EUROPEAN CENTRAL BANK

EUROSYSTEM

Macro-modelling for forecasting and policy analysis

The views expressed in this presentation are those of the presenter and do not necessarily reflect those of the ECB or the Eurosystem

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Romanos Priftis
Lead Economist – DG Economics, Forecasting and Policy Modelling Division

Overview

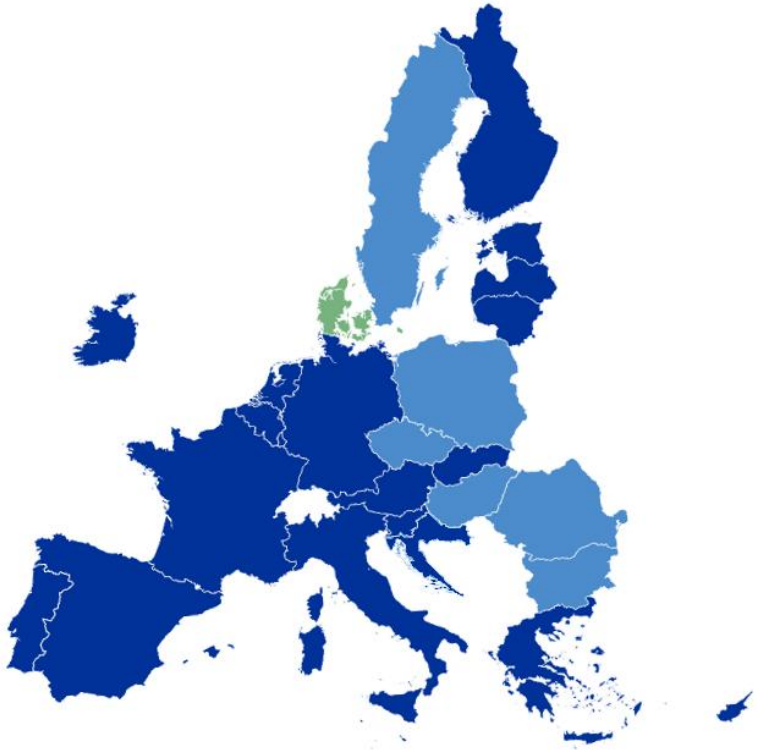
1. ECB mandate and monetary policy strategy
2. Macro-modelling portfolio and policy use
3. The road ahead for modelling at the ECB

1

ECB mandate and monetary policy strategy

The European Central Bank and the Eurosystem

- The ECB is an EU institution and the central bank of the euro area. All its decisions focus on the euro area and are based on euro area statistics and information.
- ECB has a special status within the EU institutional set-up due to: Independence, clearly defined mandate and set of tasks, accountability, legal personality of its own and since 2014, ECB is also the Banking Supervisor for all banks in the euro area with the Single Supervisory Mechanism (SSM).
- Eurosystem comprises the ECB and the National Central Banks (NCBs) of those 20 countries that have adopted the euro.



Monetary policy in a nutshell

- **[TFEU, Article 127]** "The primary objective of the Eurosystem shall be to maintain **price stability**. Without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Community with a view to contributing to the objectives of the Community"
- The ECB tries to steer financial market interest rates by setting the price of short-term credit to commercial banks (**official interest rates**) and determining the amount of that credit (**liquidity**) to ultimately influence price developments
- In crisis situations and when official interest rates are no longer effective (**zero lower bound**), the ECB has to use alternative instruments to influence financial market conditions (**non-standard instruments**)

Outcomes of the 2021 Strategy Review

2% annual inflation target

to provide a clear anchor for inflation expectations and a buffer above 0

Symmetric commitment

to consider negative and positive deviations equally undesirable

Medium-term orientation

to allow short-term deviations and cater to other relevant considerations relevant for price stability

Policy based on an integrated assessment

to account for economic, financial and monetary factors and medium-term risks

Extended policy toolkit

to cope with new challenges, including new policy instruments

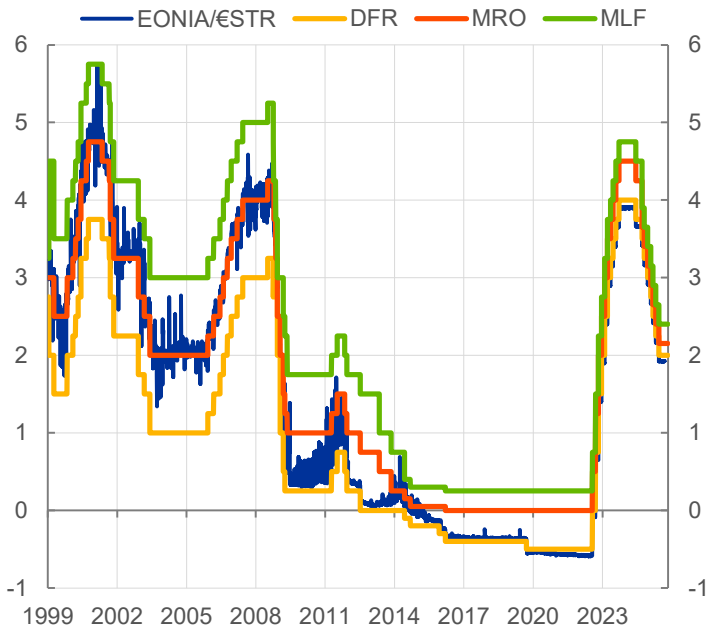
Climate considerations

to account for its implications for price stability through its structural and cyclical impacts

