression model requirements may be violated (e.g., independent and identically distributed normal error terms).
- Need specifics on the model's jump process and parameters given that the exposed scenario information does not allow for the identification and understanding of modeled jumps

Equity Model – Structural Considerations (continued)

- Need to assess and understand the potential for the proposed model structure and calibration approach to increase procyclicality
    - Updating initial volatilities and tying the jump process to volatility seem to increase the likelihood of additional equity drops after an actual equity stress.
        - In contrast, equity returns are invariant under the existing ESG, and other valuation frameworks may incorporate equity mean reversion or equity dampeners.
        - Historically, negative jumps tend to be followed by strong recoveries, e.g. drop in 1Q20 & recovery in 2Q20
    - If the Fed lowers interest rates after an equity market decline, the proposed model structure may depress average annual equity returns for the near to medium term and cumulative returns for all subsequent years. (Lowering interest rates to stimulate the economy worsens equity markets, which differs from historical experience, particularly over the last decade.)
    - Will need scenario sets under different initial conditions (e.g., controlled sensitivities, scenario sets at different time periods) prior to field testing
- Need to review the equity calibration for any changes in the interest rate recommendations given potential structural relationships and consistency considerations

Equity Model (2020 Revised Baseline) - Calibration Concerns

- While theoretically possible, projecting that equity indices become essentially worthless in some scenarios is extreme for reserve and capital projections and may cause operational issues (e.g., scenario selection).

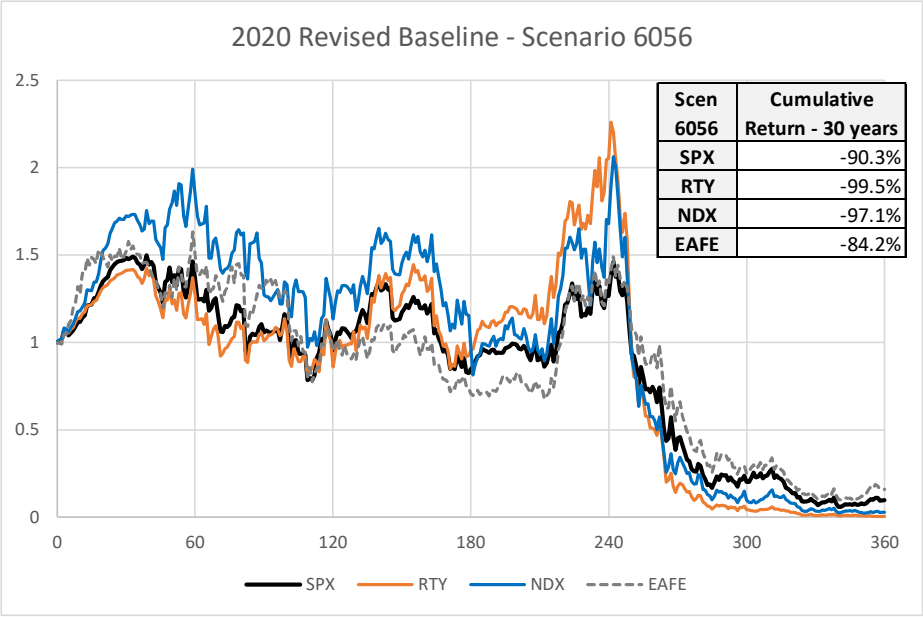
Price Index Levels (Initial = 1.00)

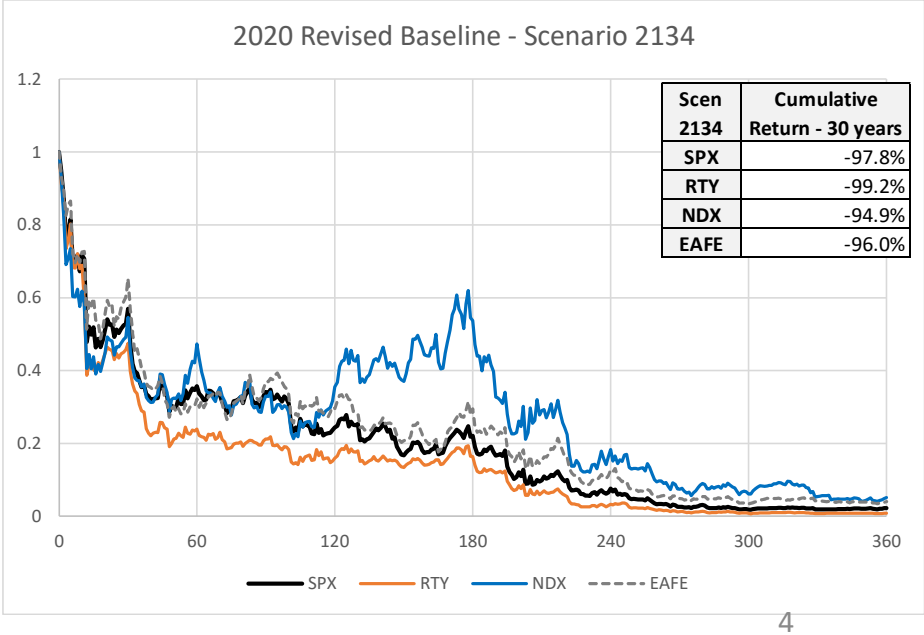
S&P 500	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.46	0.10	0.04	0.02	0.02
1.0%	0.70	0.42	0.28	0.24	0.20
2.5%	**0.75**	**0.52**	**0.39**	0.34	0.34
5.0%	**0.81**	**0.62**	**0.51**	**0.48**	0.49
10.0%	**0.87**	**0.74**	**0.68**	**0.68**	0.77
25.0%	0.96	0.94	1.00	1.21	1.57
50.0%	1.05	1.20	1.42	2.07	3.09
75.0%	1.13	1.47	1.96	3.36	5.80
90.0%	**1.21**	**1.74**	**2.55**	**5.06**	9.98
95.0%	**1.25**	**1.91**	**2.95**	**6.38**	13.68
97.5%	**1.29**	**2.11**	**3.35**	7.90	18.06
99.0%	1.34	2.35	3.93	9.90	24.43
Max	1.67	3.55	7.88	21.70	129.38

