

# **GOES Field Test #2: YE2023 Scenarios**

## Preliminary Observations / Concerns

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# Preliminary Observations

## • Interest Rates

- The Fall National Meeting (FNM) / Field Test #2 (FT2) interest rate calibration is mostly unchanged from the original field test.
  - The risk neutral parameters (a.k.a. core parameters) that drive scenario dynamics are unchanged.
  - Only the risk premium parameters (lambdas) for 2 of 3 state variables have been tweaked.
- The interest rate scenarios continue to exhibit the same issues highlighted in the original Field Test and Fall National Meeting scenario discussions\*. These include:
  - Flooring: Modeled interest rates are overridden by substantial and pervasive flooring. (E.g., 90% of scenarios are affected by flooring. In ~15% of scenarios, flooring overrides modeled rates in at least 180 of the first 360 months.)
  - Negative Rates: Frequent and severe negative rates (even after flooring) treat worse-than-history events as moderately adverse or even likely occurrences. (E.g., Nearly 15% of scenarios *in the steady state* have negative short rates. 65% of scenarios are expected to experience negative rates in the next 30 years – with 15% of scenarios experiencing negative rates for ~7+ of those years.)
  - Volatility: Short rate volatility is roughly double historical levels (and the AAA criterion) for the Low interest rate bucket which accounts for roughly 50% of the rates in the first 360 months. The short vs. long rate volatility relationship for the Low rate bucket is inconsistent with historical and theoretical expectations.
  - Spreads / Curve Shape: Severe, frequent, and persistent inversions are inconsistent with historical data and theoretical relationships. (E.g., -13.4% spread, inversions that are 3x larger than the worst-in-history, 25% to 50% of inversions exceeding worst-than-history levels, elevated inversion frequencies for 10-20 years, rates remaining inverted for 360 months.)
  - High Rates: Although relatively rare, rates in some scenarios skyrocket to levels that are double historical US maximums (and exceed levels seen in foreign crises).

\* Links to examples of prior discussions:

- [Oct. 31, 2022 CID Appointed Actuary Symposium ESG Update slides](#) posted on the GOES SharePoint site
- Feb. 6, 2024 posts in the [GOES SharePoint Treasury Model Flooring Discussion thread](#)

# Preliminary Observations (continued)

## • Equities

- Extreme left tail GWFs for Large Cap US (S&P 500) equities are materially more severe than AAA criteria for key time horizons.
- Indices other than Large Cap US (S&P 500) may need further review and/or refinement.
  - Extreme tail returns for Emerging Markets (and, to a lesser extent, NASDAQ and Aggressive equities)
  - Unintuitive risk/reward relationship between Mid Cap (and, to a lesser extent, some other indices) and Large Cap equities
    - Mid Cap equities have higher expected returns and upside potential but similar downside risk than Large Cap equities.
    - Note: Unlike other metrics (e.g., Sortino ratio), the Sharpe ratio measures returns relative to total volatility and not downside volatility. This may allow unintuitive risk/reward relationships if returns are not normally distributed (e.g., more skew or kurtosis).

## • Corporate Credit

- Insufficient information to understand and assess the model, calibration, crude (but substantial) overlays / overrides of modeled spreads and excess returns, and the resulting scenarios
- Dynamics seem less unintuitive than the YE2022 scenario statistics (as well as the statistics for other market environments) shared on the Jan. 25, 2024 GOES call\*. However, it's unclear how/which initial conditions changed, how they were set, and how they drove the observed differences.
- Scenarios may be assuming the already narrow investment grade spreads for short- and intermediate-term bonds continue to narrow in the near-term (instead of beginning to mean revert), and credit spreads may be mean reverting more slowly than historical data, existing VM-20 guidance, and the AAA's recommended criteria.
- Extreme right tail excess returns for the High Yield bond fund seem rather high (e.g., over 10% annually for 20 years).

\* Links to prior questions about the Jan. 25 GEMS-based Corporate Model distributions:

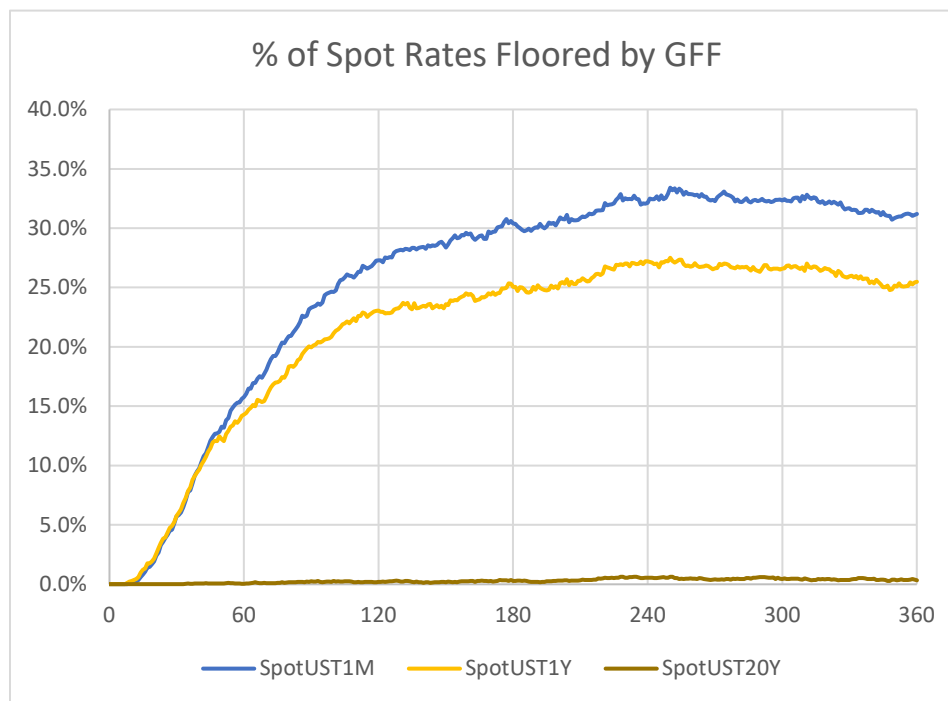
- [GOES SharePoint Corporate Model GEMS / AAA Comparisons thread](#)
- [GOES SharePoint Corporate Model Fall National Meeting Corporate Calibration thread](#)

# Interest Rates: Flooring

- Flooring continues to be substantial in both frequency and magnitude (even with initial rates well above the flooring threshold) – overriding a significant portion of modeled rates and rate relationships.
  - Unfloored spot rates produced by the NAIC GEMS calibration are as low as **-7.4%**.
  - Looking across scenarios (graph), 25% to 30% of shorter maturity rates are floored even in (roughly) the steady state.
  - From a pathwise perspective (first 30 years): Almost **90%** of scenarios are affected by flooring. In **~1/3** of scenarios, rates are floored for at least 120 months, and in **~15%** of scenarios, rates are floored for at least 180 months. One scenario is floored for **29** years.
    - If low rate scenarios are the adverse scenarios, reserve or capital results may be largely dependent on the arbitrary flooring function and parameters.

Minimum Rate (First 360 Months)

	1M Spot	1Y Spot	20Y Spot
Unfloored	-7.4%	-6.2%	-0.6%
Floored	-1.2%	-0.9%	0.2%



% of Scenarios with Floored Rates (First 360 Months)

# of Floored Months	1M Spot	1Y Spot	20Y Spot
> 0 months	89%	85%	8%
> 6 months	83%	78%	4%
> 12 months	80%	74%	3%
> 24 months	73%	66%	1%
> 36 months	68%	60%	1%
> 48 months	62%	54%	0%
> 60 months	57%	48%	0%
> 120 months	33%	26%	0%
> 180 months	16%	11%	0%
> 240 months	5%	4%	0%
> 300 months	1%	1%	0%
> 360 months	0%	0%	0%

Max # of Floored Months	348	339	95
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# Interest Rates: Negative Rates

- Negative rates occur frequently – with worse-than-history events becoming moderately adverse (or even likely) events.
  - Looking across scenarios (graph), roughly 10% to 15% of short maturity rates are negative even as rates approach steady state levels. (Not in a low rate environment.)
  - From a pathwise perspective (first 30 years): Almost  $\frac{2}{3}$  of scenarios experience negative rates. In  $\sim 15\%$  of scenarios, rates are negative for  $\sim 7+$  more years. (One scenario has negative rates for over 26 years.)