Key ECB interest rates and non-standard measures at the current juncture

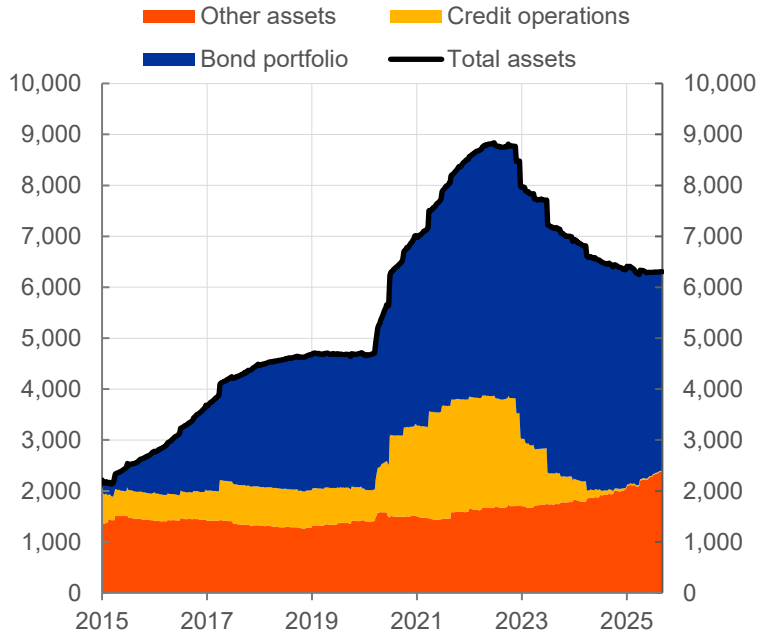
Key ECB interest rates and market rates

(percentages, annualised)



Eurosystem balance sheet (assets)

(EUR billion)



Sources: ECB and ECB calculations.
Latest observation: 12 September 2025 for €STR; 