Russell 2000	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.38	0.05	0.02	0.01	0.00
1.0%	0.65	0.33	0.22	0.15	0.12
2.5%	**0.71**	**0.44**	**0.32**	0.26	0.24
5.0%	**0.77**	**0.55**	**0.45**	**0.41**	0.40
10.0%	**0.84**	**0.69**	**0.63**	**0.65**	0.72
25.0%	0.95	0.94	1.01	1.27	1.69
50.0%	1.06	1.25	1.54	2.38	3.76
75.0%	1.16	1.56	2.16	4.08	7.58
90.0%	**1.25**	**1.87**	**2.85**	**6.24**	13.11
95.0%	**1.31**	**2.08**	**3.36**	**7.90**	18.29
97.5%	**1.36**	**2.30**	**3.88**	10.03	24.41
99.0%	1.42	2.58	4.51	12.92	35.10
Max	1.71	6.11	13.45	32.05	102.61

NASDAQ	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.41	0.06	0.03	0.01	0.01
1.0%	0.66	0.36	0.20	0.15	0.11
2.5%	**0.73**	**0.45**	**0.30**	0.23	0.21
5.0%	**0.78**	**0.56**	**0.43**	**0.36**	0.36
10.0%	**0.85**	**0.69**	**0.61**	**0.59**	0.63
25.0%	0.96	0.96	1.00	1.24	1.64
50.0%	1.07	1.29	1.61	2.52	4.10
75.0%	1.18	1.68	2.46	4.86	9.56
90.0%	**1.27**	**2.08**	**3.43**	**8.31**	19.34
95.0%	**1.33**	**2.37**	**4.16**	**11.44**	27.64
97.5%	**1.38**	**2.67**	**4.94**	15.00	38.99
99.0%	1.44	2.99	6.07	20.17	55.73
Max	1.72	5.35	12.27	52.50	711.43

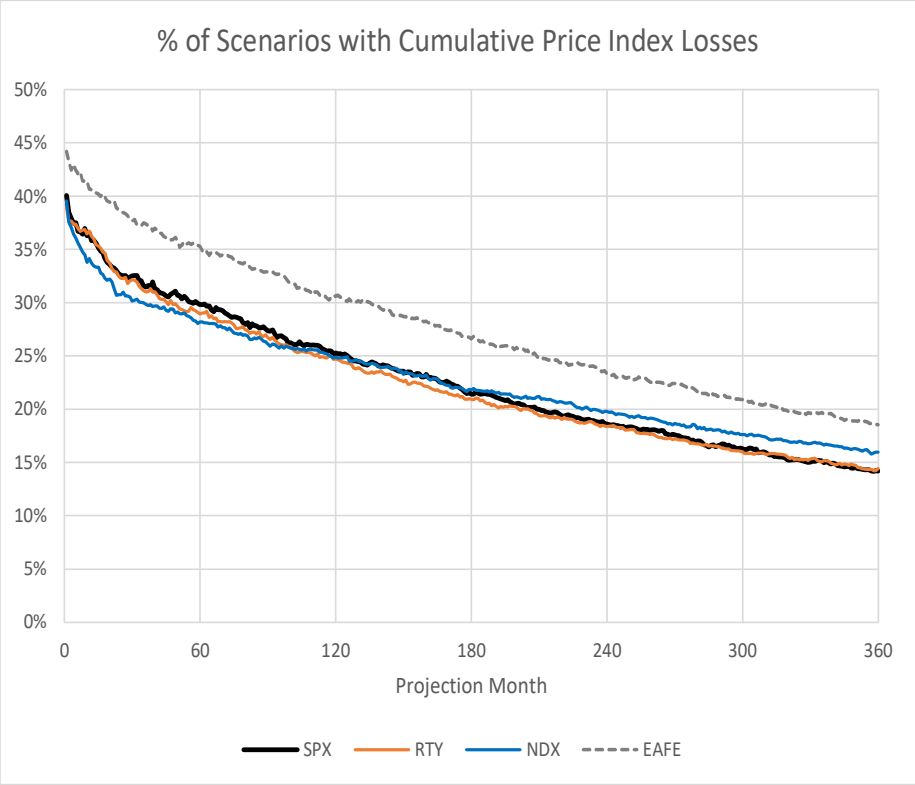
EAFE	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.46	0.13	0.07	0.06	0.04
1.0%	0.68	0.42	0.29	0.21	0.19
2.5%	**0.74**	**0.50**	**0.38**	0.31	0.29
5.0%	**0.79**	**0.59**	**0.48**	**0.42**	0.42
10.0%	**0.84**	**0.69**	**0.63**	**0.59**	0.65
25.0%	0.93	0.89	0.91	1.04	1.27
50.0%	1.04	1.15	1.32	1.83	2.60
75.0%	1.15	1.47	1.89	3.06	5.13
90.0%	**1.25**	**1.82**	**2.61**	**4.86**	8.93
95.0%	**1.31**	**2.06**	**3.14**	**6.43**	12.85
97.5%	**1.36**	**2.28**	**3.70**	8.29	17.06
99.0%	1.44	2.64	4.45	11.49	25.18
Max	1.72	4.43	8.74	30.60	109.10





Equity Model (2020 Revised Baseline) – Calibration Concerns (continued)

- The S&P 500 (price index) has negative returns over 30 years in ~14% scenarios even though this has never been observed in history, even using data since 1928.
  - Worse-than-history events should be allowed but should generally be considered tail risks and not "moderately adverse."



