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Contents

1 Introduction

This report offers a strategic view on the economic and inflation environment in the euro area as part of the monetary policy strategy assessment 2025. It reassesses the factors shaping the inflation and economic environment in light of the recent inflation experience, analyses changes in structural factors and examines the implications for the inflation environment the ECB is likely to face. It also draws conclusions regarding the enhancements that need to be made to the existing analytical toolkit and inflation forecasting.

The starting point for the report is the outcome of the monetary policy strategy review (MPSR) 2020-21. The review included detailed analyses of the economic and inflation environment in the euro area, inflation measurement focusing on the inclusion of owner-occupied housing in the Harmonised Index of Consumer Prices (HICP), the inflation buffer, inflation expectations and the influence of structural drivers such as climate change, globalisation, digitalisation and demographic shifts.

While the previous review was conducted in an economic environment of low inflation and interest rates in proximity to the effective lower bound, the inflation environment changed rapidly after the MPSR 2020-21. Inflation hit record highs amid a series of unprecedented shocks linked to the COVID-19 pandemic and Russia's invasion of Ukraine. There were also notable shifts in the structural factors shaping the economic and inflation environment. One of the most significant changes has been the evolving global geopolitical and geo-economic landscape, marked by increased tensions and a shift towards more protectionist and interventionist policies. In addition, the effects of climate change have accelerated, with rising global temperatures and more frequent extreme weather events. At the same time, efforts to spur a green transition have produced results. Digitalisation has reached a new phase, with the emergence of generative artificial intelligence models. Despite recent surges in migration that have boosted the euro area population and labour force, underlying longer-term demographic trends continue to point towards an ageing population and a shrinking workforce. Changes in the inflation and economic environment also pose important challenges for the established analytical toolkit and inflation forecasting techniques. This report contains three main chapters that provide a comprehensive analysis of these developments:

Chapter 2 reassesses economic and inflation developments in the euro area and examines their drivers and the lessons learned since mid-2021, as well as the broader shifts between low and high inflation since the euro area's inception. The chapter starts with a review of the inflation landscape at the time of the previous MPSR before looking at inflation developments since then. Key aspects assessed in the chapter are the role played by supply and demand drivers in inflation developments, changes in the link between real activity and inflation, the role played by inflation expectations and the interplay between wages, productivity, profits and inflation. **Box 1** reports new insights on the drivers of inflation since the previous

MPSR from the perspective of consumers, firms and professional forecasters based on a set of special survey questions introduced to coincide with the 2025 monetary policy strategy assessment. **Chapter 2** also assesses monetary and fiscal policy responses to inflation developments and their impact. Finally, the chapter reviews developments in the natural interest rate and their drivers since the previous MPSR.

Four boxes in the report assess the progress made since the previous strategy review. Box 2 discusses improvements in data and tools for monitoring and modelling price-setting, and the extent and ways in which it is state-dependent. **Box 3** reviews the development of auxiliary inflation indicators incorporating owner-occupied housing and their use in preparing monetary policy decisions. **Box 4** presents improvements in monitoring and analysing inflation expectations, including for households and firms and on more granular data. **Box 5**, which accompanies **Chapter 4**, discusses progress in integrating climate change into economic analysis, modelling and forecasting.

Chapter 3 looks ahead and discusses how structural factors are expected to shape changes in the euro area economy in the coming years, including the implications for the inflation environment the ECB is likely to face. Structural economic developments, such as climate change, geopolitical changes and global fragmentation as well as digitalisation (with a focus on artificial intelligence), demographic change and the related policy responses, can have important effects on inflation developments looking ahead. Building on the work done in the context of the previous MPSR, **Chapter 3** assesses how secular factors are expected to affect inflation via changing developments in the highly persistent trend component, volatility and uncertainty, relative prices and the interaction of wages, profits and prices. Lastly, the chapter also reviews the potential effects of these changes on the natural rate of interest.

Following on from the findings in Chapters 2 and 3, Chapter 4 outlines the implications of the changing inflation and economic environment for the analytical toolkit and inflation forecasting. The first part of the chapter discusses potential improvements in forecasting accuracy, including via the conditioning assumptions (**Section 4.2**). It then goes on to assess ways to better account for uncertainty through, for example, the appropriate use of sensitivity and scenario analysis (**Section 4.3**). Lastly, **Section 4.4** examines the progress made and the gaps that remain in order to improve the analytical toolkit, including a discussion of modelling non-linearities, long-term economic drivers and sectoral analyses. Three boxes in this chapter compare the performance of ECB/Eurosystem staff inflation projections and financial market inflation expectations (**Box 6**), assess the role of underlying inflation measures in complementing the medium-term inflation projections (**Box 7**) and present the work of the ChaMP research network for enhancing the analytical toolkit for modelling monetary policy transmission in a heterogenous monetary union (**Box 8**).

The report uses a blend of established and new modelling approaches, diverse data sources and meta-analyses to assess the impact of cyclical and structural drivers on inflation and economic dynamics. It incorporates new datasets and emphasises granular approaches in both data and modelling to enhance the understanding of sectoral dynamics.

2 Assessing inflation developments in the euro area: lessons learned from the low and high inflation periods

2.1 Inflation landscape at the time of the last monetary policy strategy review

Inflation had been persistently below 2% for several years when the last monetary policy strategy review began in 2020. During that review the aim of the extensive analytical work performed by the Eurosystem was to understand why inflation had been persistently low since 2013. The evidence pointed to a combination of interconnected factors, including weak aggregate demand, low costs pressures, falling inflation expectations, and unfavourable structural trends (Koester et al., 2021). A *de facto* asymmetric inflation target has also likely contributed to the low inflation environment, through the expectation channel (Rostagno et al., 2019, Corsello et al., 2021, and Paloviita et al., 2021).

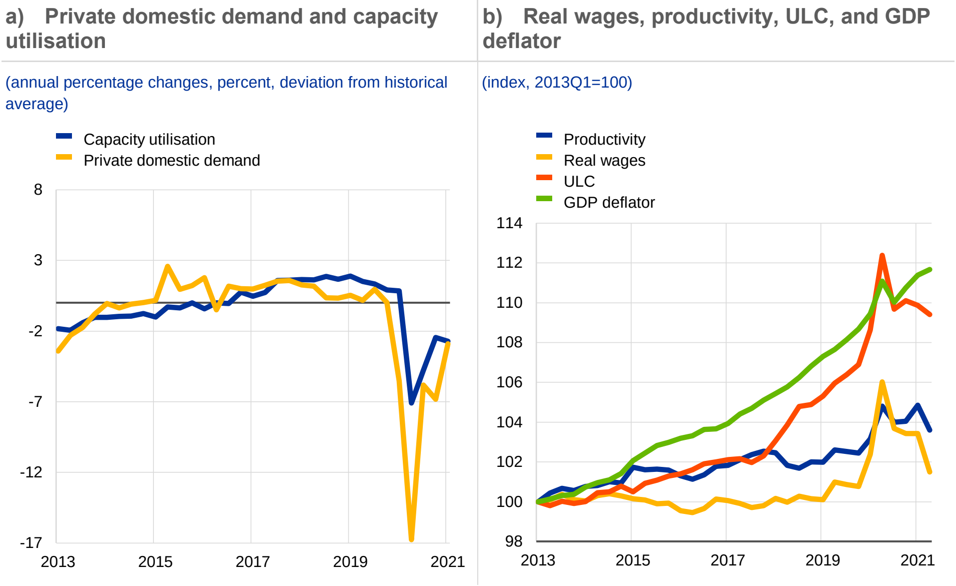
On the demand side, the euro area economy recovered slowly from the recessions of 2009 and 2012. Real GDP only returned to its pre–global financial crisis (GFC) level in 2015. The protracted weakness of global trade also played a key role in slowing the recovery, in particular between 2012 and 2016 (IRC Trade Task Force, 2016). In the meanwhile, capacity utilisation remained below the historical average for five years after the 2012 recession (**Chart 1**, panel a) contributing to the sluggishness of total gross fixed capital formation, which only returned to pre-GFC level in 2018 and prolonging the disinflationary impact of the twin recessions. Alternative approaches to measuring the output gap showed that it might have been much larger than official estimates and that the period of slack extended into 2017-19 (Jarociński and Lenza, 2018). To better assess the outlook and the amount of slack in the economy, the last strategy review stressed that economic analysis had to make increasing use of household and firm surveys and complement the analysis of traditional data with new, high-frequency indicators.

Domestic cost pressures were also a source of disinflation in the years preceding the last strategy review. Domestic sources of inflation were compressed between 2013 and 2019 (Nickel et al., 2019), as unit labour costs (ULC) grew by 1% per annum, which was even below the muted growth rate of the value-added deflator of 1.3% per annum (**Chart 1**, panel b). The increase in EU labour market flexibility between 2010 and 2012, following the wave of reforms that took place after the euro area sovereign debt crisis, likely contributed to these developments (Turrini et al., 2015 and Rustler, 2024 among others). The empirical evidence prior to 2020 found that the wage-price pass-through was lower in a low inflation, low growth environment (Bobeica et al., 2019 and Hahn, 2020).

In an environment of persistently low inflation, medium term inflation expectations trended downwards until 2021. Persistently low inflation and possibly also the de facto asymmetric inflation target contributed to lower inflation expectations. This led to an increase in de-anchoring risks, as the effective lower bound made it more difficult for interest rate policy to offset disinflationary shocks. Against the background of low inflation and low policy rates, longer-term inflation expectations fell. Such dynamics were also recorded in other advanced economies, pointing to the existence of a common global factor (see Workstream on inflation expectations, 2021).

