Economic Scenarios for ALM

Investment Advisory Committee of the North Carolina State Treasurer

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Agenda

Purpose of this meeting is to inform and discuss

- Introduction Ortec Finance
- Process ALM study
- Methodology Economic Scenario Generator (ESG)
- Modeling of assets and macroeconomics
- Capital Market Assumptions

Our Company

Founded in 1981,
380+ employees

Independent – 100%
owned by employees

Expert provider of
investment decision
technology and solutions

Innovative, strong ties
with academic world

Global and long-standing
clients manage over
$16 trillion in assets

Solutions for institutional investors

Institutional
- Asset Managers
- Pensions
- Insurance
- Non-Profits
- Consultants / OCIO

Private Wealth
- Banks
- Wealth Managers

Real Estate
- Housing Associations

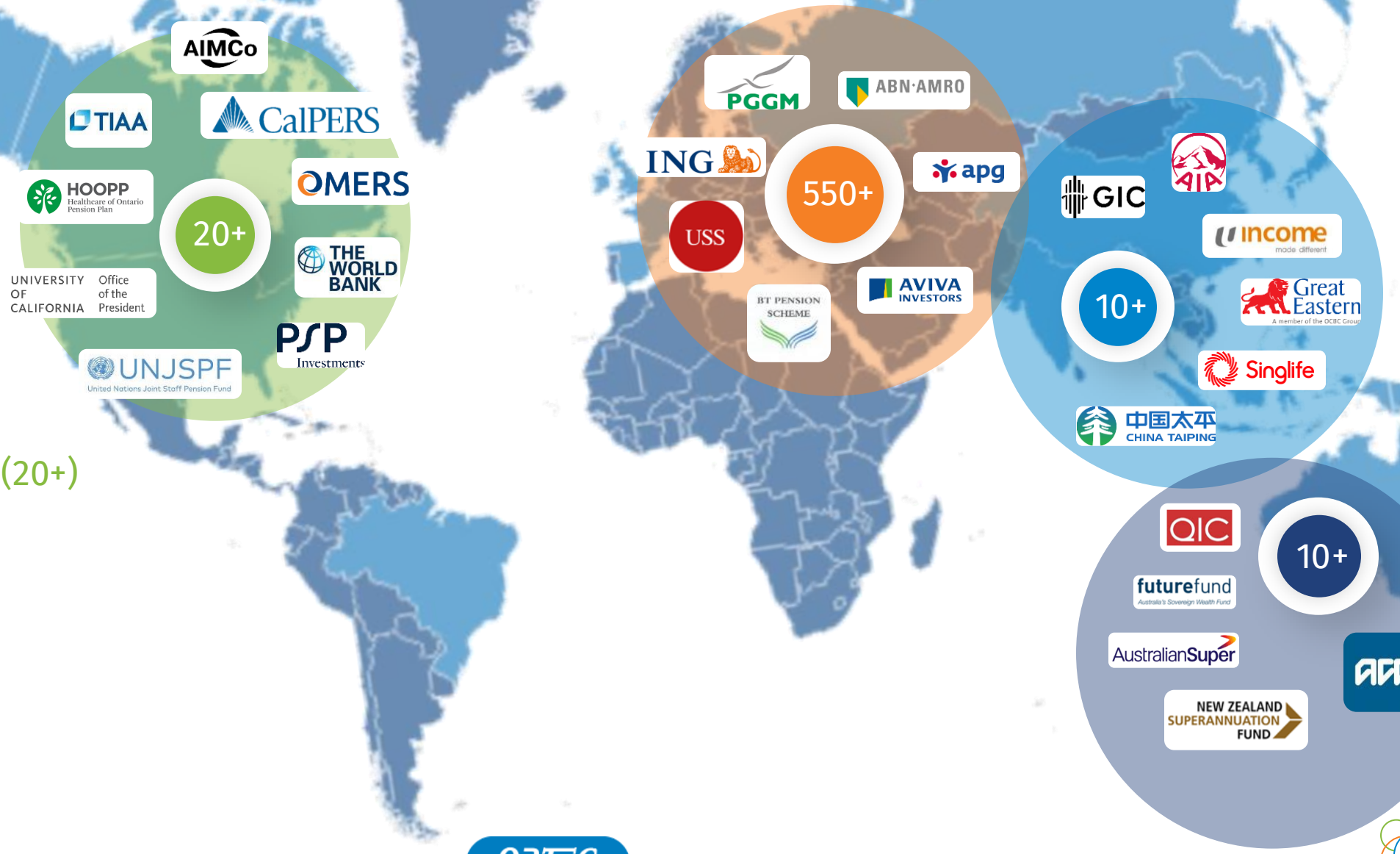
Strategic Asset Allocation & ALM
GLASS
Risk Monitoring and Reporting
Consultancy, ALM studies & Bespoke Projects
Investment Consultancy Risk Management

Economic Scenarios
Real-World Scenario Generator
Risk-Neutral Scenario Generator
Stress Scenarios

