ACLI Alternative Interest Rate/Equity Soft Linkage Proposal

Executive Summary

- Regulators want to ensure that the scenarios reflect robust probability and severity of low for long rates combined with low equity returns.

- However, the current equity return linkage approach is overly complex and results in significant non-economic volatility.

- Further, historical data suggested there is no clear durable relationship between interest rates and returns.

- ACLI believes the constant expected equity return relationship implemented in Run 6 and current generator is a more practical and supportable simplification of multifaceted interactions between asset classes that achieves the regulators goals around low for long.

Recommendation

ACLI recommends reflecting positive correlation between rate/equity movements as means of achieving regulators' desired low rate/low equity tails (see appendix I & II) and joint criteria is based on the ranges determined by a reference model with and without the correlation (see appendix III & IV).

Tail Gross Wealth Factor (GWF) Targets	10 Years	30 Years
Low Rates / Low Equity Quadrant[1]	0.82 – 0.89	1.88 – 2.18
High Rates / Low Equity Quadrant[1]	0.89 – 1.04	2.18 – 2.79

[1]: Quadrant is defined in page 10/11 under appendix III

Benefits of Correlation Approach

- This approach has several advantages over current structural equity linkage:

    - Ease of implementation:
        - Equity model can be calibrated separately to ensure reasonable overall distribution
        - Correlation between rate level and equity return ensures robust risks in the tail quadrants
        - No need to centralize or adjust the equity distribution as starting conditions change
        - Straightforward methodology for DR/SERT scenarios
        - We do not believe any structural change to GEMS is needed

    - Robust representation of equity risk in both low and high-rate scenarios

    - Incentivizes hedging of both equity and rate risk drivers

    - Avoids excess capital volatility due to rate fluctuations

    - Positive correlation emulates partial linkage in the tail quadrants of the distribution and address some undesirable effects under structure equity linkage (see detail in next slide)

Field Test Scenarios Evaluated Against Quadrant CTE90 GWF

Average Tail GWFs: 10 years

	1a	2a	6	6a	ACLI	ACLI +20% Corr.	Target Range
Low Rates	0.80	0.80	0.89	0.87	0.93	0.82	**0.82 - 0.89**
High Rates	1.10	1.36	0.86	0.87	0.90	1.04	**0.89 - 1.04**
All Rates	0.84	0.91	0.88	0.88	0.89	0.89	

Average Tail GWFs: 30 years

	1a	2a	6	6a	ACLI	ACLI +20% Corr.	Target Range
Low Rates	1.47	1.21	2.42	2.34	2.38	1.88	**1.88 - 2.18**
High Rates	5.78	7.70	2.12	2.13	2.18	2.79	**2.18 - 2.79**
All Rates	2.01	1.85	2.21	2.21	2.18	2.18	

Geometric Average UST20 over 10 years

	1a	2a	6	6a	ACLI	ACLI +20% Corr.
Low Rates	1.1%	2.2%	1.1%	2.2%	1.3%	1.3%
High Rates	4.8%	7.4%	4.8%	7.4%	4.9%	4.9%

Geometric Average UST20 over 30 years

	1a	2a	6	6a	ACLI	ACLI +20% Corr.
Low Rates	1.5%	2.1%	1.5%	2.1%	1.7%	1.7%
High Rates	6.5%	8.4%	6.5%	8.4%	6.8%	6.8%

Implied Linkage in the Distribution

	1a	2a	6	6a	ACLI	ACLI +20% Corr.
10 years	88%	104%	-9%	-1%	-8%	68%
30 years	90%	97%	-9%	-5%	-6%	26%

🟨 = GWFs outside of target range but deviation not expected to be material

🟥 = GWFs outside of target range by amount that is likely to be material

- The table provides the average of bottom decile of the equity GWF under top/bottom decile of the rates over 10/30 years for the field test scenarios (see page 10/11 in appendix III for the joint quadrant definition)

- Linkage in 1a and 2a introduces undesirable effects in quadrants of the distribution (see highlighted in red):
  - Understates risk of low equity return when rates are high (e.g., Extremely favorable tail equity returns in High-Rate scenarios, averaging 6-7% per year over 30 years and positive vs. negative average return over 10 years)
  - More severe equity tail Low Rates in 2a vs. 1a although rates start 2.3% higher
  - Overly severe cumulative effect of linkage over 30 years in Low-Rate scenarios

- ACLI proposal reflects implied positive linkage (=26% over 30 years), which addresses regulators' concern on the severity of low rate combined with low equity return and mitigates the undesirable effect of the distribution through the structural equity linkage.