Chart 1

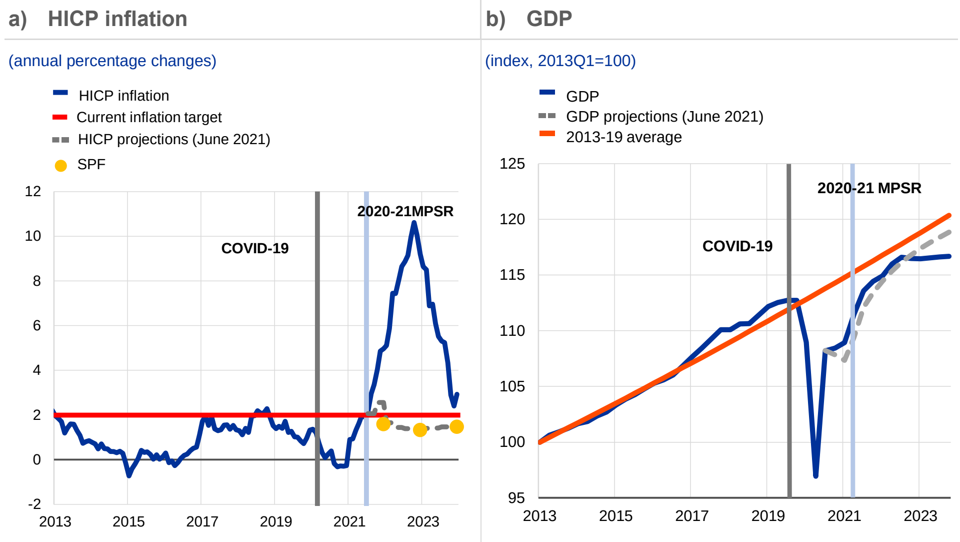
Main economic indicators at the time of the last monetary policy strategy review



Sources: Eurostat, DG-ECFIN and Eurosystem calculations.
Notes: Panel a): Historical average calculated over the period 1999-2019. Private domestic demand is the sum of private consumption and private investment (excluding Irish Intellectual Property Products (IPP), annual changes in deviation from historical average. In the second quarter of 2020 private domestic demand fell by 16.8%. Panel b): Productivity and ULC per hours worked, real wages deflated with the GDP deflator.

Chart 2

HICP and GDP outlook at the time of the last monetary policy strategy review



Sources: Eurostat, Survey of Professional Forecasters (SPF) and June 2021 Broad Macroeconomic Projections Exercise.

Several past and ongoing key structural changes likely contributed to the low inflation environment. The last strategy review showed that structural developments such as globalisation (Lodge and Perez, 2021), digitalisation (Anderton and Cette, 2021), climate change (Drudi et al., 2021) and population ageing (Bodnár and Nerlich, 2022) had seen an acceleration during the previous twenty years and were increasingly affecting the spending and investment decisions of firms and households. Although these factors primarily have a temporary impact on inflation, their effects may persist. Therefore, it was important to further investigate these longer-term factors, as they have significant implications for monetary policy (**Section 2.2.4**) and for a broader assessment of the medium-term outlook (**Chapter 3**).

The pandemic started just after the last strategy review had begun. HICP inflation averaged 0.3% in 2020, as the generalised lockdowns triggered by the COVID-19 pandemic led to extraordinary constraints on production, spending and lower capacity utilisation, and several governments cut indirect taxes to support the economy (**Chart 1**, panel a). The monetary and fiscal response was exceptionally strong and helped the economy to recover much more quickly than after the twin recessions mentioned previously. When COVID-19 struck, the information was too limited to properly assess the full implications of the shock caused by the pandemic.

When the last strategy review was concluded, HICP inflation had reached 1.9%. In June 2021 HICP inflation stood at 1.9%, driven mainly by the increase in energy prices, while core inflation (HICP excluding energy and food) was still below 1%. In June 2021 the Eurosystem forecasts projected an acceleration in GDP towards the previous growth trend (**Chart 2**, panel b) and a marginal overshoot of the inflation target during the second half of 2021 (boosted by energy prices and a base effect caused by the German VAT reduction in 2020), followed by a return to the pre-pandemic average of 1.5% in 2022 and 2023. Professional forecasters held similar views (**Chart 2**, panel a).

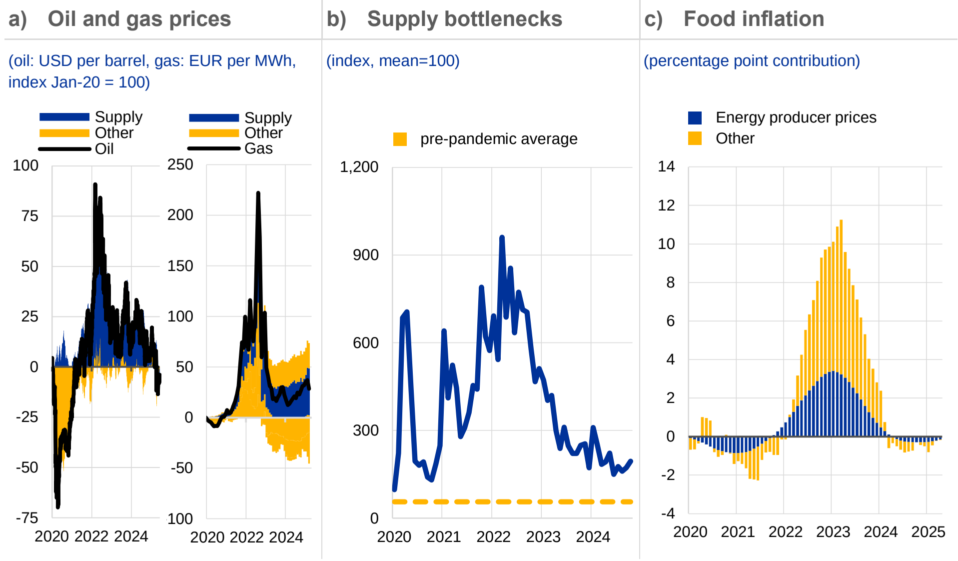
2.2 Assessing inflation developments since the last monetary policy strategy review

2.2.1 Evidence on the supply and demand drivers of inflation

The period after the previous strategy review saw inflation hitting record highs amid unprecedented shocks. Back-to-back sectoral shocks proved to be more sizeable and diverse than previously, reflecting the post-pandemic reopening, shifts in consumer spending, supply chain bottlenecks, and energy and food price shocks, with Russia's invasion of Ukraine significantly amplifying the resulting economic disruptions and inflationary pressures (**Chart 3**). Supply shocks, originating primarily from external sources, were key drivers of the inflation surge. While global and domestic surges in demand in specific sectors also contributed to sectoral demand-supply mismatches, the overall level of aggregate demand in the euro area recovered faster compared to earlier crisis but was only barely above pre-pandemic levels by the end of 2022. Diagnosing the nature of inflation in real time was crucial for calibrating the appropriate monetary policy response and this implied distinguishing between: i) temporary and persistent drivers; ii) domestic and external ones; and iii) those on the demand side and those on the supply side. This section analyses the inflation drivers since the latest strategy review, distinguishing between various phases: (i) an initial surge in the course of 2021, as a consequence of the pandemic and ensuing sectoral demand-supply mismatches; (ii) a second phase when Russia's invasion of Ukraine led to massive war-related inflationary effects; and (iii) a third phase of disinflationary pressures which unfolded at different speeds: first, a steep decline starting in October 2022, as supply chains and energy issues were resolved and as monetary policy kicked in, and then a less pronounced decline, as wages and lagging prices for items such as services reacted to the previous price shocks with delays.

Chart 3

Sectoral shocks affecting euro area inflation since the previous strategy review



Sources: Panel a): left-hand side: LSEG and ECB staff calculations based on Gazzani et al. (2024) and right-hand side: LSEG, Bloomberg, IEA and ECB staff calculations based on Adolfsen et al., 2024. Panel b) and c): ECB staff calculations and Eurostat.
Notes: Panel a): left-hand side: Structural shocks are estimated using the 1m future, 12m to 1m futures spread, markets' expectations on oil price volatility and stock price index, following a BVAR based on Gazzani et al. (2024). Right-hand side: The decomposition is based on a 4 variables Bayesian VAR where shocks are identified with sign restrictions including a euro area gas quantity proxy (defined as imports+domestic production-exports), gas price, gas inventories and euro area industrial production. The last two observations for gas quantity and industrial production are nowcasted. The latest observations are for 6 June 2025 for the left-hand side and April 2025 for the right-hand side. Panel b): Supply bottlenecks as in Burriel et al., 2024. The latest observations are for October 2024. Panel c): decomposition of food price inflation based on Kuik et al., 2024. The latest observations are for April 2025.

Energy prices were a significant driver of the inflation surge as the economy recovered from the pandemic. The primary driver of inflation surprises in the autumn of 2021 (the first in a series of sizeable one-quarter-ahead inflation forecast errors) was the unexpected surge in energy prices, which also explained a substantial share of forecast errors during 2022 (see Lane, 2024). In 2021 oil prices rebound from pandemic-induced lows due to rising demand from economies re-opening and travel resuming. Oil price hikes were subsequently aggravated by supply side issues. Gas price inflation had already surged since the summer of 2021, particularly in Europe, reflecting a combination of supply and demand factors amid increased uncertainty, including escalating geopolitical tensions.[1] Russia's invasion of Ukraine in early 2022 had a major aggravating effect. Past energy shocks had mainly been oil-driven, but in early 2022 when energy consumer price inflation peaked at 44%, gas and electricity accounted for half of the increase. This created unprecedented heterogeneity in energy inflation across countries reflecting different price-setting mechanisms, taxes and network fees, as well as different HICP weights for gas.

Meanwhile, pandemic-related lockdowns disrupted global production and transport chains, and shifted demand towards goods, causing a surge in shipping costs and delays in delivery times. In the euro area, manufacturing faced prolonged delays in sourcing key components that were in high demand, such

[1] Supply from Norway was low in the first half of 2021 owing to maintenance work on pipelines, and since the summer of 2021 supply of gas from Russia to the EU dropped significantly, contributing to the slow replenishment of gas inventories ahead of the winter season.

as semiconductors (Attinasi et al., 2021), as the frequent lockdowns during COVID-19 pandemic had dislocated global production and delivery. Booming global demand due to exceptional fiscal stimulus programmes especially in the United States contributed towards bottlenecks in specific sectors as economies re-opened. Prices of intermediate goods surged and eventually had an impact on consumer goods prices (see Corporate Telephone Survey, 2021) also underscoring the importance of accurately tracking of the build-up of pipeline pressures along the pricing chain, including from producers to retailers. Consumer goods prices reached record highs after a two-year surge, also driven by lockdown-related shifts in demand towards goods, particularly durable goods.[2] The major post-pandemic economic dislocations therefore generated large relative price swings, opening up an unprecedented positive gap between goods and services inflation (see **Section 3.4** for more details).

In a second phase, Russia's invasion of Ukraine in February 2022 exacerbated pressures and led to an extraordinary surge in inflation during 2022, affecting not only energy, but also food and other tradable sectors.[3] Russia's war against Ukraine led to a surge in oil, gas and wholesale electricity prices in the euro area and was also an important factor behind higher consumer food inflation over this period (Kuik et al., 2024). Increases in global food commodity prices and euro area farm-gate prices also made a significant contribution. Overall, price increases in these initial phases mainly reflected external shocks and were concentrated in specific sectors with a larger share of internationally tradable inputs and products, such as energy, food and some categories of goods (**Chart 4**, panel a).

