CAIM | CROWN AGENTS INVESTMENT MANAGEMENT

QUANTITATIVE BOOTCAMP

YIELD CURVE MODELING AND SCENARIO ANALYSIS

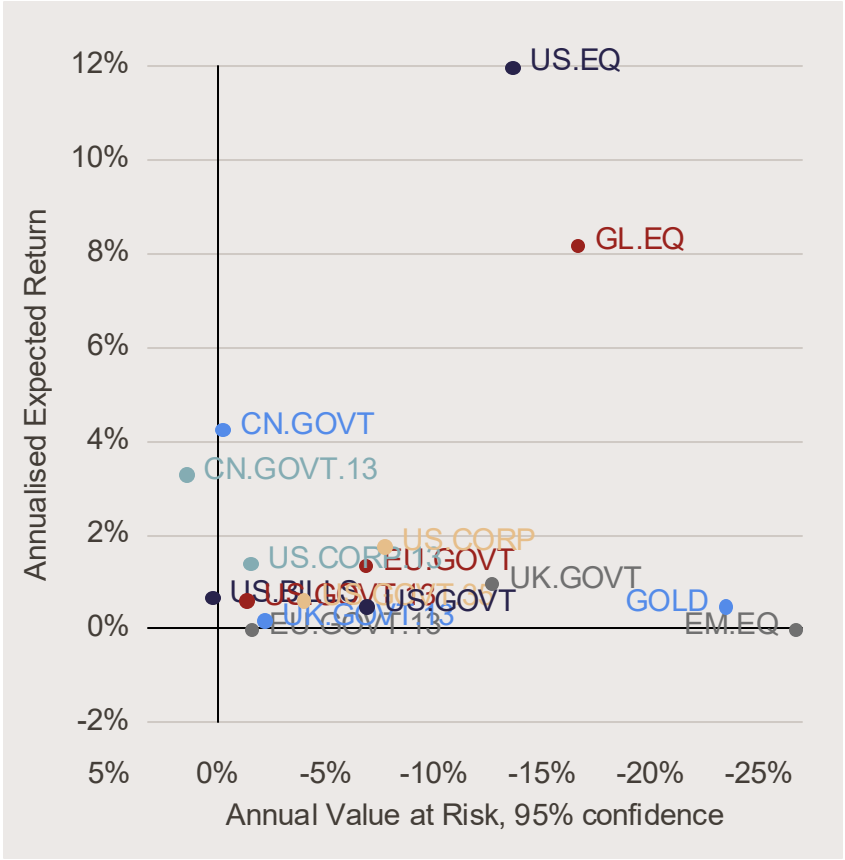
OCTOBER 2025

YIELD CURVE MODELING AND SCENARIO ANALYSIS

THEN VS. NOW

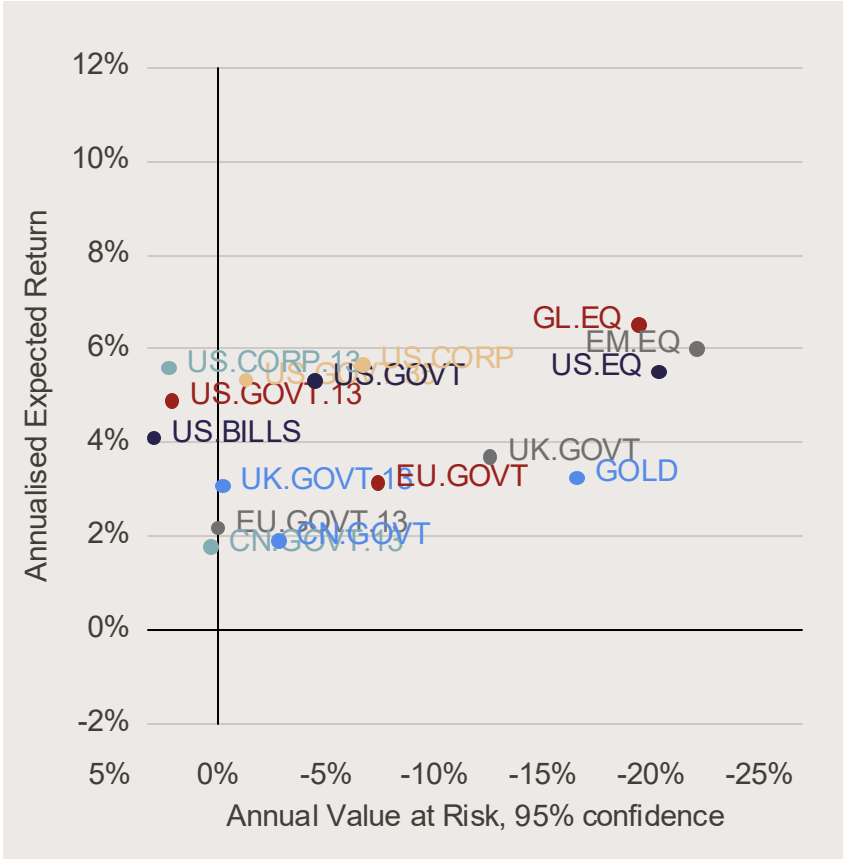
Expected returns and risk look materially better now