26% = change in equity return / change in rates
= (ln(2.79/1.88)/30) / (6.8% - 1.7%)

Note that (1) Run 1a, 6, and ACLI start at UST20 = 1.94%, (2) Run 2a and 6a start at UST20 = 4.24%, (3) Run 1a and 2a embed positive linkage and subject to centralization adjustment to reflect current rates, and (4) Run 6 and ACLI embed neutral linkage and don't need to be adjusted for starting rate levels

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Appendix

Appendix I -- Robust Low Rate/ Low Equity using Correlation

- Positive correlation ties the distribution of rate changes and equity returns to ensure a greater portion of adverse equity outcomes occurs when underlying rates tend to be lower

- Correlation directly impacts incremental (e.g. monthly) joint equity/rate return and affects long term/cumulative outcomes in the tail scenarios, while preserving the severity in the middle of the distribution

- Correlation preserves the underlying distribution of rates and equity when considered in isolation but impact the joint tail of the distribution where the specific concerns have been raised. This approach enables greater variety of interest rate and equity interactions by allowing stochastic drivers in each respective model to have more influence on the joint distribution

- Correlation coefficient of 15-20% can be historically supported, as realized correlation of monthly changes in UST20 rates vs. S&P return is ~+19% from 2000 to 2022.

Appendix I -- Robust Low Rate/ Low Equity using Correlation

- Correlating Rates and Equity in GEMS:

  - Introduce a positive correlation coefficient between the random driver of the CIR factor responsible for the level of rates and the random driver of equity return diffusion that is multiplied by stochastic volatility of the equity process (see appendix II)

  - No structural model changes are required

  - Rates and Equity parameters can be set independently and rely on existing calibrations.

  - Equity calibration reflective of neutral linkage was already introduced in support of Scenario 6 of the Field Test and can serve as the basis/starting point.

- Scenario quadrants to be evaluated against criteria/joint distribution statistics on slide 5

Appendix II -- Correlation Effect on Incremental Equity Return

Correlation	20%			
Rate Volatility	0.8%			
Equity Volatility	15%			
Rate Down/ Equity Down				
	Uncorrelated Normal Deviate	Correlated Deviate	Uncorrelated Return	Correlated Return
Rates	-1.00	-1.00	-0.008	-0.008
Equity	-1.00	-1.18	-0.150	-0.177
Rate Up/ Equity Down				
	Uncorrelated Normal Deviate	Correlated Deviate	Uncorrelated Return	Correlated Return
Rates	1.00	1.00	0.008	0.008
Equity	-1.00	-0.78	-0.150	-0.117

$= 20\% * \text{-}1 + \sqrt{1 - 20\%^2} * \text{-}1$

Correlation-affected equity deviate is: $\hat{Z}_{eq} = \rho Z_{ir} + \sqrt{1 - \rho^2} Z_{eq}$ where:
ρ is the correlation coefficient and Z_{ir} and Z_{eq} are uncorrelated standard normal deviates

Appendix III -- Evaluating Correlation Effect in ACLI/AIRG Model

- +20% Correlation is introduced between the process that generates the Long Rate (UST20) and equity return process that uses the original AIRG SLV model. Resulting quadrant statistics are compared relative to baseline 0% correlation assumption.

- Quadrant Statistics using generated 10k monthly scenarios:

  - Separately consider 10 year and 30 year time horizon

  - Defining the tail Low-for-Long and High-for-Long rates – consistent with exposed Rate criteria
    - Uses Geometric Average (GAVG) of UST20 rate over 10 and 30 year time horizon
    - **Low for Long Rates**: Sample the bottom decile of the scenarios ranked by the GAVG metric to define 1,000 Low-for-Long scenarios
    - **High for Long Rates**: Sample top decile to define 1,000 High-for-Long scenarios

Appendix III -- Evaluating Correlation Effect in ACLI/AIRG Model

- Defining the Equity portion of the quadrant – low equity return over 10 and 30 years
  - **Low Rates/ Low Equity quadrant**: for L4L scenario set of 1,000, consider the bottom decile of the GWF (gross wealth factor) , to sample 100 scenarios representative of low equity and low rates.
  - **High Rates/ Low Equity quadrant**: for L4L scenario set of 1,000, consider the bottom decile of the GWF (gross wealth factor) , to sample 100 scenarios representative of low equity and low rates

- Take the average of the 100 GWFs representative of a "CTE 90" severity of the equity distribution in both quadrants.

Appendix IV -- Evaluating Correlation Effect in ACLI/AIRG Model: Results

Average GAVG Rates (bottom and top decile)

	Low rates	High Rates
10yr	1.3%	4.9%
30yr	1.7%	6.8%

Average GWF (bottom decile): 20% Correlation

	Low rates	High Rates	All 10k
10yr	0.82	1.04	0.89
30yr	1.88	2.79	2.18

Average GWF (bottom decile): No Correlation (AIRG)

	Low rates	High Rates	All 10k
10yr	0.93	0.90	0.89
30yr	2.38	2.18	2.18

Implied Linkage Calc

	return diff	GAVG rate diff	implied linkage
10yr	2.4%	3.5%	68%
30yr	1.3%	5.1%	26%

- Scenarios were generated using 12/31/2021 rates (UST20 = 1.94%) as a starting point.

- Example: Low Rates/Low Equity quadrant over 30 years:
  - **Average UST20** = 1.7%
  - Average GWF = 1.88 if correlated vs. 2.18 assuming 0 correlation in base AIRG

- Example: High Rates/Low Equity quadrant over 30 years:
  - Average UST20 = 6.8%
  - Average GWF = 2.79 if correlated vs. 2.18 assuming 0 correlation in base AIRG

- Positive correlation produces more severe equity tail in low rates and more favorable equity tail in high rates, implying a linkage-like effect in the tail.