Indirect effects from energy and food price spikes passing through into core inflation led to the broadening of inflationary pressures. The atypically large sectoral relative price movements turned into upward pressure on the overall price level, as downward nominal rigidities prevented prices from falling in sectors that faced low demand (Bonam and Hobijn, 2024). The higher energy and food price shocks – multiple, persistent and large - were being increasingly passed through to goods and services sectors via input costs. The magnitude of such indirect effects is subject to substantial model uncertainty (**Chart 4**, panel b), but models suggest that this kind of pass-through takes time to fully materialize. Also, in this particular episode, the delay was amplified by the atypical role of gas, for which certain studies find a more protracted impact compared with oil (Alessandri and Gazzani, 2023 and Banbura et al., 2023).[4]

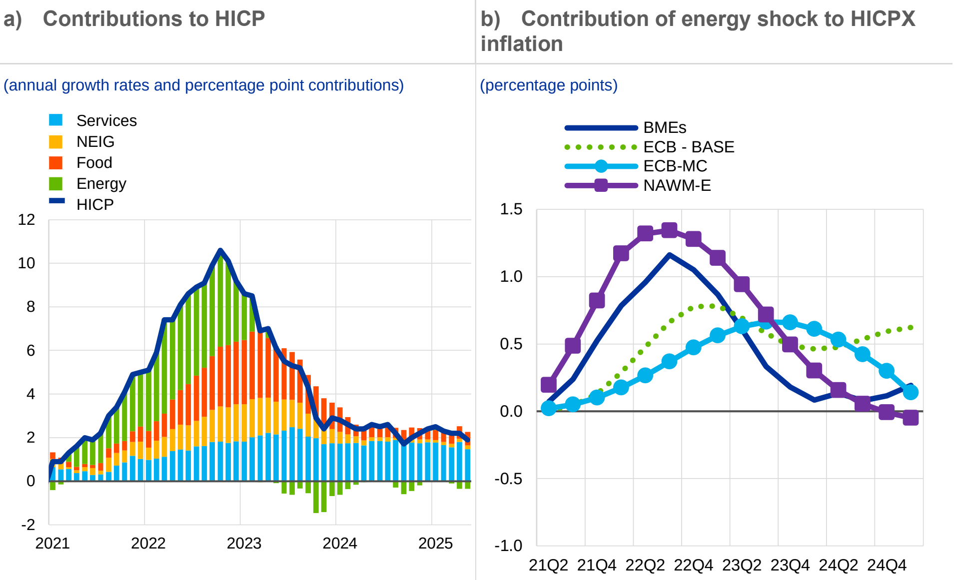
[2] The inflationary impact of supply chain disruptions was revived in 2023-24 due to geopolitical tensions in the Red Sea, a crucial route for imported goods to the euro area (Attinasi et al., 2024).

[3] Anttonen and Lehmus, 2024 estimate that Russia's invasion of Ukraine added more than 2 percentage points to euro area inflation.

[4] This holds also when it comes to direct effects. Model-based evidence for the euro area suggests that the pass-through of crude and refined oil prices to consumer prices is generally complete and quick, within 3-5 weeks. The pass-through of wholesale gas prices is slower, taking about 3-6 months on average; see Kuik et al., 2022.

Chart 4

Decomposition of inflation into main components and indirect effects



Sources: Panel a): ECB staff calculations and Eurostat, Panel b): ECB staff calculations using ECB's workhorse models and Basic Model Elasticities (BMEs), ECB-BASE, ECB-MC and NAWM-E.
Notes: Panel a): The latest observations are for May 2025 (flash estimate). Panel b) The BMEs correspond to the oil price level of 85€ per barrel. The latest observations are for the first quarter of 2025.

Increasing demand, particularly in supply-constrained, contact-intensive services such as tourism and hospitality, added to inflationary pressures. In the course of 2022, it was also increasingly clear that the euro area economy was more firmly on the exit path from the pandemic, and a strong recovery in tourism and other contact-intensive services was expected. Measures of underlying inflation were picking up, confirming the more generalised nature of inflation (Lane, 2023). The consumption-driven reopening phase in 2022 had been strongly supported by fiscal policies that shielded household' incomes (e.g. through job retention schemes or other subsidies) during the successive pandemic-related lockdowns between 2020 and 2021 (see **Section 2.2.4**). Across services, the first prices to surge were those of contact-intensive and energy-sensitive items such as travel- and tourism-related services (**Chart 5**, panel a). At the same time, supply shocks were still at play, as bottlenecks were constraining the manufacturing and food sectors, compounded by the ongoing shutdown in China and the impact of Russia's invasion of Ukraine. Lastly, the size and multitude of upward shocks encouraged firms to raise prices more frequently.[5]

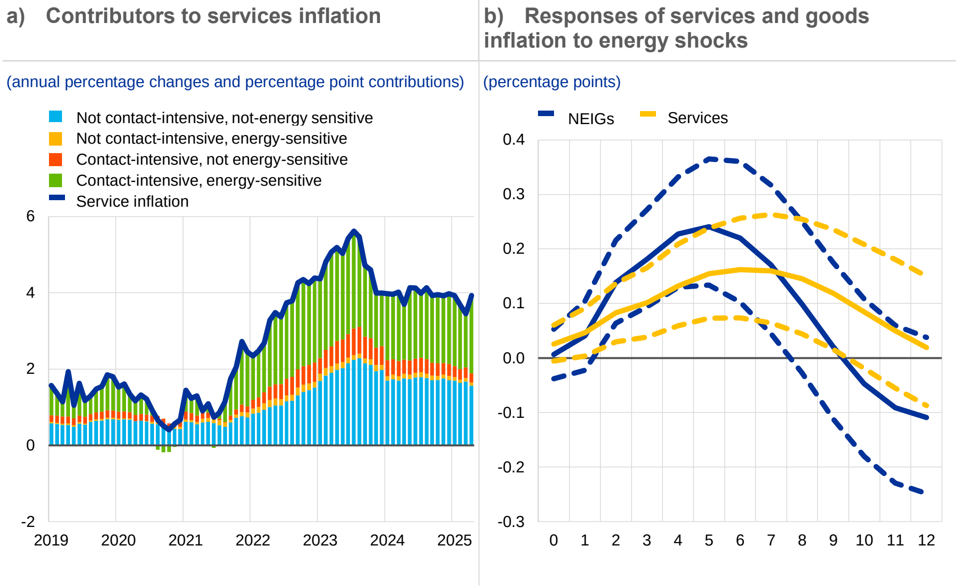
In a third phase, disinflation occurred at various speeds: as the energy and supply chain issues abated and monetary policy dampened demand, headline inflation declined sharply, while services inflation adjusted more slowly also reflecting the lagged effects of past shocks. During 2023 supply shocks eased and energy prices fell. A synchronous monetary policy tightening across advanced economies, in response to the inflation shock, tightened financing conditions and

[5] Evidence from PRISMA micro-price data confirms that the inflation surge corresponded to a large increase in the relative frequency of price increases, rather than in an increase in the size of price changes. See Box 1 in Dedola et al., 2024 and Box 2 in this Report.

weakened global demand for European exports. It also dampened consumption and investment in the euro area, further easing inflationary pressures. But the large shocks influenced sectors and consumption items at different speeds. The price of services, particularly those produced domestically, were still reflecting past inflationary pressure, and rising at 4-5% in late-2024. Strengthening wages, which themselves react with a lag to inflation and economic activity, have been a relevant driver of inflationary pressures, particularly in the services sector, which is more labour intensive. In general, service prices tend to change less frequently compared with other items. In particular some of them, such as insurance, rents and public sector service prices, adjust in a staggered and mostly backward-looking way. These items, which are less affected by monetary policy given the acyclical pattern of their consumption, only started fuelling inflation in late-2022 and continued to fuel it in 2024, slowing down the whole disinflation process (Corsello and Neri, 2025). **Chart 5**, panel a, shows that the part of services inflation that was neither contact-intensive nor energy-sensitive rose later than the rest but proved to be more persistent. Overall, services inflation reacts to shocks in a more delayed fashion compared with goods inflation, as illustrated in **Chart 5**, panel b for the case of energy shocks.

Chart 5

Services inflation and reaction to energy shocks



Sources: Eurostat and ECB staff calculations.
Notes: Panel a): The latest observations are for April 2025. Panel b): reports impulse-response functions based on a quarterly VAR model over the sample period 1996-2023; the x-axis indicates the number of quarters after the energy shock. Model specification and identification of energy shocks are similar to those presented in Neri et al. (2023), 'Energy price shocks and inflation in the euro area', Banca d'Italia, Questioni di Economia e Finanza, n. 792. The impulse responses show the effect of a one standard deviation shock to energy prices. Dotted lines depict the 68 percent confidence interval.

Quantifying the relative importance of demand versus supply factors is challenging given the multitude of shocks hitting at the same time, but many models confirm that both played a significant role, with supply shocks quantitatively more important during this period. Numerous studies have attempted to disentangle post-pandemic inflation drivers given that this distinction may require a differentiated policy response.[6] The approaches differ in terms of the information sets used, the types of drivers considered, the models used or the assumptions made to identify individual shocks or monetary and fiscal policy responses. Typically, models identify (a subset of) shocks to various commodity prices, global supply bottlenecks, (external and domestic) aggregate demand and supply, monetary policy and several other macroeconomic aspects.

Chart 6 shows the estimated contributions of supply and demand shocks to euro area headline inflation across several Eurosystem models. The ranges indicate the uncertainty inherent in disentangling the supply- and demand-side drivers. The models tend to agree that supply-side factors were more prominent, particularly in the initial phase, while the contribution of demand was more contained before gaining importance at a later stage in the course of 2022. The contribution of demand also covered the relevance of monetary and fiscal policy in influencing inflation first via expansionary pandemic-related monetary and fiscal policies and subsequently via monetary and fiscal policy tightening, see **Section 2.2.4** and the Workstream 2 report for an in-depth assessment of this. Consumers and professionals alike were attributing the lion's share of the inflation surge to increases in inputs costs, while at the end of 2024, domestic drivers such as wages gained importance, see **Box 1** for more details. The narrative that supply shocks played a predominant role in the initial stage is also supported by comparing the euro area with other economies. The euro area is very open, highly integrated into global value chains, and dependent on energy imports, particularly gas. This meant that it was particularly vulnerable to large, external supply shocks in the post-pandemic landscape.