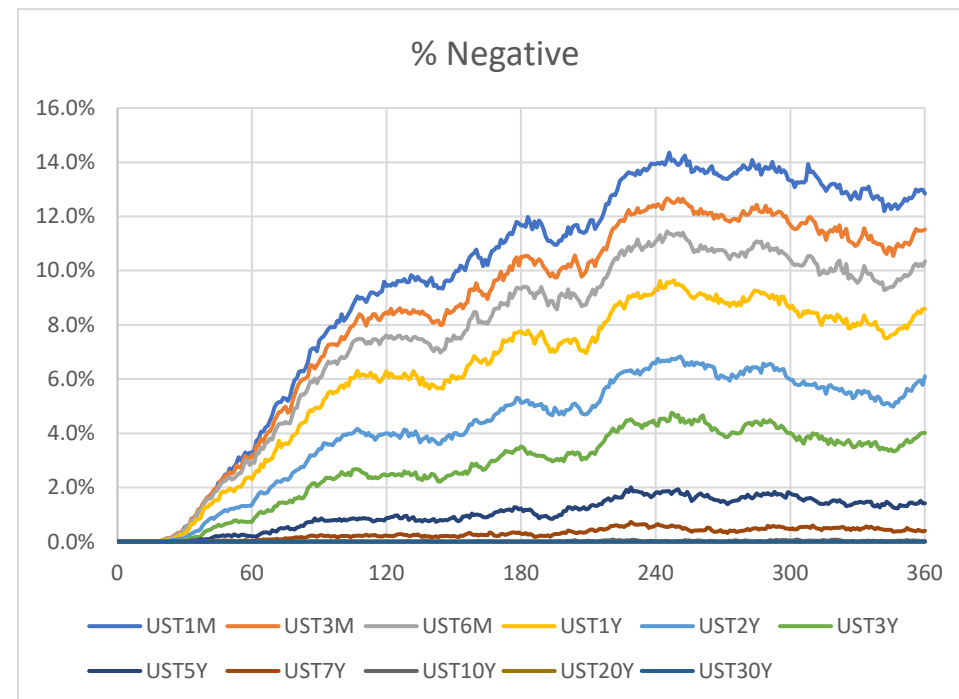
## In the First 360 Months:

### % of Scenarios with Negative Rates

# of Neg Months	UST1M	UST3M	UST6M	UST1Y	UST2Y	UST3Y	UST5Y	UST7Y	UST10Y	UST20Y	UST30Y
> 0 months	65%	61%	58%	53%	44%	34%	18%	8%	1%	0%	0%
> 12 months	48%	45%	41%	36%	27%	20%	9%	3%	0%	0%	0%
> 24 months	40%	36%	33%	28%	20%	14%	5%	1%	0%	0%	0%
> 36 months	32%	29%	27%	22%	15%	10%	3%	1%	0%	0%	0%
> 48 months	27%	24%	21%	17%	11%	7%	2%	0%	0%	0%	0%
> 60 months	22%	19%	17%	13%	8%	5%	1%	0%	0%	0%	0%
> 120 months	7%	6%	5%	4%	2%	1%	0%	0%	0%	0%	0%
> 180 months	2%	2%	1%	1%	0%	0%	0%	0%	0%	0%	0%
> 240 months	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

### # of Negative Months

%-tile	UST1M	UST3M	UST6M	UST1Y	UST2Y	UST3Y	UST5Y	UST7Y	UST10Y	UST20Y	UST30Y
Min	0	0	0	0	0	0	0	0	0	0	0
50%	10	7	5	2	0	0	0	0	0	0	0
75%	53	46	40	30	16	6	0	0	0	0	0
85%	83	74	66	55	37	21	2	0	0	0	0
90%	106	96	88	75	53	35	9	0	0	0	0
Max	320	315	299	287	263	231	173	124	42	0	0



# Interest Rates: 1Y UST Volatility

- **Low Rate Bucket:** Volatility in the scenario set is **roughly double** the AAA criterion despite extremely low volatility at ultra-low rate levels (due to the Generalized Fractional Floor factor).
  - Note: ~40% of rates in the first 10 years and ~50% of rates in the first 30 years fall in the Low Rate bucket, so overstated volatility affects a significant portion of the scenario set.
- **Medium Rate Bucket:** Volatility in the scenario set is roughly **50% higher** than the AAA criterion.
  - Bucket averages reflect different underlying rate distributions. Using more granular buckets to better control for rate distribution differences reveals that for rate levels between 3% and 6%, scenario set volatility continues to be **nearly double** historical levels.
- **High Rate Bucket:** Volatility in the scenario set is roughly **30% lower** than the AAA criterion.
  - However, volatilities remain **relatively aligned** with historical levels for rate levels between 8% and 11%.
  - Note: Less than 10% of rates in the first 30 years fall in the High bucket, and only about 2% of rates in the first 30 years exceed 11%.

## UST1Y Vols by Rate Bucket

	<=0%	(0%, 0.4%]	(0.4%, 1%]	(1%, 2%]	(2%, 3%]	(3%, 4%]	(4%, 5%]	(5%, 6%]	(6%, 7%]	(7%, 8%]	(8%, 9%]	(9%, 10%]	(10%, 11%]	(11%, 12%]	(12%, 25%]	>25%
Initial (First 120 months)	0.2%	0.5%	1.2%	1.5%	1.6%	1.7%	1.8%	1.9%	2.0%	2.1%	2.1%	2.2%	2.3%	2.4%	2.5%	N/A
"SS" (Months 480-720)	0.2%	0.5%	1.2%	1.5%	1.6%	1.7%	1.8%	1.9%	1.9%	2.0%	2.1%	2.2%	2.3%	2.3%	2.5%	3.3%

	<=0%	(0%, 1%]	(1%, 2%]	(2%, 3%]	(3%, 4%]	(4%, 5%]	(5%, 6%]	(6%, 7%]	(7%, 8%]	(8%, 9%]	(9%, 10%]	(10%, 11%]	(11%, 12%]	(12%, 25%]	>25%
Initial (First 120 months)	0.2%	0.8%	1.5%	1.6%	1.7%	1.8%	1.9%	2.0%	2.1%	2.1%	2.2%	2.3%	2.4%	2.5%	N/A
"SS" (Months 480-720)	0.2%	0.8%	1.5%	1.6%	1.7%	1.8%	1.9%	1.9%	2.0%	2.1%	2.2%	2.3%	2.3%	2.5%	3.3%

	<=3%	(3%, 8%]	>8%
Initial (First 120 months)	1.3%	1.8%	2.2%
"SS" (Months 480-720)	1.1%	1.8%	2.3%

## For Reference:

	<=3%	(3%, 8%]	>8%
AAA Criteria	0.6%	1.2%	3.3%

	<=0%	(0%, 1%]	(1%, 2%]	(2%, 3%]	(3%, 4%]	(4%, 5%]	(5%, 6%]	(6%, 7%]	(7%, 8%]	(8%, 9%]	(9%, 10%]	(10%, 11%]	(11%, 12%]	(12%, 25%]	>25%
Historical	N/A	0.4%	0.8%	0.8%	0.9%	1.1%	1.0%	1.4%	1.7%	1.8%	2.2%	2.5%	4.1%	5.5%	N/A

# Interest Rates: Short vs. Long Rate Volatility

- A key characteristic of low-rate environments is a decrease in short rate volatilities.
  - In the AAA criteria and historical data, 1Y and 20Y volatilities in the Low Rate bucket and for rates between 0% and 4% are relatively similar.
  - However, in the scenario set, 1Y vols are 60% higher than 20Y vols for the Low Bucket and more than double in some of the more granular buckets.

## 1Y vs. 20Y UST Vols by Rate Bucket

"SS" (Months 480-720)	<=3%	(3%, 8%]	>8%
1Y UST	1.1%	1.8%	2.3%
20Y UST	0.7%	1.1%	1.7%

"SS" (Months 480-720)	<=0%	(0%, 1%]	(1%, 2%]	(2%, 3%]	(3%, 4%]	(4%, 5%]	(5%, 6%]	(6%, 7%]	(7%, 8%]	(8%, 9%]	(9%, 10%]	(10%, 11%]	(11%, 12%]	(12%, 25%]	>25%
1Y UST	0.2%	0.8%	1.5%	1.6%	1.7%	1.8%	1.9%	2.0%	2.1%	2.1%	2.2%	2.3%	2.4%	2.5%	N/A
20Y UST	N/A	0.5%	0.6%	0.8%	0.9%	1.0%	1.2%	1.3%	1.4%	1.5%	1.6%	1.7%	1.8%	2.0%	3.1%

## For Reference:

AAA Criteria	<=3%	(3%, 8%]	>8%
1Y UST	0.6%	1.2%	3.3%
20Y UST	0.6%	0.7%	1.6%

Historical	<=0%	(0%, 1%]	(1%, 2%]	(2%, 3%]	(3%, 4%]	(4%, 5%]	(5%, 6%]	(6%, 7%]	(7%, 8%]	(8%, 9%]	(9%, 10%]	(10%, 11%]	(11%, 12%]	(12%, 25%]	>25%
1Y UST	N/A	0.4%	0.8%	0.8%	0.9%	1.1%	1.0%	1.4%	1.7%	1.8%	2.2%	2.5%	4.1%	5.5%	N/A
20Y UST	N/A	0.4%	0.8%	0.7%	0.8%	0.8%	0.8%	0.9%	1.1%	1.0%	1.6%	1.6%	2.2%	2.6%	N/A

- [Note: Interest rate volatility may affect the cost of product guarantees, and both short and long rate volatilities (and the relationship between them) may be used depending on the product and/or hedging strategy.]

