BIS

The Strategic Asset Allocation Process

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# The Strategic Asset Allocation Process

1. **Reserve manager returns**

2. Elements of a sound asset allocation framework

    a. Factor-based approach

    b. Macro foundation

3. BIS Asset Allocation Module (BAAM)

    a. Sound portfolio construction approaches

A history of reserve manager returns

- Historically, reserve managers have reaped the benefits of diversification, term premiums and spread returns.

Historical risk and return relationship of selected asset classes*
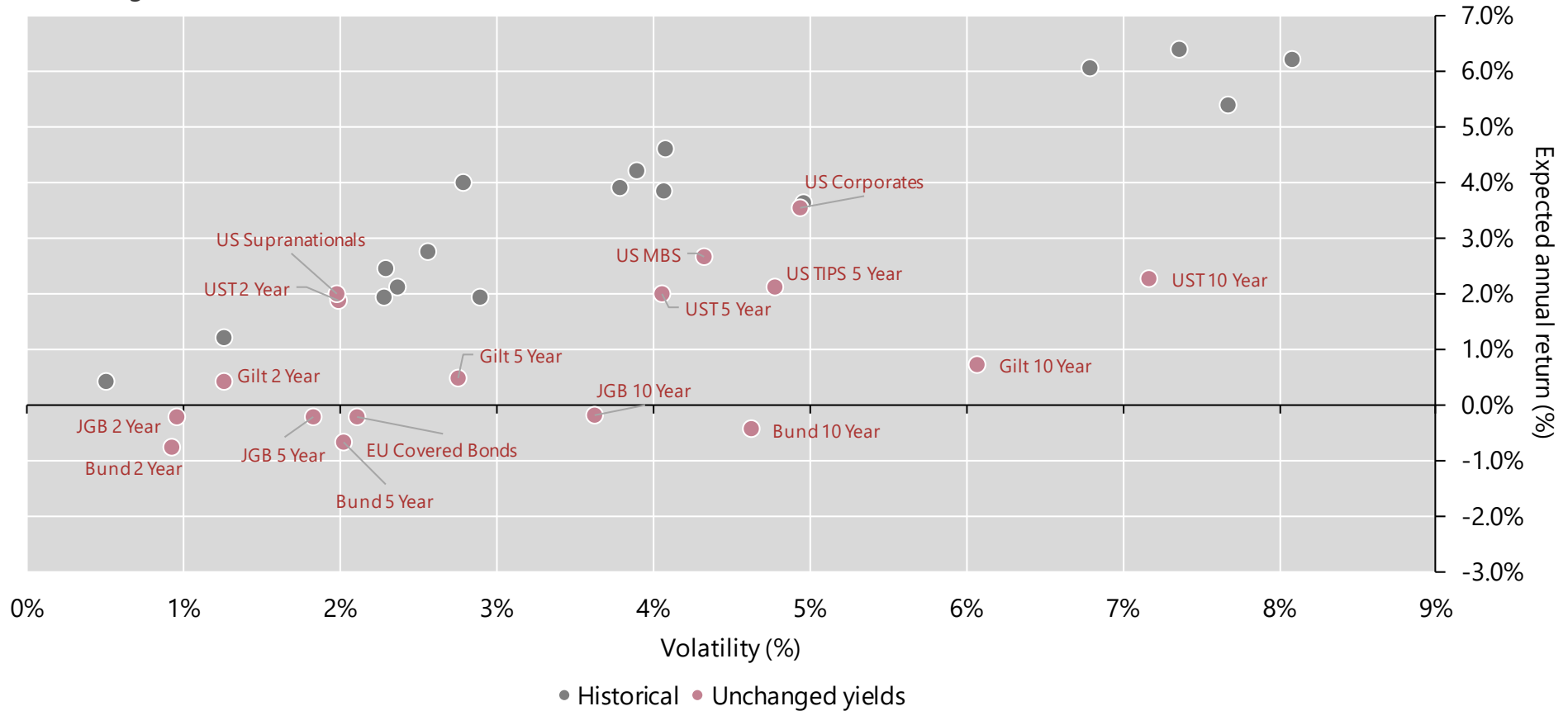Percentage
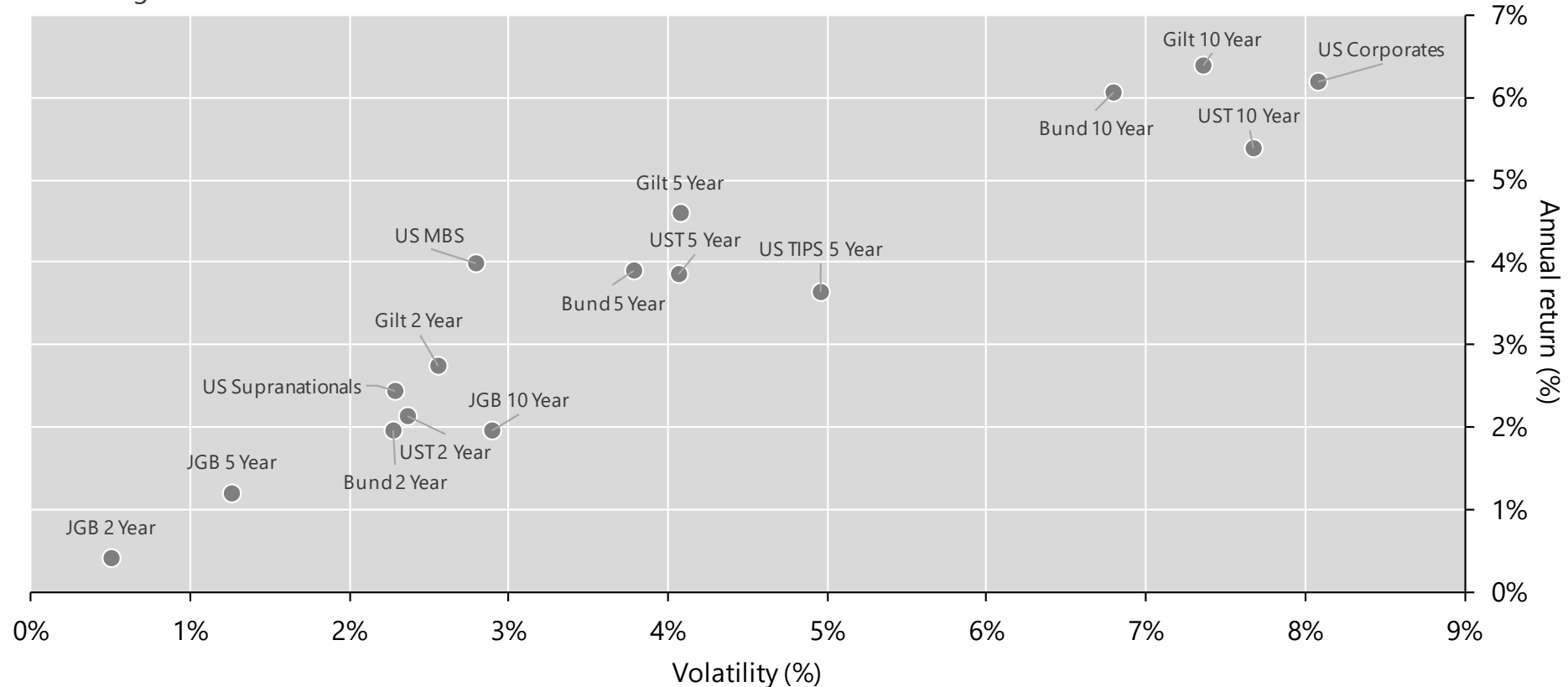
*Yearly average returns on common history from 1953 to 2018. All returns in local currency.
Source: BIS Asset Management Asset Allocation Module (BAAM).

The future of reserve manager returns

- However, under several forward-looking scenarios, the traditional relationships that we know start to breakdown.

Projected risk and return relationship of selected asset classes under an unchanged yields scenario*
Percentage

● Historical ● Unchanged yields

*"Increasing yields" and "Unchanged yields" are forward-looking regimes with annualised returns over a five-year projection horizon.
Source: BIS Asset Management Asset Allocation Module (BAAM).

The future of reserve manager returns

- However, under several forward-looking scenarios, the traditional relationships that we know start to breakdown.

Projected risk and return relationship of selected asset classes under different scenarios*
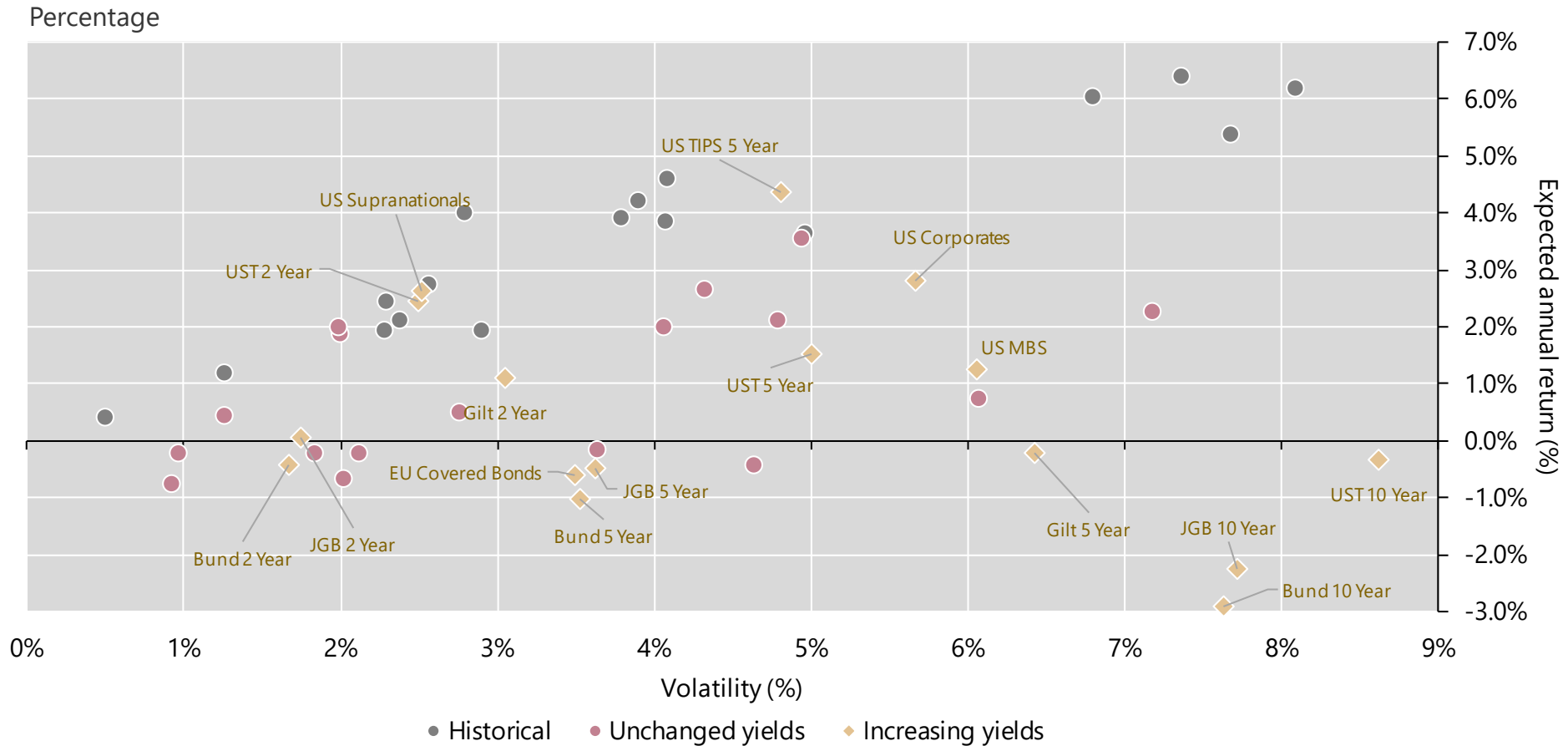Percentage

*"Increasing yields" and "Unchanged yields" are forward-looking regimes with annualised returns over a five-year projection horizon.
Source: BIS Asset Management Asset Allocation Module (BAAM).