Climate Scenarios & Sustainability
ClimateMAPS & Consultancy

Performance Measurement & Attribution
PEARL

96% retention rate – Global Client Base



- North America (20+)
- Europe (550+)
- Asia (10+)
- Pacific (10+)

Process

ALM process

Overview

Assumptions & objectives

Evaluation of current status

Asset allocation analyses

Sensitivity analyses and stress testing

ALM process

Assumptions

Assumptions & objectives → Evaluation of current status → Asset allocation analyses → Sensitivity analyses and stress testing

Define objectives, metrics, and risk tolerances

Model assets and Capital Market Assumptions

Model liabilities & Funding policies

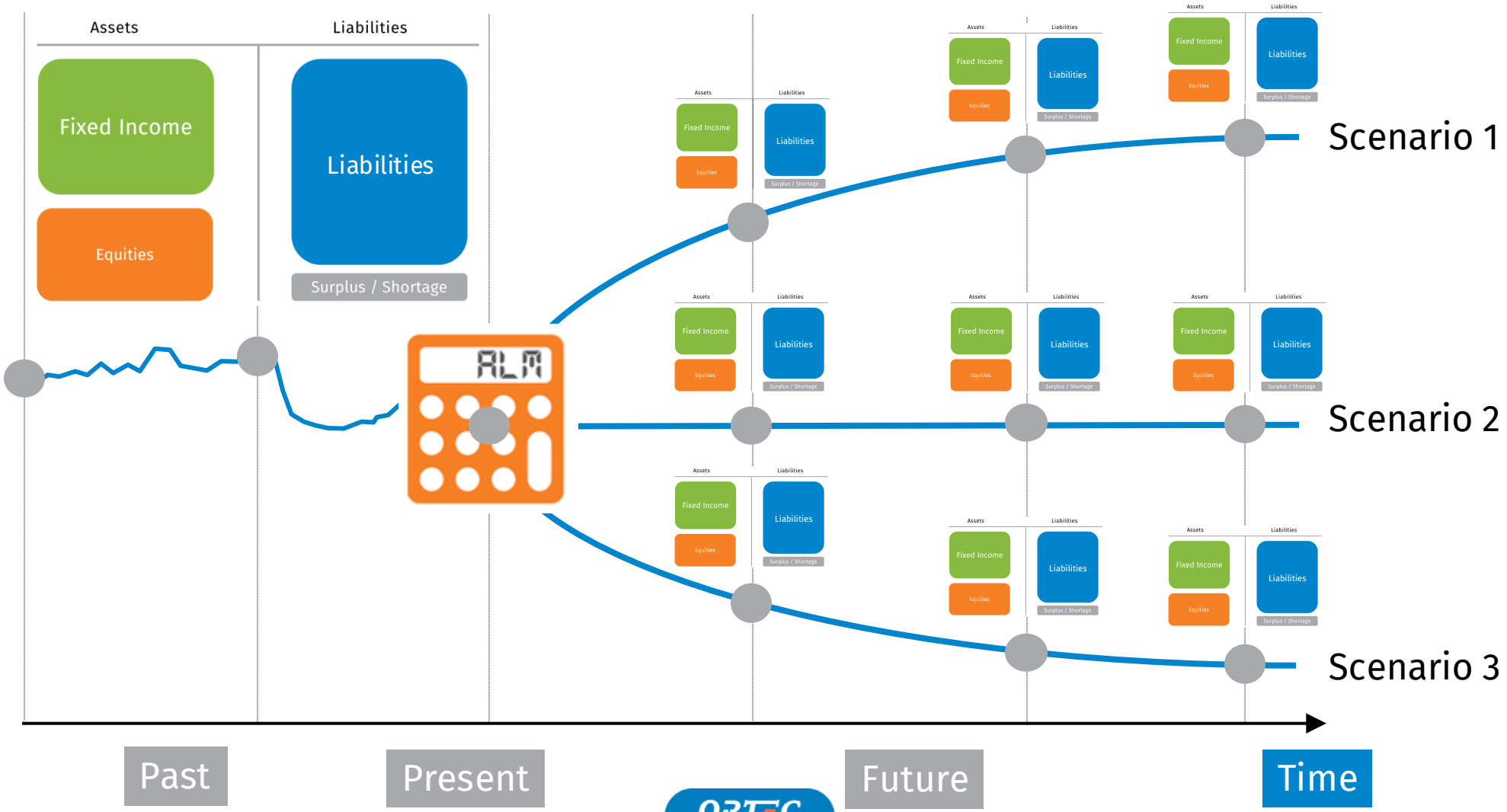
Today

- Presenting Ortec Finance methodology
- Discussing ESG and CMA assumptions

Methodology

Scenario analysis: strategy evaluation

Simulating the balance sheet across different scenarios



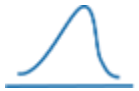
Methodological foundations

Current market conditions

Current economic and financial market conditions drive short-term risk and return:

- Global economy
- Bond yields
- Valuation levels
- Volatility

Stylized facts



Scenarios consistent with robust stylized facts of economies and financial markets:

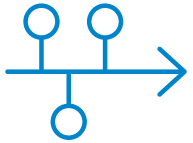
- Term structure of risk and return
- Business cycles
- Time varying volatility and tail risk
- Skewed and fat tailed distributions
- Yield curve dynamics

Risk and return views

Information not captured by historical data (yet) but relevant for future risk and return. Examples:

- Monetary policy
- Trade wars

Long-term Capital Market Assumptions

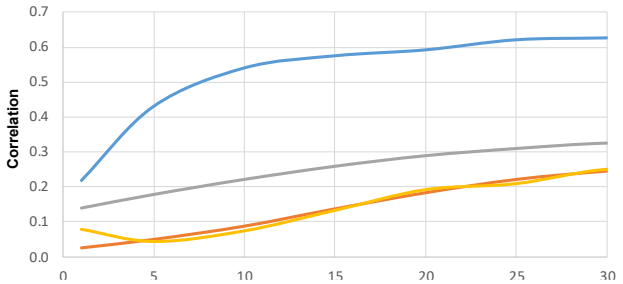


Scenarios converge to uncertain steady state or equilibrium assumptions

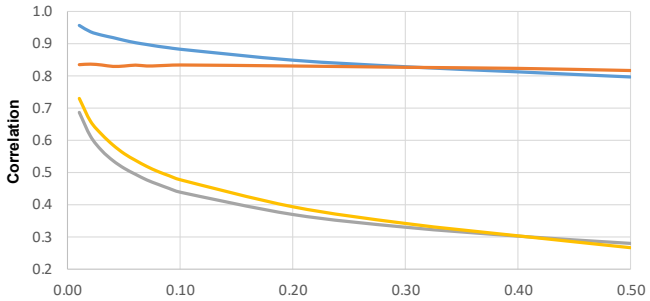
Building-block approach provides **structure** and **consistency**

Scenario assumptions – founded on robust stylized facts

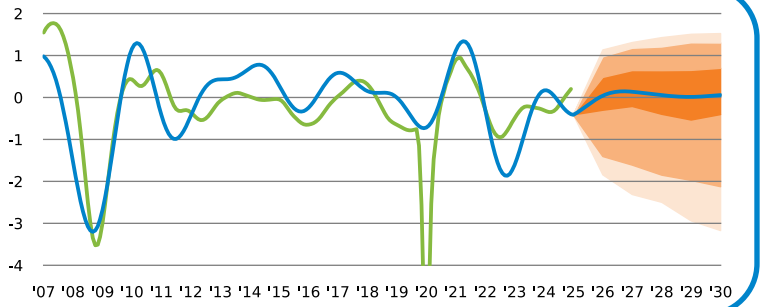
Term structure of risk and return



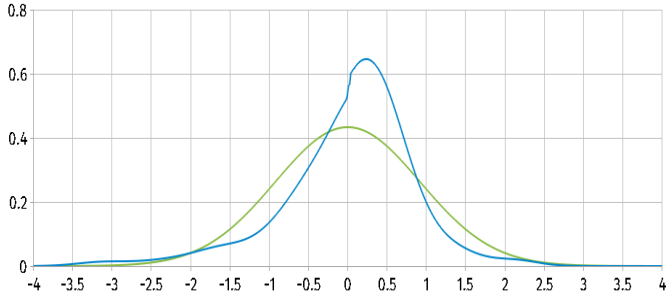
Tail risk and correlations



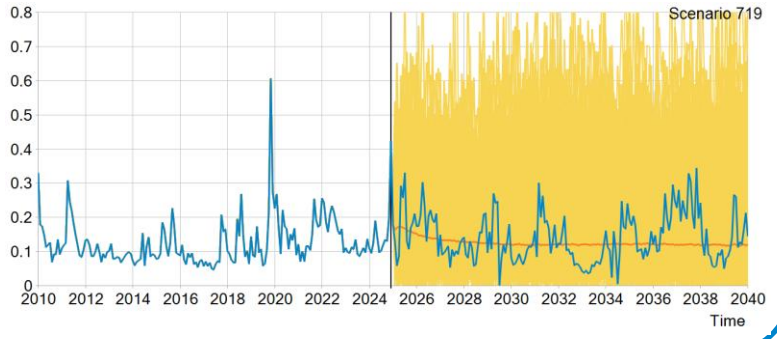
Business cycles



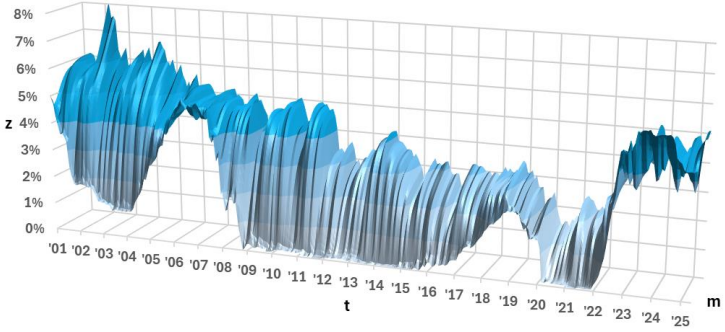
Skewed and fat tailed distributions



Time varying volatility



Yield curve dynamics



Economic Scenario Generator

Scenario construction

- We achieve these stylized facts by projecting our scenarios with a *factor model*
  - Enables us to jointly capture short, medium, and long-term economic cycles and behavior
  - Provides consistency between regions, asset classes and macroeconomics
  - Produces thousands of plausible scenarios, to account for uncertainty