# Interest Rates: Term Spreads & Inversion Severity

- The scenario set includes very severe inversions, and worse-than-history inversions are commonplace.
  - The worst inversions over the first 30 years (pathwise view) are 4 to 5 times the worst-in-history inversions. In 100% of the scenarios, the worst short rate inversions in the first 30 years exceeded the worst-in-history. For other terms, roughly 25% to 50% of the scenarios had inversions that exceeded the worst-in-history.
  - The magnitude of the inversions are similarly extreme when examined by rate buckets.
    - 20Y - 1Y inversions for the Initial Period (= first 120 months) are shown on page 9 (but dynamics are similar for the distribution of “steady state” inversions and for other spreads).

**For Scenarios with Inversions (in First 360 Months) - Distribution of Worst Inversions**

%-tile	2Y - 1M	10Y - 2Y	30Y - 10Y	20Y - 1Y
0%	-5.8%	-8.0%	-5.0%	-13.4%
25%	-2.0%	-2.0%	-1.2%	-3.3%
50%	-1.8%	-1.4%	-0.9%	-2.3%
75%	-1.6%	-0.9%	-0.5%	-1.4%
100%	-1.5%	-0.3%	0.0%	-0.6%

<b>Historical Worst</b>	-1.4%	-2.0%	-0.9%	-3.4%
<b>Scen Worst / Hist Worst</b>	4.2x	4.0x	5.3x	4.0x



# Interest Rates: Term Spreads & Inversion Severity by Rate Bucket

## Distribution of Inverted 20Y - 1Y Spreads

Initial Period = First 120 Months

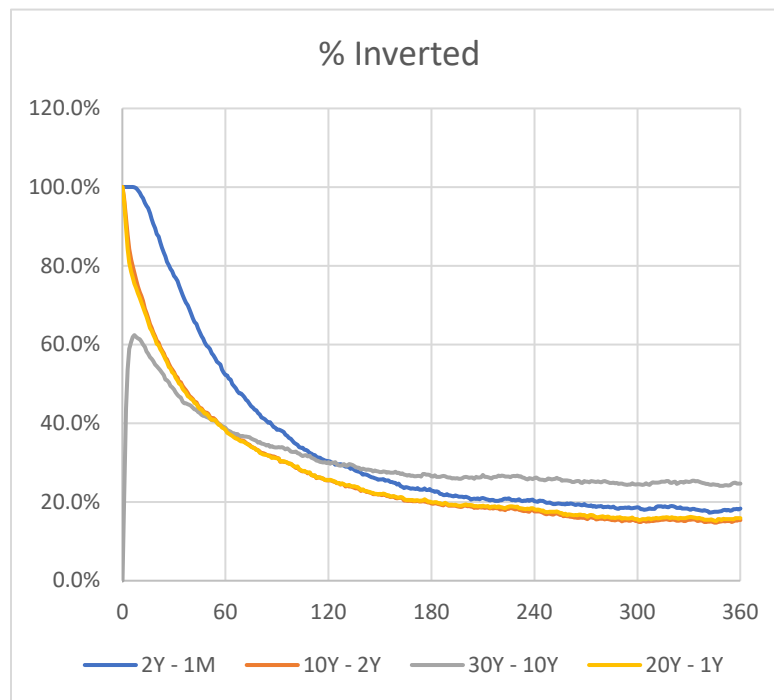
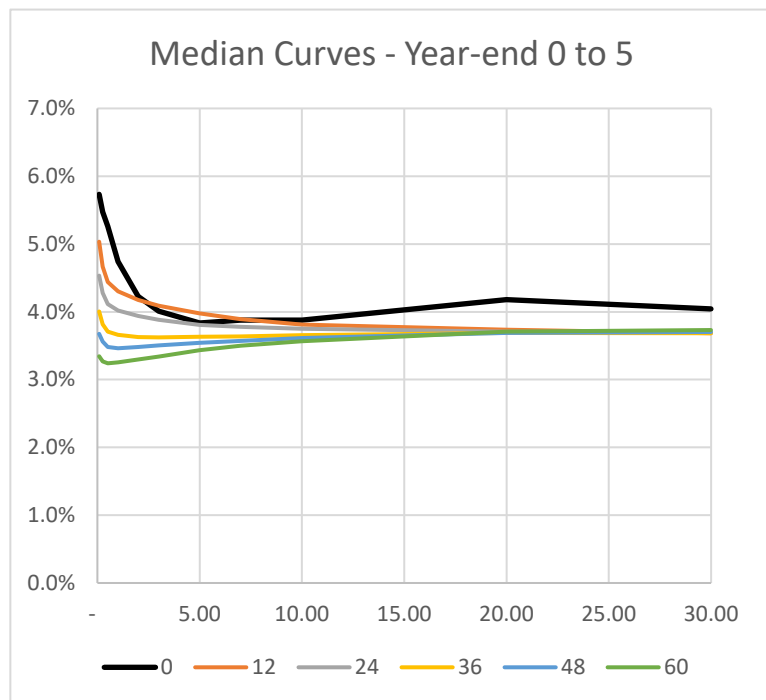
20Y Rate -->	[0%,1%)	[1%,2%)	[2%,3%)	[3%,4%)	[4%,5%)	[5%,6%)	[6%,7%)	[7%,8%)	[8%,9%)	[9%,10%)	>=10%	All
0%		-1.9%	-4.0%	-6.1%	-7.0%	-8.0%	-8.8%	-9.3%	-9.7%	-10.8%	-9.2%	-10.8%
1%		-1.3%	-2.5%	-3.3%	-4.0%	-5.1%	-5.8%	-6.3%	-6.8%	-6.9%	-8.0%	-4.9%
5%		-1.0%	-1.8%	-2.4%	-3.0%	-3.8%	-4.4%	-4.9%	-5.3%	-5.5%	-6.1%	-3.4%
15%		-0.7%	-1.3%	-1.7%	-2.2%	-2.8%	-3.3%	-3.7%	-4.0%	-4.2%	-4.5%	-2.3%
25%		-0.5%	-1.0%	-1.3%	-1.7%	-2.3%	-2.7%	-2.9%	-3.3%	-3.5%	-3.5%	-1.8%
50%		-0.3%	-0.6%	-0.7%	-1.0%	-1.4%	-1.7%	-1.8%	-2.0%	-2.2%	-2.1%	-1.0%
75%		-0.1%	-0.2%	-0.4%	-0.5%	-0.7%	-0.8%	-0.9%	-1.0%	-1.1%	-1.1%	-0.5%
85%		-0.1%	-0.1%	-0.2%	-0.3%	-0.4%	-0.5%	-0.5%	-0.6%	-0.7%	-0.7%	-0.3%
95%		0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.1%
99%		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%
100%		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>Historical Worst</b>		N/A	N/A	-1.0%	-1.3%	-0.8%	-1.4%	-1.2%	-1.6%	-1.5%	-3.4%	-3.4%
<b>Historical Median</b>		N/A	N/A	-0.2%	-0.3%	-0.2%	-0.4%	-0.5%	-0.6%	-1.1%	-1.4%	-0.4%
<b>Scen / Hist Worst</b>		N/A	N/A	6.1x	5.2x	9.8x	6.4x	7.5x	6.2x	7.3x	2.7x	3.2x
<b>Scen / Hist Median</b>		N/A	N/A	4.5x	3.8x	3.6x	3.5x	3.5x	3.4x	3.1x	3.7x	4.9x
<b>Bucket Information:</b>	[0%,1%)	[1%,2%)	[2%,3%)	[3%,4%)	[4%,5%)	[5%,6%)	[6%,7%)	[7%,8%)	[8%,9%)	[9%,10%)	>=10%	All
# Scen-Months	11,513	91,671	235,208	346,195	268,029	131,705	62,989	28,825	13,423	6,020	4,422	1,200,000
# Inversions	-	2,136	42,621	152,039	160,498	81,530	42,142	20,336	9,984	4,689	3,532	519,507
Avg Rate (20Y UST)	0.7%	1.6%	2.6%	3.5%	4.4%	5.4%	6.4%	7.4%	8.4%	9.4%	11.1%	3.9%

Roughly 25% to 50%+ of the inversions in the scenario set are worse than the worst-in-history inversions.

The worst and median inversions in the scenarios are *multiples* of historical values.

# Interest Rates: Inversion Frequency & Persistency

- Inversions are typically episodic and not persistent trends (see background information in the Appendix – page 19). In contrast, inversions in the scenario set seem frequent and persistent.
  - The median curve remains inverted for the first 5 years, and looking across scenarios, the % of scenarios with inversions remains elevated for the first ~10 years.
  - In ~15% to 20% scenarios, rates are inverted for 180+ of the first 360 months.
  - One scenario is inverted for the entire 30 year period.