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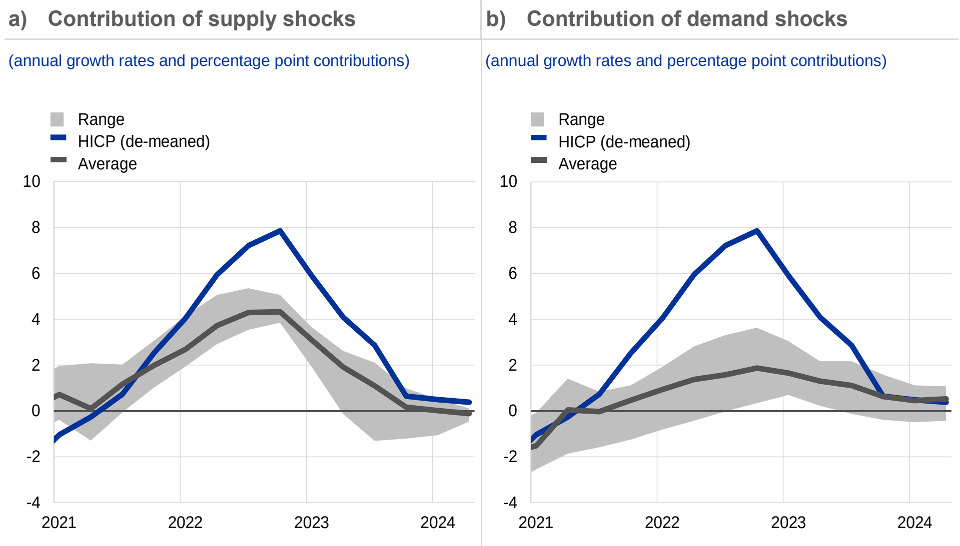
6 See, for example, Arce et al., 2024, Ascari et al., 2023, Ascari et al., 2024, Banbura et al., 2023, Bergholt et al., 2024, Bonomolo et al., 2024, Delle Monache, Pacella, 2024, Depalo and Lo Bello, 2024, De Santis, 2024, Eickmeier and Hoffman, 2022, Garcia-Revelo, 2024, Giannone and Primiceri, 2024, Goncalves and Koester, 2022, Hoynck and Rossi, 2023, Kataryniuk et al., 2024, Neri et al., 2023, Pallara et al., 2023 and Oinonen and Vilmi, 2024.

Chart 6

Contribution of supply and demand shocks to euro area headline HICP



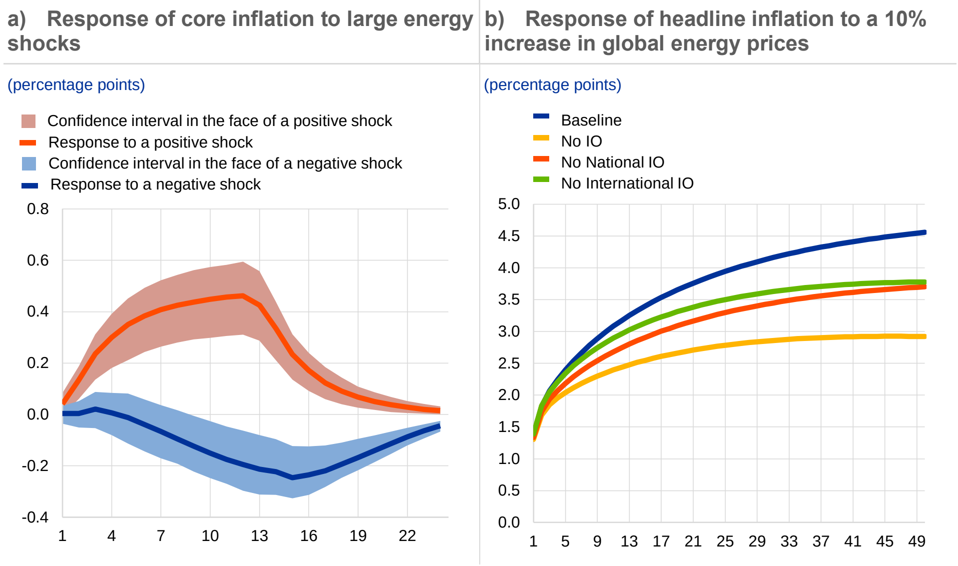
Sources: Eurostat and ECB's staff calculations.
Notes: The charts show the ranges of the contributions of supply and demand shocks to euro area annual headline inflation rate estimated using several models: Bayesian VARs as in Bonomolo et al., (2024), Bobeica and Jarocinski, (2019), augmented with global supply chain shocks, as in Banbura et al.,2023, a structural factor model of Eickmeier and Hofmann, 2022, a structural VAR model of Kataryniuk et al., 2025 and a large DSGE model, namely the New Area Wide Model II of Coenen, Karadi, Schmidt and Warne (2018).Half of these models distinguish between foreign and domestic supply and demand. Some models also contain other drivers in addition to supply and demand factors, which are not reflected in the chart. Therefore, the contribution of supply and demand do not always add up to the total. Depending on the model, the contributions are calculated for headline HICP in deviation from historical mean and contribution of other deterministic components or from the steady state of 2%. The latest observations are for the second quarter of 2024.

A comparison with the United States is helpful to understand which specific euro area factors drove inflation in this period. Compared with the United States, the euro area economy is more vulnerable to supply shocks, such as those related to energy or global value chains. Pallara et al., 2023 show that during the period under review, the effect of energy prices on core inflation was negligible in the United States but large and persistent in the euro area. At the same time, demand shocks from the fiscal stimulus following the pandemic were much more substantial in the United States, whose public debt-to-GDP ratio rose more significantly than in the euro area. The differences in the support provided to the economy are evident when comparing the dynamics of real aggregate demand, which recovered quickly in the United States and overshot the pre-pandemic level, while remaining muted in the euro area. This suggests demand factors made a larger contribution in the United States than in the euro area (Andersson et al., 2024).

The inflation surge likely came with a change in the pass-through of shocks, which complicates the model-based quantification of the various inflation drivers, especially in real time. Most macroeconomic models rely on estimates of economic relationships over long historical sample periods and typically assume that such relationships do not change (much) over time. This is also because such changes are difficult to detect reliably in real time, and most of the time linear approximations work well. Consequently, linear models might only provide an incomplete approximation of how recent shocks were propagated, especially as some of them were never recorded over the euro area history, such as the pandemic and the war, and given that there is evidence that their propagation was different than in previous periods. This can reflect the unprecedented size, persistence, direction and source of the shocks. To illustrate this, **Chart 7** shows that a large rise in energy prices increases core inflation twice as much as an equivalent fall reduces it.[7] Also, the exceptional size of the energy shock helped quicken and magnify its impact (Neri, 2025). A possible explanation for a proportionally larger reaction to large shocks is provided by available micro-evidence for the post-pandemic recovery period suggesting a higher frequency of price adjustments in the euro area (see **Box 2**). This is in line with state-dependent pricing models, in which prices are more flexible under large shocks. Cavallo et al., 2024, allow for the frequency of price changes to increase sharply after a large shock, following the price-setting patterns observed in granular data, and indeed find that large shocks travel faster than small shocks.[8]

Chart 7

Role of non-linearities and network effects



Sources: Panel a): See Burriel et al., 2024; Panel b): ECB staff calculations.
Notes: Panel a): The x-axis shows the time after the shock in months. The y-axis shows the response of year-on-year core inflation in percent. The energy price shock increases (decreases) energy price inflation by 6% on impact. Results are based on a bivariate non-linear SVAR which consists of y-o-y energy price inflation and y-y-o-y core inflation. The energy price shock is identified via contemporaneous restrictions. Panel b): CIRFs of headline inflation to a 10% increase in imported energy price. Baseline: full input-output (IO) structure. No IO: without input-output structure. No international IO: without international input-output structure. No Nat. IO: without national input-output structure. When shutting off parts of the input-output structure, energy is always kept as intermediate good input in production (Aguilar, Domínguez-Díaz, Gallegos and Quintana; 2025).

Production networks also appeared to be an additional shock amplification mechanism, as among supply shocks, the ones that affect more upstream sectors, as seen during the inflation surge have larger effects within a network.[9] Aguilar et al., 2025 find that the inflation response to an energy shock in a model featuring a production network is 50% higher compared with a counterfactual that has no production networks (**Chart 7**, panel b): “baseline-with full IO” versus ”No

[7] Burriel et al., 2024 find that this asymmetry is greater for components that use more energy in their production, if the shock is large. Adolfsen et al., 2024 find differentiated effects of gas supply shocks on inflation for different levels of unemployment.

[8] Other work using PRISMA scanner price data gives an indication that the likelihood of changing prices is higher when it implies an increase than a decrease, see Karadi et al., 2023

[9] See the ChaMP work by Ghassibe and Nakov, 2024.

IO”). This implies that the contribution of supply shocks during the initial phase might have been even larger than estimated using stylised models without production networks.

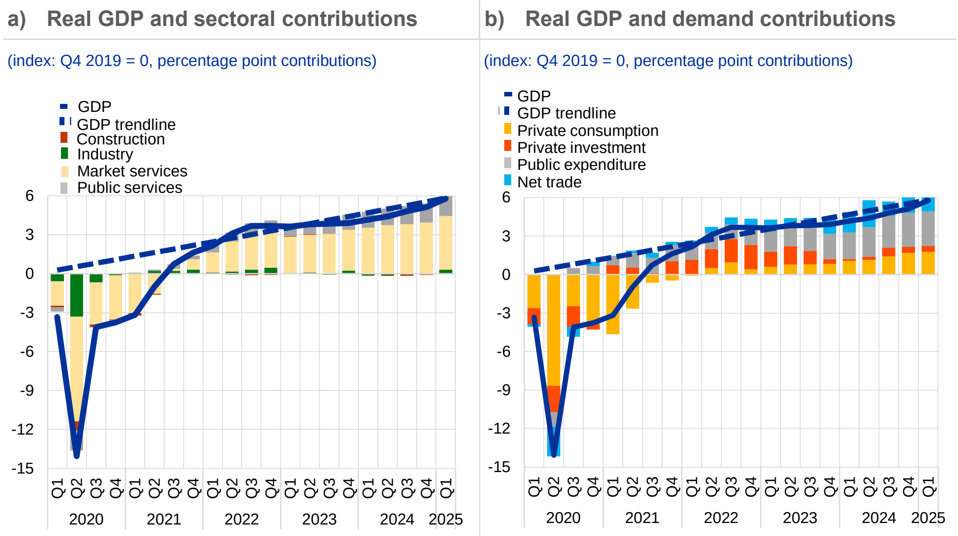
2.2.2 The changing link between inflation and real activity

Real activity recovered quickly from the COVID-19 shock compared with how it recovered from the crises of the previous decade, but with large sectoral differences. Real activity in the euro area took seven quarters to return to its pre-COVID-19 level, while it took 29 quarters to return to its pre global financial crisis level. While the two shocks were very different, the post pandemic recovery was supported by the strong response of monetary policy, national fiscal policies and EU support schemes (**Section 2.2.4**). Despite initially expanding quickly, in the second half of 2022 euro area growth started to disappoint compared with its long-term trend (**Chart 2**, panel b).