Historical Frequency of Rolling Negative Cumulative Returns					
	S&P 500	Nasdaq	Russell	S&P Mid	EAFE
Start →	1/1/1951	10/1/1985	10/1/1987	1/1/1985	12/31/1998
Years					
1	26.3%	17.1%	28.5%	23.2%	39.0%
5	17.6%	14.5%	10.8%	2.4%	17.5%
10	8.5%	9.2%	0.4%	0.0%	1.4%
15	0.0%	0.4%	0.0%	0.0%	0.0%
20	0.0%	0.0%	0.0%	0.0%	0.0%
25	0.0%	0.0%	0.0%	0.0%	N/A
30	0.0%	0.0%	0.0%	0.0%	N/A

Longest Negative cumulative return period

	Duration	
Index	Months	Years
S&P 500	164	13.67
Russell	140	11.67
Mid	108	9.00
Nasdaq	193	16.08
EAFE	149	12.42

Equity Model (2020 Revised Baseline) – Calibration Concerns (continued)

- The 5.6% median annualized (geometric average) S&P 500 total return over 30 years is significantly below the NAIC's prior C-3 Phase 2 equity calibration decision (~7.5%) and historical averages.
  - Historical geometric average returns: 10.0% for history from 1955 to 2003 and 8.9% using 1927 to 2016 (both from 20171201 NAIC VA QIS II Recommandations vF.pdf p. 13). 13% from 2010-2020 (ACLI calculated)

S&P 500 Gross Wealth Factors

Revised Baseline	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.47	0.12	0.06	0.04	0.05
1.0%	0.72	0.46	0.35	0.36	0.37
2.5%	**0.76**	**0.58**	**0.47**	0.51	0.61
5.0%	**0.82**	**0.68**	**0.62**	**0.70**	0.89
10.0%	**0.88**	**0.81**	**0.82**	**0.99**	1.35
25.0%	0.97	1.03	1.19	1.71	2.66
50.0%	1.06	1.30	1.67	2.87	5.11
75.0%	1.15	1.59	2.28	4.61	9.41
90.0%	**1.23**	**1.87**	**2.95**	**6.95**	16.00
95.0%	**1.27**	**2.06**	**3.46**	**8.67**	21.86
97.5%	**1.31**	**2.27**	**3.90**	10.79	28.96
99.0%	1.36	2.53	4.57	13.36	38.70
Max	1.70	3.88	9.25	28.22	201.01

AAA Dec 2005	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.41	0.32	0.26	0.35	0.38
1.0%	0.70	0.62	0.66	0.83	1.22
2.5%	**0.76**	**0.72**	**0.77**	1.10	1.69
5.0%	**0.82**	**0.81**	**0.92**	**1.41**	2.25
10.0%	**0.89**	**0.93**	**1.12**	**1.83**	3.09
25.0%	0.98	1.16	1.51	2.74	5.11
50.0%	1.09	1.45	2.09	4.27	8.84
75.0%	1.19	1.81	2.88	6.80	15.35
90.0%	**1.30**	**2.22**	**3.81**	**10.15**	24.98
95.0%	**1.37**	**2.48**	**4.44**	**12.92**	34.25
97.5%	**1.44**	**2.72**	**5.17**	15.65	45.88
99.0%	1.52	3.06	6.18	20.49	60.45
Max	1.92	4.77	11.86	66.94	235.95

Conning / AAA	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	114%	39%	23%	11%	13%
1.0%	102%	74%	54%	44%	30%
2.5%	**101%**	**80%**	**61%**	46%	36%
5.0%	**101%**	**84%**	**67%**	**50%**	40%
10.0%	**99%**	**86%**	**73%**	**54%**	44%
25.0%	99%	89%	79%	63%	52%
50.0%	98%	89%	80%	67%	58%
75.0%	97%	88%	79%	68%	61%
90.0%	**94%**	**84%**	**78%**	**68%**	64%
95.0%	**93%**	**83%**	**78%**	**67%**	64%
97.5%	**92%**	**83%**	**75%**	69%	63%
99.0%	90%	83%	74%	65%	64%
Max	88%	81%	78%	42%	85%

S&P 500 Annualized Cumulative Total Return

Revised Baseline	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	-53.3%	-34.4%	-24.8%	-14.9%	-9.6%
1.0%	-28.4%	-14.5%	-9.9%	-4.9%	-3.2%
2.5%	**-23.6%**	**-10.4%**	**-7.2%**	-3.3%	-1.6%
5.0%	**-17.7%**	**-7.5%**	**-4.6%**	**-1.8%**	-0.4%
10.0%	**-11.9%**	**-4.2%**	**-2.0%**	**0.0%**	1.0%
25.0%	-2.9%	0.5%	1.7%	2.7%	3.3%
50.0%	6.4%	5.3%	5.2%	5.4%	5.6%
75.0%	15.1%	9.7%	8.6%	7.9%	7.8%
90.0%	**22.5%**	**13.4%**	**11.4%**	**10.2%**	9.7%
95.0%	**27.2%**	**15.6%**	**13.2%**	**11.4%**	10.8%
97.5%	**31.5%**	**17.8%**	**14.6%**	12.6%	11.9%
99.0%	36.3%	20.4%	16.4%	13.8%	13.0%
Max	69.7%	31.1%	24.9%	18.2%	19.3%

AAA Dec 2005	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	-59.0%	-20.6%	-12.7%	-5.1%	-3.1%
1.0%	-30.0%	-9.1%	-4.1%	-0.9%	0.7%
2.5%	**-24.4%**	**-6.3%**	**-2.6%**	0.5%	1.8%
5.0%	**-18.2%**	**-4.2%**	**-0.8%**	**1.7%**	2.7%
10.0%	**-11.4%**	**-1.4%**	**1.2%**	**3.1%**	3.8%
25.0%	-1.6%	3.0%	4.2%	5.2%	5.6%
50.0%	8.9%	7.7%	7.6%	7.5%	7.5%
75.0%	19.0%	12.6%	11.1%	10.1%	9.5%
90.0%	**29.7%**	**17.3%**	**14.3%**	**12.3%**	11.3%
95.0%	**37.0%**	**19.9%**	**16.1%**	**13.6%**	12.5%
97.5%	**43.5%**	**22.2%**	**17.8%**	14.7%	13.6%
99.0%	51.7%	25.1%	20.0%	16.3%	14.7%
Max	92.0%	36.7%	28.1%	23.4%	20.0%