First 360 Months (including t = 0)

% of Scenarios with Inversions

	2Y - 1M	10Y - 2Y	30Y - 10Y	20Y - 1Y
> 0 months	100%	100%	99%	100%
> 12 months	100%	93%	91%	93%
> 24 months	97%	84%	85%	84%
> 36 months	93%	76%	78%	76%
> 48 months	87%	67%	72%	67%
> 60 months	80%	60%	66%	60%
> 120 months	44%	31%	40%	31%
> 180 months	20%	15%	21%	15%
> 240 months	7%	6%	10%	6%
> 300 months	2%	2%	3%	2%
> 360 months	0%	0%	0%	0%

For Scenarios with Inversions - Distribution of # of Inverted Months

%-tile	2Y - 1M	10Y - 2Y	30Y - 10Y	20Y - 1Y
Min	10	1	1	1
25%	68	37	44	37
50%	109	78	96	78
75%	163	137	166	138
Max	361	361	360	361

# Interest Rates: Inversion Frequency & Persistency

- When viewed by rate bucket (controlling for rate level differences), inversion frequencies appear to remain elevated even beyond the first 10 years due to the inversion of the initial rate curve and scenario calibration.

**% Inverted Scenario-Months for 20Y - 1Y Rates by 20Y Rate Bucket**

Period Start	Period End	[0%,1%)	[1%,2%)	[2%,3%)	[3%,4%)	[4%,5%)	[5%,6%)	[6%,7%)	[7%,8%)	[8%,9%)	[9%,10%)	>=10%	All
1	120	0%	2%	18%	44%	60%	62%	67%	71%	74%	78%	80%	43%
121	240	0%	1%	7%	16%	24%	30%	36%	40%	44%	48%	54%	21%
241	360	0%	1%	5%	11%	16%	22%	26%	31%	35%	38%	46%	16%
361	480	0%	1%	4%	10%	15%	20%	24%	27%	31%	36%	42%	15%
480	720	0%	1%	4%	9%	14%	18%	22%	26%	30%	34%	44%	15%
961	1200	0%	1%	4%	9%	14%	18%	23%	27%	31%	34%	41%	15%

Hist % by L/M/H	0%			19%					30%			
Historical %	0%	0%	0%	14%	27%	21%	19%	11%	25%	42%	32%	18%

- [Note that frequent, persistent, and severe inversions may favor shorter-term investment strategies over more matched ALM strategies even for long-duration liabilities.]

# Interest Rates: High Rates

- While relatively rare, rates in a few scenarios spike to extremely high levels within the first 360 months (e.g., roughly double historical US maximums and higher than even some crisis levels internationally).
  - May have a disproportionate impact in capital scenarios if the extreme scenario is included in the selected scenario subset and/or introduce ALM modeling or dynamic assumption challenges

Maximum Rate	UST1M	UST3M	UST6M	UST1Y	UST2Y	UST3Y	UST5Y	UST7Y	UST10Y	UST20Y	UST30Y
First 120 Months	26.9%	25.8%	24.5%	23.7%	22.4%	21.3%	19.7%	18.6%	17.6%	17.0%	16.7%
First 360 Months	37.9%	37.0%	35.3%	35.0%	34.4%	33.8%	33.0%	32.5%	31.9%	31.3%	31.1%

# Equities: Large Cap US (S&P 500) Left Tail Total Returns

- Left tail gross wealth factors (GWF) for Large Cap US equities are significantly more severe than the AAA criteria adopted by the GOES Subgroup for key percentiles (e.g., for CTE98 TAR) and time horizons (e.g., 10-, 20-, 30-years). For example:
  - The minimum 20-year GWF is ~30% of the target GWF → Cumulative 92% loss (-12% annualized) vs. 75% loss (-7% annualized) target
  - The 1%-tile 20-year GWF is ~80% of the target GWF → Cumulative 37% loss (-2% annualized) vs. cumulative 21% loss (-1% annualized)

## Gross Wealth Factors

FT #2	12	60	120	240	360	600
0.0%	0.49	0.21	0.14	0.08	0.17	0.26
1.0%	0.70	0.55	0.53	0.63	0.94	2.07
5.0%	0.82	0.79	0.88	1.29	2.03	5.50
10.0%	0.88	0.92	1.11	1.74	2.93	8.83
15.0%	0.93	1.02	1.28	2.10	3.73	12.04
50.0%	1.10	1.49	2.17	4.48	9.28	39.71
85.0%	1.26	2.03	3.40	8.62	21.02	116.05
90.0%	1.30	2.17	3.76	9.97	25.08	148.38
95.0%	1.36	2.39	4.38	12.30	32.53	207.83
99.0%	1.47	2.83	5.68	17.53	50.56	413.19
100.0%	1.82	4.29	9.32	38.28	120.07	2,292.43

AAA	12	60	120	240	360	600
0.0%	0.46	0.25	0.22	0.25	0.29	0.46
1.0%	0.70	0.58	0.60	0.79	1.15	2.82
5.0%	0.82	0.80	0.91	1.36	2.20	6.38
10.0%	0.88	0.93	1.12	1.81	3.08	9.78
15.0%	0.92	1.02	1.28	2.18	3.84	12.94
50.0%	1.09	1.48	2.15	4.47	9.23	39.98
85.0%	1.25	2.02	3.36	8.69	21.06	115.31
90.0%	1.28	2.15	3.71	10.09	25.20	147.92
95.0%	1.34	2.37	4.30	12.33	33.19	210.72
99.0%	1.45	2.82	5.64	18.18	53.74	397.23
100.0%	1.76	4.20	8.98	42.03	140.72	1,676.94

FT2/AAA	12	60	120	240	360	600
0.0%	1.08	0.87	0.64	0.29	0.57	0.57
1.0%	1.00	0.95	0.88	0.79	0.82	0.73
5.0%	1.00	1.00	0.96	0.95	0.92	0.86
10.0%	1.00	0.99	0.99	0.96	0.95	0.90
15.0%	1.00	1.00	1.00	0.96	0.97	0.93
50.0%	1.01	1.01	1.01	1.00	1.01	0.99
85.0%	1.01	1.01	1.01	0.99	1.00	1.01
90.0%	1.01	1.01	1.01	0.99	1.00	1.00
95.0%	1.01	1.01	1.02	1.00	0.98	0.99
99.0%	1.01	1.00	1.01	0.96	0.94	1.04
100.0%	1.03	1.02	1.04	0.91	0.85	1.37

## Cumulative Annualized Returns

FT #2	12	60	120	240	360	600
0.0%	-50.7%	-26.5%	-17.9%	-12.1%	-5.8%	-2.7%
1.0%	-29.6%	-11.3%	-6.1%	-2.3%	-0.2%	1.5%
5.0%	-18.0%	-4.5%	-1.2%	1.3%	2.4%	3.5%
10.0%	-11.8%	-1.7%	1.0%	2.8%	3.7%	4.5%
15.0%	-7.4%	0.5%	2.5%	3.8%	4.5%	5.1%
50.0%	10.0%	8.3%	8.1%	7.8%	7.7%	7.6%
85.0%	25.7%	15.2%	13.0%	11.4%	10.7%	10.0%
90.0%	29.5%	16.8%	14.2%	12.2%	11.3%	10.5%
95.0%	35.6%	19.1%	15.9%	13.4%	12.3%	11.3%
99.0%	47.0%	23.1%	19.0%	15.4%	14.0%	12.8%
100.0%	81.7%	33.8%	25.0%	20.0%	17.3%	16.7%

AAA	12	60	120	240	360	600
0.0%	-54.4%	-24.5%	-14.1%	-6.6%	-4.0%	-1.6%
1.0%	-29.8%	-10.4%	-5.0%	-1.1%	0.5%	2.1%
5.0%	-17.8%	-4.5%	-0.9%	1.6%	2.7%	3.8%
10.0%	-11.7%	-1.5%	1.1%	3.0%	3.8%	4.7%
15.0%	-7.6%	0.4%	2.5%	4.0%	4.6%	5.3%
50.0%	9.3%	8.1%	7.9%	7.8%	7.7%	7.7%
85.0%	24.8%	15.0%	12.9%	11.4%	10.7%	10.0%
90.0%	28.4%	16.6%	14.0%	12.3%	11.4%	10.5%
95.0%	34.2%	18.8%	15.7%	13.4%	12.4%	11.3%
99.0%	45.3%	23.1%	18.9%	15.6%	14.2%	12.7%
100.0%	75.8%	33.3%	24.6%	20.6%	17.9%	16.0%

FT2-AAA	12	60	120	240	360	600
0.0%	3.8%	-2.1%	-3.8%	-5.5%	-1.8%	-1.1%
1.0%	0.2%	-0.9%	-1.2%	-1.2%	-0.7%	-0.6%
5.0%	-0.2%	0.0%	-0.4%	-0.3%	-0.3%	-0.3%
10.0%	-0.1%	-0.2%	-0.1%	-0.2%	-0.2%	-0.2%
15.0%	0.2%	0.0%	0.0%	-0.2%	-0.1%	-0.2%
50.0%	0.7%	0.2%	0.1%	0.0%	0.0%	0.0%
85.0%	0.9%	0.1%	0.1%	0.0%	0.0%	0.0%
90.0%	1.1%	0.2%	0.2%	-0.1%	0.0%	0.0%
95.0%	1.4%	0.2%	0.2%	0.0%	-0.1%	0.0%
99.0%	1.6%	0.1%	0.1%	-0.2%	-0.2%	0.1%
100.0%	5.9%	0.5%	0.5%	-0.6%	-0.6%	0.7%

# Equities: Non-S&P Tail Total Returns

- Tail total returns for Emerging Market equities seem very extreme.
  - The index fund may grow **explosively** for extended periods or become essentially **worthless**.
- [Extreme right tail returns from NASDAQ and Aggressive equities also reach high (but not as dramatic) levels over extended periods.]