4 November 2025 (end of MP6) for key ECB interest rates (as decided in the 11 September 2025 GovC meeting), 5 September 2025 for balance sheet

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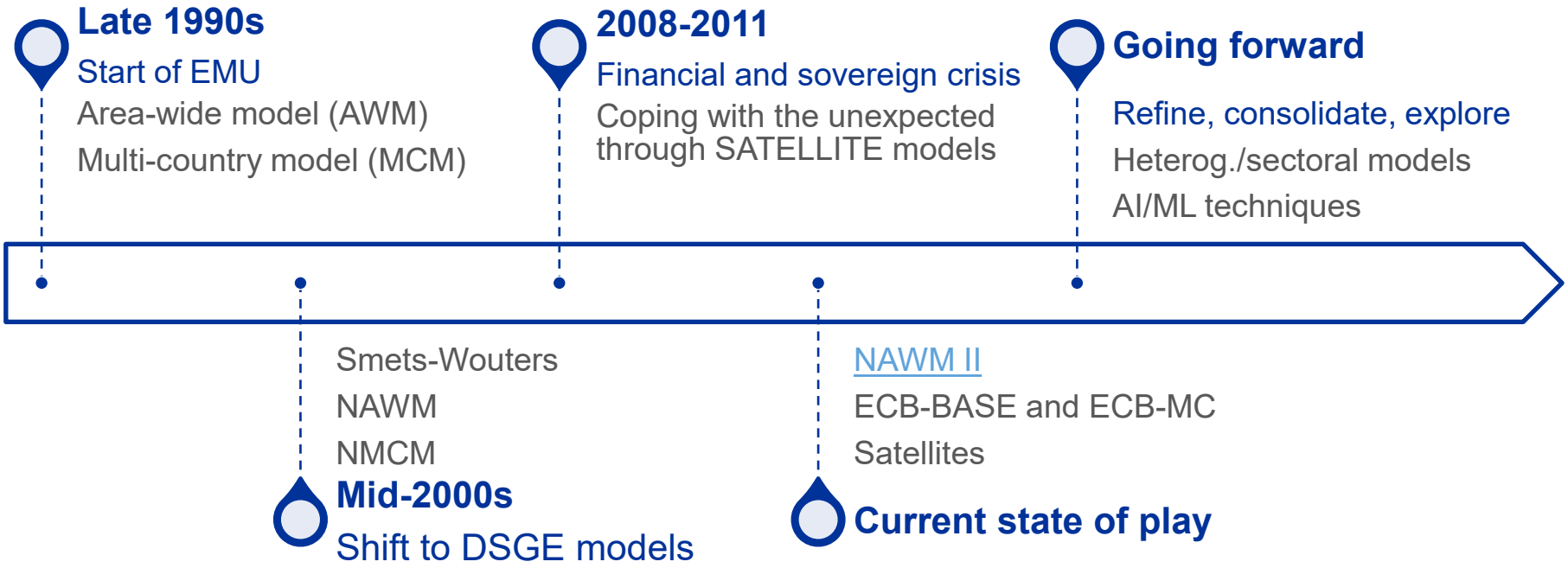
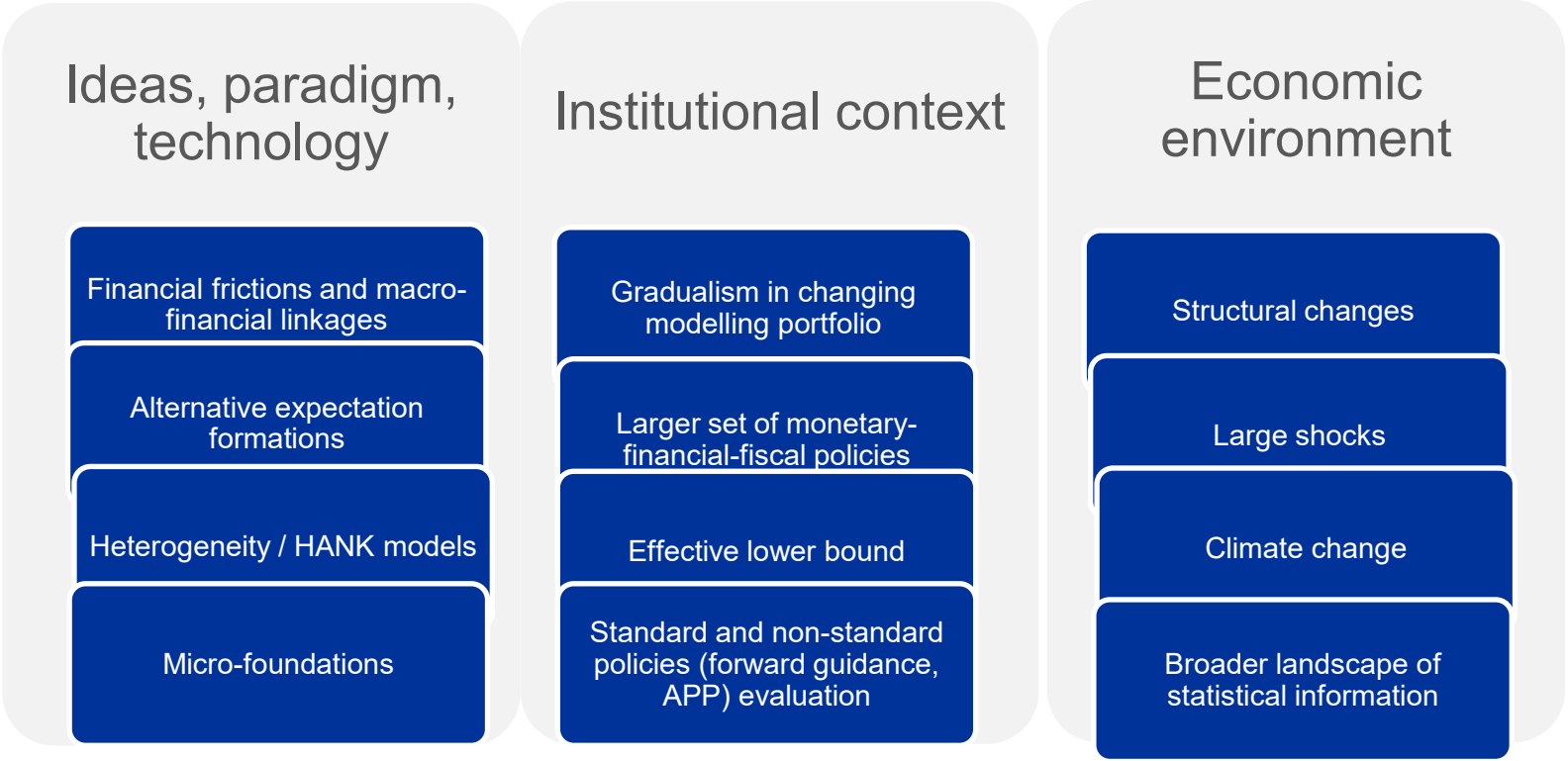
Macro-modelling portfolio and policy use