Conning - AAA	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	5.8%	-13.7%	-12.1%	-9.7%	-6.5%
1.0%	1.6%	-5.4%	-5.7%	-4.0%	-3.9%
2.5%	**0.8%**	**-4.1%**	**-4.6%**	-3.8%	-3.4%
5.0%	**0.6%**	**-3.3%**	**-3.9%**	**-3.5%**	-3.1%
10.0%	**-0.5%**	**-2.8%**	**-3.1%**	**-3.1%**	-2.8%
25.0%	-1.4%	-2.4%	-2.5%	-2.4%	-2.3%
50.0%	-2.5%	-2.4%	-2.4%	-2.1%	-1.9%
75.0%	-3.9%	-3.0%	-2.6%	-2.1%	-1.8%
90.0%	**-7.2%**	**-3.9%**	**-2.9%**	**-2.1%**	-1.6%
95.0%	**-9.9%**	**-4.3%**	**-2.9%**	**-2.2%**	-1.7%
97.5%	**-12.1%**	**-4.4%**	**-3.3%**	-2.1%	-1.7%
99.0%	-15.4%	-4.7%	-3.6%	-2.5%	-1.7%
Max	-22.3%	-5.6%	-3.1%	-5.2%	-0.6%

Equity Model (2020 Revised Baseline)

- 141 bps decrease in initial overnight rates → ~10% lower price index levels though 30 years (= -0.4% annualized)
  - Patterns are similar for total return accumulation factors and for other indices.
  - Differences in the extreme tails may be from differences in the # of scenarios with multiple large jumps (e.g., ±20% or 25%)

S&P 500 Price Accumulation Factors

YE2020	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.46	0.10	0.04	0.02	0.02
1.0%	0.70	0.42	0.28	0.24	0.20
2.5%	**0.75**	**0.52**	**0.39**	0.34	0.34
5.0%	**0.81**	**0.62**	**0.51**	**0.48**	0.49
10.0%	**0.87**	**0.74**	**0.68**	**0.68**	0.77
25.0%	0.96	0.94	1.00	1.21	1.57
50.0%	1.05	1.20	1.42	2.07	3.09
75.0%	1.13	1.47	1.96	3.36	5.80
90.0%	**1.21**	**1.74**	**2.55**	**5.06**	9.98
95.0%	**1.25**	**1.91**	**2.95**	**6.38**	13.68
97.5%	**1.29**	**2.11**	**3.35**	7.90	18.06
99.0%	1.34	2.35	3.93	9.90	24.43
Max	1.67	3.55	7.88	21.70	129.38

YE2019	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.45	0.15	0.06	0.05	0.01
1.0%	0.69	0.43	0.30	0.26	0.23
2.5%	**0.75**	**0.53**	**0.42**	0.38	0.35
5.0%	**0.80**	**0.63**	**0.55**	**0.52**	0.54
10.0%	**0.87**	**0.76**	**0.72**	**0.73**	0.86
25.0%	0.96	0.98	1.05	1.31	1.74
50.0%	1.06	1.25	1.52	2.26	3.44
75.0%	1.15	1.54	2.09	3.71	6.55
90.0%	**1.23**	**1.83**	**2.74**	**5.56**	11.30
95.0%	**1.28**	**2.03**	**3.17**	**7.11**	15.73
97.5%	**1.33**	**2.23**	**3.62**	8.74	20.79
99.0%	1.37	2.46	4.24	11.33	28.39
Max	1.72	3.63	7.62	26.61	101.61

YE2020 / YE2019	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	101%	71%	75%	44%	183%
1.0%	103%	97%	94%	91%	88%
2.5%	100%	99%	92%	88%	96%
5.0%	101%	98%	93%	91%	91%
10.0%	100%	97%	95%	93%	90%
25.0%	100%	96%	95%	92%	90%
50.0%	99%	96%	93%	92%	90%
75.0%	98%	95%	94%	90%	89%
90.0%	98%	95%	93%	91%	88%
95.0%	98%	94%	93%	90%	87%
97.5%	98%	95%	93%	90%	87%
99.0%	98%	96%	93%	87%	86%
Max	97%	98%	103%	82%	127%

S&P 500 Annualized Cumulative Returns

YE2020	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	-54.3%	-36.3%	-27.0%	-17.1%	-11.9%
1.0%	-29.6%	-16.1%	-11.9%	-7.0%	-5.2%
2.5%	**-25.0%**	**-12.1%**	**-9.0%**	-5.3%	-3.6%
5.0%	**-19.1%**	**-9.2%**	**-6.5%**	**-3.6%**	-2.3%
10.0%	**-13.3%**	**-5.9%**	**-3.8%**	**-1.9%**	-0.9%
25.0%	-4.5%	-1.1%	0.0%	0.9%	1.5%
50.0%	4.8%	3.7%	3.5%	3.7%	3.8%
75.0%	13.4%	8.0%	6.9%	6.2%	6.0%
90.0%	**20.7%**	**11.7%**	**9.8%**	**8.4%**	8.0%
95.0%	**25.3%**	**13.9%**	**11.4%**	**9.7%**	9.1%
97.5%	**29.5%**	**16.1%**	**12.9%**	10.9%	10.1%
99.0%	34.4%	18.7%	14.7%	12.1%	11.2%
Max	66.8%	28.8%	22.9%	16.6%	17.6%