Market services made up the lion’s share of economic growth in the past five years, while there were almost no direct contribution from industry (Chart 8, panel a). Re-opening effects were a significant driver of the growth differential between industry and services, as pandemic restrictions and subsequent re-opening shocks had a higher and longer lasting impact on the behaviour of contact-intensive services compared with manufacturing (Battistini and Gareis, 2023). Across demand components, private consumption led the recovery of GDP up to 2022, while it largely stalled afterwards owing to the outbreak of the energy crisis, the resulting terms-of-trade shock and the drop in confidence brought about by the war in Ukraine. The recovery in GDP was also fostered by the rebound in private investment, supported by the favourable financing environment and net trade. After this initial phase, public spending took over as the largest fraction in the output expansion, while private domestic demand flattened as monetary policy became progressively tighter (**Chart 8**, panel b).

Chart 8

Sectoral contributions to real GDP growth



Sources: Eurostat and ECB calculations.
Notes: Panel a): the pre-COVID-19 trend estimated over 1999Q1 to 2019Q4. Owing to statistical differences between GDP and total gross value added, contributions from industry, services and construction do not add up to total GDP. The latest observations are for the first quarter of 2025. Panel b): demand components exclude the impact of Irish IPP. The latest observations are for the first quarter of 2025.

The unwinding of the large stock of savings accumulated during the pandemic is unlikely to have contributed much to inflationary pressures, not least because of their composition and distribution. One key distinctive feature of the past five years has been the exceptionally high accumulation of savings, as households' disposable income grew much more than private consumption (**Chart 9**, panel a). An analysis of private savings. shows that the bulk is held by richer households that invested it mostly in illiquid assets.[10] This suggests that most of the additional savings might continue not to be used for private consumption, and may instead constitute reserves for a rainy day. This makes it unlikely that the stock of accumulated saving would exert renewed inflationary pressures as private consumption recovers.[11]

Capacity utilisation, commonly used to measure cyclical slack, has behaved differently across sectors. Capacity utilisation in the manufacturing sector has been on a declining path since 2022, in line with weakening demand for goods, while it has remained broadly stable around the historical average for services (**Chart 9**, panel b). While there is high uncertainty, official measures of the output gap showed a relatively robust correlation with aggregate capacity utilisation. In a context characterised predominantly by supply shocks, there is evidence that supply factors might have been behind the opening of the output gap in 2022 (González-Torres G., et al, 2023).

10 See Battistini et al., 2023.

11 See Battistini and Gareis, 2023.

Chart 9

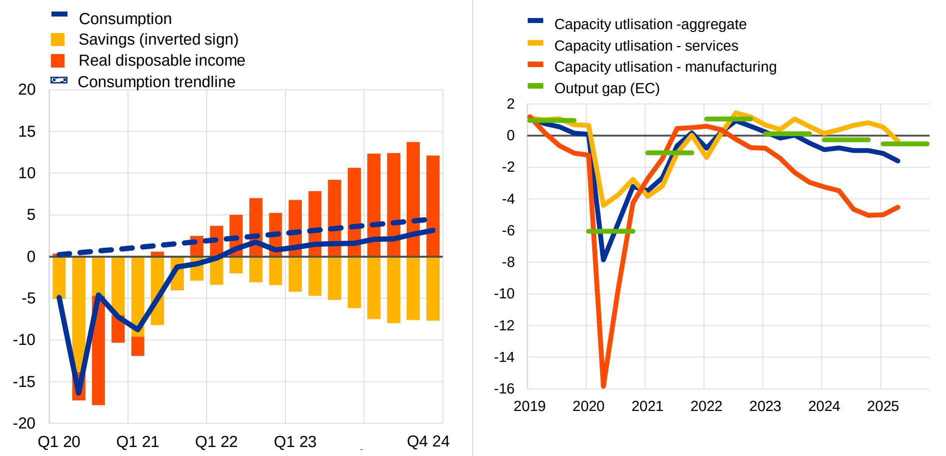
Drivers of private consumption and measures of cyclical slack

a) Drivers of private consumption

(index: Q4 2019 = 0, percentage point contributions)

b) Measures of cyclical slack

(in deviation from potential output or historical averages)

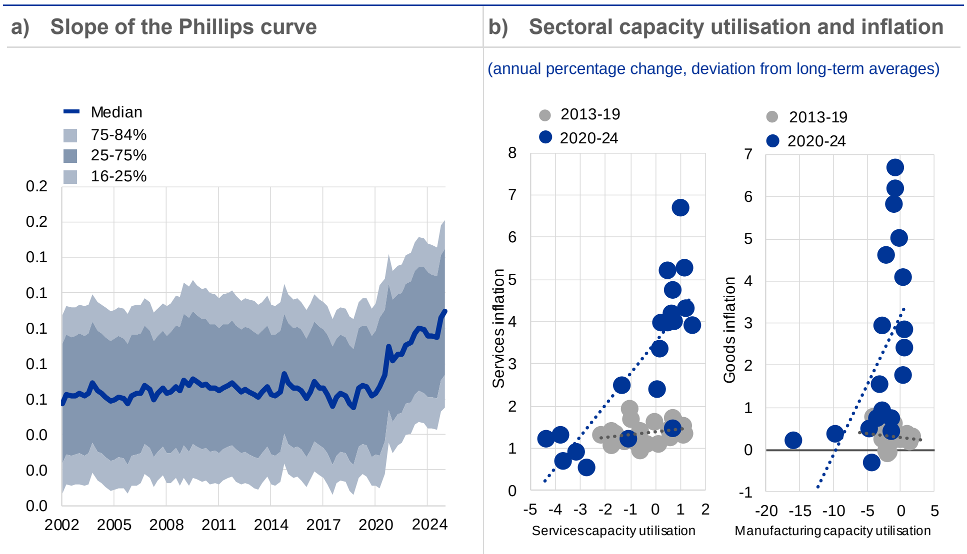


Sources: Eurostat, DG-ECFIN, and Eurosystem calculations.
Notes: Panel a): private consumption trendline computed over the period 1999-2019. The chart shows the cumulative contributions of real disposable income (deflated by the private consumption deflator) and savings, cumulated quarterly flows. The latest observations are for the fourth quarter of 2024. Panel b): historical averages computed since 1999 for manufacturing and 2011 for services (start of the time series). The latest observations are for the first quarter of 2025.

There is tentative evidence that the link between real activity and inflation has changed in the past five years, amid high uncertainty. Empirical, reduced-form models show some steepening of the slope of the Phillips Curve in the post-COVID-19 period when capacity utilisation is used as a measure of slack, although the slope remains generally very low (**Chart 10**, panel a). Other measures of slack, such as the unemployment gap, do not point to a significant steepening of the Phillips Curve. The steepening that emerges when capacity utilisation is used as a measure of slack – which arguably could better reflect cyclical conditions than unobserved measures – might arise from an increase in the frequency of price adjustment, consistently with the evidence reported in **Section 2.2.1** and **Box 1**. In turn, this might imply that in the absence of frequent price changes, the estimated link between the two could again return to being rather weak. Evidence of recent steepening of reduced-form Phillips Curves was reported across advanced economies by the IMF World Economic Outlook (October 2024). However, an alternative explanation is that the Phillips Curve has shifted upwards due to higher short-term inflation expectations (Waller, 2023, see Section 2.2.5) or as a reflection of more frequent supply shocks which could have led to an upward shift in the equilibrium relationship between output and inflation.

Chart 10

Link between inflation and total and sectoral capacity utilisation



Sources: Eurostat, DG-ECFIN and Eurosystem calculations.
Notes: Panel a): The slack measure used is capacity utilisation. Time-varying parameter estimate where coefficients and log variance are assumed to follow a random walk. Panel b): Services and manufacturing capacity utilisation are shown in deviation from the pre-Covid long-term average.

Sectoral results also suggest a change in the relationship between inflation and slack, which could indicate an upward shift or an increase in the slope of the Phillips Curve in the post-pandemic period. In the past five years the large sectoral heterogeneity highlighted the new limitations of estimates based on aggregate data and the need to go granular to gauge the Phillips Curve slope.[12] When comparing correlations between sectoral capacity utilisation measures and sectoral inflation it is possible to observe a change in the link in the post-pandemic period (**Chart 10**, panel b). There might be two possible explanations. First, it resembles an inverted-L relationship, similar to the one described by Benigno and Eggertsson, 2023 or Gitti, 2024 for the United States in relation to the labour market tightness. This inverted-L relationship implies that relatively modest changes in capacity utilisation are associated with large changes in sectoral inflation. Second, this simple correlation analysis might also be compatible with an upward shift of the Phillips curve in an environment characterised by frequent supply shocks.