Historical perspective on ECB macro-modelling



Source: Ciccarelli et al, ECB macroeconometric models for forecasting and policy analysis, ECB OP 344, 2024

Lessons from 20 years of macro-modelling at the ECB

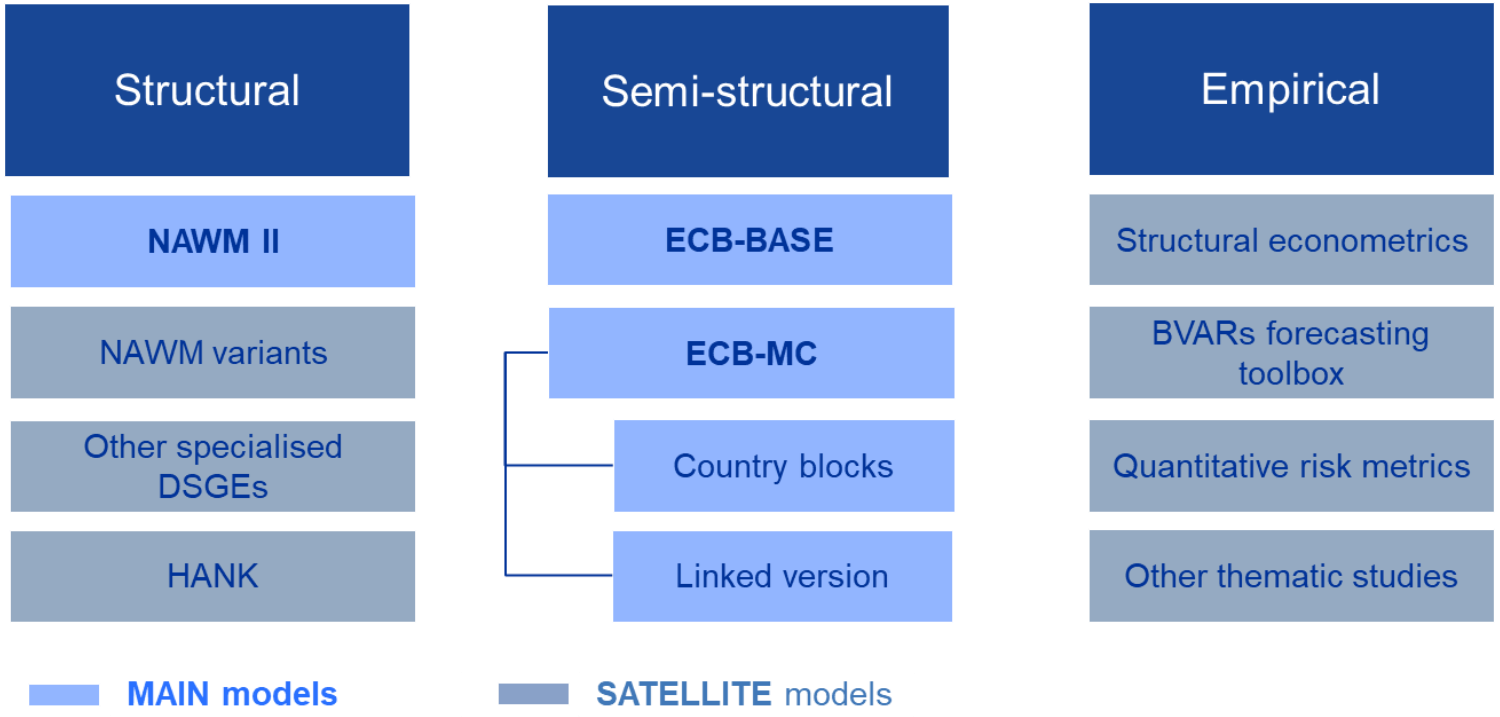


Source: Ciccarelli et al, ECB macroeconometric models for forecasting and policy analysis, ECB OP 344, 2024

The suite-of-models approach

- Ensure robustness of model-based policy advice
- Exploit the trade-off between structural features and empirical performance
- Address the business needs of euro area and country-specific analysis
- Create a common language through few Main models and several specialised Satellite models
- Balance research creativity and consistency in the model-based input to the policy process

Broad ECB macro-modelling portfolio



Source: Ciccarelli et al, ECB macroeconometric models for forecasting and policy analysis, ECB OP 344, 2024

Policy use of the ECB macro-modelling portfolio

Economic projections

- Forecasting with judgment and model-based projection narratives for the euro area as well as for the largest euro area countries

Sensitivity, risk and scenario analysis

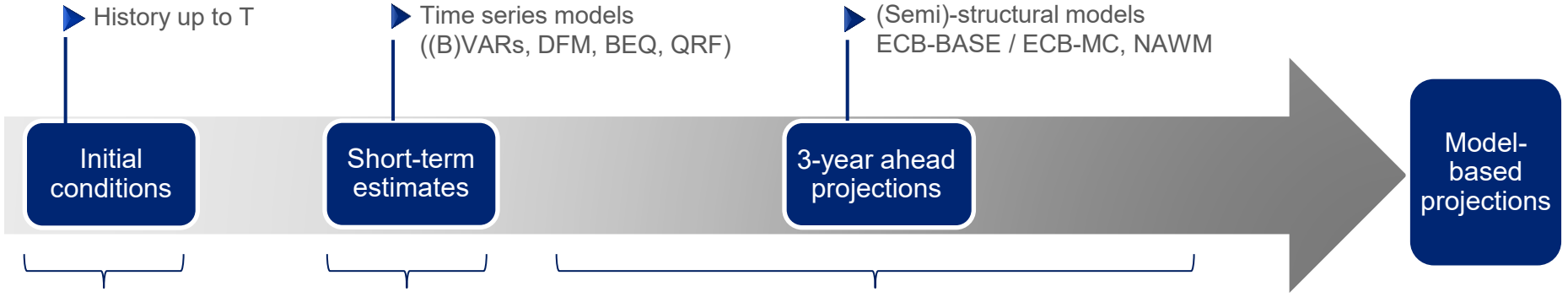
- Conditional predictive densities from forecasting models
- Sensitivity of baseline to key assumptions (Oil, FX, Fiscal, Financial)
- Risk balance for the (B)MPEs
- Scenario analysis of relevant macroeconomic contingencies

Policy analysis

- Impact study of monetary policy options
- Optimal monetary policy analysis
- Strategic issues related to monetary-fiscal-financial policy mix in the euro area