YE2019	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	-54.6%	-31.8%	-24.8%	-13.6%	-13.7%
1.0%	-31.5%	-15.5%	-11.3%	-6.5%	-4.8%
2.5%	**-25.0%**	**-11.9%**	**-8.3%**	-4.7%	-3.4%
5.0%	**-19.5%**	**-8.9%**	**-5.9%**	**-3.2%**	-2.0%
10.0%	**-13.5%**	**-5.4%**	**-3.2%**	**-1.5%**	-0.5%
25.0%	-4.1%	-0.3%	0.5%	1.4%	1.9%
50.0%	5.8%	4.6%	4.3%	4.2%	4.2%
75.0%	15.3%	9.0%	7.6%	6.8%	6.5%
90.0%	**23.3%**	**12.8%**	**10.6%**	**9.0%**	8.4%
95.0%	**28.0%**	**15.2%**	**12.2%**	**10.3%**	9.6%
97.5%	**32.5%**	**17.4%**	**13.7%**	11.4%	10.6%
99.0%	37.4%	19.7%	15.5%	12.9%	11.8%
Max	72.4%	29.4%	22.5%	17.8%	16.7%

YE2020 - YE2019	1 Yr	5 Yr	10 Yr	20 Yr	30 Yr
Min	0.3%	-4.5%	-2.1%	-3.4%	1.8%
1.0%	1.9%	-0.6%	-0.6%	-0.5%	-0.4%
2.5%	0.0%	-0.2%	-0.8%	-0.6%	-0.1%
5.0%	0.5%	-0.3%	-0.7%	-0.4%	-0.3%
10.0%	0.1%	-0.5%	-0.5%	-0.4%	-0.4%
25.0%	-0.4%	-0.8%	-0.5%	-0.4%	-0.4%
50.0%	-1.0%	-0.9%	-0.8%	-0.5%	-0.4%
75.0%	-2.0%	-1.0%	-0.7%	-0.5%	-0.4%
90.0%	-2.5%	-1.2%	-0.8%	-0.5%	-0.4%
95.0%	-2.7%	-1.4%	-0.8%	-0.6%	-0.5%
97.5%	-3.0%	-1.3%	-0.9%	-0.6%	-0.5%
99.0%	-3.0%	-1.0%	-0.9%	-0.8%	-0.6%
Max	-5.5%	-0.6%	0.4%	-1.2%	0.9%

Proposed Stylized Facts for Discussion / Feedback – Rate/Equity Relationships

- The relationship between interest rate levels and equity returns (i.e., the equity risk premium) should be consistent with historical dynamics and economic theory.
  - Over long time horizons, there should be a reasonable relationship between expected interest rates and expected equity returns – consistent with risk/reward relationships.
  - The relationship in any given period is subject to non-constant patterns – i.e., ERPs expand / contract in low / high rate environments, particularly in the tails.
    - Consistent with historical data and dependencies on economic and macroeconomic factors, fiscal and monetary policy, and investor sentiment
- Equity returns and *changes in* interest rates along a scenario path should exhibit a range of positive and negative correlations*.

* Included for completeness, but generally occurs naturally in any stochastic interest rate model (including the AIRG and GEMS)

Summary of Equity Risk Premium References

- Fed Paper:
  - Original link: https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr714.pdf
  - Link to an updated / better formatted version* of the original paper: https://www.newyorkfed.org/medialibrary/media/research/epr/2015/2015_epr_equity-risk-premium.pdf?la=en
- Article from Global Financial Data:
  - https://globalfinancialdata.com/expansionism-the-impact-of-the-fed-s-monetary-regime-on-the-equity-risk-premium
- Duff & Phelps:
  - Original link (full report): https://www.duffandphelps.com/-/media/assets/pdfs/publications/valuation/us-equity-risk-premium-recommendation-increased.pdf
  - Link to a more abbreviated update*: https://www.duffandphelps.com/insights/publications/valuation-insights/valuation-insights-first-quarter-2021/duff-and-phelps-recommended-us-equity-risk
- Prof. Damodaran Paper*:
  - Expansive paper on many potential drivers and considerations for ERPs: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3825823
  - Quote read during on 11/8 call: "Equity risk premiums reflect both economic fundamentals and investor risk aversion and they do change over time, sometimes over very short intervals, as evidenced by what happened in the last quarter of 2008. Shocks to the system – a collapse of a large company or sovereign entity or a terrorist attack – can cause premiums to shoot up overnight. A failure to recognize this reality will lead to analyses that lag reality."
- Statistical testing* of constant vs. inverse rate ERP relationships against historical data suggests that an inverse rate relationship is more likely to be consistent with historical observations in the tail

ERP in high-low rates v1.32.pdf

* Additional reference cited during 11/8 call. All other references were previously provided in ERP_Excerpts.doc.

From the Fed paper:

https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr714.pdf

Key takeaways:

- Equity risk premiums (ERPs) and expected equity returns can be high when rates are low.
- There are many different ERP models that produce many different estimates.

Key quotes:

- "We estimate the equity risk premium (ERP) by combining information from twenty models. The ERP in 2012 and 2013 reached heightened levels—of around 12 percent—not seen since the 1970s. We conclude that the high ERP was caused by unusually low Treasury yields."

- "When it comes to the ERP, we find that there is substantial heterogeneity in estimation methodology and final estimates."

From the Global Financial Data article:

https://globalfinancialdata.com/expansionism-the-impact-of-the-fed-s-monetary-regime-on-the-equity-risk-premium

Key takeaways:

- The risk relationship between equity returns and rates holds over long periods of time.
- ERPs are not constant and can deviate from long-term averages for significant periods (e.g., decades), allowing bonds to outperform equities over even long periods.
- ERPs are driven by macroeconomics, business cycles, and monetary and fiscal policy.

Key quotes:

- "Risk and return are positively correlated. Equities are riskier than bonds and bills and should provide a higher rate of return to compensate investors for this risk. Over long periods of time, this has been true."