The most recent disinflationary process has been associated with much milder output losses than historical experiences. Following the methodology of Ball, 1994 an analysis of 46 advanced and emerging market economies showed that there have been 230 completed episodes of disinflation since the 1960s (Deutsche Bundesbank, 2024). Against the aboved-mentioned historical episodes, the sacrifice ratio - the loss in output during a disinflationary period- has been small in the euro

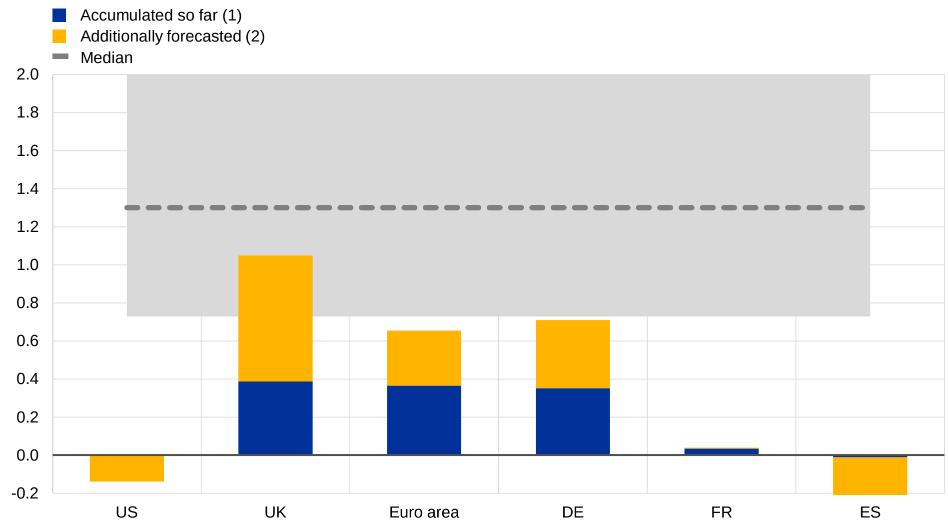
[12] On the micro front, Gagliardone et al., 2023 show that a Phillips Curve that includes an estimate of marginal costs using firm-level data features a high slope. Although the pass-through of marginal costs into inflation is substantial, the elasticity of marginal costs in relation to the output gap is low.

area.[13] This also holds true for Germany, whose large industrial sector has been particularly exposed to the energy crisis and monetary policy tightening. In other large European countries, sacrifice ratios have remained below or within historical norms (**Chart 11**). As in the United States, real GDP in Spain has even grown at slightly above trend rates throughout the disinflationary period. Overall, this evidence is consistent with the above tentative conclusion of a steepening of the Phillips Curve. An additional explanation is that while monetary policy tightening has been transmitted forcefully to the economy (see Lane, 2024 and Workstream 2 report), other important factors were at play. A combination of receding adverse supply-side shocks, robust employment creation (**Section 2.2.3**), fiscal policy support (**Section 2.2.4**) and well-anchored inflation expectations (**Section 2.2.5**) can also explain the mild impact of the disinflation process on output between 2022 and 2024.[14] Moreover, while monetary policy tightening was transmitted through the financial system to the macroeconomy, the transmission was not disorderly, which might also have favoured economic resilience.

Chart 11

Sacrifice ratio for the current disinflation episode

(Cumulative percentage GDP losses relative to the decline in trend inflation)



Sources: OECD and Bundesbank calculations.
Notes: Based on the approach by Ball, 1994. The sacrifice ratio is measured as the sum of the percentage deviations of GDP from its trend divided by the decline in underlying consumer price inflation. (1) Up to the fourth quarter of 2023; (2) Calculated based on the OECD forecasts. In grey is depicted the historical interquartile range.

13 For this exercise, trend inflation is measured by a centred moving average of the annualised quarterly percentage change in the seasonally adjusted consumer price index over nine quarters. Disinflation episodes are defined by a fall in this metric of at least 2 percentage point. Historical sacrifice ratios cluster around a value of 1, implying that a reduction of 1 percentage point in trend inflation was accompanied by an average output loss of 1%. See Ball, 1994 and Deutsche Bundesbank, 2024.

14 See Deutsche Bundesbank, 2024.

2.2.3 The labour market, productivity, wages and profits

Labour demand, labour supply and productivity

The euro area labour market showed remarkable resilience in the aftermath of the pandemic. While the economy was hit by a succession of shocks, unemployment rates remained at record lows and employment grew steadily. Meanwhile, the adjustment of hours worked per person absorbed the lockdown's shock, as government-sponsored job retention schemes protected employment. While both employment and total hours worked recovered from the pandemic, the recovery of hours worked has been much more muted; in the first half of 2024 it still stood 1% below its pre-pandemic level (**Chart 12**, panel a). In other words, firms have expanded their employment base (extensive margin) instead of increasing average hours worked (intensive margin). The incomplete recovery of hours worked appears consistent with the long-term downward trend in average working hours that pre-dated the pandemic (Astinova et al., 2024). Meanwhile – on aggregate – firms continued to create new jobs and tended not to lay off workers following a deterioration in their turnover, leading to labour hoarding (**Chart 12**, panel b).

Several factors contributed to strong labour demand in the past five years. During the pandemic, jobs were protected by government-sponsored job retention schemes (Anderton et al., 2021) and, as the economy reopened, firms also started to hoard labour to prevent labour shortages. It is also possible that firms were not able to adjust the intensive margin, due to an employee preference to work fewer hours. While job retention schemes were successful in preventing job losses, they may have made the reallocation of resources more difficult later on, especially in comparison with the United States (Kugler, 2024). With the inflation surge starting in late 2021, real wages dropped well below productivity dynamics, and this development probably also stimulated labour demand (**Chart 13**, panel a). Furthermore, increasing prices for raw materials and intermediate goods and tighter financing conditions led firms to increase capacity via labour rather than capital, known as factor substitution. Some of these developments reinforced each other and resulted in an increase in employment in heads significantly above Okun's law predictions (Berson et al., 2025). Further evidence shows that the increase in profit margins allowed firms to hold on to their employees for longer than usual, despite falling revenues (Botelho, 2024). Such behaviour generally occurs when firms expect that the fall in demand is temporary and may be aggravated by labour shortages across certain skills and occupations that make adjusting the workforce more difficult.

The resilience of the labour market was also supported by an expanding labour supply, which in turn helped mitigate real wage pressures. Despite the downward trend of average hours worked (Consolo et al., 2023), the labour force recovered quickly in the post-pandemic period to surpass its pre-pandemic levels at the end of 2021. Refugees (Botelho, 2022) and migrant workers contributed to around half the labour force increase as of early 2022, and this likely mitigated the upward pressures on wage growth (Berson et al., 2025). In turn, strong labour demand implied low transition rates from the inactivity unemployment and a sustained increase in transition rates from inactivity to employment.

Chart 12

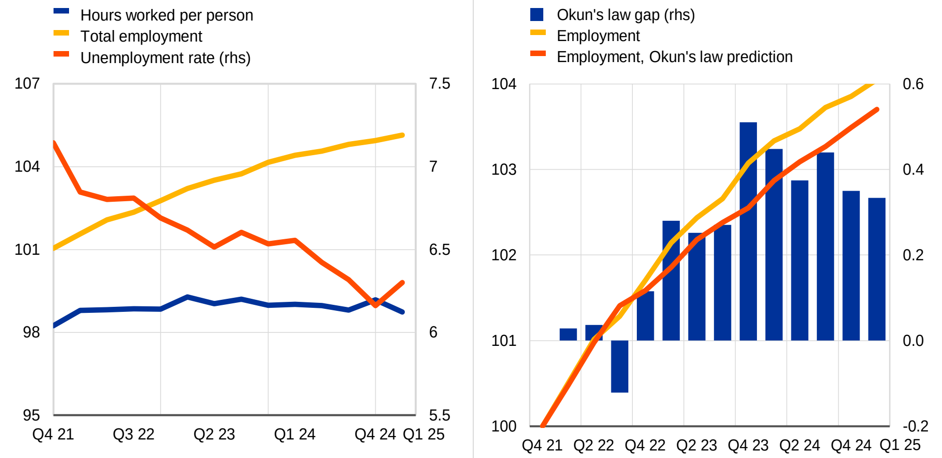
Labour market developments

a) Employment, hours worked and unemployment

(index: Q4 2019=100 and ratio to labour force)

b) Decoupling from Okun's law

(Q4 2021 = 100 and percentage points.)



Sources: Eurostat, LFS, and Eurosystem staff computations.
Notes: Panel a): The latest observations are for the first quarter of 2025. Panel b): the blue bars show the deviations (in percentage points) from Okun's law, estimated as an autoregressive distributed lag (1,1) model on the sample for the period from the first quarter of 1995 to the first quarter of 2025, with dummies to take into account the extraordinary dynamics in the second and third quarters of 2020. The latest observations are for the first quarter of 2025.

Chart 13

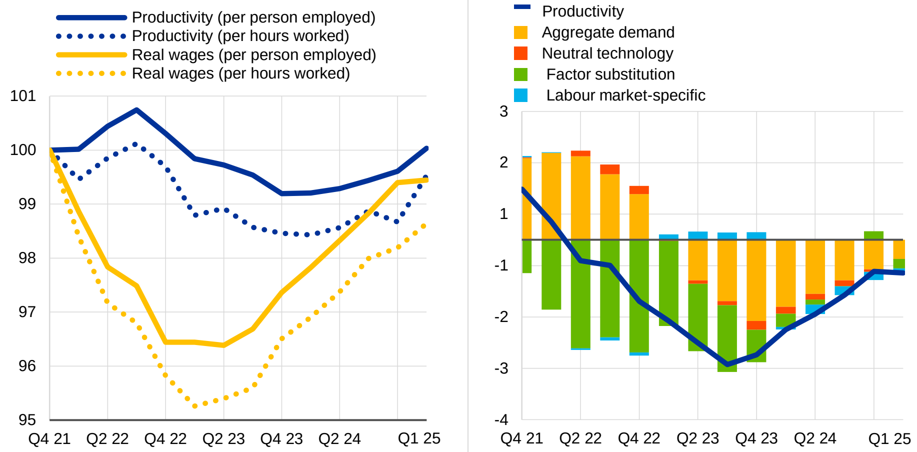
Productivity and real wages and model-based drivers of productivity growth

a) Productivity and real wages

(index Q4 2021=100)

b) Model-based drivers of productivity growth

(deviation from model trend and percentage points contributions)



Sources: Eurostat, Consolo and Foroni, 2024.
Notes: Panel a): Real wages are deflated with the GDP deflator. The latest observations are for the first quarter of 2025. Panel b): Productivity is measured as output per worker. The line depicts year-on-year productivity growth in terms of deviation from the deterministic component. The bars show the percentage point contribution of each shock. The latest observations are for the first quarter of 2025.