- With the purpose to consistently and realistically project all assets and liabilities (inflation and wage growth sensitive)
  - Allows us to assess the tradeoff between risks and returns on both sides of the balance sheet, considering restrictions and objectives (e.g. COLA, contribution stability, surplus, liquidity) → improves decision making

- Our projections start at current valuations and the current state of the economy

- The projections ultimately (25+ years) trend towards a long-term steady state (also modelled stochastically to reflect parameter uncertainty)

Economic outlook

Long-term expectation (25+ years)

- Long-term neutral world view
- In the long-term a positive, yet lower than historical economic growth
  - Motivation: continuing technological progress (productivity growth) which is counteracted by limited population growth
- Long-term expectation of 2.25% for CPI
  - This is derived from the Federal Reserve's target for Personal Consumption Expenditures (PCE) of 2.0%
  - PCE is typically somewhat below CPI
- US long rates in the medium-term hovering slightly above 4%, after which yields normalize to the long-term expectation of around 3.75%
- These long-term values are not point estimates, but averages of thousands of scenarios.

	Year 10	Long-term expectation
Inflation US	2.5%	2.25%
Long interest rate US (10y)	4.1%	3.75%
Equity World DM (geomean)	6.0%	6.25%

Economic outlook

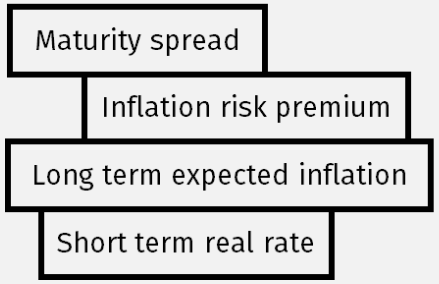
Medium- and long-term

Medium-term expectations (0-10 years)

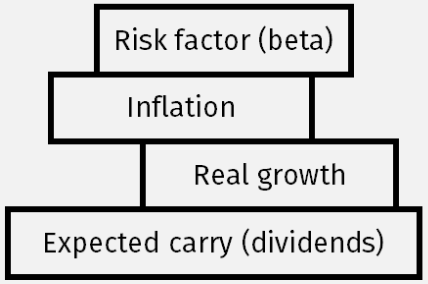
- The current economic cycle and short-term outlook improves, driven by a recovery in investor confidence despite ongoing (trade) policy uncertainty. Nevertheless, the short-term US equity outlook has somewhat deteriorated after a strong rebound in the second quarter.
- For the coming years, long rates are expected to move around their recent levels for most developed markets. This reflects higher for longer dynamics as inflation is anticipated to remain somewhat above central bank target.
- The impact of trade tariffs on inflation remains to be seen. Potential rising costs might be passed on to consumers later in the second half of the year. In the medium term, inflation is expected to stabilize somewhat above central bank target, amongst others, owing to anticipated upward fiscal spending pressures associated with elevated geopolitical risks.
- The outlook is marked by elevated downside risks due to policy uncertainty and geopolitical tensions.

Long-term expectations (25+ years)