Historical local annualised return and risk (2012 - 2023)



Source: CAIM, January 2023. Please see appendix for asset class abbreviations

Forward-looking local annualised return and risk



Source: CAIM, January 2023. Calculated using 5000 simulations based on current market conditions and forward-looking expectations. Please see appendix for asset class abbreviations.

WHY IS IT IMPORTANT TO LOOK AT YIELDS, NOT HISTORICAL RETURNS, IN FIXED INCOME?

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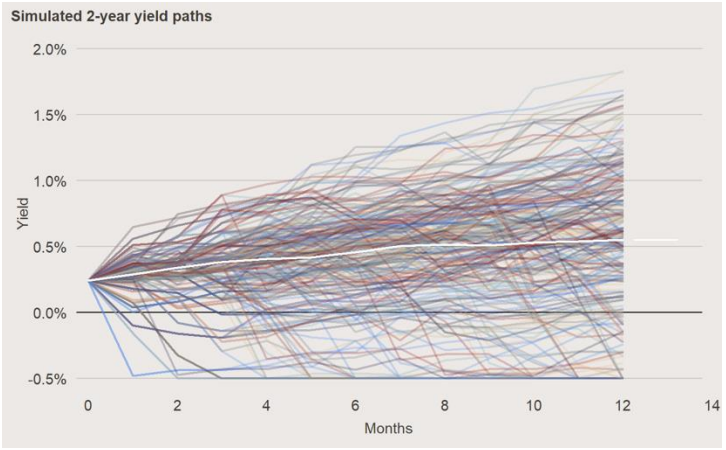
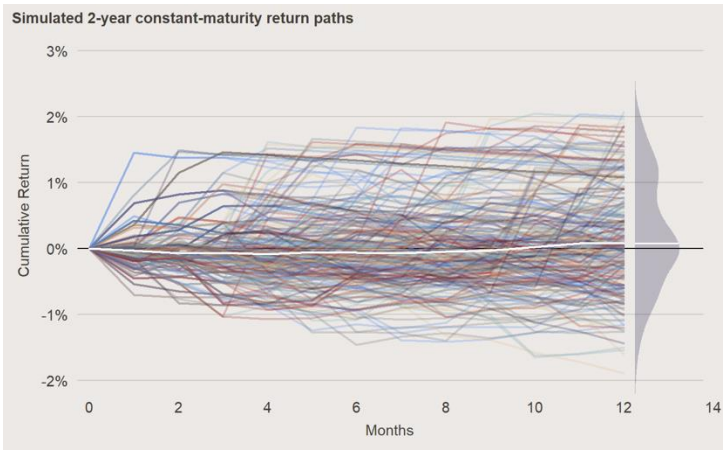
Higher current yields lead to increased forward-looking return expectations in fixed income