Source: ECB macroeconometric models for forecasting and policy analysis

Model-based projections for the euro area and large countries

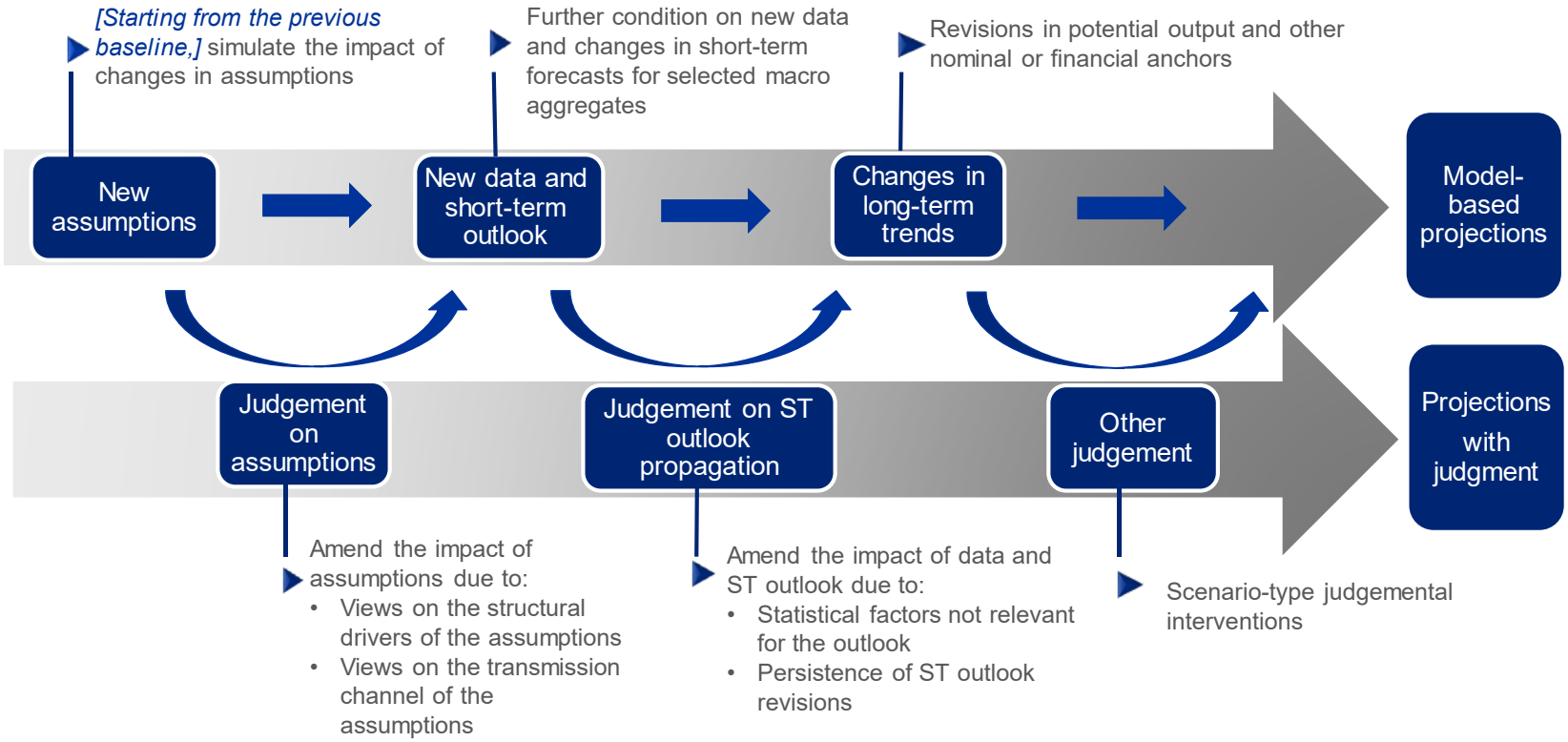


Conditional on:
- initial conditions
- technical assumptions*
- surveys and market-based information
- high-frequency indicators

Conditional on:
- initial conditions
- short-term estimates
- technical assumptions*
- judgement on impact of assumptions, propagation of short-term, changes in real/nominal anchors

Note: Short-term estimates and 3-year ahead projections share a common set of exogenous assumptions

Final forecasts are not only based on models

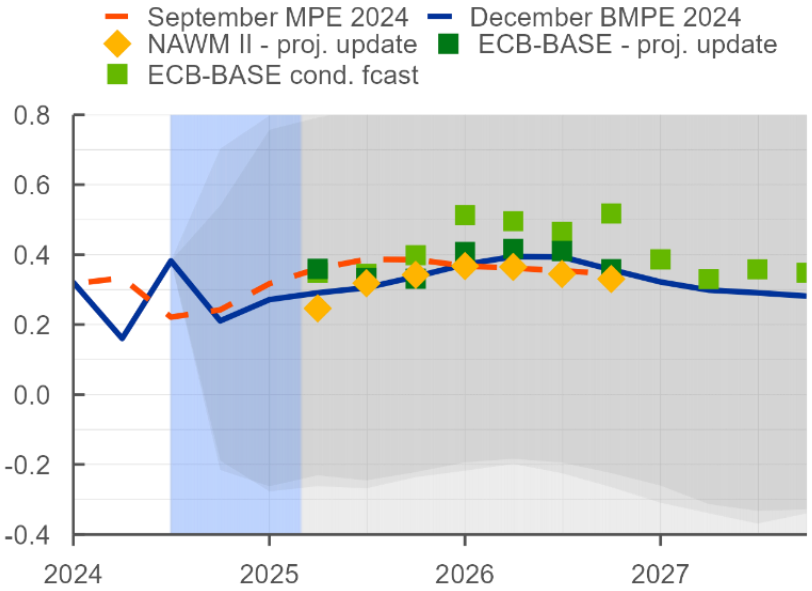


Source: ECB macroeconometric models for forecasting and policy analysis

Model-based projections for the euro area in December 2024

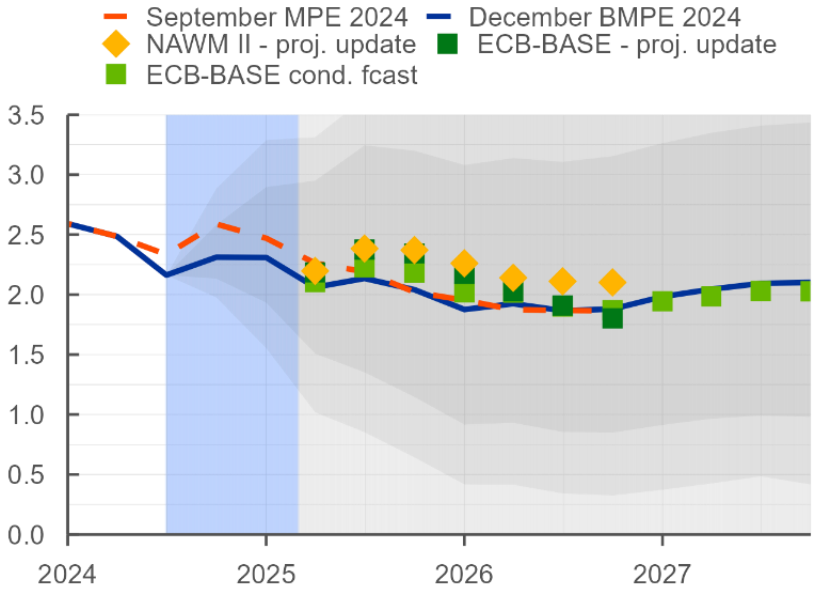
Real GDP – Euro area

(q-o-q growth rates, in %)