- "Most research has focused on determining the value of the ERP assuming it is a constant that could be directly related to the level of increased risk. Estimates of the equity risk premium are generally in the range of 3-7% depending upon the time period covered. However, the relative risk of stocks and bonds, as well as the perception of this risk changes over time. It is not fixed.

There is no agreement on the value of the ERP, primarily because historical comparisons of relative returns between stocks, bonds and bills vary greatly over time as well as between countries. Moreover, in some cases, as in Japan between 1989 and 2013, the total return to government bonds has exceeded the return to equities over a period of 20 years or more. So if the ERP is not constant, why does it change over time, or does it even exist?

It is the argument of this paper that a fixed value for the ERP may not even exist for two reasons. First, it is not possible to arbitrage the ERP, even when it significantly deviates from its long-term average. There is no historical evidence that it is possible to go long one asset class and short the other and profit from this arbitrage. The evidence for this is that the ERP can significantly differ from its long-term average for decades at a time. If the ERP could be arbitraged, such profitable opportunities would be eliminated more quickly than they are. The example of Japan in which the ERP was 11.14 between 1950 and 1989 and -5.92 from 1990 to 2013 is the best example of this.

The primary reason for this result is that equity returns are primarily driven by the growth in corporate profits and nominal bond yields by both inflation and the growth in the economy as a whole. Moreover, the business cycle driving equities is substantially shorter than the policy cycle driving bond yields. While a bull or bear market in equities may last two to five years, a bull or bear market in fixed income can last two or three decades. A fixed ERP assumes it is exogenous when in fact it may be endogenous and influenced by monetary and fiscal policy.

There is no fixed value for the Equity Risk Premium because both monetary and fiscal policy heavily influence the ERP over periods of a decade or less, primarily through the influence of monetary policy on fixed income returns, but also through the effect on equities. Expansionary fiscal policy only has a short-run impact on GDP. Fiscal policy influences the ERP by generating deficits because of wars, economic and financial crises, or other factors which influence the economy. Monetary policy is used to redress the problems created by government deficits and economic and financial crises, and impacts the money supply, inflation and interest rates, and thus the ERP."

From Duff & Phelps report:

https://www.duffandphelps.com/-/media/assets/pdfs/publications/valuation/us-equity-risk-premium-recommendation-increased.pdf

Key takeaways:

- ERPs are not constant over time. They expand and contract with business cycles and may be higher in a recession.

Key quotes:

- “Conditional ERP – The objective is to determine where within the unconditional ERP range the conditional ERP should be, based on current economic conditions. Research has shown that ERP fluctuates during the business cycle. When the economy is near (or in) a recession, the conditional ERP is at the higher end of the normal, or unconditional ERP range. As the economy improves, the conditional ERP moves back toward the middle of the range and at the peak of an economic expansion, the conditional ERP approaches the lower end of the range.”

- “In estimating the conditional ERP, valuation analysts cannot simply use the long-term historical ERP without further analysis. There is ample academic evidence that equity risk premia are not constant over time.“

Proposed Stylized Facts for Discussion / Feedback – Reaction to Changes in Initial / Recent Conditions

- Fluctuations in initial market conditions (e.g., recent equity returns or equity volatility, interest rates) during "business as usual" monthly scenario updates should have no more than a limited and transient effect on equity distributions. For example:
  - There should be no impact on equity returns beyond the near-term (e.g., beyond the next 5-6 years).
  - The distribution of annual equity returns after 2 years should not vary by more than [X]%.
    - Could be also bounded based on percentile relationships (instead of a specific values)
  - Any near-term and cumulative impacts should be proportionate to the change in initial conditions.
- In the absence of compelling historical and/or theoretical evidence, there should be not be any material procyclical or countercyclical equity return response to changes in initial conditions.

Economic Cycles

- Month to month fluctuations in market conditions are likely to be related to the current phase of the economic cycle.
  - Seems reasonable to assume that impacts will not generally spill over to other phases or future business cycles
  - Assumes that persistent changes in markets would be reflected via the periodic recalibration governance process
- According to NBER's economic cycle statistics for 1945-2020:
  - Contractions have averaged ~1 year
  - Expansions have averaged ~5 years
  - Full cycles have averaged ~6 years

From NBER (https://www.nber.org/research/data/us-business-cycle-expansions-and-contractions):

Peak month (Peak Quarter)	Trough month (Trough Quarte	Contraction	Expansion	Cycle	
		Duration, peak to trough	*Duration, trough to peak*	*Duration, trough to trough*	*Duration, peak to peak*
	December 1854 (1854Q4)				
June 1857 (1857Q2)	December 1858 (1858Q4)	18	30	48	
October 1860 (1860Q3)	June 1861 (1861Q3)	8	22	30	40
April 1865 (1865Q1)	December 1867 (1868Q1)	32	46	78	54
June 1869 (1869Q2)	December 1870 (1870Q4)	18	18	36	50
October 1873 (1873Q3)	March 1879 (1879Q1)	65	34	99	52
March 1882 (1882Q1)	May 1885 (1885Q2)	38	36	74	101
March 1887 (1887Q2)	April 1888 (1888Q1)	13	22	35	60
July 1890 (1890Q3)	May 1891 (1891Q2)	10	27	37	40
January 1893 (1893Q1)	June 1894 (1894Q2)	17	20	37	30
December 1895 (1895Q4)	June 1897 (1897Q2)	18	18	36	35
June 1899 (1899Q3)	December 1900 (1900Q4)	18	24	42	42
September 1902 (1902Q4)	August 1904 (1904Q3)	23	21	44	39
May 1907 (1907Q2)	June 1908 (1908Q2)	13	33	46	56
January 1910 (1910Q1)	January 1912 (1911Q4)	24	19	43	32
January 1913 (1913Q1)	December 1914 (1914Q4)	23	12	35	36
August 1918 (1918Q3)	March 1919 (1919Q1)	7	44	51	67
January 1920 (1920Q1)	July 1921 (1921Q3)	18	10	28	17
May 1923 (1923Q2)	July 1924 (1924Q3)	14	22	36	40
October 1926 (1926Q3)	November 1927 (1927Q4)	13	27	40	41
August 1929 (1929Q3)	March 1933 (1933Q1)	43	21	64	34
May 1937 (1937Q2)	June 1938 (1938Q2)	13	50	63	93
February 1945 (1945Q1)	October 1945 (1945Q4)	8	80	88	93
November 1948 (1948Q4)	October 1949 (1949Q4)	11	37	48	45
July 1953 (1953Q2)	May 1954 (1954Q2)	10	45	55	56
August 1957 (1957Q3)	April 1958 (1958Q2)	8	39	47	49
April 1960 (1960Q2)	February 1961 (1961Q1)	10	24	34	32
December 1969 (1969Q4)	November 1970 (1970Q4)	11	106	117	116
November 1973 (1973Q4)	March 1975 (1975Q1)	16	36	52	47
January 1980 (1980Q1)	July 1980 (1980Q3)	6	58	64	74
July 1981 (1981Q3)	November 1982 (1982Q4)	16	12	28	18
July 1990 (1990Q3)	March 1991 (1991Q1)	8	92	100	108
March 2001 (2001Q1)	November 2001 (2001Q4)	8	120	128	128
December 2007 (2007Q4)	June 2009 (2009Q2)	18	73	91	81
February 2020 (2019Q4)	April 2020 (2020Q2)	2	128	130	146
1854-2020		17.0	41.4	58.4	59.2
1854-1919		21.6	26.6	48.2	48.9
1919-1945		18.2	35.0	53.2	53.0
1945-2020		10.3	64.2	74.5	75.0