## Emerging Markets

GWF	12	60	120	240	360	600
0.0%	0.31	0.10	0.02	0.02	0.01	0.05
0.5%	0.49	0.32	0.23	0.21	0.33	0.54
1.0%	0.54	0.38	0.29	0.32	0.48	0.88
2.5%	0.61	0.47	0.45	0.55	0.82	1.95
5.0%	0.69	0.60	0.61	0.84	1.32	3.87
10.0%	0.78	0.76	0.87	1.40	2.43	8.31
15.0%	0.84	0.88	1.09	1.91	3.48	13.71
50.0%	1.12	1.63	2.63	6.52	16.28	104.53
85.0%	1.45	2.87	5.97	21.03	69.29	673.40
90.0%	1.54	3.26	7.18	27.53	97.20	1,028.55
95.0%	1.68	3.94	9.51	40.14	156.55	1,801.06
97.5%	1.80	4.65	12.17	56.46	229.37	3,191.21
99.0%	1.94	5.57	15.57	80.92	361.02	6,090.31
99.5%	2.05	6.24	18.33	108.51	481.39	9,784.95
100.0%	2.61	11.40	39.95	645.06	1,649.68	161,082.73

Ann Ret	12	60	120	240	360	600
0.0%	-68.7%	-36.9%	-32.6%	-17.9%	-13.7%	-5.8%
0.5%	-51.0%	-20.4%	-13.6%	-7.5%	-3.7%	-1.2%
1.0%	-46.3%	-17.8%	-11.6%	-5.5%	-2.4%	-0.3%
2.5%	-39.2%	-14.1%	-7.7%	-2.9%	-0.7%	1.3%
5.0%	-30.8%	-9.7%	-4.8%	-0.8%	0.9%	2.7%
10.0%	-22.0%	-5.3%	-1.4%	1.7%	3.0%	4.3%
15.0%	-16.2%	-2.5%	0.9%	3.3%	4.2%	5.4%
50.0%	12.1%	10.2%	10.1%	9.8%	9.7%	9.7%
85.0%	45.2%	23.4%	19.6%	16.5%	15.2%	13.9%
90.0%	54.0%	26.7%	21.8%	18.0%	16.5%	14.9%
95.0%	67.9%	31.6%	25.3%	20.3%	18.3%	16.2%
97.5%	79.6%	36.0%	28.4%	22.3%	19.9%	17.5%
99.0%	93.9%	41.0%	31.6%	24.6%	21.7%	19.0%
99.5%	104.9%	44.2%	33.8%	26.4%	22.9%	20.2%
100.0%	161.4%	62.7%	44.6%	38.2%	28.0%	27.1%

# Equities: Risk/Reward Relationships

- The equity calibration seems to favor Mid Cap over Large Cap equities. For horizons beyond 1 year, the Mid Cap statistics often have
  - Higher expected or median returns
  - Relatively similar downside risk
  - Higher upside potential.

## Cumulative Annualized Total Returns

S&P	12	60	120	240	360	600
0.0%	-50.7%	-26.5%	-17.9%	-12.1%	-5.8%	-2.7%
0.5%	-34.4%	-13.9%	-8.3%	-3.4%	-1.2%	0.8%
1.0%	-29.6%	-11.3%	-6.1%	-2.3%	-0.2%	1.5%
2.5%	-23.3%	-7.5%	-3.3%	-0.2%	1.1%	2.6%
5.0%	-18.0%	-4.5%	-1.2%	1.3%	2.4%	3.5%
10.0%	-11.8%	-1.7%	1.0%	2.8%	3.7%	4.5%
15.0%	-7.4%	0.5%	2.5%	3.8%	4.5%	5.1%
25.0%	-1.2%	3.4%	4.5%	5.3%	5.6%	6.0%
50.0%	10.0%	8.3%	8.1%	7.8%	7.7%	7.6%
75.0%	20.4%	12.9%	11.3%	10.2%	9.7%	9.2%
85.0%	25.7%	15.2%	13.0%	11.4%	10.7%	10.0%
90.0%	29.5%	16.8%	14.2%	12.2%	11.3%	10.5%
95.0%	35.6%	19.1%	15.9%	13.4%	12.3%	11.3%
97.5%	40.8%	21.1%	17.4%	14.3%	13.1%	11.9%
99.0%	47.0%	23.1%	19.0%	15.4%	14.0%	12.8%
99.5%	51.7%	24.5%	20.4%	16.1%	14.6%	13.2%
100.0%	81.7%	33.8%	25.0%	20.0%	17.3%	16.7%
Avg	9.4%	8.9%	8.9%	8.7%	8.7%	8.7%

Mid Cap	12	60	120	240	360	600
0.0%	-47.4%	-21.5%	-14.9%	-9.9%	-7.7%	-3.2%
0.5%	-33.7%	-12.5%	-7.3%	-3.0%	-1.0%	0.9%
1.0%	-29.2%	-10.5%	-5.5%	-1.9%	-0.1%	1.7%
2.5%	-23.2%	-7.4%	-3.2%	-0.2%	1.2%	2.8%
5.0%	-18.3%	-4.7%	-1.2%	1.2%	2.5%	3.6%
10.0%	-12.5%	-1.8%	0.8%	2.8%	3.7%	4.6%
15.0%	-8.4%	0.1%	2.3%	3.8%	4.6%	5.2%
25.0%	-2.2%	3.0%	4.4%	5.3%	5.8%	6.2%
50.0%	9.3%	8.4%	8.2%	8.0%	8.0%	7.9%
75.0%	21.0%	13.5%	11.8%	10.6%	10.1%	9.6%
85.0%	27.3%	16.2%	13.7%	11.9%	11.2%	10.4%
90.0%	31.7%	18.0%	15.0%	12.8%	11.9%	11.0%
95.0%	38.3%	20.7%	16.9%	14.2%	13.0%	11.9%
97.5%	44.8%	22.9%	18.7%	15.4%	13.9%	12.6%
99.0%	51.9%	25.4%	20.7%	16.5%	14.9%	13.4%
99.5%	57.4%	26.7%	21.6%	17.3%	15.6%	14.1%
100.0%	88.2%	34.3%	26.5%	22.7%	18.6%	16.2%
Avg	9.6%	9.3%	9.3%	9.2%	9.2%	9.2%

Mid - S&P	12	60	120	240	360	600
0.0%	3.3%	5.1%	3.0%	2.2%	-2.0%	-0.6%
0.5%	0.7%	1.3%	1.0%	0.3%	0.3%	0.2%
1.0%	0.4%	0.8%	0.7%	0.4%	0.1%	0.3%
2.5%	0.1%	0.2%	0.2%	0.0%	0.1%	0.2%
5.0%	-0.4%	-0.2%	0.0%	-0.1%	0.1%	0.2%
10.0%	-0.7%	-0.1%	-0.2%	0.0%	0.1%	0.1%
15.0%	-1.0%	-0.3%	-0.2%	0.1%	0.1%	0.1%
25.0%	-1.1%	-0.4%	-0.1%	0.0%	0.2%	0.2%
50.0%	-0.6%	0.0%	0.1%	0.2%	0.3%	0.3%
75.0%	0.6%	0.6%	0.5%	0.4%	0.4%	0.4%
85.0%	1.6%	1.0%	0.7%	0.5%	0.5%	0.4%
90.0%	2.1%	1.3%	0.8%	0.6%	0.6%	0.5%
95.0%	2.7%	1.6%	0.9%	0.8%	0.7%	0.6%
97.5%	4.0%	1.8%	1.3%	1.1%	0.8%	0.7%
99.0%	4.9%	2.3%	1.8%	1.1%	0.9%	0.6%
99.5%	5.7%	2.2%	1.2%	1.2%	1.0%	0.9%
100.0%	6.5%	0.5%	1.5%	2.8%	1.3%	-0.5%
Avg	0.1%	0.4%	0.4%	0.4%	0.4%	0.5%