Long term yields



Equity returns

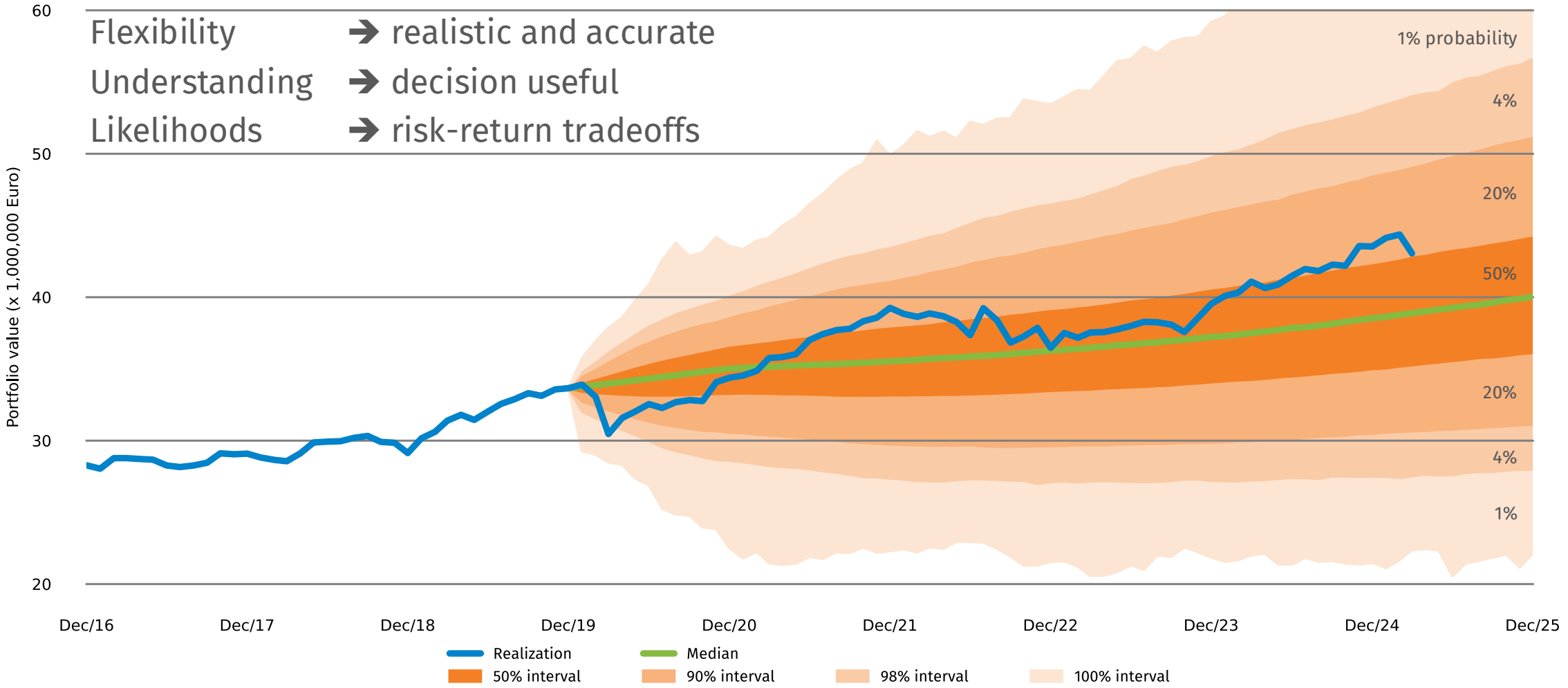


Projections converge (on average) to a steady state or equilibrium. These assumptions are based on a building block approach.

- In the long-term a positive, yet lower than historical economic growth.
  - Motivation: continuing technological progress (productivity growth) which is counteracted by limited population growth
- Interest rates are expected to move slightly decrease in the long term (to levels lower than historical)

Stochastic scenario approach

Simulating portfolios and balance sheets across a wide range of scenarios



Portfolio of 15 million Euro at the end of 2005 simulated forward on a monthly basis assuming an investment strategy with an asset allocation of 50% fixed income (60% government bonds, 40% corporate bonds), 25% global equities and 25% alternatives (including real estate), bi-annual rebalancing and a quarterly 50% hedge of all FX risk. The blue line represents the realized value of the portfolio until the end of March 2025. The orange "fan chart" represents the possible scenario developments of the value of the portfolio based on the December 2019 Ortec Finance scenario outlook in terms of the 1%, 5%, 25%, 75%, 95% and 99% percentiles.

Asset modeling

Modeling approach

Fixed Income

- We model total returns of fixed income using yield curves in combination with a specification of the remaining maturities, coupons, and principals of bond portfolios.
  - Deriving total returns from yield curves provides consistency across different fixed income portfolios
- Term structures for nominal yields, real yields, swap spreads, and credit spreads based on a consistent and parsimonious extended dynamic Nelson-Siegel yield curve model.
  - Captures the shapes, dynamics, and correlations of many yield curves simultaneously
- For corporate credits, an excess (remainder) return captures the impact of rating migration and default risk

Modeling approach

Public equities

- Equites are modelled on a total return basis. We achieve consistency across regions by regressing equity returns for different regions on the same underlying global factors.
  - Distinguish different types of equities, e.g., cap level, low volatility, and/or regional/country differences (small cap vs. Japanese equities) if so desired.
  - We create scenarios for all major developed countries and regions. For emerging markets equity, we model the returns for specific countries (e.g., China) or regions (e.g. Eastern Europe) or “stage of emergence” (emerging vs. frontier).
- The geometric long-term expected returns for traditional equities are based on the building block approach. The building blocks are the forward-looking real earnings growth, inflation, and payout yield.
- Long-term expected total returns for individual countries/regions are derived using the CAPM model, using beta with respect to Developed Market Equities as the base assumption.
- The model is calibrated to reflect a passive investment strategy.

Modeling approach

Private Equity

- We model total return series for:
  - US and European venture capital (VC)
  - Non-venture capital private equity (dominantly buyout)
  - Private equity mezzanine investments (leveraged buyout, fixed income product with equity-like features)

- Each benchmark represents a broadly diversified investment in private equity funds. Broad diversification is assumed along the following lines:
  1. The number of funds in the modeled benchmark.
  2. The different stages of the life cycles of the funds.
  3. The vintages of the funds.

- We apply unsmoothing to the historical data to remove strong autocorrelation and to reflect market risk.