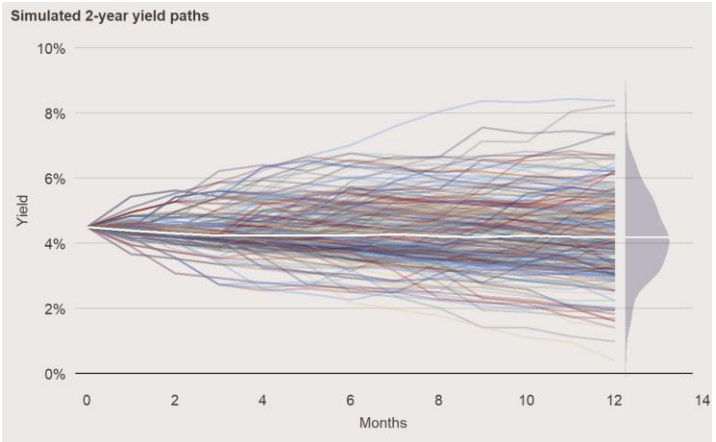
Lower Yields



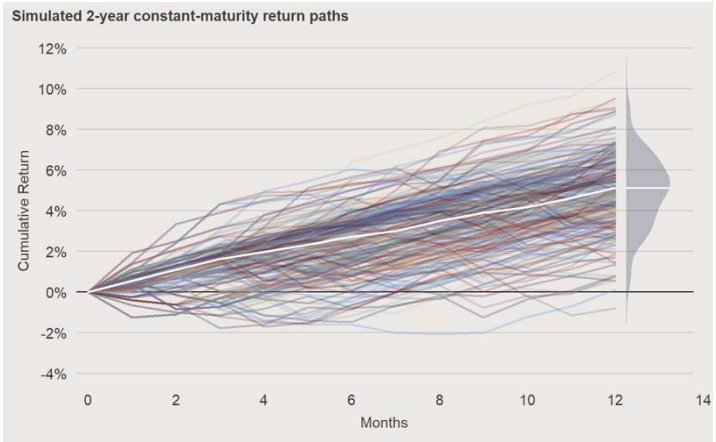
Lower Yields



Higher Yields



Higher Yields



Source: CAIM, January 2023

CONSTANT MATURITY FIXED INCOME RETURN MODELING

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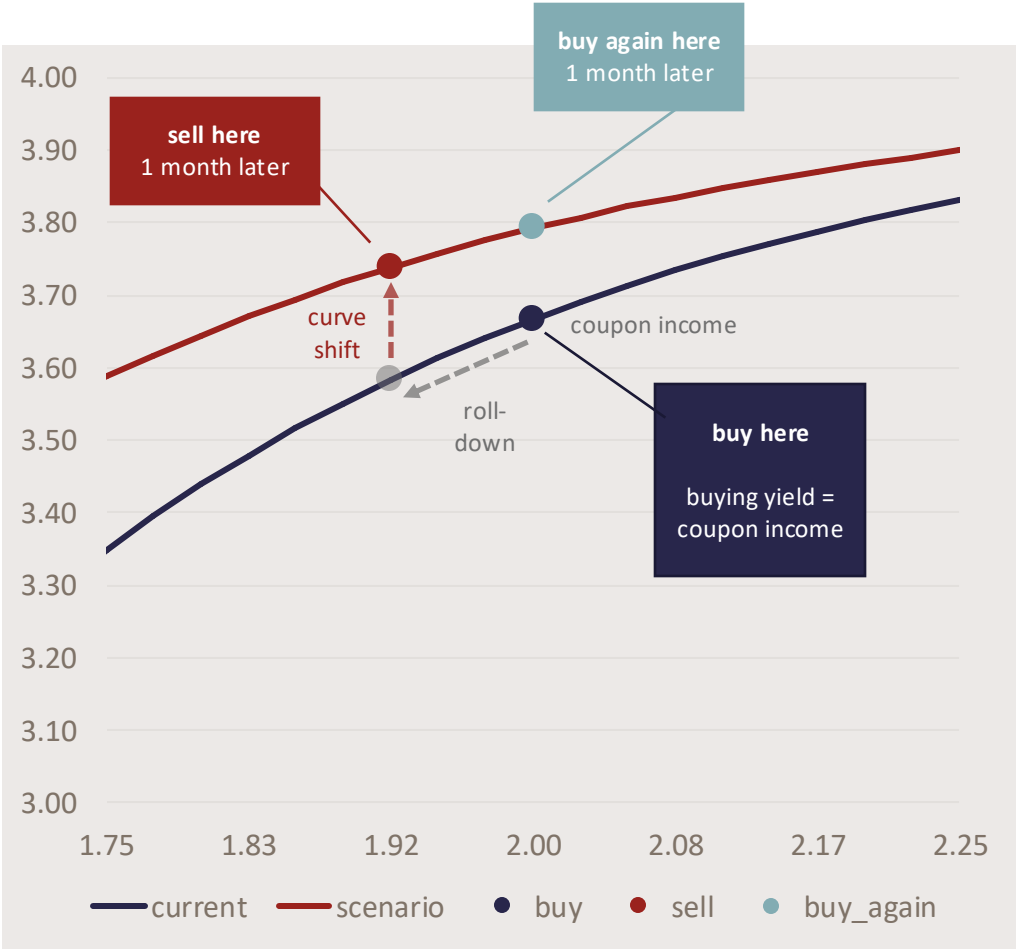
Scenario analysis, carry and roll