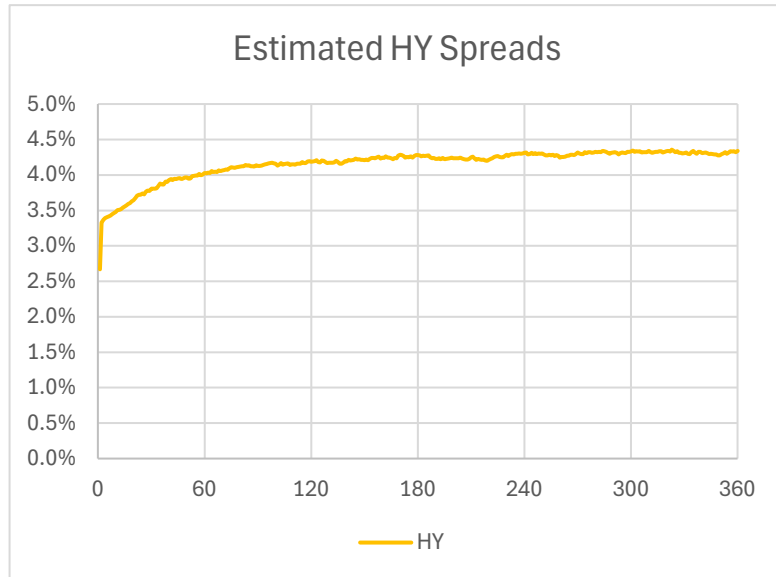
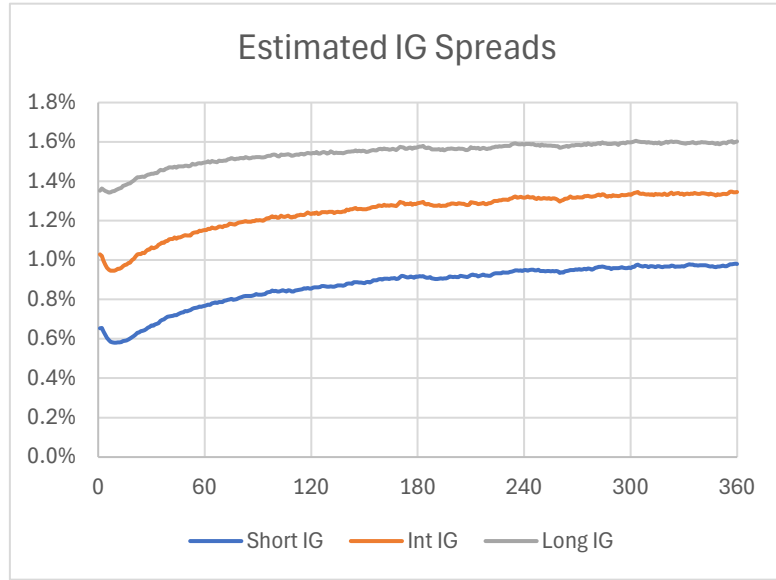
Green: Mid Cap > Large Cap  
 Red: Mid Cap < Large Cap

# Corporate Credit:

- Public information is insufficient to understand and assess the model, calibration, large adjustments / overlays to modelled results, and the overall distribution.
- Some of the unexplained dynamics (e.g., disconnect between spread levels and first year excess returns) in the YE2022 summary statistics from the Jan. 25, 2025 GOES call seem to be less of an issue in the YE2023 scenarios. (However, the drivers of this change are unknown since the initial market conditions used by the model have not been publicly disclosed.)
- There are still some unexplained dynamics. E.g.,
  - Credit spreads are a key driver of bond fund returns but are not available in the Basic Data Set. Spreads inferred from investment grade vs. government bond fund income returns (see page 17) seem to suggest that
    - Historically narrow credit spreads are expected to continue **narrowing in the near-term instead of mean reverting**. (May explain the unexpectedly higher year 1 excess returns for Short and Intermediate Investment Grade bond funds?)
    - Investment Grade credit spreads appear to mean revert more slowly than historical data, existing VM-20 guidance (grade to long-term in **4 years**), and AAA recommendations (**~2-year half-life**). High Yield credit spreads have a pronounced pop up in the first month.
  - While extreme right tail High Yield excess returns are not as high as in other initial conditions, High Yield excess returns are still substantial in the extreme right tail or when compounded over 30 years. (See page 18.)



# Corporate Credit:



## Estimated Annualized Spreads

Approx Half Life

Estimated as  $(1 + \text{Corporate Income Return in Month } t)^{12} - (1 + \text{Gov Income Return in Month } t)^{12}$

Approaches long-term

Short IG	1	12	24	36	48	60	72	84	96	108	120	240	360	First 360
0%	0.7%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
25%	0.7%	0.5%	0.5%	0.5%	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%	
50%	0.65%	0.58%	0.64%	0.70%	0.73%	0.77%	0.79%	0.82%	0.84%	0.84%	0.85%	0.95%	0.98%	
75%	0.7%	0.8%	0.9%	1.0%	1.0%	1.1%	1.1%	1.2%	1.2%	1.2%	1.2%	1.3%	1.4%	
100%	0.7%	4.7%	5.8%	6.3%	7.6%	5.7%	6.6%	6.8%	5.0%	7.6%	6.7%	5.7%	6.1%	9.7%
Avg	0.7%	0.7%	0.8%	0.8%	0.9%	0.9%	0.9%	1.0%	1.0%	1.0%	1.0%	1.1%	1.1%	

Int IG	1	12	24	36	48	60	72	84	96	108	120	240	360	First 360
0%	1.0%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.6%	0.5%	0.5%	0.5%
25%	1.0%	0.8%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.0%	1.0%	
50%	1.03%	0.96%	1.03%	1.09%	1.12%	1.15%	1.17%	1.19%	1.21%	1.22%	1.23%	1.32%	1.35%	
75%	1.0%	1.2%	1.4%	1.5%	1.5%	1.5%	1.6%	1.6%	1.6%	1.6%	1.6%	1.8%	1.8%	
100%	1.0%	4.5%	6.3%	6.3%	8.0%	6.5%	8.3%	8.3%	5.9%	7.1%	6.0%	6.3%	6.9%	10.3%
Avg	1.0%	1.1%	1.2%	1.2%	1.3%	1.3%	1.3%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	

Long IG	1	12	24	36	48	60	72	84	96	108	120	240	360	First 360
0%	1.4%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.9%	0.8%
25%	1.4%	1.2%	1.2%	1.2%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	
50%	1.35%	1.36%	1.42%	1.46%	1.48%	1.50%	1.50%	1.52%	1.53%	1.53%	1.54%	1.59%	1.60%	
75%	1.4%	1.6%	1.7%	1.8%	1.8%	1.8%	1.9%	1.9%	1.9%	1.9%	1.9%	2.0%	2.0%	
100%	1.4%	4.8%	6.5%	6.3%	7.0%	6.1%	7.9%	7.6%	5.5%	6.6%	5.5%	6.3%	6.4%	9.1%
Avg	1.4%	1.5%	1.6%	1.6%	1.6%	1.6%	1.6%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	

HY	1	12	24	36	48	60	72	84	96	108	120	240	360	First 360
0%	2.7%	2.2%	2.1%	2.2%	2.1%	2.1%	2.2%	2.2%	2.1%	2.1%	2.1%	2.1%	2.0%	2.0%
25%	2.7%	2.9%	2.9%	3.1%	3.1%	3.2%	3.2%	3.2%	3.3%	3.3%	3.3%	3.4%	3.4%	
50%	2.67%	3.51%	3.72%	3.87%	3.95%	4.03%	4.08%	4.13%	4.16%	4.14%	4.19%	4.31%	4.34%	
75%	2.7%	4.5%	5.0%	5.2%	5.3%	5.4%	5.5%	5.5%	5.5%	5.6%	5.6%	5.7%	5.8%	
100%	2.7%	14.4%	19.3%	19.9%	25.5%	18.4%	24.6%	22.7%	18.1%	23.1%	21.2%	19.6%	20.3%	30.3%
Avg	2.7%	3.9%	4.3%	4.4%	4.5%	4.6%	4.6%	4.7%	4.7%	4.7%	4.7%	4.9%	4.9%	17

# Corporate Credit: Excess Returns

## Gross Wealth Factors

Short IG	12	60	120	240	360
0.0%	0.90	0.91	0.93	0.95	1.00
0.5%	0.96	0.96	0.98	1.03	1.09
1.0%	0.97	0.97	0.99	1.04	1.10
2.5%	0.97	0.98	1.01	1.06	1.12
5.0%	0.98	0.99	1.02	1.07	1.14
10.0%	1.00	1.00	1.03	1.09	1.16
15.0%	1.00	1.01	1.04	1.10	1.17
50.0%	1.01	1.03	1.06	1.13	1.22
85.0%	1.01	1.04	1.07	1.17	1.28
90.0%	1.01	1.04	1.08	1.18	1.30
95.0%	1.01	1.04	1.09	1.20	1.33
97.5%	1.02	1.04	1.09	1.21	1.36
99.0%	1.02	1.05	1.10	1.23	1.41
99.5%	1.02	1.05	1.10	1.25	1.44
100.0%	1.02	1.07	1.15	1.34	1.68