- We model the median manager and assume listed equity betas (after fees) slightly above 1, reflecting small cap similarity
  - Literature finds mixed results on potential outperformance.

- Our model captures stylized facts such as the upward sloping correlation term structure with public equities.

Modeling approach

Private Credit

- For private credit we use a spread-based approach similar to corporate credits (carry + market value gain/loss + remainder)
  - Average maturity of 3 years
  - Floating rate product with fixed spread
  - High recovery rate vs. high yield corporate credits
- Private credit, or direct lending, has a positive return correlation with US HY, leveraged loans, and equities.
- In our standard asset universe, we offer models for direct lending, leveraged loans, infrastructure debt, and structured assets.

Capital Market Assumptions

CMAs in the context of ALM

Key considerations

- For an ALM study, it's important to have a coherent set of assumptions
  - Fit for purpose: projecting both assets and liabilities
    - Consistent modeling of asset returns and macroeconomic variables such as yields and inflation
    - Support investment decisions that aim to e.g. reduce contribution volatility, while maintaining the expected funding ratio
  - Can be used for multiple horizons. Returns not just based on historic observations, but forward-looking and considering trends and cycles

- For the success of an ALM study it is crucial that the stakeholders support the Capital Market Assumptions
  - Assumptions and models can be tailored to your views (e.g. on alpha)

Capital Market Assumptions

Key considerations

- On the next slide, we present the expected returns for a selection of asset classes, based on the Ortec Finance Scenarios (OFS) per end of June 2025
- These Capital Market Assumptions reflect the Ortec Finance house view. The underlying model includes non-normal distributions, non-static correlations, etc. The model is supported by both historical data and forward-looking analysis.
- Returns shown are net-of-fees
- Returns reflect a passive investment strategy (for public assets) or a median manager (for private assets)
- In the next phase of the ALM study, where needed we can tailor the asset modeling to more accurately reflect the investments of TSERS and LGERS. If appropriate, assumptions on alpha can be incorporated as well.

Capital Market Assumptions

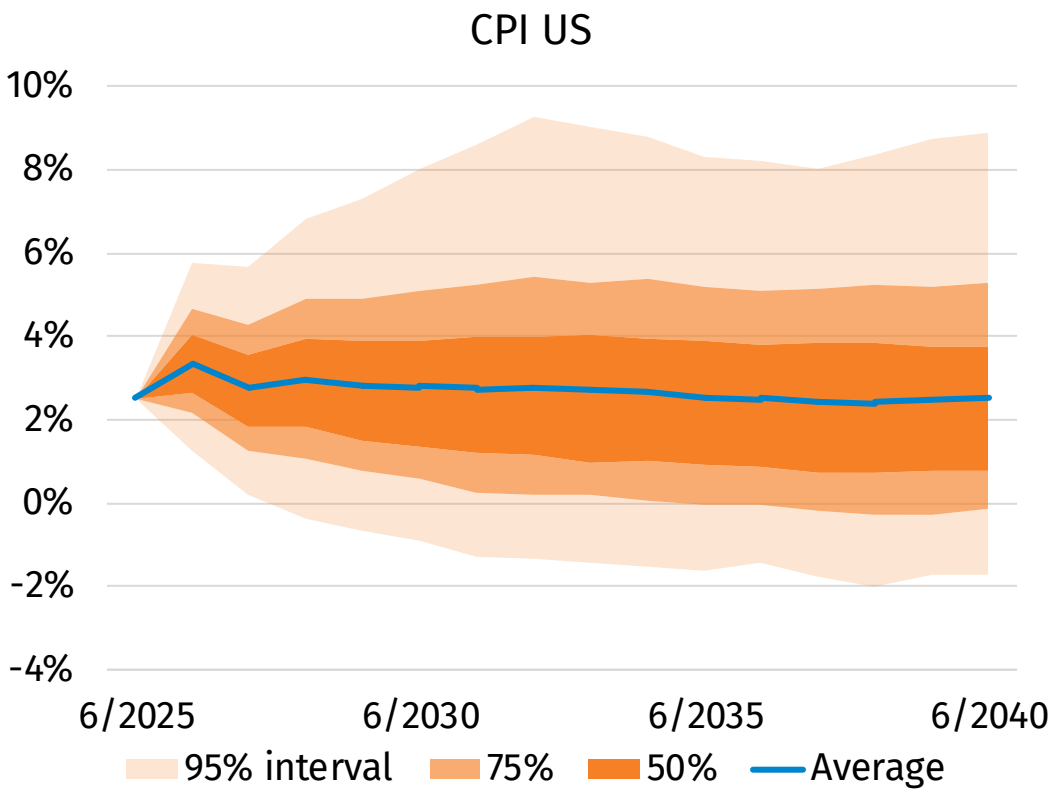
June 2025 Ortec Finance Scenarios (OFS)