The future of reserve managers' investment strategies

● A more systematic look at these relationships renders the reserve manager with distinct investment strategies.

Projected risk and return relationship of selected asset classes under different scenarios*
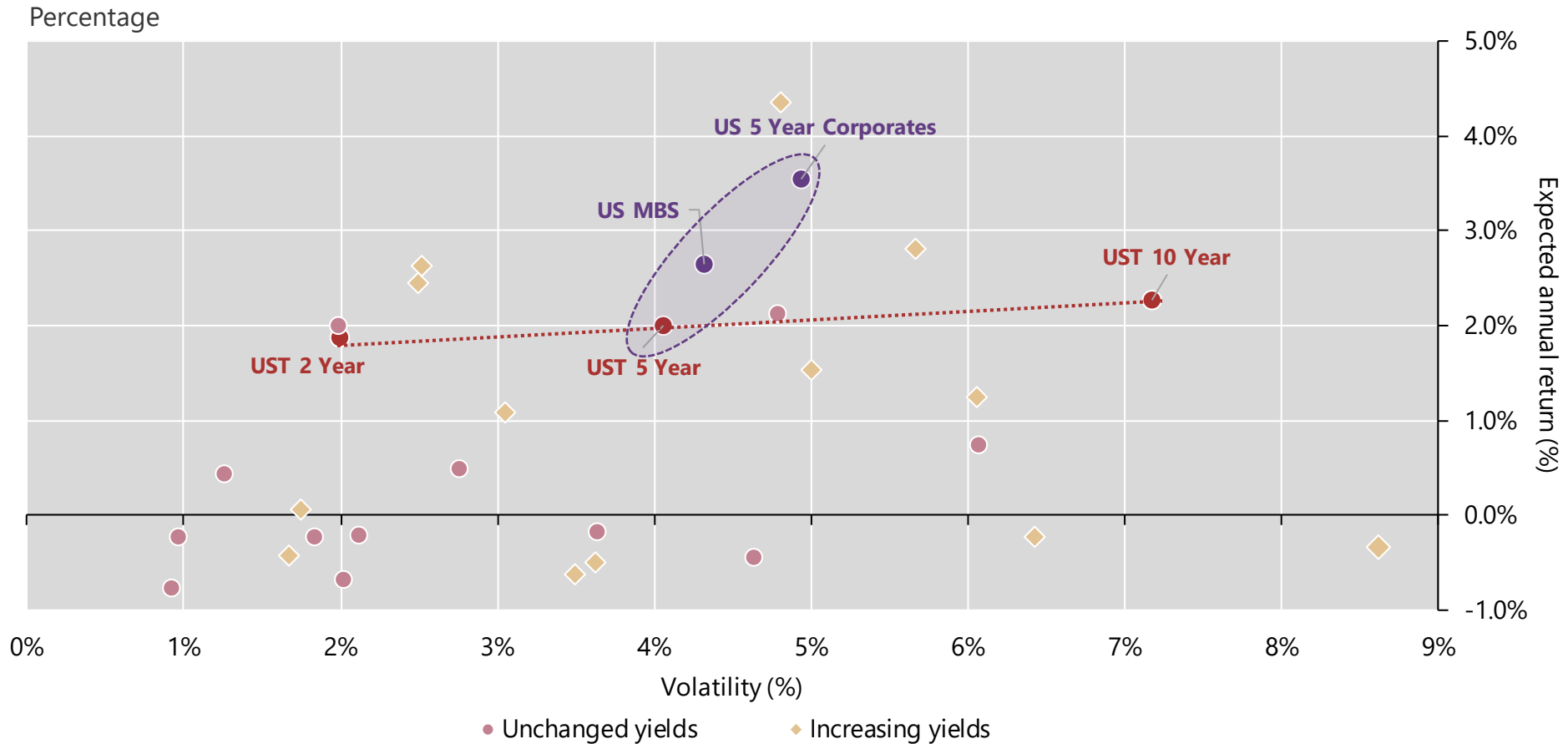Percentage

*"Increasing yields" and "Unchanged yields" are forward-looking regimes with annualised returns over a five-year projection horizon.
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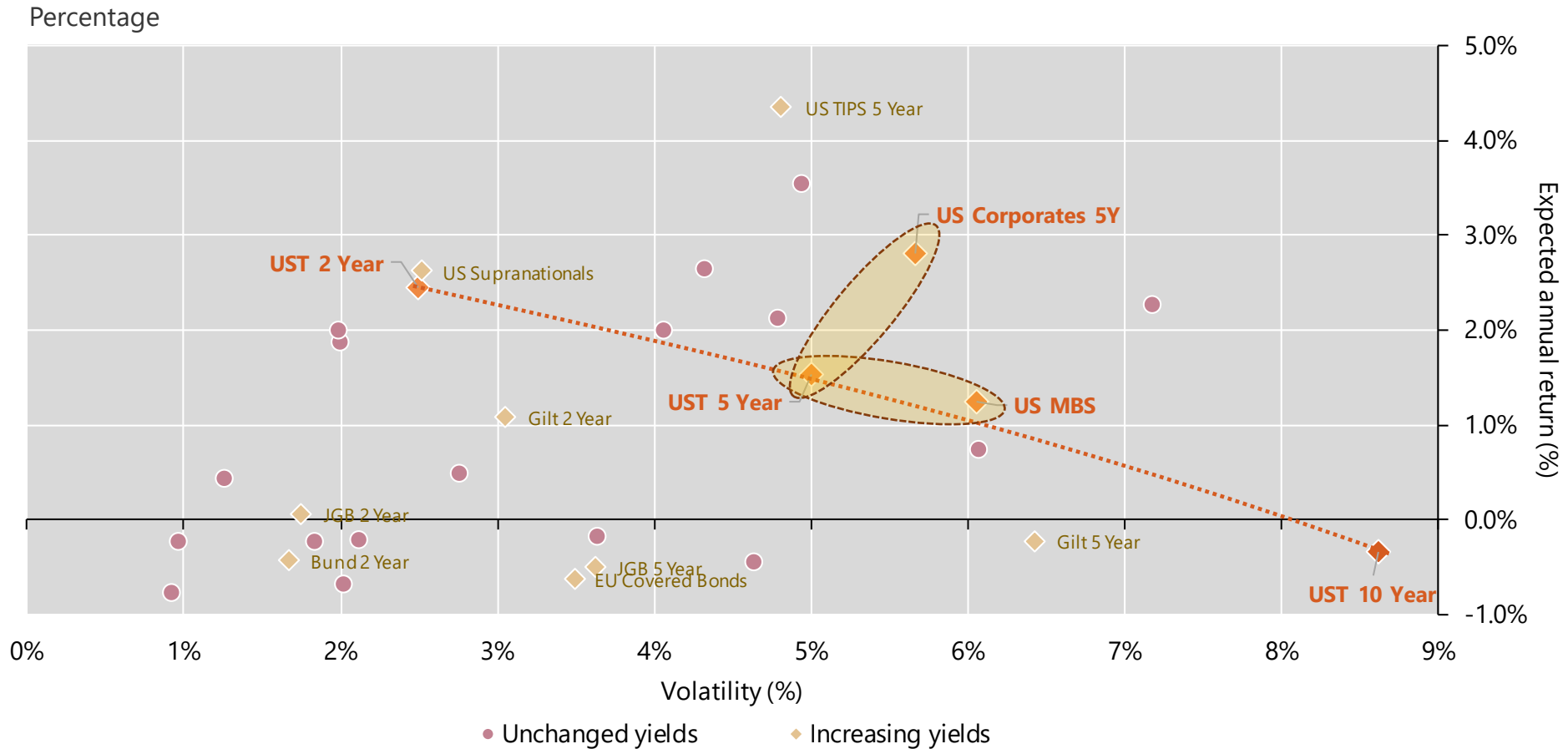Percentage

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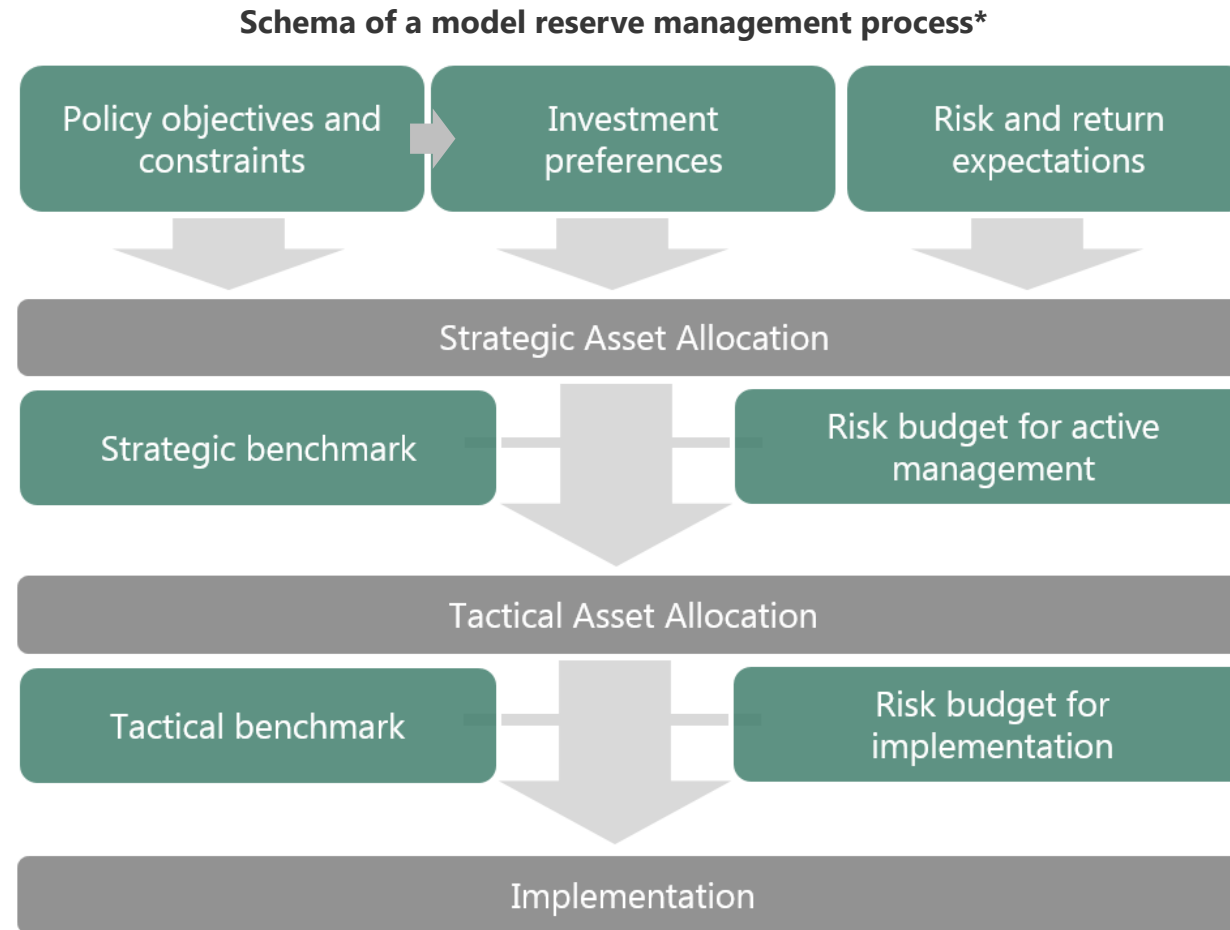Source: BIS Asset Management Asset Allocation Module (BAAM).