HICP – Euro area

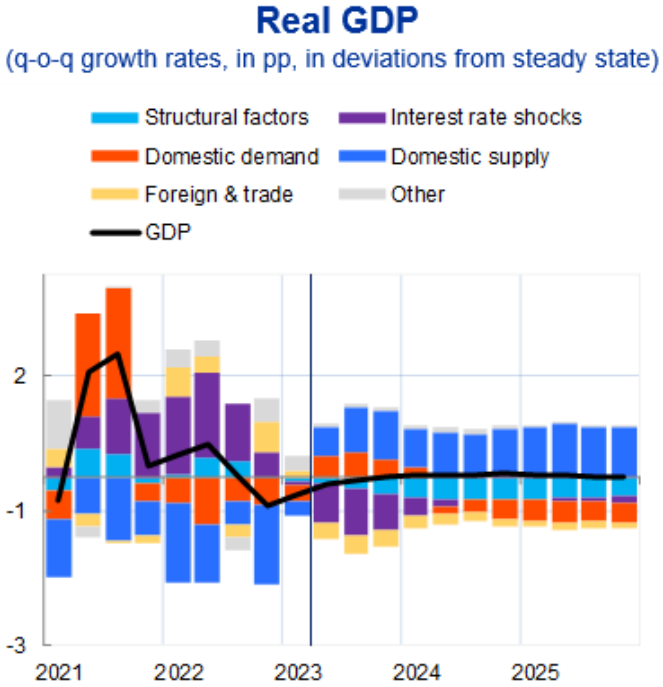
(y-o-y growth rates, in %)

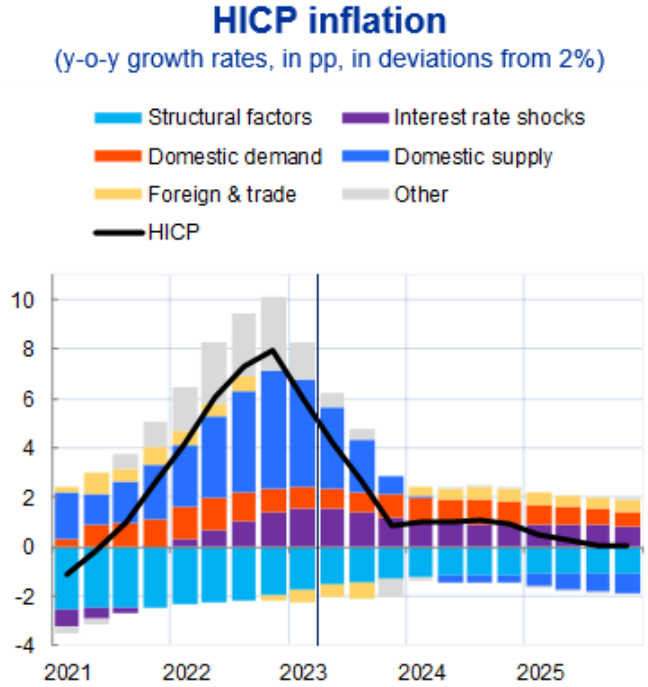


Source: ECB/NCB projections database and ECB/NCB staff calculations based on ECB-BASE and NAWM II.
December 2024 BMPE WGFB assumptions and short-term outlook until 25Q1.

'Projection updates' correspond to model-based updates of the previous (B)MPE baseline on the basis of changes in assumptions as well as new data and changes in the short-term outlook up to 2024Q1. The dark grey areas represent the 68% confidence interval from the conditional ECB-BASE stochastic forecast and the light grey areas represent the 68% confidence interval from the unconditional ECB-BASE stochastic forecast. They are both centered around the baseline. In the ECB-BASE model, the density forecast is computed using a bootstrap method that re-samples the in-sample residuals of the model. The forecasted value of an endogenous variable is calculated by adding the re-sampled residual to the value forecasted by the model and the distribution is obtained by repeating the process 5000 times.