June 2025 OFS Net of fees	Year 1-10 Arithmetic return	Year 1-10 Geometric return	Year 1-10 Volatility	Year 1-30 Arithmetic return	Year 1-30 Geometric return	Year 1-30 Volatility
Fixed Income						
Cash US	3.7%	3.7%	1.6%	3.3%	3.3%	2.2%
Government Bonds US (dur 8.8)	5.3%	5.0%	8.5%	4.9%	4.5%	8.6%
Corporate Credits IG US (dur 6.7)	5.4%	5.1%	8.2%	5.5%	5.1%	8.7%
Corporate Credits HY US (dur 3.9)	5.6%	4.6%	14.2%	6.6%	5.6%	14.9%
Leveraged Loans US	5.3%	5.0%	8.8%	5.9%	5.5%	9.2%
Public Equity						
All Country World Index	7.5%	6.2%	17.4%	7.8%	6.2%	18.0%
Private Equity	**9.2%**	**7.6%**	**19.3%**	**9.6%**	**7.9%**	**19.5%**
Buyout US	8.1%	6.3%	20.9%	8.1%	6.1%	21.1%
Venture Capital US	11.3%	6.5%	37.1%	11.2%	6.2%	37.6%
Distressed Debt	9.0%	5.7%	27.2%	10.5%	7.0%	28.3%
Real Estate						
Private Core US	7.2%	5.6%	19.1%	7.3%	5.6%	19.3%
Inflation Sensitive						
US TIPS (dur 2.1)	4.4%	4.3%	3.6%	3.8%	3.8%	4.0%
Private Infrastructure Equity US	8.9%	7.3%	19.8%	8.6%	6.9%	19.8%
Farmland	6.2%	5.6%	10.9%	5.9%	5.4%	10.9%
Timberland	6.1%	5.4%	12.5%	6.0%	5.3%	12.6%
Commodities (Bloomberg)	7.2%	5.6%	19.1%	6.2%	4.6%	19.1%

Capital Market Assumptions

Inflation

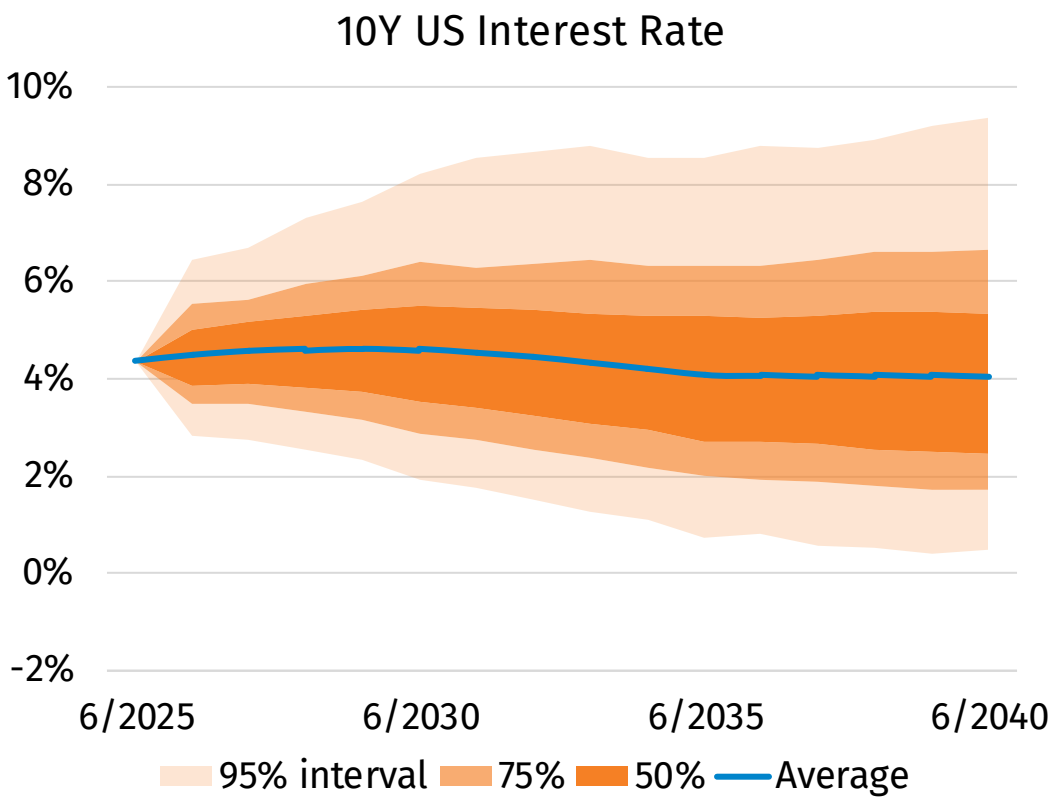
- The projection of the liabilities is dependent on CPI and Wage Inflation
- Both CPI and Wage Inflation are modelled stochastically
- Long-term expectation of 2.25% for CPI
  - This is derived from the Federal Reserve's target for Personal Consumption Expenditures (PCE) of 2.0%
  - PCE is typically somewhat below CPI
- Realized nominal wage inflation is stochastically modelled as CPI US + real wage growth US
  - Based on historical data analysis, assume a long-term average real wage growth of 0%
- Medium-term inflation is expected to stabilize above central bank target amongst others owing to anticipated upward fiscal spending pressures and elevated geopolitical risks.