FYI - Other Regulatory Frameworks

- Countercyclical equity return assumptions are common in other accounting frameworks
  - A common practice in existing US GAAP insurance accounting models (e.g., FAS 97 UL deferred acquisition costs, SOP 03-1 reserves for GMDBs and life secondary guarantees) is to assume equity mean reversion, with lower recent returns followed by higher future projected returns (and vice versa).
    - E.g., Equity returns over the past M years and next N years (combined) are consistent with long-term averages. (Lookback and lookforward periods are often 4-5 years.)

- However, OSFI does not allow equity mean reversion for Canadian reserves.
  - From https://www.osfi-bsif.gc.ca/Eng/fi-if/rg-ro/gdn-ort/pp-do/Pages/mnrv.aspx

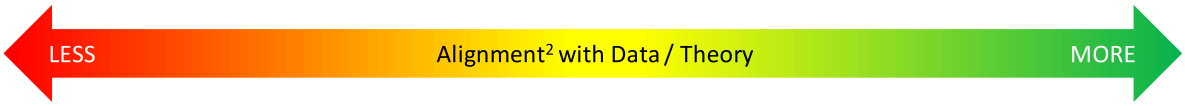
    "The claim that equity returns revert to the mean over the long term is not completely unfounded, and cannot be dismissed out of hand. However, there is at least as much evidence to refute this claim as there is to support it, and there is certainly no consensus answer within the economics profession. OSFI must therefore rely on its own judgement as to whether to accept mean reversion assumptions in modeling segregated funds.

    …

    Given the large reduction in segregated fund guarantee reserve and capital requirements that would result from assuming mean reversion in equity returns, it would not be prudent for OSFI to approve equity return models that are based on the assumption of mean reversion without strong evidence that mean reversion actually occurs in the market and is likely to continue in the future. The current state of research does not provide such evidence to a sufficiently high degree of certainty."

Potential Equity Risk Premium (ERP) Modeling Options

- Expected equity returns may be expressed and modeled as E[Return][1] = Interest Rate (IR) + Equity Risk Premium (ERP)
  - Scenario properties depend on the expected return and selected Equity Risk Premium model
  - Different simplifications will have different tradeoffs



Options 0 & 3	**Option 2**	[Option 1.5]	**Option 4**	**Option 1**
Constant Mean ERP	**Stylized Inverse ERP**	Fitted Inverse ERP	**Regime Switching Hybrid of Simple ERP Models**	**Enhanced ERP Model based on Economic Factors**
ERP = Constant	ERP = Constant – IR	ERP = Const - Factor * IR	(from left)	
E[Return][1] increases as IR increases and vice versa	E[Return][1] = Constant	E[Return][1] decreases as IR increases and vice versa		

We recommend simpler, practical approaches that improve alignment with data / theory.

ERP models that are inconsistent with data/theory are inappropriate for statutory reserves/capital and will not promote sound risk management while building an enhanced ERP model based on economic factors may be time consuming and difficult.

[1] Expected return typically closely aligns with average return in generated scenarios, but tail scenarios can be influenced by shifts in expected return and/or volatility
[2] Illustrates relative relationship only. Not drawn to scale.

Option 0: Constant Mean ERP

- Assume that the equity risk premium has a constant mean in every projection period (i.e., is independent from any economic factors)

Pros

- Out-of-the-box GEMS functionality for calibrating and generating scenarios
- Simplified approach may be adequate for analysis that focuses on the center of the distribution and assets / liability that are not path dependent. [Not applicable for Life and Annuity statutory reserves and capital]
- Facilitates the generation of nested risk neutral scenarios. [However, this functionality will not be used by the NAIC.]