How can we tell in which regime we will be?

The Strategic Asset Allocation Process

1. Reserve manager returns

2. **Elements of a sound asset allocation framework**

   a. Factor-based approach

   b. Macro foundation

3. BIS Asset Allocation Module (BAAM)

   a. Sound portfolio construction approaches

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Reserve management framework

- We need a framework and a process.

Schema of a model reserve management process*

| Policy objectives and constraints | → | Investment preferences | | Risk and return expectations |

Strategic Asset Allocation

| Strategic benchmark | | Risk budget for active management |

Tactical Asset Allocation

| Tactical benchmark | | Risk budget for implementation |

Implementation

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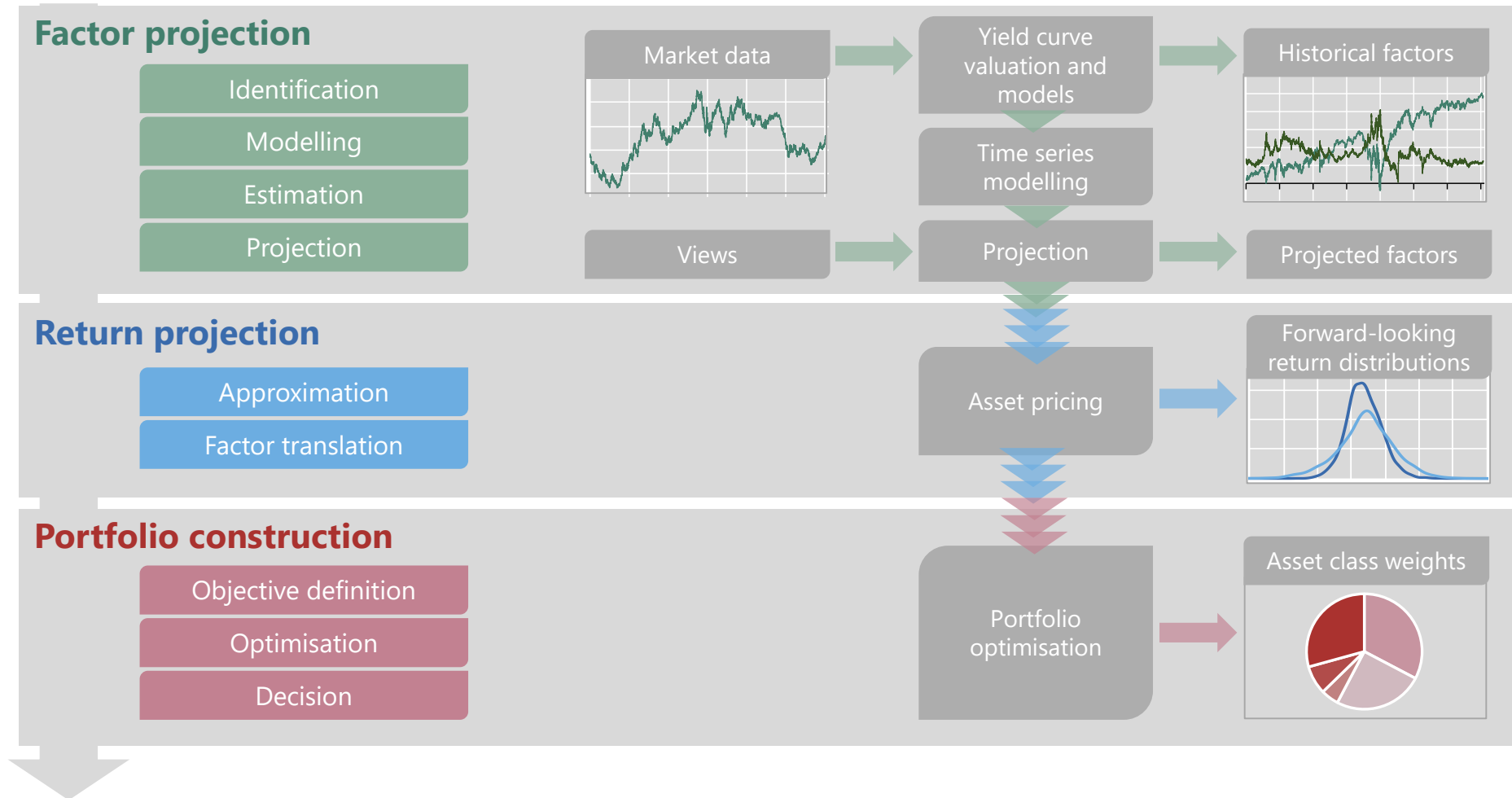# Elements of a Sound Asset Allocation Framework

1. A careful assessment of **objectives and constraints**
   - Policy objectives & constraints
   - Investment preferences

2. A **comprehensive assessment** of risks (interest rate, credit and currency and other market risks)

3. Forward looking analysis of **risk factors** instead of historical returns

4. Analysis of alternative views of the world based on a **macro foundation**

5. **Careful application** of quantitative portfolio construction tools

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The factor-based approach: summary

Schematic representation of a factor-based approach to portfolio construction

Factor projection
- Identification
- Modelling
- Estimation
- Projection

Market data → Yield curve valuation and models → Historical factors

Time series modelling

Views → Projection → Projected factors

Return projection
- Approximation
- Factor translation

Asset pricing → Forward-looking return distributions

Portfolio construction
- Objective definition
- Optimisation
- Decision

Portfolio optimisation → Asset class weights

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The link between macro and financial variables

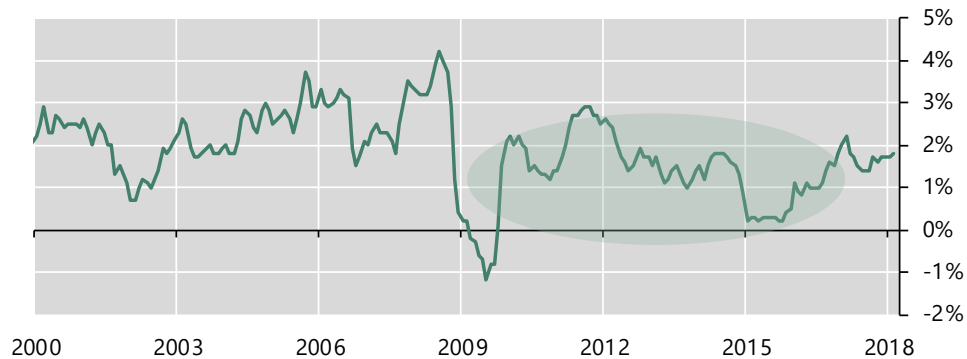● We must start by establishing a link between macroeconomic and financial variables.

Evolution of the United States output gap
Percentage points
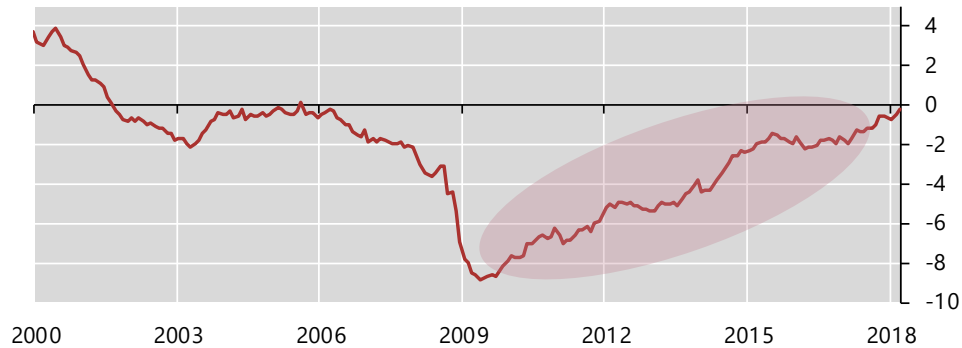
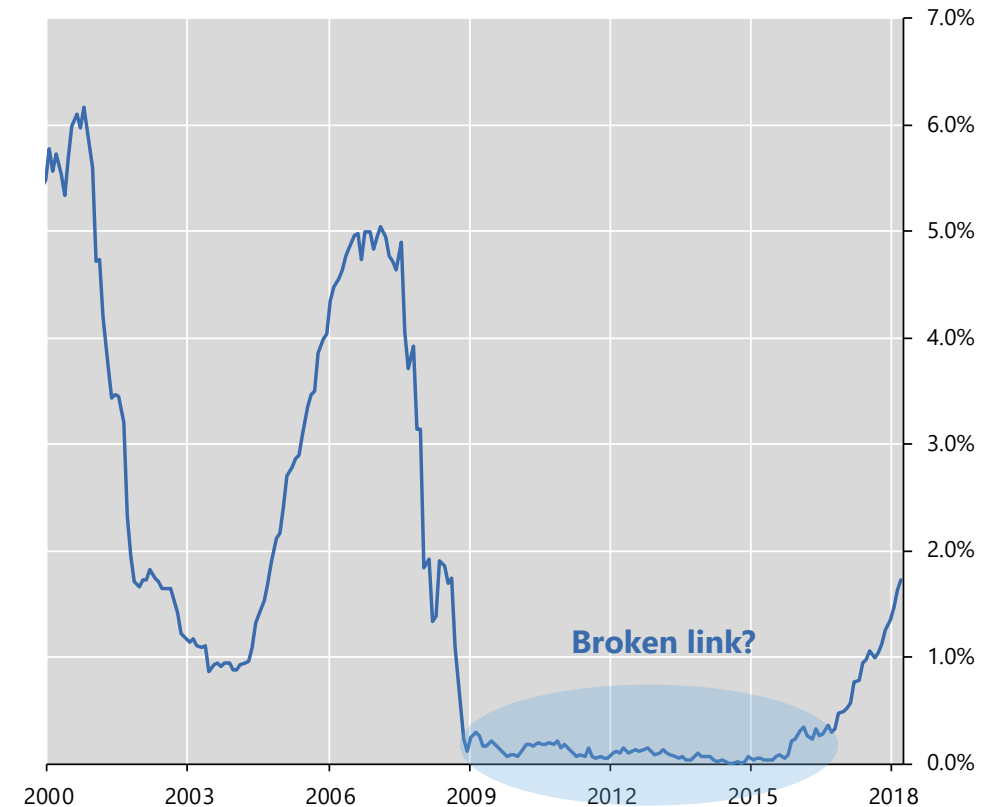**Evolution of the United States PCE inflation**
Yearly percent change

Evolution of the US Federal Funds Rate
Percentage

Broken link?

Source: BIS Asset Management Asset Allocation Module (BAAM).