Int IG	12	60	120	240	360
0.0%	0.77	0.75	0.76	0.73	0.71
0.5%	0.91	0.87	0.88	0.90	0.95
1.0%	0.92	0.89	0.90	0.93	0.98
2.5%	0.94	0.92	0.93	0.97	1.02
5.0%	0.95	0.94	0.96	1.00	1.05
10.0%	0.97	0.96	0.98	1.03	1.09
15.0%	0.98	0.98	1.00	1.05	1.12
50.0%	1.01	1.03	1.06	1.13	1.22
85.0%	1.03	1.05	1.09	1.19	1.30
90.0%	1.03	1.06	1.10	1.20	1.32
95.0%	1.03	1.06	1.11	1.22	1.35
97.5%	1.03	1.06	1.12	1.23	1.37
99.0%	1.03	1.07	1.12	1.25	1.40
99.5%	1.03	1.07	1.13	1.26	1.42
100.0%	1.04	1.09	1.15	1.33	1.59

Long IG	12	60	120	240	360
0.0%	0.68	0.59	0.61	0.56	0.57
0.5%	0.85	0.79	0.81	0.80	0.85
1.0%	0.86	0.82	0.83	0.83	0.88
2.5%	0.89	0.85	0.87	0.89	0.94
5.0%	0.91	0.89	0.90	0.93	0.98
10.0%	0.94	0.92	0.94	0.98	1.04
15.0%	0.95	0.94	0.96	1.01	1.07
50.0%	1.00	1.02	1.05	1.13	1.21
85.0%	1.03	1.07	1.11	1.21	1.32
90.0%	1.04	1.08	1.13	1.23	1.34
95.0%	1.04	1.09	1.14	1.26	1.37
97.5%	1.05	1.10	1.15	1.27	1.40
99.0%	1.05	1.11	1.17	1.29	1.43
99.5%	1.06	1.11	1.17	1.31	1.44
100.0%	1.07	1.14	1.20	1.38	1.66

HY	12	60	120	240	360
0.0%	0.52	0.60	0.52	0.71	0.70
0.5%	0.75	0.74	0.79	0.87	0.98
1.0%	0.78	0.78	0.83	0.91	1.04
2.5%	0.81	0.82	0.87	0.97	1.11
5.0%	0.85	0.86	0.91	1.02	1.17
10.0%	0.89	0.90	0.96	1.08	1.25
15.0%	0.91	0.93	0.99	1.12	1.30
50.0%	0.99	1.02	1.09	1.31	1.59
85.0%	1.04	1.09	1.24	1.64	2.12
90.0%	1.04	1.11	1.30	1.75	2.30
95.0%	1.05	1.15	1.40	1.96	2.62
97.5%	1.05	1.19	1.53	2.16	2.98
99.0%	1.06	1.27	1.67	2.50	3.58
99.5%	1.06	1.33	1.84	2.84	4.11
100.0%	1.07	1.83	4.00	7.23	10.78

## Cumulative Annualized Excess Returns

Short IG	12	60	120	240	360
0.0%	-10.1%	-1.9%	-0.7%	-0.3%	0.0%
0.5%	-3.9%	-0.9%	-0.2%	0.1%	0.3%
1.0%	-3.3%	-0.7%	-0.1%	0.2%	0.3%
2.5%	-2.5%	-0.4%	0.1%	0.3%	0.4%
5.0%	-1.6%	-0.2%	0.2%	0.4%	0.4%
10.0%	-0.5%	0.0%	0.3%	0.4%	0.5%
15.0%	-0.1%	0.2%	0.4%	0.5%	0.5%
50.0%	0.9%	0.5%	0.6%	0.6%	0.7%
85.0%	1.3%	0.7%	0.7%	0.8%	0.8%
90.0%	1.4%	0.8%	0.8%	0.8%	0.9%
95.0%	1.5%	0.8%	0.8%	0.9%	1.0%
97.5%	1.5%	0.9%	0.9%	1.0%	1.0%
99.0%	1.5%	1.0%	1.0%	1.1%	1.1%
99.5%	1.6%	1.0%	1.0%	1.1%	1.2%
100.0%	1.7%	1.3%	1.4%	1.5%	1.7%

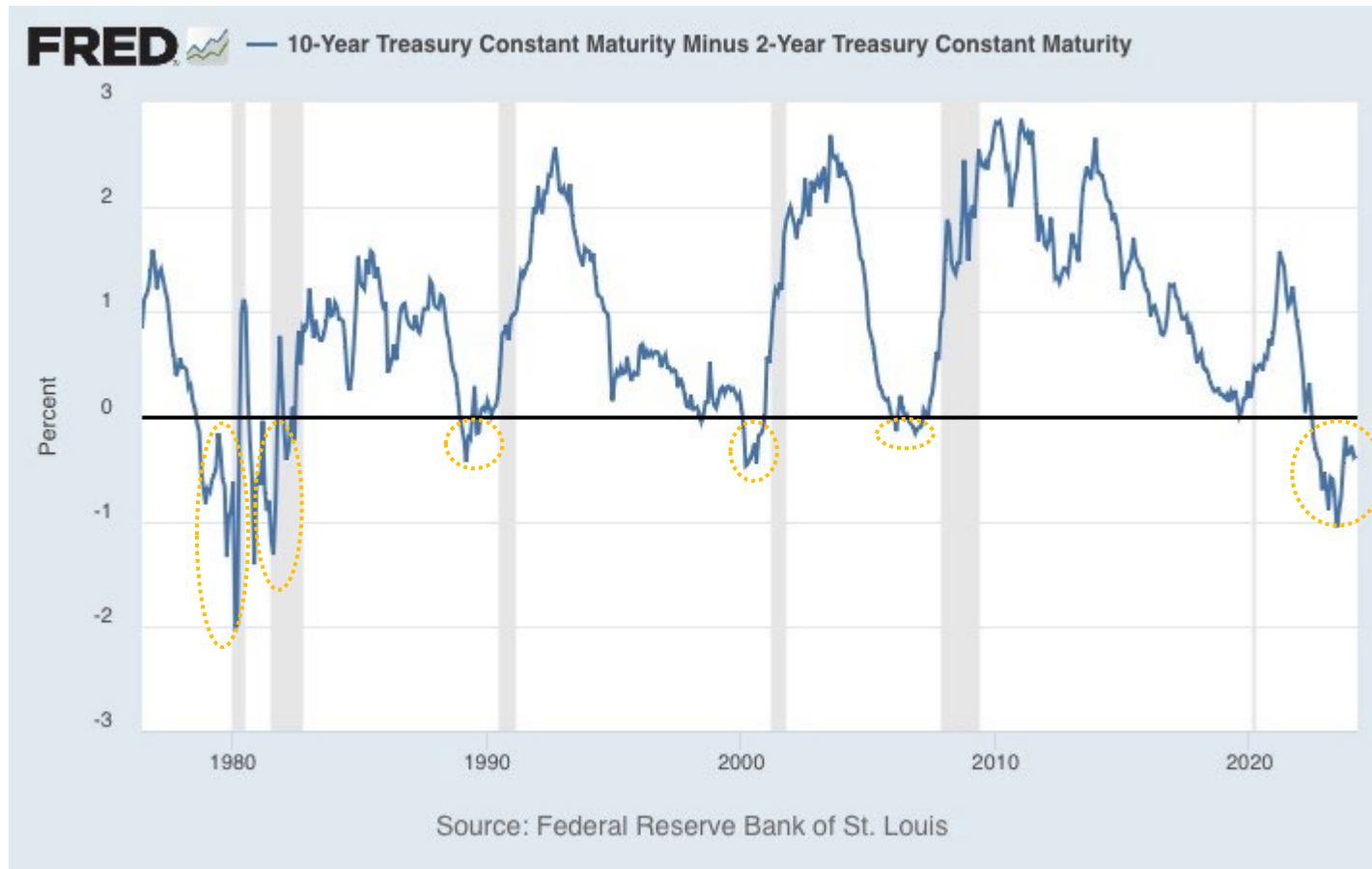
Int IG	12	60	120	240	360
0.0%	-22.8%	-5.6%	-2.7%	-1.6%	-1.1%
0.5%	-9.3%	-2.8%	-1.2%	-0.5%	-0.2%
1.0%	-8.0%	-2.4%	-1.0%	-0.4%	-0.1%
2.5%	-6.2%	-1.7%	-0.7%	-0.2%	0.1%
5.0%	-4.7%	-1.3%	-0.4%	0.0%	0.2%
10.0%	-3.0%	-0.7%	-0.2%	0.2%	0.3%
15.0%	-1.9%	-0.4%	0.0%	0.3%	0.4%
50.0%	1.2%	0.6%	0.6%	0.6%	0.7%
85.0%	2.6%	1.0%	0.9%	0.9%	0.9%
90.0%	2.8%	1.1%	1.0%	0.9%	0.9%
95.0%	3.0%	1.2%	1.0%	1.0%	1.0%
97.5%	3.2%	1.3%	1.1%	1.1%	1.1%
99.0%	3.3%	1.3%	1.2%	1.1%	1.1%
99.5%	3.4%	1.4%	1.2%	1.2%	1.2%
100.0%	3.8%	1.8%	1.4%	1.4%	1.6%