For constant-maturity strategies (e.g. managing against a 1-3 year benchmark):

- **Fixed income invariants:** yield, coupon, maturity, spread (if applicable)
- Buy a 2-year maturity note at par
- 1 month later:
  - Earn 1 month of coupon income at purchase yield
  - Sell a 1-year 11-month note at the relevant yield
    - Calculate the price, which includes roll-down and curve shift.
- Repeat for your n-month horizon
- Repeat 1,000, 5,000, 1 million times (e.g.) with simulated curves for asset allocation analysis
- **You do not need individual curve points at every maturity! Calculate using a yield curve model**

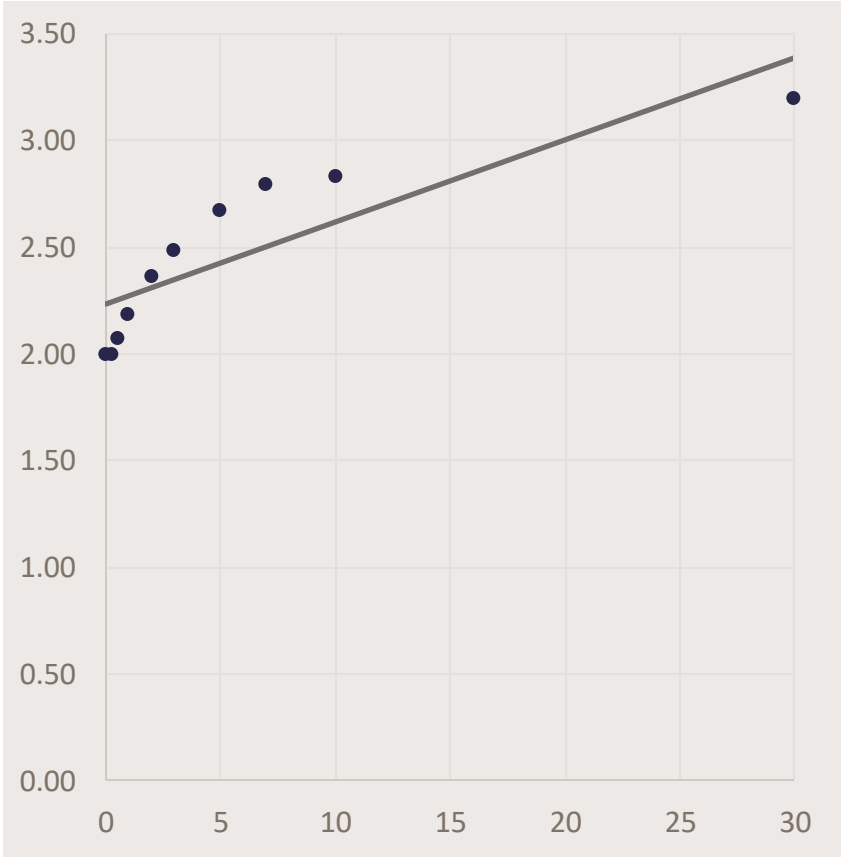


Hypothetical example, CAIM, April 2023

WHAT ARE WE TRYING TO DO HERE?