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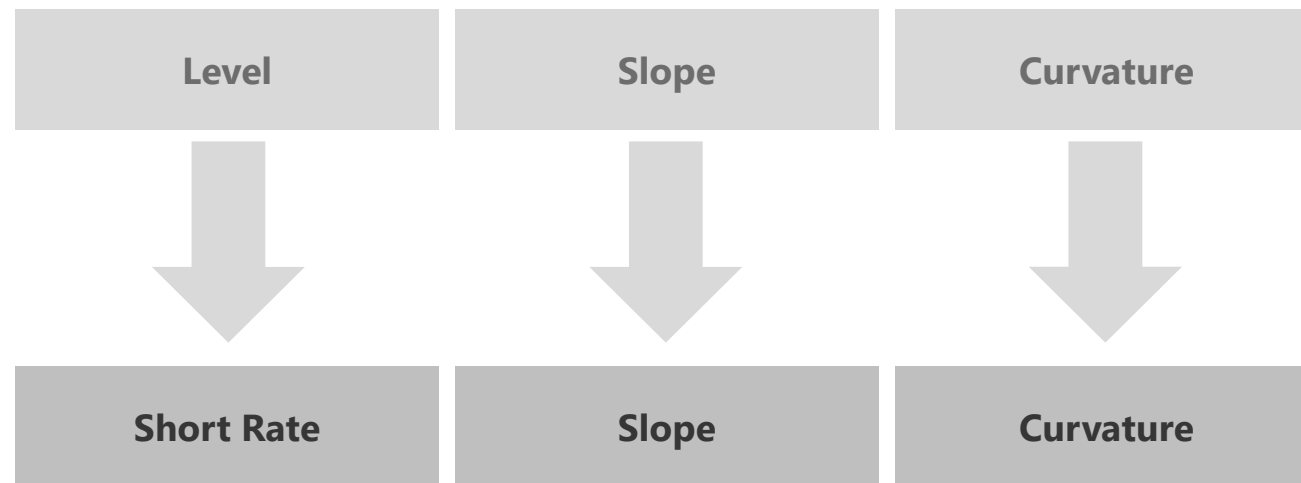
Fixing the broken link

- We propose three steps to rebuild the relationship between macro and financial variables.

1

Extending the dynamic Nelson-Siegel term structure model (Diebold and Li, 2006)

- The extension allows to move away from abstract definitions of the "level" factor

- Integrating large scale factor models

- Rotated version with short rate, slope and curvature (Nyholm, 2015)

Yield curve factors under the dynamic Nelson Siegel and the rotated version

Level	Slope	Curvature

Short Rate	Slope	Curvature

$$y_t(\tau) = \beta_1 + \beta_2 \left(1 - \frac{1 - e^{-\lambda \tau}}{\lambda \tau}\right) + \beta_3 \left(\frac{1 - e^{-\lambda \tau}}{\lambda \tau} - e^{-\lambda \tau}\right)$$
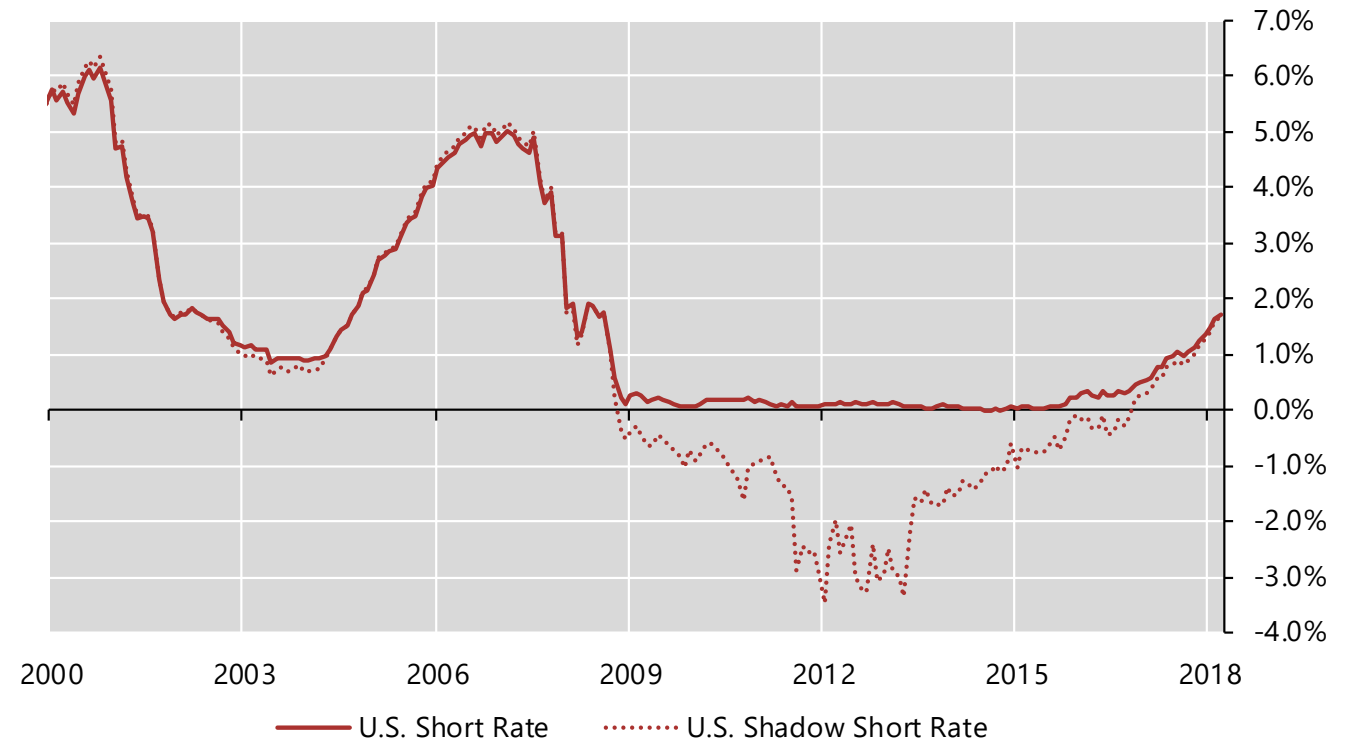
Fixing the broken link

- We propose three steps to rebuild the relationship between macro and financial variables.

2

Modelling the short rate in its *shadow* version

- The shadow yield curve is a hypothetical yield curve that would exist if Physical currency were not available

- Replication of Krippner (2011, 2015) in a Nelson-Siegel Framework

- Co-operation with ECB's Capital Markets Division

Evolution of the short rate and the shadow short rate
Percentage

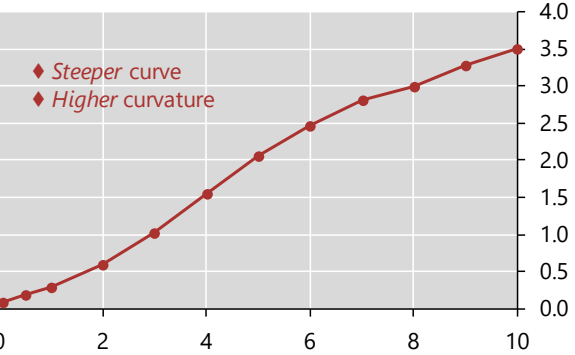U.S. Short Rate ·········· U.S. Shadow Short Rate

Source: BIS Asset Management Asset Allocation Module (BAAM).
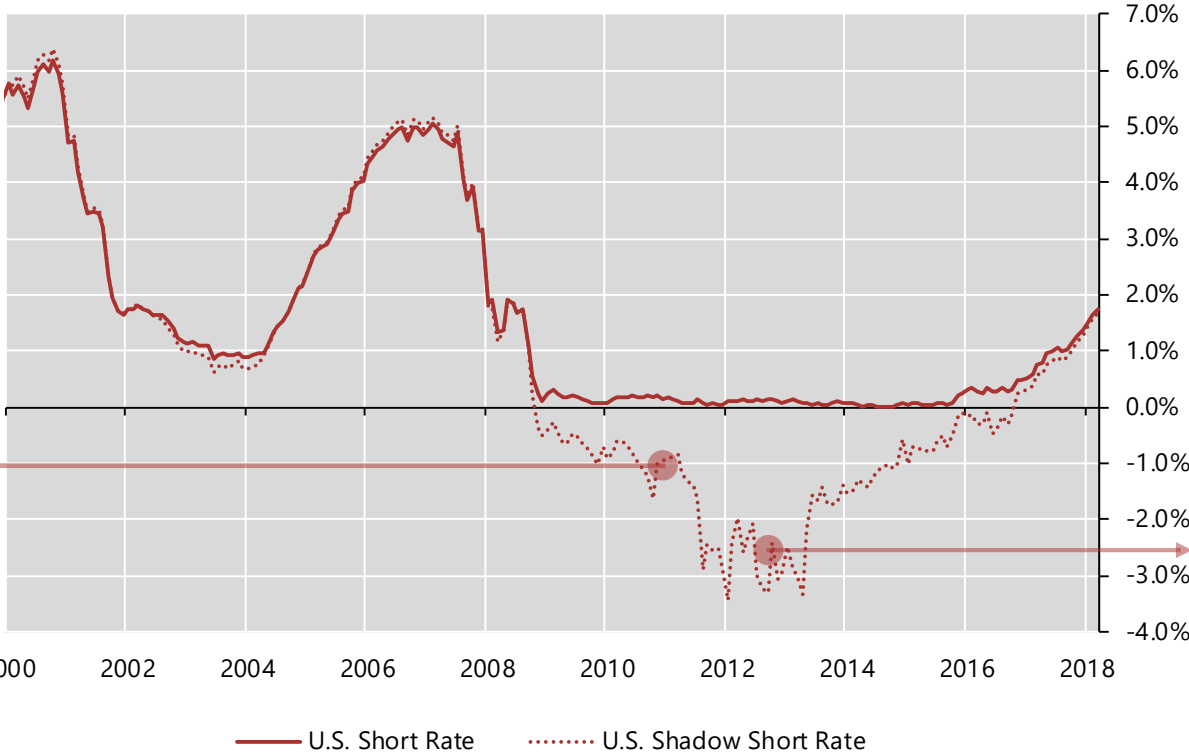
Fixing the broken link

- The shadow short rate captures the full yield curve dynamics in one single number.

US government yield curve as of the end of November 2010
Percentage

♦ *Steeper* curve
♦ *Higher* curvature

Source: BIS Asset Management Asset Allocation Module (BAAM).

Evolution of the short rate and the shadow short rate
Percentage

—— U.S. Short Rate   ······· U.S. Shadow Short Rate

Source: BIS Asset Management Asset Allocation Module (BAAM).

US government yield curve as of the end of November 2010
Percentage
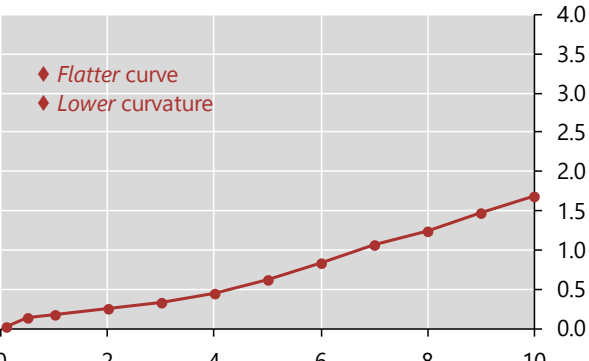
♦ *Flatter* curve
♦ *Lower* curvature

Source: BIS Asset Management Asset Allocation Module (BAAM).

Fixing the broken link: does it work?

- We propose three steps to rebuild the relationship between macro and financial variables.

2

Modelling the short rate in its _shadow_ version

- The shadow yield curve is a hypothetical yield curve that would exist if Physical currency were not available

- Replication of Krippner (2011, 2015) in a Nelson-Siegel Framework

- Co-operation with ECB's Capital Markets Division

Evolution of the shadow short rate and Consensus Expectations for the Federal Funds Rate
Percentage

Sources: BIS Asset Management Asset Allocation Module (BAAM), Consensus Expectations.