Cons

- Counterintuitive relationships in projected equity returns (e.g., short term fluctuations in interest rates would change expected equity returns 10 to 20+ years in the future)
- Equity returns that are inconsistent with historical and/or theoretical dynamics in projected tail scenarios and/or as actual rates move (i.e. distribution can shift up/down as low rates → low expected equity returns, high rates → high expected equity returns)
- Would require more frequent recalibration to maintain reasonable central distribution properties. (See Option 3)
- Potential artificial volatility from reporting period to reporting period. (Reserves and capital may swing from being overly conservative to overly aggressive)
- Counterintuitive results (e.g., reserves for an equity only product with no investment in short term assets may change materially as overnight rates move and force companies to consider hedging an ESG modeling simplification instead of inherent product risk)
- Near-term return relationships between asset classes may be inconsistent with history (e.g., high equity / high money market returns, low equity / low money market returns)

Option 1: Enhanced ERP Model

- Develop and implement a more sophisticated ERP model that captures the most significant ERP dynamics by explicitly reflecting dependencies on market and macroeconomic factors

Pros

- Most theoretically sound option
- Captures historical and conceptual dynamics that may be material in tail scenarios and path dependent liabilities (i.e., ERPs can fluctuate in response to changes in interest rates / other factors)

Cons

- Developing an appropriate theoretical ERP model may be time consuming and difficult
- Will require structural changes to GEMS to generate the equity scenarios
- Will require changes in Conning's internal calibration tools / methodologies

Option 2: Simple ERP Model (Stylized Inverse Relationship)

- Special case of Option 1 that assumes that the expected ERP is a Constant - Interest Rate
  - Stylistic simplification that tries to recognize that the ERP has both constant and non-constant components
  - Equivalent to assuming a constant mean equity return that is independent of rates
- May include a check during each *full* calibration that steady state interest rates and long-term equity returns have a reasonable relationship. (Would be implemented via the selection of parameters at calibration (not dynamically along projected scenarios) and should not require changes in the GEMS model structure)

Pros

- Recognizes a key observed dynamic of equity risk premiums (i.e., they tend to contract in high rate environments and expand in low rate environments) while also allowing for a relationship between long-term rate levels and long-term equity returns
- Very simple and familiar approach [Simplifies down to an AIRG-type structure]
- Does not require structural changes to GEMS to *generate* the equity scenarios

Cons

- The simplification may understate the strength of the historical ERP relationships and their implications in tail scenarios (i.e., be conservative when rates are low) or omit other dynamics
- May require changes in Conning's internal calibration tools

Option 3: Calibration Partial Workaround

- Special case of Option 0: Assumes that the equity risk premium has a constant mean but **changes / recalibrates the equity model parameters** every reporting period as a partial workaround
  - Recalibration mitigates some of the impact of using a simplified constant mean ERP model. (Analogous to changing base surrender rates (= constant ERP) in every period as a workaround to try to make up for not having a dynamic assumption (= dynamic ERP))

Pros

- Out-of-the-box GEMS functionality
- Mitigates some of the counterintuitive impacts from changes initial market conditions

Cons

- Governance and operational challenges to change parameters every month and deliver scenarios on the first day of the month. (Could try to approximate adjustments to the equity model parameters formulaically?)
- Mitigates but does not eliminate potential artificial volatility from reporting period to reporting period and counterintuitive relationships. Adjustments may only address averages / wealth factors at one (or a limited number of) target time horizons – leaving potential artificial volatility (risk of overly aggressive or conservative results) and unintuitive results for products with path dependency (e.g., variability annuities with guarantees) or longer or shorter time horizons than the targeted horizon
- Does not address tail behavior / relationships within the projection. (Still assumes low rates → low expected equities, high rates → high expected equities. Recalibration primarily "recenters" the distribution as initial conditions change without addressing limitations in projected tail dynamics)

Option 4: Hybrid of Simple ERP Models

- Develop an ERP model from a hybrid of simple ERP models
  - Variation 1: Create subsets of scenarios from each of the simple ERP models (e.g., M scenarios from the constant mean ERP, N scenarios with a Constant - Interest Rate ERP, P scenarios with a Constant - Factor * Interest Rate ERP, etc.)
  - Variation 2: Create a regime switching ERP model that switches between the simple ERP models

Pros

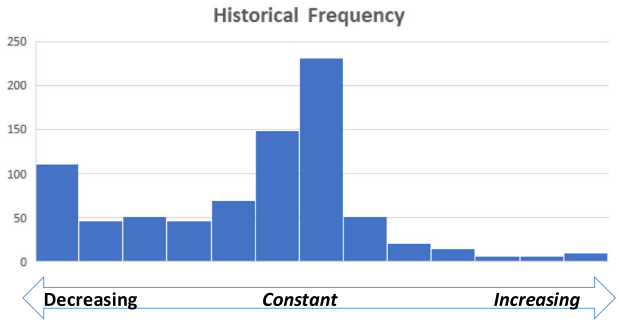
- Recognizes the uncertainty and complexity of ERP relationships by allowing for multiple types of dynamics
  - Historical data may be consistent with a regime switching approach (vs. assuming one ERP model governs forever in a scenario)
- Avoids more difficult theoretical ERP models

Cons

- Need to fit a regime switching model or develop an assumption for weighting the scenarios from the different ERP models
- Will require structural GEMS and/or process changes to generate the equity scenarios. (However, likely to be less extensive than Option 1)
- Will require changes in Conning's internal calibration tools / methodologies
- Variation 1 may require additional testing or analysis to check for a reasonable full distribution, scenario selections, and/or SERT scenarios

Historical Data Suggests ERPs Are More Likely a *Decreasing* Function of Short Rates

- Consider a regime-switching model that incorporates three simplified models of expected equity return
  1. Increasing Return or Constant ERP: *Expected Return = IR + Constant ERP*
  2. Constant Return: *Expected Return = Constant*, or *Expected Return = IR + (Constant - IR)*
  3. Decreasing Return: *Expected Return = Constant - IR*, or *Expected Return = IR + (Constant - 2 x IR)*
- Fitting this model to monthly S&P price index returns from 4/1953 to 12/2020 indicates a greater likelihood and statistical support for regimes 2 and 3 throughout history
- Compared to any basic or regime switching model that includes a *Constant Return (i.e., Stylized Inverse ERP)* approach, using an *Increasing Return (i.e., Constant ERP)* model reduces the ability to explain historical equity returns.



Historical Frequency	
Increasing Return	8%
Constant Return	63%
Decreasing Return	28%