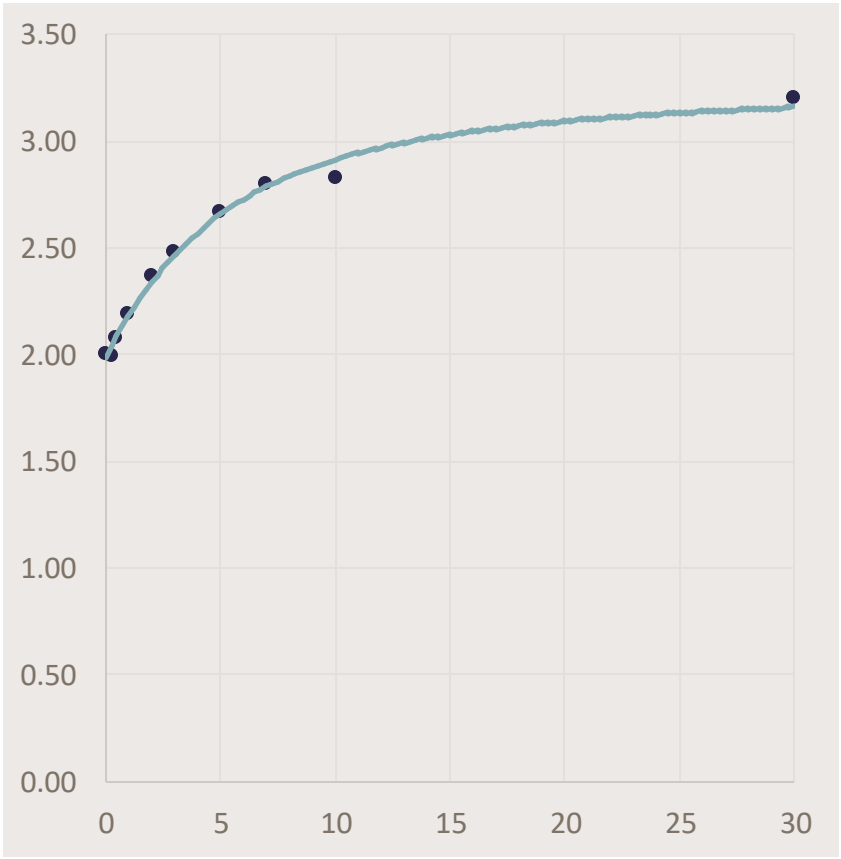
Describe an entire yield curve parametrically, with as few parameters as possible

Clearly a linear model is not ideal/appropriate



Source: Bloomberg, CAIM, CNY generic government curve, April 2023. Linear trendline from PowerPoint

This seems better,
and only needs 3 coefficients and 1 constant



Source: Bloomberg, CAIM, CNY generic government curve, April 2023 . Nelson-Siegel model.

INTRODUCING THE (PARSIMONIOUS) NELSON-SIEGEL YIELD CURVE MODEL

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Just three coefficients (and a lambda constant) can describe an entire yield curve

Nelson-Siegel model:

$$y(\tau) = \beta_0 + \beta_1\left(\frac{1 - e^{-\lambda\tau}}{\lambda\tau}\right) + \beta_2\left(\frac{1 - e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right) + \epsilon_\tau$$

y: yield to be forecasted

τ: time (maturity) in years

β_0: level factor

β_1: slope factor

β_2: curvature factor

λ: decay factor, directly related to location of curve's "hump"

ϵ_τ: error term at given maturity

Restated slightly:

$$yield_{mat} = \beta_{level} + \beta_{slope} \times loading_{slope_{mat}} + \beta_{curvature} \times loading_{curvature_{mat}}$$

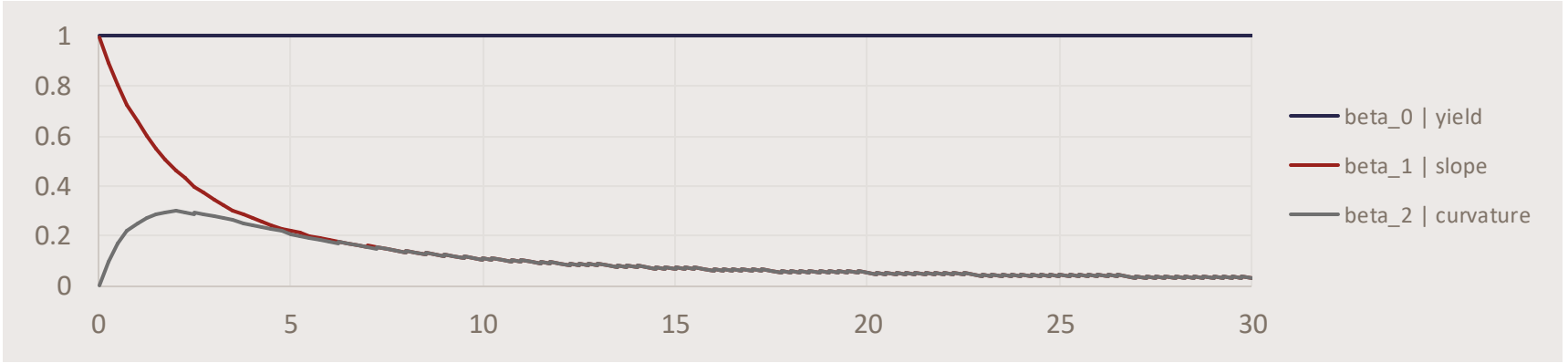
Excel formula:

= beta_0 + beta_1 * ((1 - EXP(-lambda * *maturity*)) / (lambda * *maturity*))
+ beta_2 * ((1 - EXP(-lambda * *maturity*)) / (lambda * *maturity*) - EXP(-lambda * *maturity*))