Fixing the broken link: does it work?

- We propose three steps to rebuild the relationship between macro and financial variables.
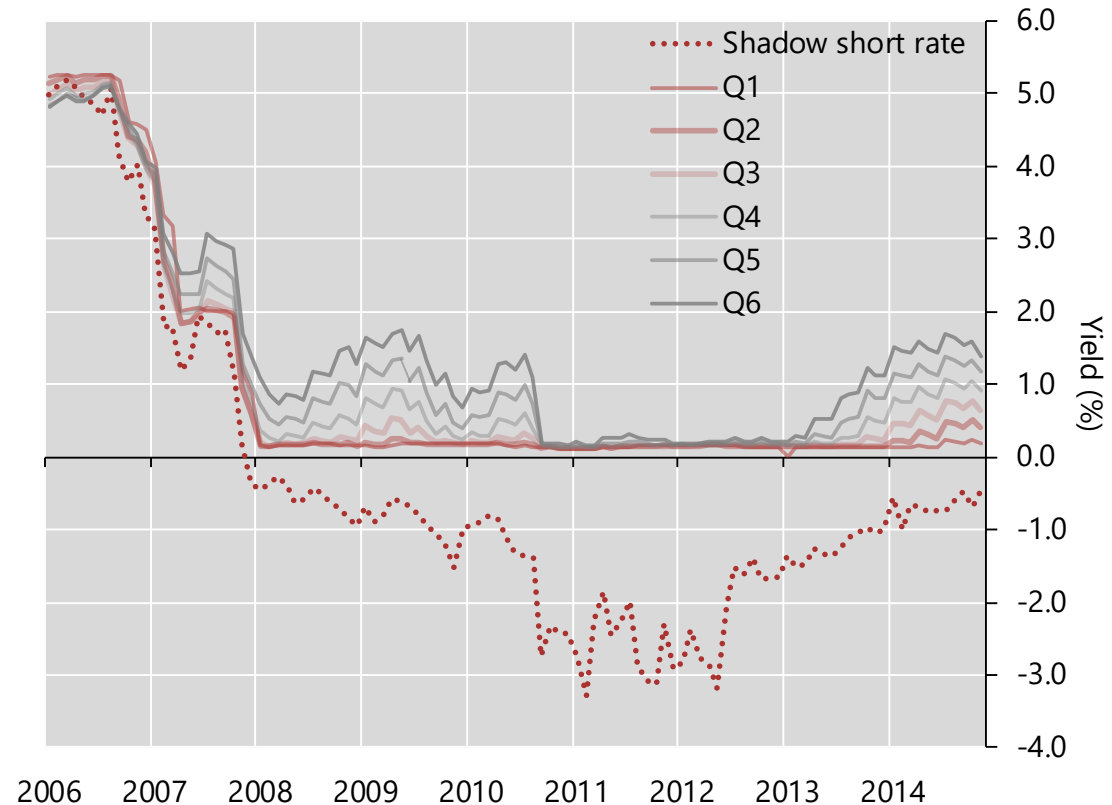
(2)

Modelling the short rate in its *shadow* version

- The shadow yield curve is a hypothetical yield curve that would exist if Physical currency were not available

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- Co-operation with ECB's Capital Markets Division

Evolution of the shadow short rate and Federal Funds Rate futures prices
Percentage

Sources: BIS Asset Management Asset Allocation Module (BAAM), Consensus Expectations.

Fixing the broken link

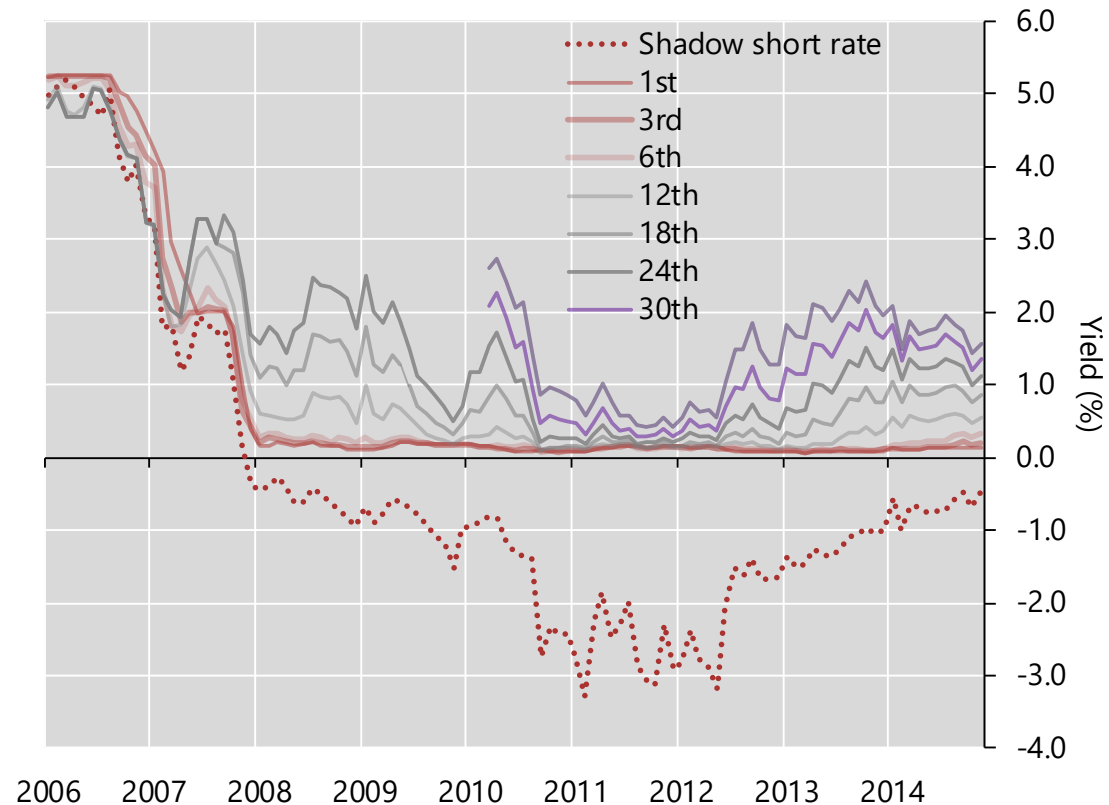- We propose three steps to rebuild the relationship between macro and financial variables.

3

Form a Taylor-rule based projection of the *shadow* short rate

- Directly modelling the short rate allows to easily integrate assumptions on the policy rate setting into the yield curve modelling.

- Specification with output gap and inflation

- Policy inertia incorporated

Taylor rule under the rotated Nelson-Siegel model

$$s_t = \alpha + \beta(E_t[\pi_{t+1}] - \pi^*) + \gamma x_t + \delta s_{t-1} + \epsilon_t$$

s_t: Short rate factor in the rotated NS model

$E_t[\pi_{t+1}]$:   Expected inflation

π^*:   Inflation target

x_t: Output gap

Macro-based yield curve factor projections

- We are now in a position to ground our forecasts of yield curve factors in macroeconomic foundations.
- We can rely on a mean-reverting approach to projecting GDP growth and expected inflation, or specify views.
- In either case, our yield curve factors will be a function of the trajectory of macro variables.
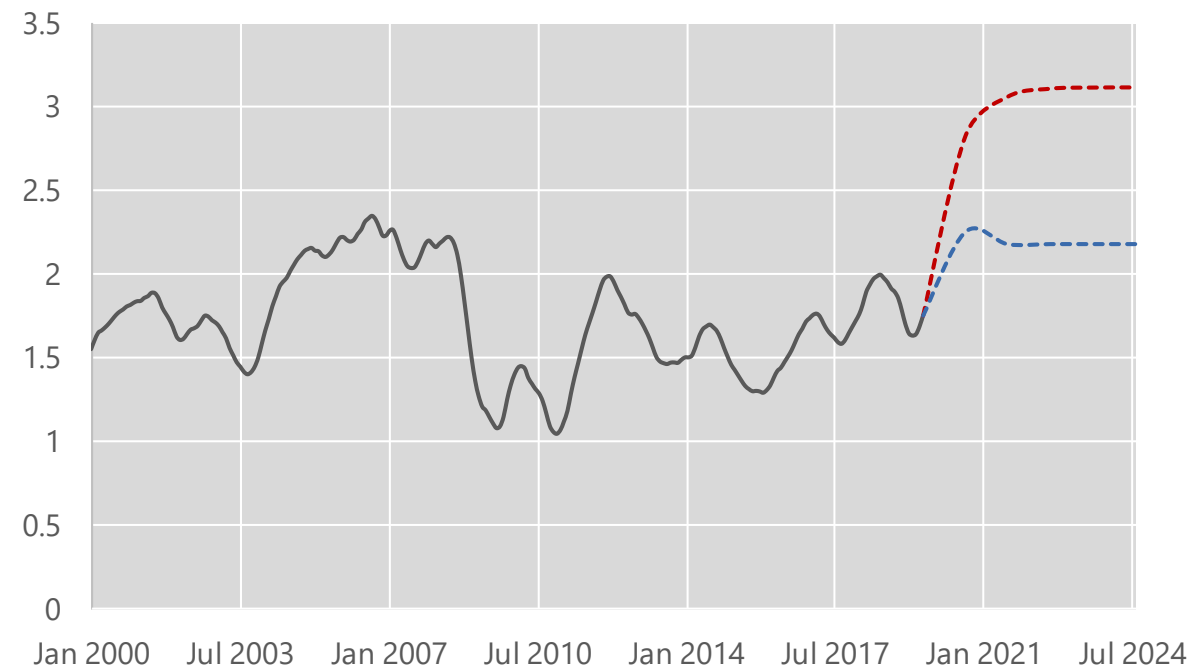

US Output Gap
Percentage points

Expected US Inflation (UCSV approach)
Percentage points

Mean reversion   Consensus

Note: Factors estimated using data since 1953

Macro-based yield curve factor projections

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- We can rely on a mean-reverting approach to projecting GDP growth and expected inflation, or specify views.
- In either case, our yield curve factors will be a function of the trajectory of macro variables.