Long IG	12	60	120	240	360
0.0%	-31.8%	-9.9%	-4.8%	-2.8%	-1.8%
0.5%	-15.2%	-4.7%	-2.1%	-1.1%	-0.6%
1.0%	-13.5%	-3.9%	-1.8%	-0.9%	-0.4%
2.5%	-10.9%	-3.1%	-1.4%	-0.6%	-0.2%
5.0%	-8.7%	-2.4%	-1.0%	-0.3%	-0.1%
10.0%	-6.3%	-1.6%	-0.6%	-0.1%	0.1%
15.0%	-4.8%	-1.2%	-0.4%	0.1%	0.2%
50.0%	0.4%	0.4%	0.5%	0.6%	0.6%
85.0%	3.3%	1.3%	1.1%	1.0%	0.9%
90.0%	3.7%	1.5%	1.2%	1.0%	1.0%
95.0%	4.4%	1.7%	1.3%	1.1%	1.1%
97.5%	4.8%	1.9%	1.4%	1.2%	1.1%
99.0%	5.3%	2.0%	1.5%	1.3%	1.2%
99.5%	5.7%	2.2%	1.6%	1.3%	1.2%
100.0%	7.2%	2.7%	1.8%	1.6%	1.7%

HY	12	60	120	240	360
0.0%	-48.0%	-9.9%	-6.3%	-1.7%	-1.2%
0.5%	-25.0%	-5.7%	-2.4%	-0.7%	-0.1%
1.0%	-22.4%	-4.9%	-1.9%	-0.5%	0.1%
2.5%	-19.0%	-3.8%	-1.4%	-0.2%	0.3%
5.0%	-15.3%	-3.0%	-0.9%	0.1%	0.5%
10.0%	-11.3%	-2.0%	-0.4%	0.4%	0.7%
15.0%	-8.8%	-1.4%	-0.1%	0.6%	0.9%
50.0%	-0.7%	0.5%	0.9%	1.3%	1.6%
85.0%	3.6%	1.7%	2.2%	2.5%	2.5%
90.0%	4.2%	2.1%	2.7%	2.8%	2.8%
95.0%	4.8%	2.8%	3.5%	3.4%	3.3%
97.5%	5.3%	3.6%	4.4%	3.9%	3.7%
99.0%	5.6%	4.9%	5.2%	4.7%	4.3%
99.5%	5.9%	5.8%	6.3%	5.4%	4.8%
100.0%	7.2%	12.9%	14.9%	10.4%	8.2%

# APPENDIX: Background Information on Yield Curve Inversions

- Inversions between long- and short-term rates (e.g., 10Y - 2Y) are generally associated with recessions and episodic (i.e., not trends that persist over long periods).
- The current inversion period of almost 21 months breaks the previous record set in 1978.



Shaded areas = Recessions

# APPENDIX: Background Information on Yield Curve Inversions

- The frequency and severity of yield curve inversions typically increases as rates increase. Aggregate statistics (e.g., across all rates) are not comparable when the underlying rate distribution differs.

2Y Rate Bucket -->	<=0%	(0%, 1%]	(1%, 2%]	(2%, 3%]	(3%, 4%]	(4%, 5%]	(5%, 6%]	(6%, 7%]	(7%, 8%]	(8%, 9%]	9%, 10%]	>10%	All	<=3%	(3%, 8%]	>8%
# Months	0	114	71	68	106	110	102	83	67	44	28	56	849	253	468	128
# Inverted	0	0	0	1	7	41	24	14	15	16	15	26	159	1	101	57
% Inverted	N/A	0%	0%	1%	7%	37%	24%	17%	22%	36%	54%	46%	19%	0%	22%	45%

## 10Y - 2Y Spread Distribution

%-tile	<=0%	(0%, 1%]	(1%, 2%]	(2%, 3%]	(3%, 4%]	(4%, 5%]	(5%, 6%]	(6%, 7%]	(7%, 8%]	(8%, 9%]	9%, 10%]	>10%	All	<=3%	(3%, 8%]	>8%
0%	N/A	0.3%	0.0%	-0.2%	-0.3%	-1.1%	-0.6%	-0.5%	-0.8%	-1.0%	-1.1%	-2.0%	-2.0%	-0.2%	-1.1%	-2.0%
5%	N/A	0.5%	0.2%	0.1%	0.0%	-0.7%	-0.3%	-0.3%	-0.6%	-1.0%	-0.8%	-1.4%	-0.6%	0.2%	-0.4%	-1.1%
10%	N/A	0.8%	0.3%	0.2%	0.1%	-0.4%	-0.2%	-0.2%	-0.4%	-0.8%	-0.7%	-1.1%	-0.3%	0.3%	-0.2%	-0.9%
15%	N/A	1.0%	0.6%	0.2%	0.1%	-0.3%	-0.1%	-0.1%	-0.2%	-0.5%	-0.7%	-0.9%	-0.1%	0.4%	-0.1%	-0.7%
25%	N/A	1.2%	0.8%	0.3%	0.3%	-0.1%	0.0%	0.2%	0.1%	-0.2%	-0.6%	-0.6%	0.1%	0.7%	0.0%	-0.6%
50%	N/A	1.6%	1.1%	0.5%	0.6%	0.1%	0.3%	0.6%	0.4%	0.1%	-0.2%	0.1%	0.6%	1.3%	0.4%	0.1%
75%	N/A	2.3%	2.2%	1.5%	0.7%	0.6%	0.7%	1.1%	0.9%	0.8%	0.9%	0.8%	1.2%	2.0%	0.9%	0.8%
85%	N/A	2.4%	2.4%	1.8%	1.2%	1.3%	1.0%	1.2%	1.0%	1.1%	1.0%	1.0%	1.6%	2.3%	1.2%	1.0%
90%	N/A	2.6%	2.4%	1.9%	1.5%	1.7%	1.5%	1.3%	1.0%	1.3%	1.2%	1.1%	1.9%	2.4%	1.4%	1.1%
95%	N/A	2.7%	2.5%	2.1%	1.9%	2.2%	1.9%	1.4%	1.1%	1.4%	1.4%	1.2%	2.3%	2.6%	1.8%	1.3%
100%	N/A	2.8%	2.8%	2.3%	2.6%	2.5%	2.2%	1.5%	1.3%	1.6%	1.6%	1.5%	2.8%	2.8%	2.6%	1.6%
Avg	N/A	1.7%	1.3%	0.8%	0.6%	0.3%	0.4%	0.6%	0.4%	0.2%	0.2%	0.1%	0.7%	1.4%	0.5%	0.1%

## 10Y - 2Y Inverted Spread Distribution

%-tile	<=0%	(0%, 1%]	(1%, 2%]	(2%, 3%]	(3%, 4%]	(4%, 5%]	(5%, 6%]	(6%, 7%]	(7%, 8%]	(8%, 9%]	9%, 10%]	>10%	All	<=3%	(3%, 8%]	>8%
0%	N/A	N/A	N/A	-0.2%	-0.3%	-1.1%	-0.6%	-0.5%	-0.8%	-1.0%	-1.1%	-2.0%	-2.0%	-0.2%	-1.1%	-2.0%
25%	N/A	N/A	N/A	-0.2%	-0.1%	-0.4%	-0.3%	-0.4%	-0.6%	-0.9%	-0.7%	-0.9%	-0.6%	-0.2%	-0.4%	-0.9%
50%	N/A	N/A	N/A	-0.2%	0.0%	-0.2%	-0.2%	-0.3%	-0.3%	-0.5%	-0.6%	-0.7%	-0.3%	-0.2%	-0.2%	-0.6%
75%	N/A	N/A	N/A	-0.2%	0.0%	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%	-0.4%	-0.4%	-0.1%	-0.2%	-0.1%	-0.2%
100%	N/A	N/A	N/A	-0.2%	0.0%	0.0%	0.0%	-0.1%	0.0%	-0.1%	-0.1%	0.0%	0.0%	-0.2%	0.0%	0.0%
Avg	N/A	N/A	N/A	-0.2%	-0.1%	-0.3%	-0.2%	-0.3%	-0.4%	-0.5%	-0.5%	-0.8%	-0.4%	-0.2%	-0.3%	-0.6%