Against a background of sluggish economic growth, the dynamic labour market led to a cyclical decline in labour productivity as of 2022. While labour hoarding and strong labour participation helped to sustain employment growth, it resulted in a decoupling from output growth, leading to a procyclical decline in productivity growth (Arce and Sondermann, 2024). A similar picture emerges when using total hours worked as reference variable to compute productivity (**Chart 13**, panel a)**.** While it is plausible that there are some structural elements embedded in the observed fall in productivity (see **Chapter 3**), negative shocks to aggregate demand have notably contributed to the weakening of productivity in the past few years, in line with its pro-cyclical nature in the euro area.[15] Factor substitution from other production factors like intermediate goods, energy, and capital towards labour (Consolo and Foroni, 2024) also exacerbated the drop in productivity (green bar in **Chart 13**, panel b). An estimated New Keynesian business cycle model with labour market search frictions and variable labour effort shows the relevance of the effort margin in labour adjustment leading to procyclical productivity and a dampening of inflation fluctuations (Lewis and Villa, 2024).

Wages and profits

Following muted growth in the pre-pandemic period, euro area wages have increased at a record pace in the past five years. Compensation per employee, the most prominent wage indicator monitored by the ECB, cumulatively increased by 15.7% between the fourth quarter of 2021 and the first quarter of 2025, implying an average increase per year of 4.6%.[16] By contrast, between 1999 and up until the outbreak of the pandemic, wage growth averaged 2.1% per year, and 1.7% between 2013 and 2019. Despite recent signs of easing wage pressures, wage growth remained well above its historical average in the first quarter of 2025. The delayed reaction of compensation per employee to the inflation surge reflects the infrequent adjustment of negotiated wages due to the staggered nature of wage bargaining. In contrast, while wage drift (comprising cyclical items like bonus payments and overtime) grew more rapidly at first in line with economic conditions, inflation compensation became increasingly embedded in collective wage bargaining rather than in the wage drift over time (**Chart 14**, panel a).[17]

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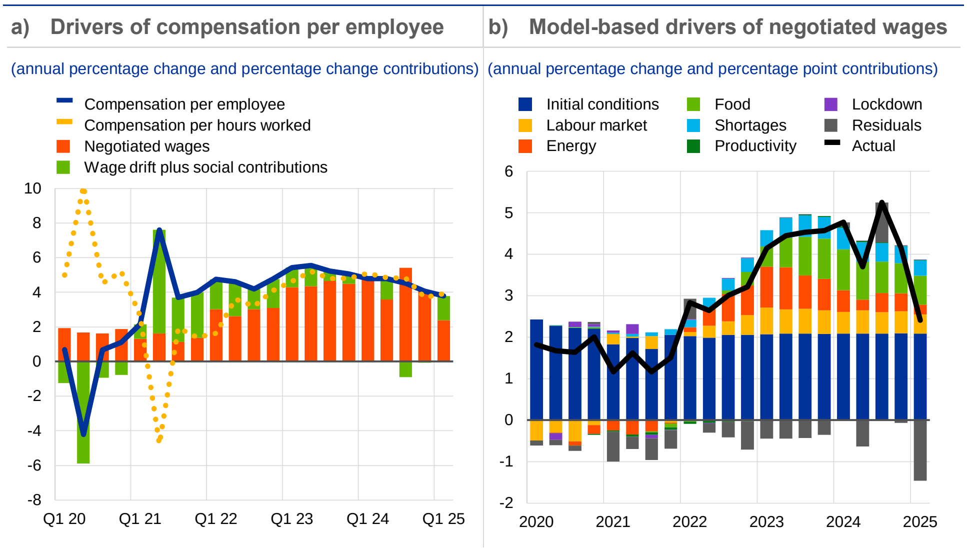
15 The behaviour of productivity was very different in the United States, where GDP growth was supported by strong productivity gains (see Andersson et al., 2024).

16 Similarly, compensation per hour worked increased by 14.7% between Q4 2021 and Q1 2025, implying an average increase of 4.3% per year.

17 The strong wage dynamics was also supported by high minimum wage increases in several countries (in some cases formally indexed to inflation).

Chart 14

Drivers of wage growth

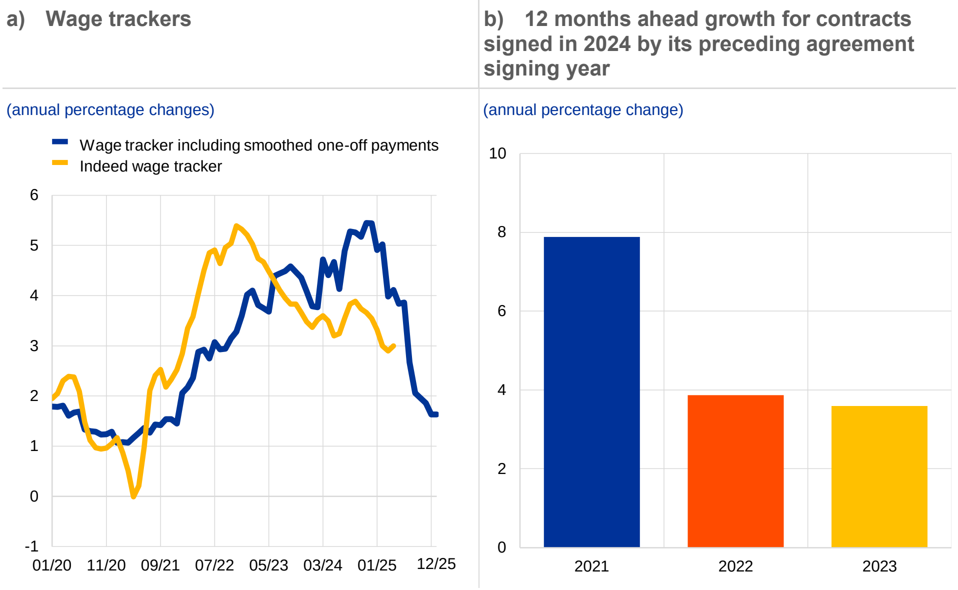


Sources: Eurostat, ECB and ECB calculations.
Notes: Panel a): The latest observations are for the first quarter of 2025. Panel b): Calculations based on Arce et al., 2023. The coloured segments of each bar show the general equilibrium, fully dynamic contribution of each exogenous variable to inflation in that period, as implied by the estimated model. The latest observations are for the first quarter of 2025.

Amid a buoyant labour market, the post-pandemic acceleration in wages primarily reflected real wage catch-up considerations. As nominal wages only adjusted to past inflation with a delay, real wages fell (**Chart 13**, panel a). This led to high wage demands, supported by the resilience and tightness of the euro area labour market. Model-based decompositions of negotiated wage growth (**Chart 14**, panel b) confirm that the real wage catch-up was a key driver of higher nominal wage growth after the inflation surge (energy and food prices in the chart), while the tightness in the labour market played a more muted role (Arce et al., 2023; Galstyan, 2023, and Oinonen and Vilmi, 2024). Wage Phillips Curve estimations also point to a strong role played by short-term inflation expectations during this period. At the same time, the role of labour market tightness as a driver of wage growth is estimated to have been weaker by most models (in contrast to the United States), although it did increase somewhat in the post-pandemic period particularly when considering alternative measures of slack, such as the vacancy-to-unemployment ratio and the labour limiting production indicator (Lo Bello and Viviano,2024; Depalo and Lo Bello, 2024, Bates et al., 2025). In most of these models, it is challenging to disentangle the role of the record-low unemployment rate from the impact of high inflation. However, with job vacancy rates and vacancy-to-unemployment ratios reaching record highs, and with a historically high share of firms citing labour shortages as a factor holding back activity, it is plausible that labour market tightness eventually contributed to real wage catch-up.

Chart 15

Wage trackers for the euro area

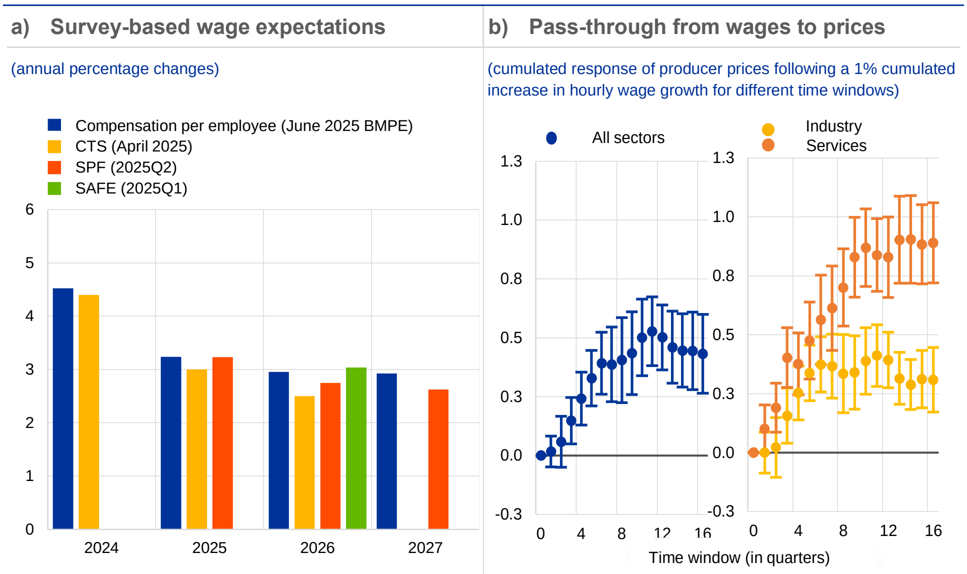


Sources: Bundesbank, Banco de España, the Dutch employer association (AWVN), Oesterreichische Nationalbank, Bank of Greece, Banca d'Italia, and Banque de France and Central bank of Ireland. Notes: Euro area aggregate based on DE, FR, IT, ES, NL, AT, GR. Note: Panel a) The latest observations are for April 2025 for the indeed wage tracker and December 2025 for the wage tracker including smoothed one-off payments.

Since the last strategy review, the collection and analysis of novel granular data has enhanced our understanding of wage dynamics and confirmed the relevance of real wage catch-up driving wage developments. The novel ECB wage tracker (**Chart 15**, panel a), calculated on the basis of micro data on wage agreements for a set of seven euro area countries, provides a unique framework to monitor the outlook for negotiated wage growth in the euro area by tracking active collective bargaining agreements (see Gornicka and Koester eds., 2024). Not only did the ECB wage tracker provide an early signal of current wage pressures, but the forward-looking nature of the contracts also helps to anticipate future wage growth and the granular nature of the data help to understand the underlying dynamics. For instance, **Chart 15**, panel b shows that wage agreements in 2024 entailed higher growth for contracts whose preceding agreement was reached three years ago compared with those of one year ago. This confirms that recent strong wage growth was driven by workers with long-term contracts that are adjusting for the first time to higher price levels and thereby recouping real wage losses. This delayed adjustment resembles that witnessed by the "late mover" components of HICP. Another new tool to monitor wage developments is the Indeed wage tracker that tracks posted wages and reacts to economic developments quickly (see Adrjan and Lydon, 2023). Furthermore, survey expectations on wage growth conducted by the ECB, not available at the time of the previous strategy review, have been regularly used to provide timely information to cross-check the validity of Eurosystem projected wage growth. Available surveys indicate a deceleration in wage dynamics in 2025 and 2026, consistent with the Eurosystem baseline (**Chart 16**, panel a).