First yield curve factor (shadow short rate) for the US
Percentage points
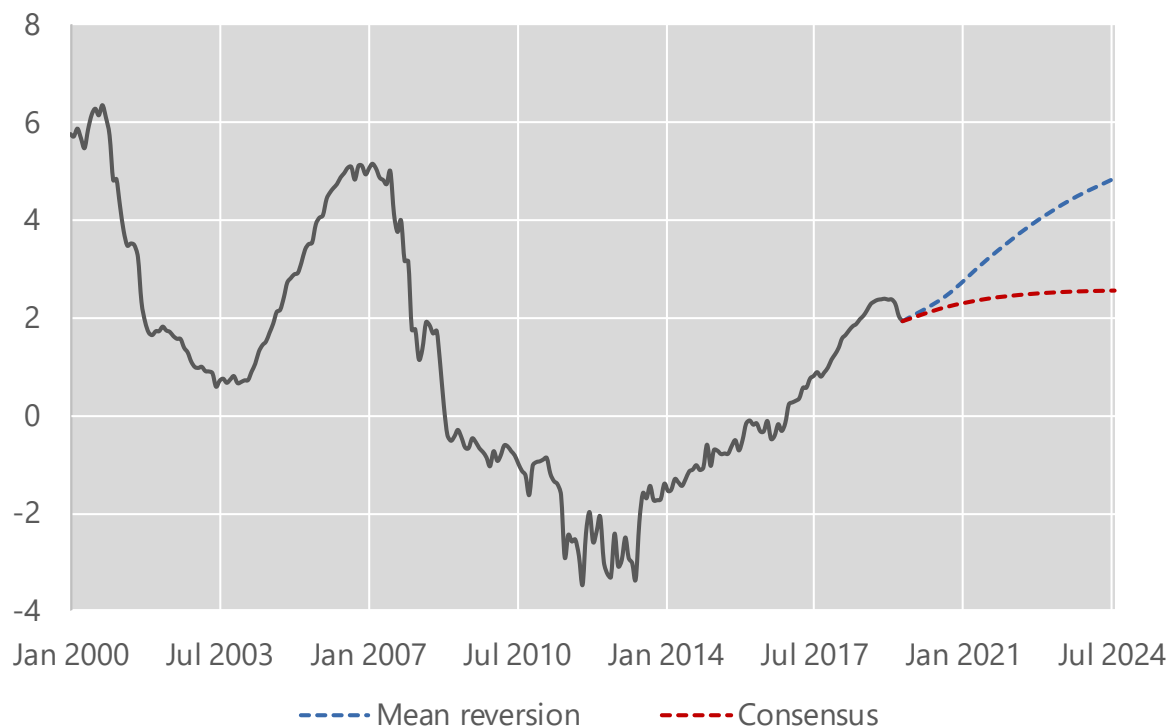
Second yield curve factor (slope) for the US
Percentage points

---- Mean reversion   ---- Consensus
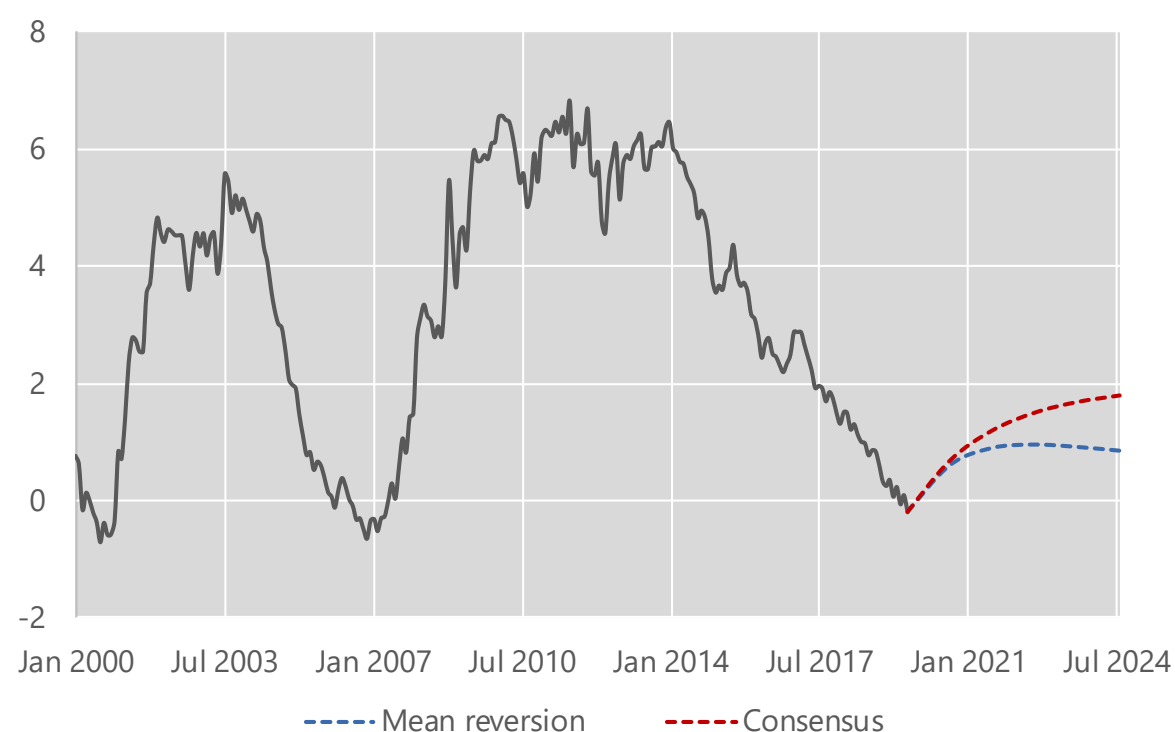
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BAAM

- A comprehensive, collaboratively developed software solution that provides forward-looking perspective on asset returns and allocations to aid the investment decision-making process of official-sector investors.

BAAM is comprehensive,   **collaborative,**   **...and forward looking.**
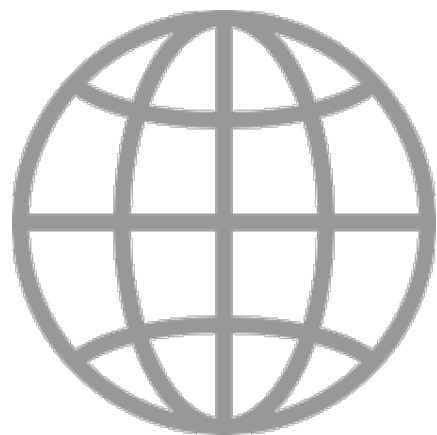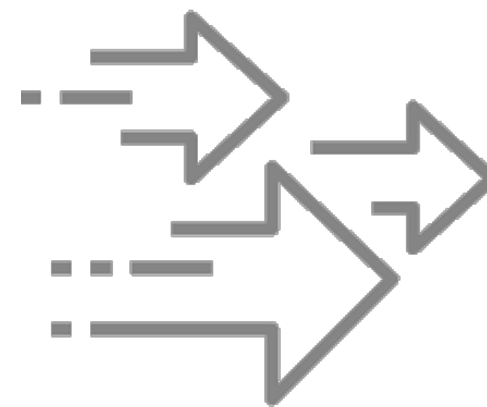
- As part of BIS Innovation 2025, the **Banking Department will institutionalize BAAM** to make it a more effective means of supporting internal decision-making and delivering on its collaborative mandate.

How is BAAM used?

- BAAM has multiple use cases supporting both internal portfolios and the Banking customer community.
- For example, BAAM was the analytical foundation of the studies supporting Innovation 2025.
- It is also routinely used to support customer requests for advisory services.
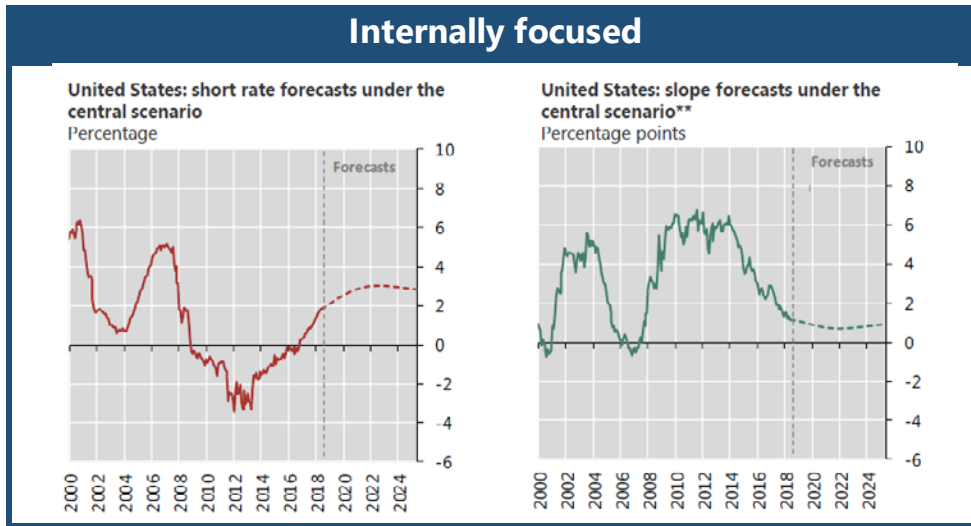
Internally focused	Customer focused
Banking strategy for Innovation 2025	Knowledge-sharing tool at Banking seminars
Gold policy	Customised studies
Strategic asset allocation proposals for the Own Funds	Peer reviews for key Banking customers
Second opinion for ALM studies of the Pension Fund	Quantitative studies for new BISIPs or other candidate products
Tactical strategy formulation	Support collaborative research projects

A brief history

- BAAM began as an entrepreneurial effort over 10 years ago to support internal asset allocation studies and serve as a tool for knowledge-sharing at BIS seminars.
- Since that time, it has grown in sophistication with an expanded set of analytical functionality and a growing number of internal and external use cases.
- Central bank collaboration has been an indispensable feature of BAAM development.

A brief development timeline

- **Prior to 2008**: Loose collection of yield curve and asset allocation tools (mostly implemented in Excel).
- **2008 - 2011**: Collaboration with Banco Central do Brasil (BCB) to develop an asset allocation system, resulting in coverage of core fixed income markets, including G4 governments, corporates, Agency MBS.
- **2012**: Coverage of all developed economy government bond markets.
- **2013**: Coverage of nearly all emerging economy government bond markets.
- **2014**: Macro based yield curves, equities and other diversifying assets (collaboration with the ECB).
- **2016**: Empirical factor construction (e.g. carry) and back-testing functionality (collaboration with Banco de Mexico).
- **2018**: External manager evaluation functionality, with a deployment of several Machine Learning techniques.

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Current projects

- From both practical and technical standpoints however, reserve managers still face **important challenges** at the portfolio optimization stage.

- **In progress:** Bayesian optimization (collaboration with Banco Central de Reserva del Peru) and Near-optimal portfolio construction (collaboration with the Bank of Israel).

Some challenges for asset allocation

Portfolio construction algorithms are well known for **being sensitive** to input parameters.

Reserve managers may also want to **incorporate their views** or priors into the allocation process.

In practice, portfolio optimisation **supports but seldom replaces** the final investment decision.

Note: Diagrams are used for illustrative purposes only.

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Your questions?

Annex

International reserves' policy objectives

- The objectives for the management of the international reserves should first and foremost stem from the economic function of the FX reserves[1].

- The potential use of foreign exchange reserves can be classified as follows:
  1. Intervention in the FX market, with a view to influencing the exchange rate and/or maintaining orderly market conditions
  2. Execution of payments for goods and services for the country, particularly assuming difficulties in obtaining external finance
  3. Granting of emergency liquidity assistance to sectors of the economy, typically the banking sector
  4. Underpinning of investor confidence in the country's ability to meet its FX commitments
  5. Execution of payments for the government (possibly within the context of broader debt management operations)
  6. Support of domestic monetary policy liquidity management operations (eg through FX swaps, effectively using FX claims as collateral)
  7. Investment of excess reserves

1/ Based on: Borio, C., et al (2008). FX Reserve Management: Elements of a Framework, BIS Papers No. 38, Monetary and Economic Department.