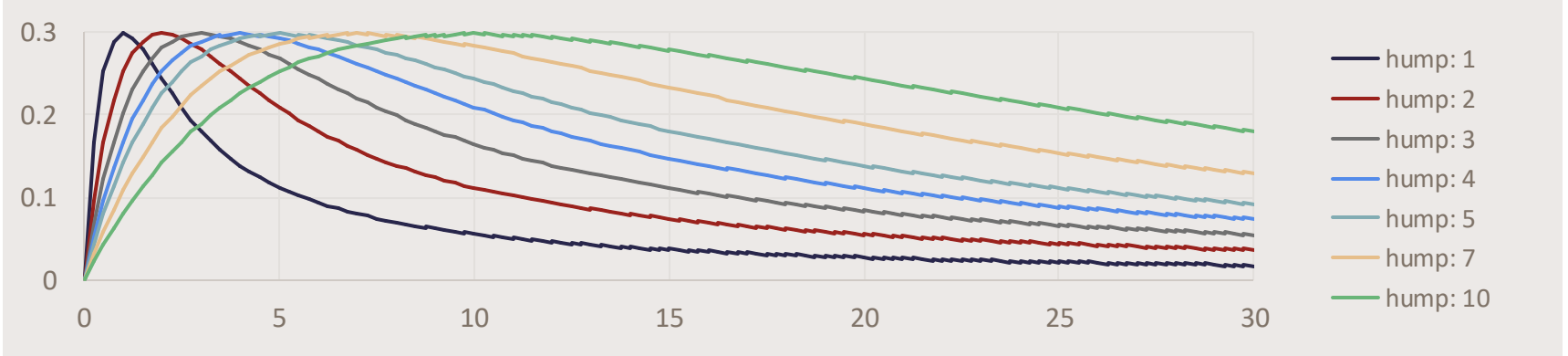
WHAT IS FACTOR LOADING?

Different Nelson-Siegel factors will have varying influence at different maturities

Factor loading: ”hump location” = 2 years, lambda = 0.8966



Different lambdas will affect factor loading across maturities



Source: CAIM, April 2023

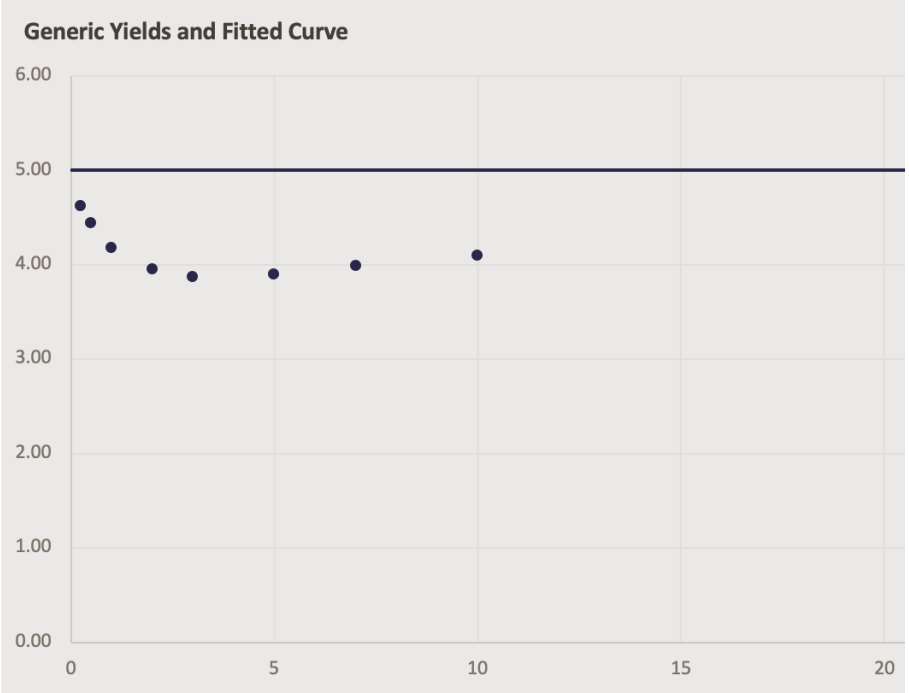
EXCEL EXAMPLE

market	obs_date
US	2024-10-11

maturity	yield	ns	err	use [1 or 0]
0.25	4.63	5.00	0.38	
0.5	4.44	5.00	0.56	
1	4.18	5.00	0.82	
2	3.96	5.00	1.04	
3	3.88	5.00	1.13	
5	3.90	5.00	1.10	
7	3.99	5.00	1.01	
10	4.10	5.00	0.90	
30	4.41	5.00	0.59	