NAWM: Structural shock decomposition of the June 2023 MPE baseline



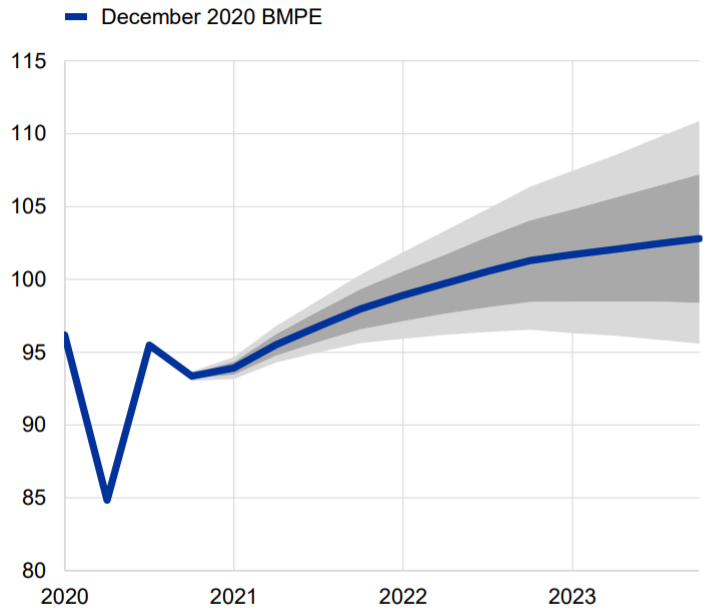


Source: ECB staff calculations using the NAWM II.
The category "**Structural factor**" includes the contributions of the initial state, the discount rate shock and the persistent component of the permanent technology shock. "**Interest rate shocks**" comprises the short-term interest rate shock and the shock to the retail bank's markdown. "**Domestic demand**" includes the domestic risk-premium shocks and shocks to government spending. The category "**Domestic supply**" captures supply-shocks, namely: the transitory component of the permanent technology shock and the transitory and investment specific technology shocks as well as wage and price mark-ups. The category "**Foreign and trade**" captures shocks to foreign demand, foreign prices, US 3-month and 10-year interest rates, competitor's export prices, oil prices, import demand , export preferences, mark-up shocks to export prices and import prices and a foreign risk-premium shock whereas "**Other**" includes measurement errors and residuals from bridge equations.

Density forecasting with ECB-BASE around the December 2020 BMPE

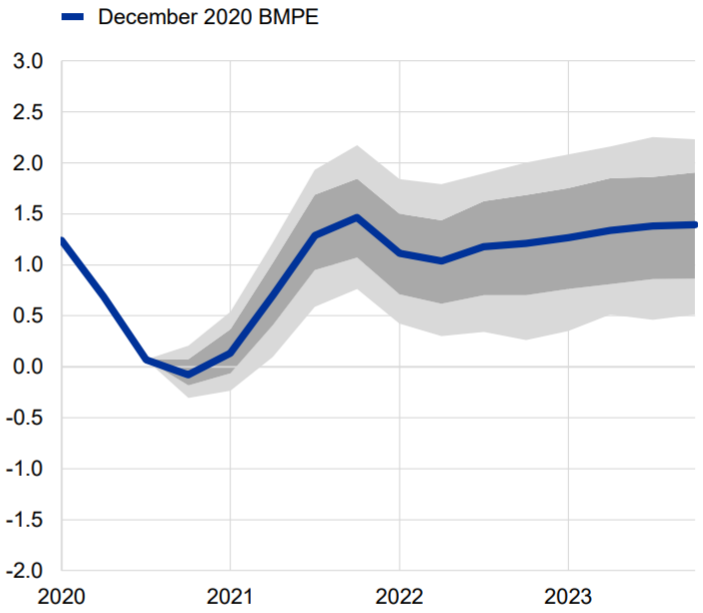
Real GDP

(fourth quarter 2019 = 100)



GDP deflator

(year-on-year percentage change)



Source: ECB-BASE.

Notes: Chart A shows the real GDP and the GDP deflator density forecast produced by ECB-BASE centred around the final December 2020 BMPE. The light grey area represents the 68% confidence interval, while dark grey shows the 95% confidence interval. The density forecast is computed using a bootstrap method that re-samples the in-sample residuals of the model. The forecast value of an endogenous variable is calculated by adding the re-sample residual to the value forecast by the model and the distribution is obtained by repeating the process 500 times.

Risk analysis: Probabilities of high inflation under alternative scenarios

	2024		2025	
	HICP between 1.75% and 2.25%	HICP > 2.25%	HICP between 1.75% and 2.25%	HICP > 2.25%
ECB-BASE				
Baseline	**11%**	**85%**	**28%**	**42%**
Uncentred	0%	100%	23%	61%
Higher wage indexation	6%	92%	24%	56%
Unanchoring of long-term inflation	10%	86%	26%	50%
Higher wage indexation and unanchoring	6%	93%	20%	65%
NAWM II				
Baseline	**12%**	**69%**	**14%**	**48%**
With supply risks	9%	80%	11%	57%
Higher wage indexation	9%	73%	13%	55%
Unanchoring of long-term inflation	10%	73%	15%	51%
Higher wage indexation and unanchoring	8%	84%	12%	60%
BVARs				
Small VAR	**11%**	**56%**	**11%**	**50%**
Large VAR	10%	63%	9%	63%
Small VAR with time-varying coefficients	9%	60%	8%	54%

Sources: ECB calculations and June 2023 BMPE.

Notes: The table shows the probability of different inflation events under different risk scenarios. The probabilities are calculated using stochastic simulations around the baseline. For ECB-BASE, in the case of higher wage indexation the parameter capturing wage indexation in the wage Phillips curve of the model increases from 0.39 to 0.5. The case of unanchoring assumes that long-term inflation expectations are an autocorrelated process that depends on the ECB's inflation target and past inflation outcomes, with the weights for target inflation (72%) and past inflation (28%) calibrated so that long-term inflation expectations in the baseline reach 2.5% at some point during the forecast horizon. For NAWM II, the case of higher wage indexation assumes that the wage indexation parameter in the model increases from 0.37 to 0.5. In the case of unanchoring, long-term inflation expectations are assumed to react to past inflation, such that $\pi_t^* = 0.75\pi_{t-1}^* + 0.25\delta\pi_{t-1}$, with $\delta = 0.32$. "Small VAR" refers to a VAR with GDP growth, headline HICP inflation and the short-term interest rate; "large VAR" includes 14 variables; "small VAR with time-varying coefficients" includes the same variables as "small VAR".