Reserve management objectives

- The balance between these will depend on country-specific factors. Invariably however, central banks can map them into the desirable characteristics of the structure of the portfolio: capital preservation (or "safety"), liquidity and return.
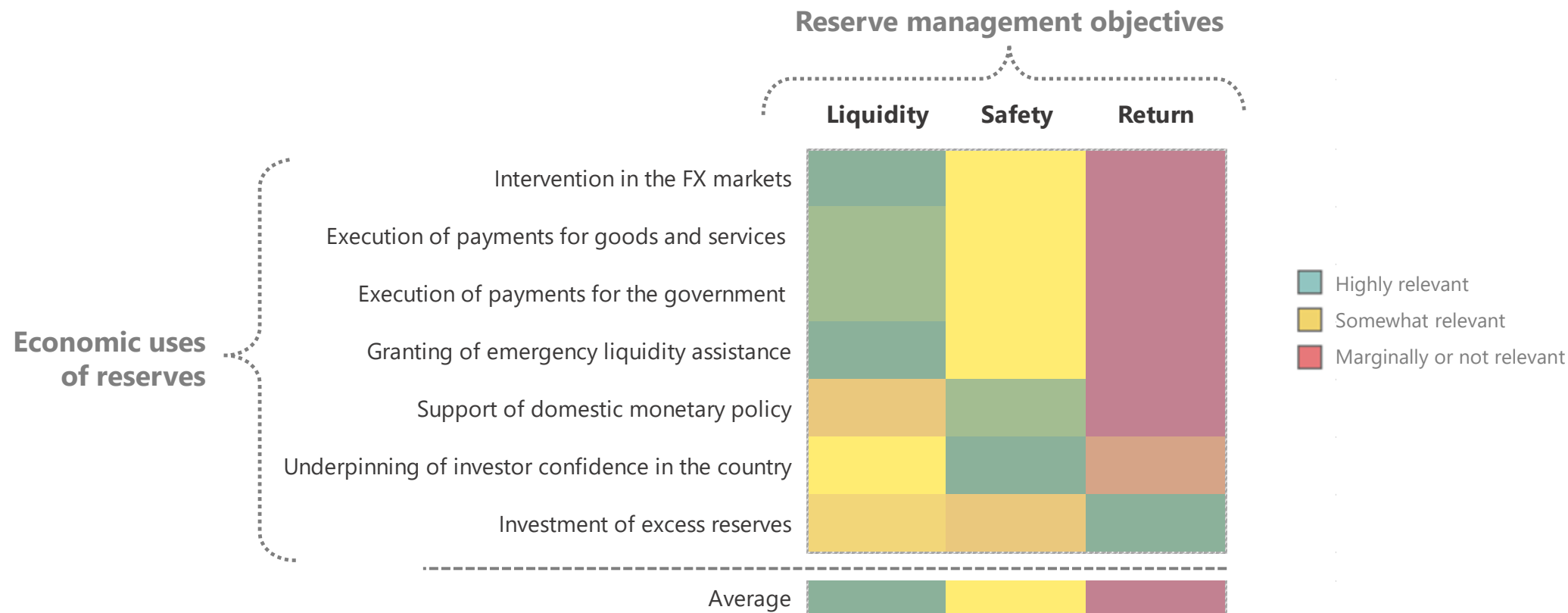
Source: Self-elaboration, for illustrative purposes.

Reserve management policy objectives

- Liquidity's definition is clear: the ability to raise sufficient funds to meet the corresponding demands.
- On the other hand, though "safety" and "return" may not appear as straightforward concepts, their precise definition depends on a number of choices.

Reserve management objectives: definitions

Liquidity

Refers to funding and market liquidity.

This can be defined as the ability to raise funds at short notice, through either the sale of an asset with low price impact, or access to external funding.

Safety

A precise definition is rarely straightforward. However, typically refers to having low tolerance for risk as a means to achieve value storage.

Often, risk tolerance is not explicitly articulated.

Return

Naturally linked to the concept of safety, it refers to the generation of investment returns.

A return target may or may not be specified by the reserve manager.

Source: Self-elaboration, for illustrative purposes.

Reserve management policy objectives

● This is usually represented as a trade-off through a hierarchical approach.

Hierarchical approach: model 1
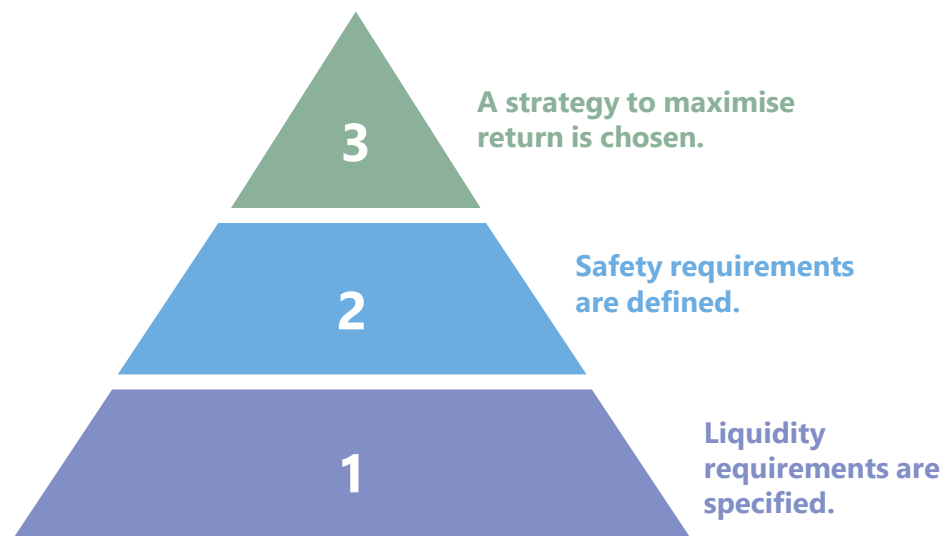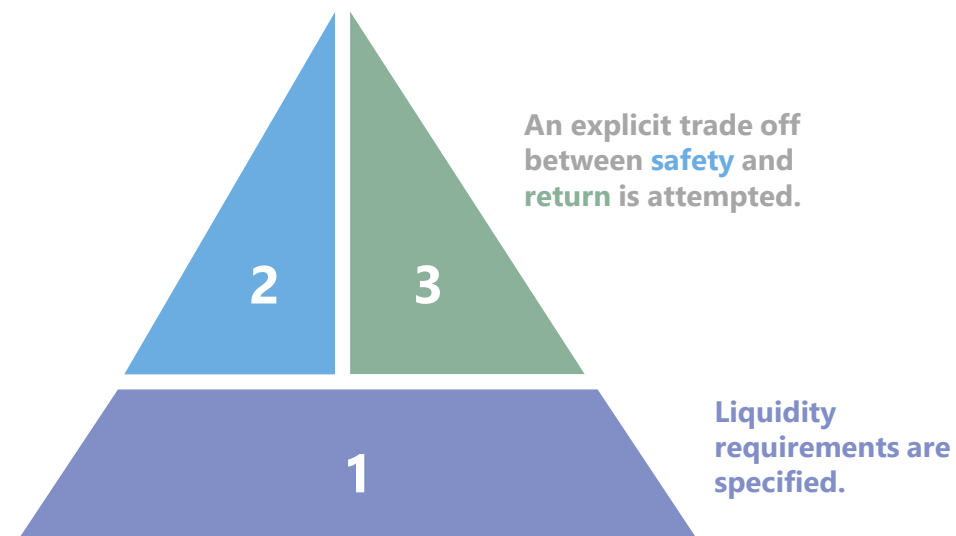
3 A strategy to maximise return is chosen.

2 Safety requirements are defined.

1 Liquidity requirements are specified.

Hierarchical approach: model 2

An explicit trade off between **safety** and **return** is attempted.

2 **3**

1 Liquidity requirements are specified.

Source: Self-elaboration, for illustrative purposes.

Reserve management policy objectives

● In practice, liquidity is typically the dominating requirement for foreign reserves management.

Reserve management objectives & priorities

Liquidity   Safety   Return

Highly relevant
Somewhat relevant
Marginally or not relevant
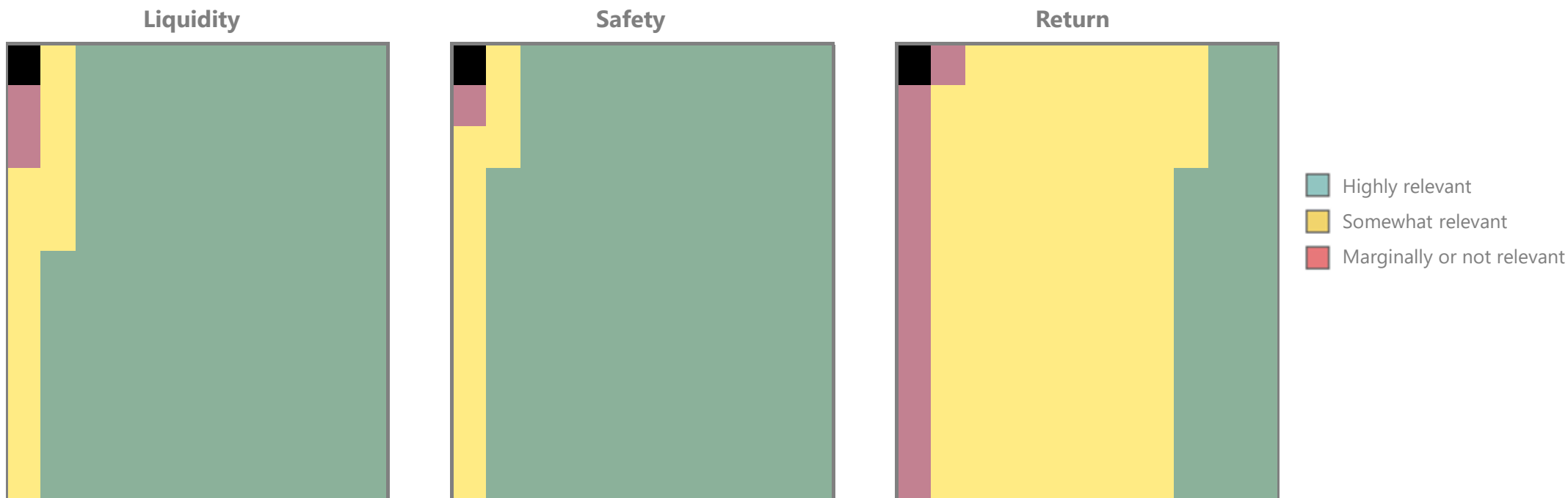
Source: BIS Reserve Management Survey 2016. 120 respondents in total.

Constraints

- In reaching any solution to the portfolio optimisation problem, central banks are inevitably subject to a series of institutional and environmental constraints that will influence their final choice.

- Four of these constraints deserve mention:

A map of constraints for reserve management

Nature	Posed question	Consequence
Primacy of monetary policy and financial stability	Whether reserve management operations interfere with primary goals?	Inhibition from investing in certain asset classes or engaging in active asset management.
Domestic governance	Are reserve management operations subject to rules for the distribution of profits?	Definition of a lower level of risk tolerance.
International environment	Do reserve managers have the potential to disrupt financial activity in the markets they operate?	Inhibition from engaging in certain assets, currencies or rebalancing practices.
Internal factors	Are the human and technological resources ample enough to achieve the desired objectives?	Restriction from entering complex markets or instruments.

Source: Self-elaboration, for illustrative purposes.

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1. Numeraire

● The first choice a reserve manager must make is the **unit** in which returns and their variability are ultimately measured for allocation purposes. Different choices imply different definitions of returns and risk (and of course, of "safety" and "return").

● The numeraire can be set in nominal or real terms and is tied to the **policy objectives** of the FX reserves.

Examples of numeraire choices

Policy objective / intended use of reserves*		Portfolio numeraire
Ensure access to imports under stressed conditions	→	The *basket* of imports in real terms
Hedge the value of the country's liabilities	→	Currency composition of the liabilities
Influence the value of the domestic currency	→	Currency *most effective* for intervention purposes
Protecting the central bank's capital position	→	Domestic currency

Source: Self-elaboration, for illustrative purposes.
*Policy objectives are not mutually exclusive. This highlights the complexity of the numeraire choice.