	ns	factor loadings		
maturity	yield	beta_0	beta_1	beta_2
0.00	5.00	1	0.9995	0.0005
0.25	5.00	1	0.9565	0.0422
0.50	5.00	1	0.9155	0.0796
0.75	5.00	1	0.8768	0.1127
1.00	5.00	1	0.8403	0.1417
1.25	5.00	1	0.8059	0.1672
1.50	5.00	1	0.7734	0.1895
1.75	5.00	1	0.7427	0.2089
2.00	5.00	1	0.7137	0.2256
2.25	5.00	1	0.6862	0.2401

nelson-siegel coefficients			
beta_0	5.0000	level	**hump_location**
beta_1	0.0000	slope	5
beta_2	0.0000	curvature	
lambda	0.3587	lambda	

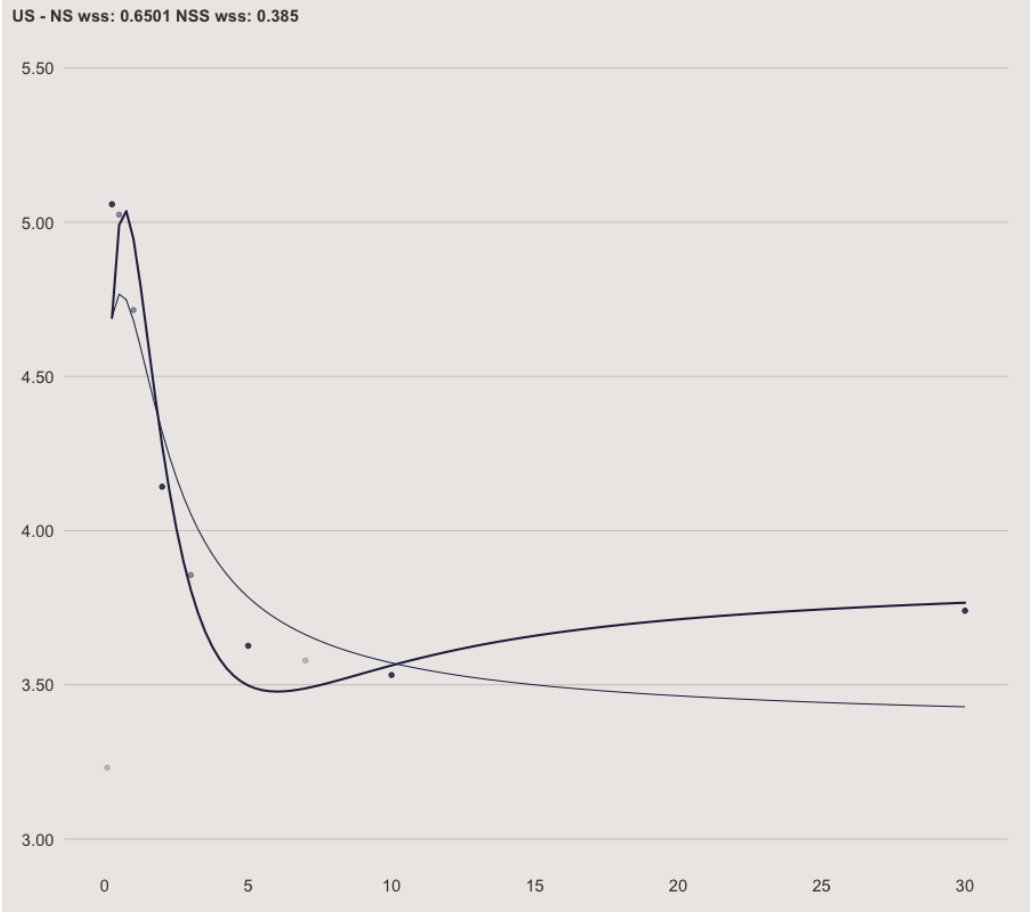


NELSON-SIEGEL SHORTCOMINGS

The Nelson-Siegel model is sometimes too simple, especially when faced with relatively complicated yield curves