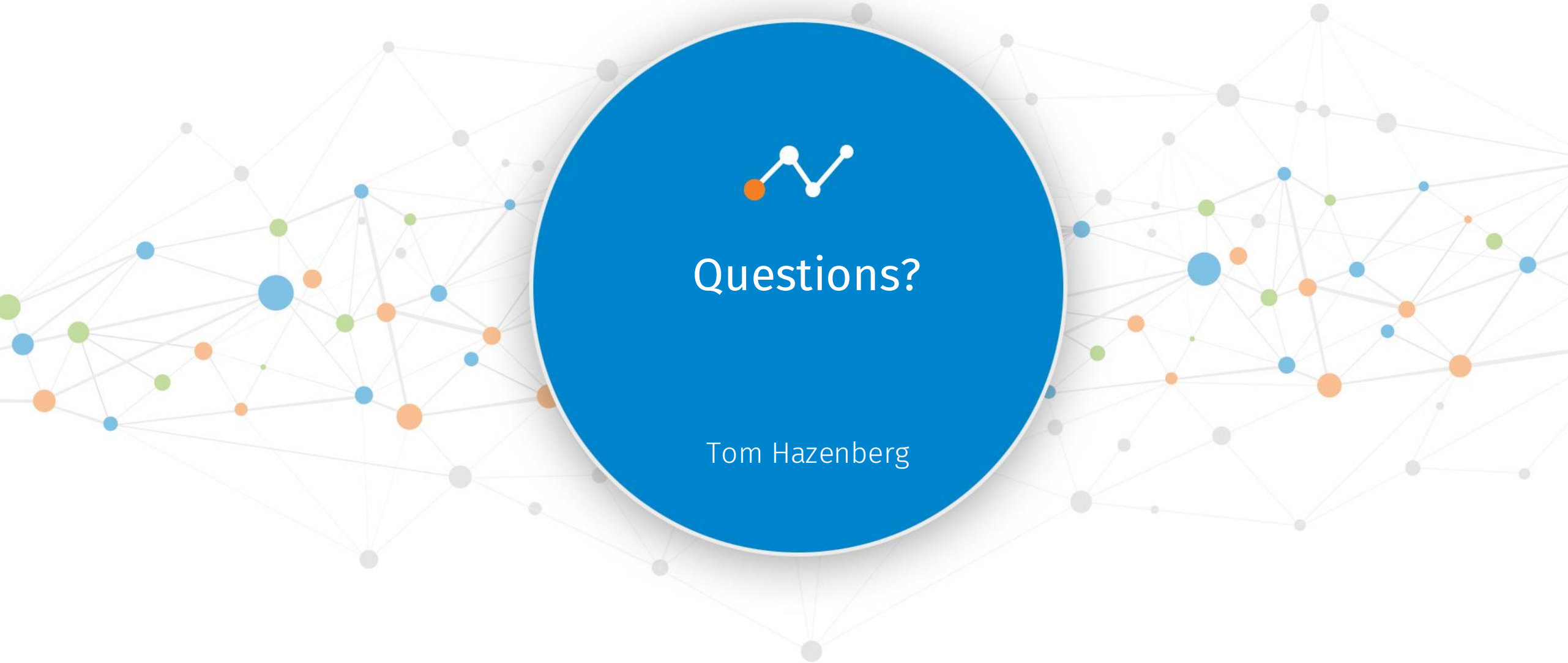


Capital Market Assumptions

Interest rates

- Shown is the development of the long rate for US treasuries
- It starts at 4.4% per end of June 2025 and, on average, stays close to 4% for the next 15 years
- In the medium term, long rates are expected to move around their recent levels for most developed markets. This reflects higher for longer dynamics as inflation is anticipated to remain somewhat above central bank target





Questions?

Tom Hazenberg

ORTEC FINANCE

Appendix

Modeling approach

Real Estate

- We model total return series for direct real estate (on sector level), private (core) real estate, and listed real estate.
- For direct and private (core) real estate, we apply unsmoothing to the historical data to remove strong autocorrelation and to reflect market risk.
- Private real estate has a strongly positive correlation with direct real estate and GDP growth. Upward sloping correlation term structure with CPI.

Modeling approach

Private Infrastructure Equity

- We model total return series for private infrastructure equity Global, Americas and Europe.
  - **Europe**: 55% mainland Europe and 45% UK
  - **Americas**: US (45%), Canada (10%), Brazil (35%), Chile (10%).
  - **World**: US (10%), Europe (40%), UK (30%) and Asia-Pacific (20%)
- Leverage: private infrastructure has a Loan-to-Value ratio of 45% similar to direct real estate.
- For private infrastructure, we do not apply unsmoothing to the historical data since we have data based on market prices.
- Upward sloping correlation term structure with CPI.