2. Investment horizon

- When contemplating the portfolio optimisation problem, a reserve manager must define its **investment horizon**.
- We define this horizon with **two dimensions**. **First**, a **projection horizon**, τ which depends on the investment philosophy and the information sets used to forecast returns.

Illustration of a portfolio construction timeline

Past history

Projection horizon

0

t

Investment decision

$t + \tau$
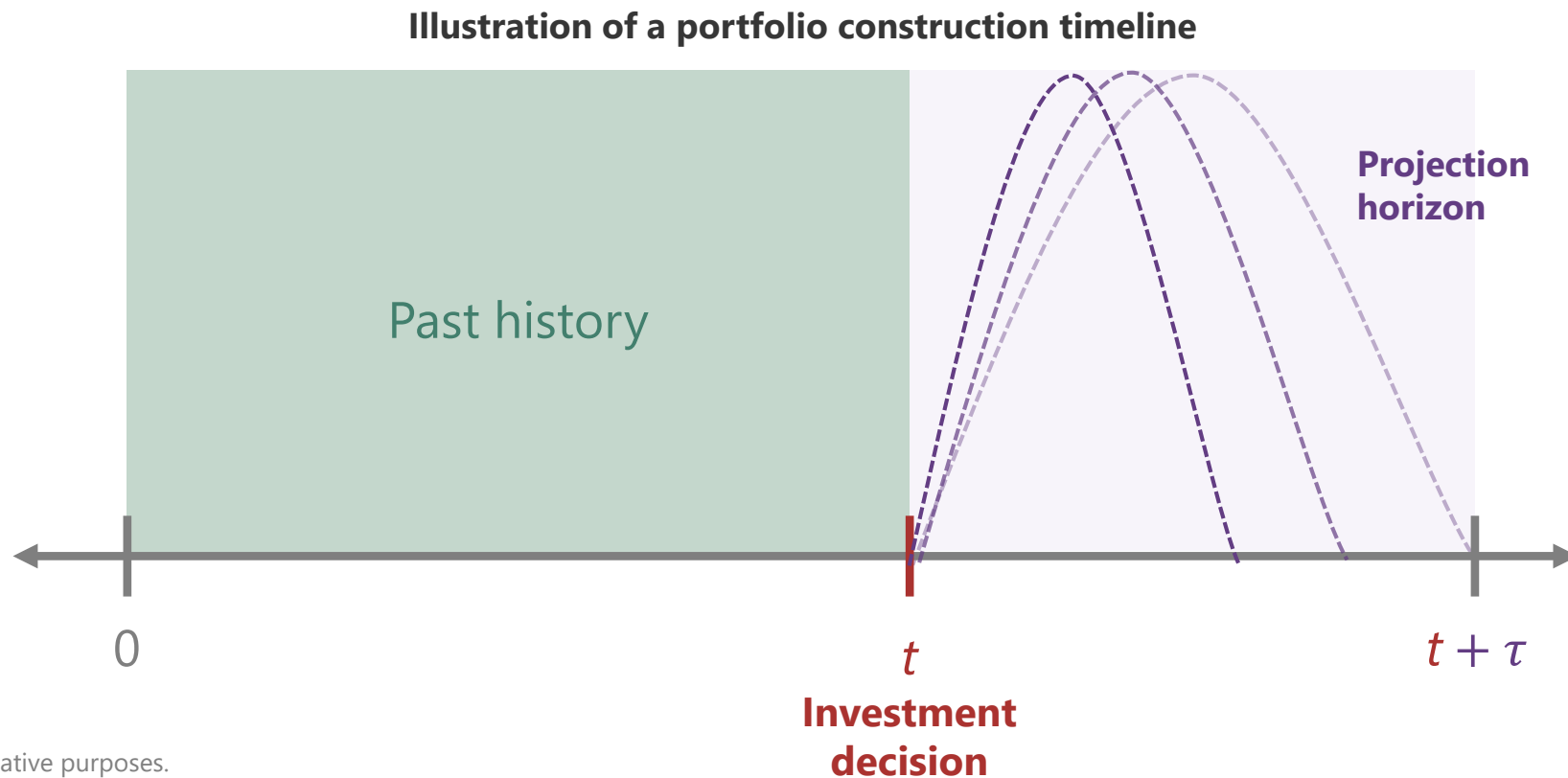
Note: Diagrams are used for illustrative purposes.

2. Investment horizon

- **Second,** a **measurement period**, k, referring to the period over which returns are computed in the portfolio construction process.

- It depends crucially on the period considered most relevant for measuring the performance of the portfolio.

Illustration of a portfolio construction timeline

Measurement period

$$0 \qquad\qquad t \qquad\qquad t + \tau$$

Investment decision $\quad r_{t+3k} = \dfrac{P_{t+3k} - P_{t+2k}}{P_{t+2k}}$
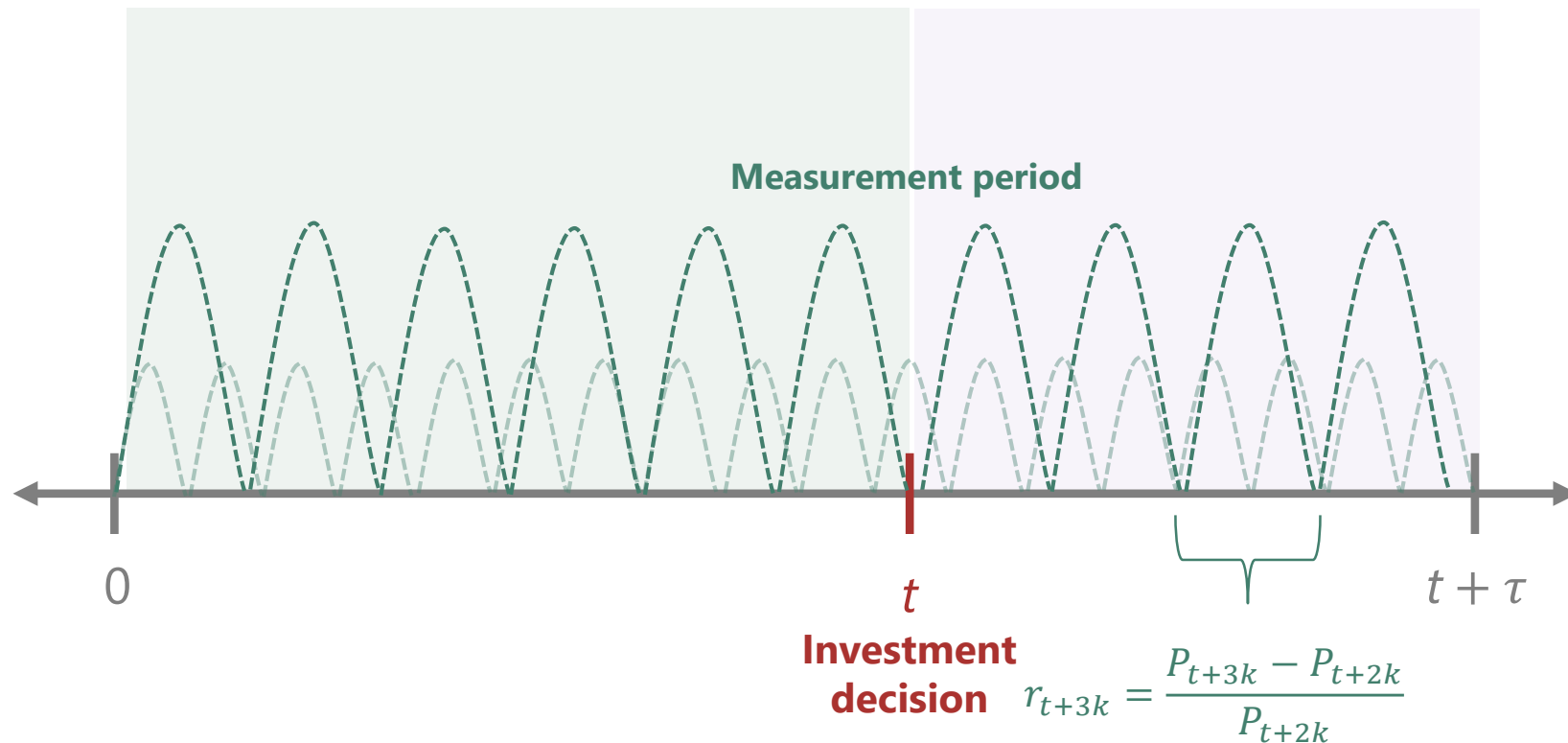
Note: Diagrams are used for illustrative purposes.

2. Investment horizon

● By answering these two questions and contemplating their determinants a reserve manager can successfully define their investment horizon and then successfully incorporate it into his or her definition of **risk tolerance**, and subsequently, into the **portfolio construction** problem.

Taxonomy of the investment horizon

		Determinant	Posed questions
Investment horizon	**Measurement period**	**Policy objectives**	What is the key purpose (or purposes) of the FX reserve portfolio? What are the funds used for in practice?
		Performance objective	Is the return of the portfolio evaluated frequently? Are bonuses paid based on short-term performance? How relevant is active management? What measures are used to gauge risk?
		Organisational influences	How aligned are the policy objectives of the central bank and the Reserve Management Department? How sensitive is the Governing Board to negative results in the accounting year?
	Projection horizon	**Investment philosophy**	Does the Reserve Department believe in mispricings or structural risk premia? Does it favour a return-based or a macro-based approach?
		Information sets	Does the Reserve Department focus on the drivers of near-term price changes or the determinants of future long-term value? Is the immediate flow of news highly relevant for the investment process?

Note: Diagrams are used for illustrative purposes.

3. Risk tolerance measure

- The risk tolerance measure is a reflection of an **institution's ability and willingness** to accept risks.
- When setting the **strategic asset allocation**, we are particularly interested in comprehensive measures of risk.
- Note that it is not only the **frequency** of adverse outcomes that counts, but also their **severity**.

Examples of risk measures

Comprehensive measures of risk

- Volatility
- Semi-variance
- Value-at-risk
- Expected shortfall
- Short-fall probability

Individual risk measures

- Duration
- Spread duration
- Probability of default
- Issuer exposure
- Counterparty exposure
- Country exposure

Source: Self-elaboration.

4. Eligible asset class universe

- Reserve managers must also have a **universe** of eligible asset classes.

- The suitability of an asset classes might be examined from a **risk factor** perspective to understand its degree of safety.

- One would also want to be aware of the **market liquidity** properties as well as the potential contribution to portfolio **return**. Additional questions would be asked about whether investment is operationally feasible for a given central bank.

Major risk factor exposures across selected asset classes for a USD-numeraire investor

Asset Class	Interest rate risk	Realized inflation risk	Prepayment risk	Corporate credit risk	DM currency risk	EM currency risk	Dividend growth risk	Liquidity risk	Other risk factors*
US Treasury securities	✓✓								
TIPS	✓	✓✓						✓	
SSAs	✓✓							✓	✓
US agency MBS	✓✓		✓✓					✓	✓
Corporate bonds	✓✓			✓✓				✓✓	✓
EM sovereign bonds in foreign currency	✓✓							✓	✓✓
Non-USD DM government securities in local currency	✓✓				✓✓			✓	✓
Non-USD DM inflation-linked securities in local currency	✓	✓✓			✓✓			✓	✓
EM sovereign securities in local currency	✓✓					✓✓		✓	✓
ABS	✓✓		✓					✓✓	✓✓
US equities	✓						✓✓	✓	✓
Global equities	✓				✓✓	✓✓	✓✓	✓	✓