Monetary policy analysis

- "**Core**" models address strategic issues of relevance for monetary policy: evaluating the impact of standard and non-standard policy

- "**Satellite**" DSGEs complement and bring a quantitative perspective to the way monetary policy interacts with fiscal, financial and structural policies

- A recent application:
  - A model-based assessment of the macroeconomic impact of the ECB's monetary policy tightening since December 2021, *Economic Bulletin, Issue 3, 2022.*

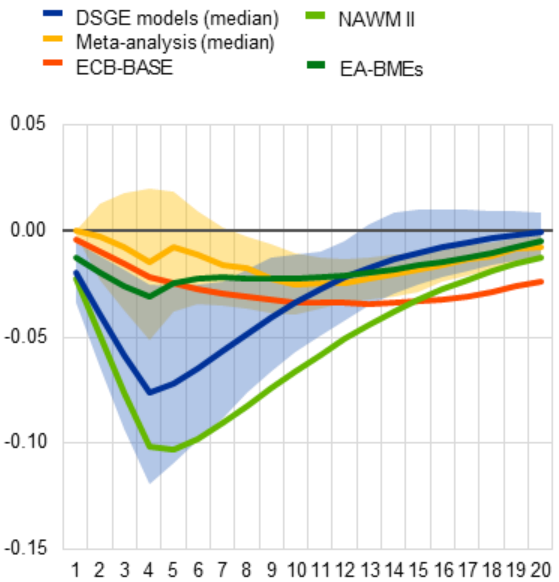
- Also, **normative** analysis:

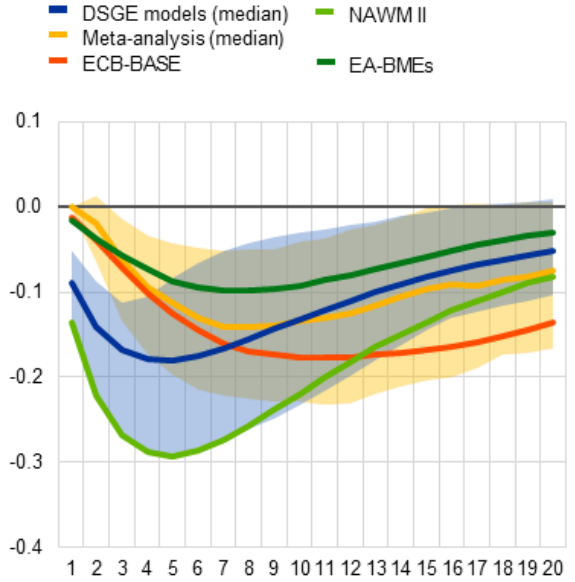
  - Monetary policy strategies to navigate post-pandemic inflation: an assessment using the ECB's New Area-Wide Model, *ECB Working Paper No 2935, 2024.*

Benchmarking against ESCB models and empirical literature: Monetary policy shock

Annual inflation (left) and output (right)

(percentage point deviations from baseline; quarters)





Source: ECB Occasional Paper on "Monetary Policy Transmission - A reference guide through ESCB models and empirical benchmarks". ECB, November 2025, No. 377.

Notes: EA-BMEs model builds on the Eurosystem's BMEs while incorporating a forward-looking financial block à la Dornbusch. This extension endogenizes monetary policy, long-term interest rates and the exchange rate. It uses forward-looking expectations for the latter two variables and assumes the same Taylor rule as ECB-BASE for the policy rate. The model equations link other endogenous variables to exogenous shocks using the official BMEs, which are updated annually.

IRFs have been harmonised to reflect the effects of a 25 basis points conventional monetary policy shock. Simulation horizon in quarters. The yellow shaded area represents the median from the 68% confidence intervals of the primary studies in the meta-analysis. The blue shaded area represents the 84th–16th percentile range of collected ESCB DSGE models' impulse response functions

4

The road ahead

What is the future of modelling and forecasting at the ECB

2025 MPSA priorities for model development – see Chapter 4.4 of ECB OP 371

1. **Structural trends and long-term issues**
   - New challenges related to competitiveness, protectionism, demographics, defence spending
     - ➢ Incorporate trends in structural models or analysis combining empirical+structural approaches
2. **Clear benchmarks for monetary policy effectiveness**
   - Recalibration and re-assessment of models to reflect evidence on state- time-dependence
3. **Sectoral and country heterogeneity:**
   - Evidence of sectoral and country characteristics affecting propagation of supply-side shocks
     - ➢ Heterogeneity in K/L ratios, nominal rigidities, I-O linkages
4. **Nonlinearity and state-dependence:**
   - Evidence of time- and state-variation in the Sacrifice Ratio and changing inflation dynamics through supply constraints
     - ➢ State-dependent Phillips curves, endogenous supply constraints, infl. expectations de-anchoring
     - ➢ Nonlinear solution and estimation: SSJ techniques, AI and machine learning
5. **Scenario synthesis and multi-system approach**
   - Combining scenarios and/or core+satellite models to inform projections and policy analysis

What is missing to put us **on track to deliver the next generation of models and tools?**

Main projects planned

Consolidation of main policy models

- Refinements of NAWM family: new re-estimation, monetary union (DREAM)
- ECB-BASE 2.0 and its infrastructure
- ECB-MC viability (ECB-WP) and documentation

R&D in core modelling activities

- Finalization and deployment of HANK model
- Progress and consolidation of sectoral modelling agenda
- Time series models for inflation forecasting
- Refinements of Bernanke and Blanchard (with a brand-new fiscal block; in cooperation with FIP; forecast evaluation)
- Projects on ML/AI
- Proof of concept on scenarios

Transmission channels of interest rate policy