- At times, market transition or dislocation results in a set of yields that are difficult to fit with only a NS model
- Sometimes two humps are better than one – consider the Nelson-Siegel-Svensson model!
  - one extra beta and one extra lambda parameter allow the fitted curve to have "humps" at two locations
- Similar practical applications and uses to NS curves, with only marginally more calculations

- Different yields can be weighted differently during the curve fitting process (a 2 year yield may be more relevant than a 1 year yield…)

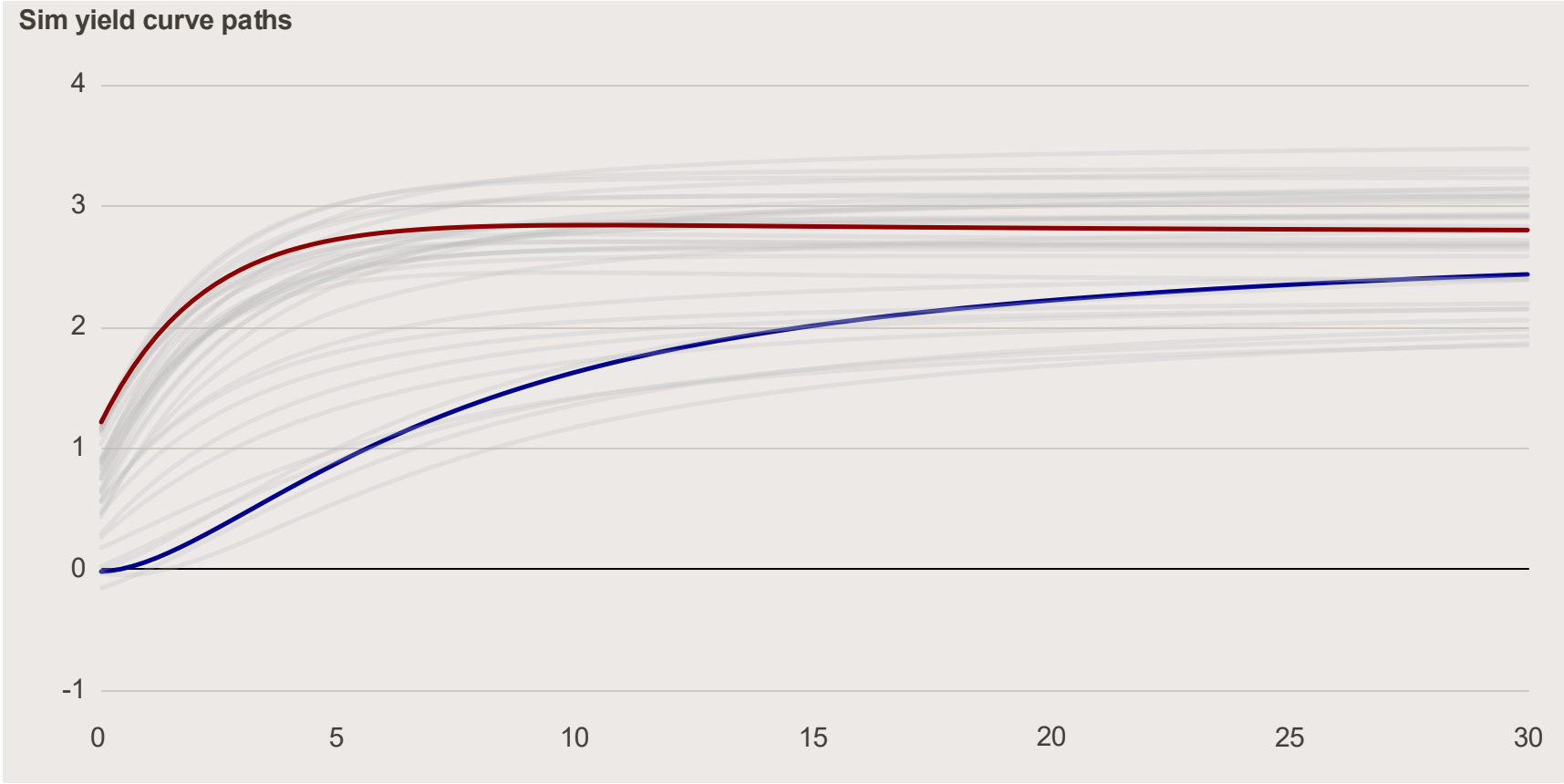


Source: CAIM, April 2023

CURVE HORIZON SIMULATION EXAMPLE

Curve development over 1 simulation over 36 month horizon

Blue = current curve, red = horizon curve



Source: CAIM, April 2021

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