Chart 16

Survey-based wage expectations and pass-through from wages to prices



Sources: Panel a): April 2025 Corporate Telephone Survey (CTS), Q2 2025 Survey of Professional Forecasters (SPF), June 2025 BMPE, and Q1 2025 SAFE. Panel b): Ampudia, et al., 2024.
Note: Panel a) The SAFE survey asks 12-month ahead wage growth, while all the other surveys are for calendar years.

The extent to which past strong wage increases feed into inflationary pressures depends on many factors. Wage growth is an important determinant of underlying inflation and a common rule of thumb for the euro area is that in the medium term an inflation rate of 2% is broadly compatible with a wage growth rate of 3% (i.e. under the assumption that productivity growth is about 1% in the medium term). An environment where wage growth remains significantly above 3% for a long period risks triggering a wage-price spiral, i.e. a feedback mechanism where wages and prices compete in adjusting upwards; wage earners try to keep up with rising prices and price setters try to keep up with rising wages (Lorenzoni and Werning, 2023). While the risk of such a feedback mechanism is bigger in the presence of large inflationary shocks, it did not materialise in the euro area as medium-term inflation expectations remained anchored (see **Section 2.2.5**). It has been shown that the link between wages and prices is time-varying and depends on the state of the economy, the shock hitting the economy, the dynamics of other costs (e.g. intermediate costs) and firms' characteristics. Santoro and Viviano, 2022, Bobeica et al., 2019 and Hahn and Gumiel, 2018 argue that it is more likely that labour costs are passed on to price inflation following demand shocks rather than supply shocks, and that the pass-through is higher when inflation is high. More recently, Ampudia et al., 2024 estimated the euro area wage-price pass-through to producer prices for all sectors at around 50% after three years, i.e. a 1% increase in cumulated wage growth would result in 0.5% cumulated producer price inflation after three years (**Chart 16**, panel b). The pass-through is higher for services firms (almost 100%) and lower for industrial firms (just under 40%). A higher labour share is naturally associated with higher pass-through, whilst greater import competition leads to lower pass-through. There is evidence that the pass-through is also time-dependent, as evidenced by the higher response of producer prices to a wage increase in the post-pandemic period, particularly in services.[18]

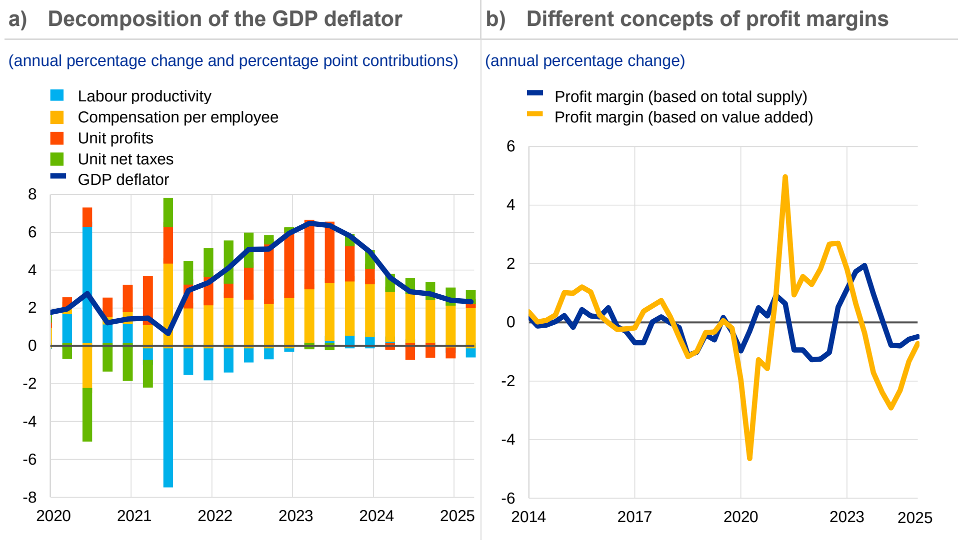
The impact of wage growth on inflation depends on how profits react, and by 2024 profits began absorbing higher wage growth. Chart 17, panel a highlights the contribution of profits to price pressures in recent years through the lens of the decomposition of the GDP deflator and the growth rate of unit profits. Unit profits – calculated as gross operating surplus and mixed income as a share of (real) GDP – made a significant contribution to price pressures during 2022 and the first half of 2023, before declining noticeably (see Arce et al., 2023 and Hahn, 2023). One limitation of such a profit indicator is that it is based on GDP rather than on gross output (defined as the sum of value added and the value of intermediate inputs/consumption), as output is not available in the national accounts in a timely manner at a quarterly frequency (see Hahn and Renault, 2024). The same limitation affects the profit margin, an alternative measure of profits computed as the ratio of the GDP deflator at basic prices to unit labour costs, which only relates profits to labour costs rather than to total costs. In general, profit margins based on GDP or output are closely related when intermediate input prices move similarly to labour costs. However, given the surges in intermediate input costs in 2022 and the subsequent declines in 2023, the assessment of profit developments in relation to total supply can provide a useful additional perspective (**Chart 17**, panel b). Comparing standard and alternative measures shows that unit profits grew in 2022 at a stronger pace than unit labour costs but not more than total costs and that their buffering of labour costs in the course of 2023 has been helped by decreasing input price pressures.[19] These developments in profit margins and unit profits are consistent with firms maintaining an invariant mark-up in an environment of large changes in intermediate costs and over a short-term horizon, such that the substitutability between labour and intermediate inputs is limited (Colonna et al., 2023 and Hahn, 2023).

[18] Updates of the pre-pandemic estimates in Bobeica et al., 2019 also confirm an increase in the pass-through from labour costs to inflation in the post-pandemic period.

[19] Measures of profit margins based on Belgian firm-level data (Bijnens et al., 2024), where the data allow to properly distinguish between margins, intermediate costs and wage costs, are showing a profile similar to the profit margin indicator based on total supply.

Chart 17

GDP deflator, unit labour costs and profit margins



Sources: Eurostat and ECB calculations.
Notes: Panel a): The latest observations are for the first quarter of 2025. Panel b): The profit margin indicator based on value added is computed as the ratio of the value added deflator to unit labour costs. The profit margin indicator based on total supply is computed as the ratio of the total supply deflator (GDP deflator plus import deflator) to unit total costs. The latter are defined as the sum of compensation of employees and imports per unit of real total supply. The latest observations are for the first quarter of 2025.

2.2.4 The role of monetary policy and fiscal policy

The impact of monetary policy on inflation and output

Monetary policy has been one of the forces affecting inflation, first through expansionary, pandemic-related measures and then through the normalisation and subsequent tightening that started in December 2021.[20] While the overall assessment of the impact of monetary policy on inflation and output in the period under review is provided in the Workstream 2 report, this section focuses on the sectoral transmission of monetary policy, pointing to possible heterogeneous and time-varying effects.

There is evidence that the transmission of monetary policy has differed across sectors, demand components, prices of consumption items and economic agents. Various factors determine this heterogeneous transmission, such as the role of bank lending across sectors, the discretionary nature of goods and services or the income level of consumers.[21] Empirical models for the euro area show that the transmission of monetary policy has been faster and stronger for the manufacturing sector than for services (Battistini and Gareis, 2023 and Hauptmeier and Holm-

[20] The precise impact of monetary policy is surrounded by uncertainty in empirical models. Part of this uncertainty comes from the fact that monetary policy has an impact on inflation with long and variable lags and through complex channels (e.g. demand, the exchange rate and inflation expectations).

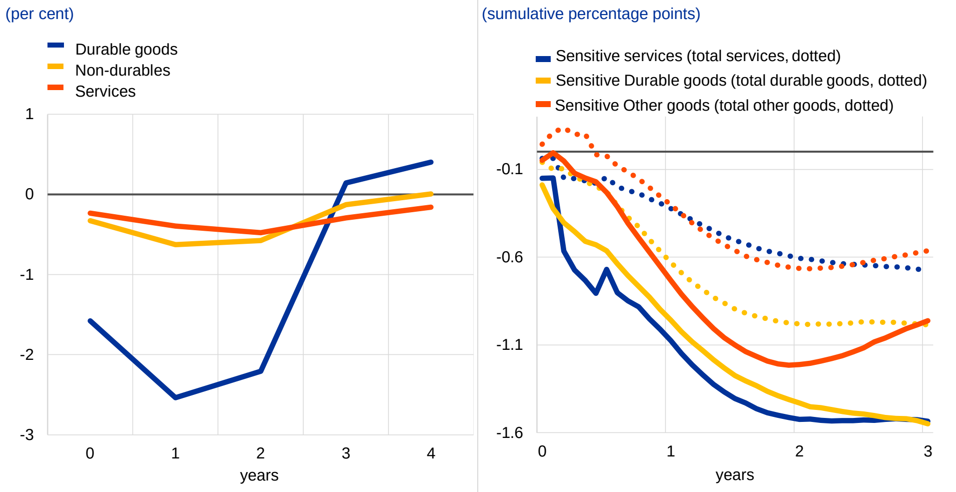
[21] The impact of monetary policy has also been very diverse across countries (Mandler et al., 2021, Deutsche Bundesbank., 2023), firms (Albertazzi, 2025, mimeo) and households (Gulan et al., 2022 and Lenza and Slacalek., 2024).

[Halluda, 2023](#)). When it comes to consumption, monetary policy shocks have a stronger effect on durable goods consumption in comparison to services, while the effect on services consumption appears to be more persistent (**Chart 18**, panel a). The effect of monetary policy is also heterogeneous across items of the HICP basket. In general, items of a discretionary nature, as reflected in a higher share in the consumption baskets of wealthier households, and those with a larger role played by credit in financing their purchase, tend to be more sensitive to monetary policy. A granular study of the transmission of monetary policy shocks finds that prices sensitive to monetary policy make up a larger share of the non-energy industrial goods (NEIG) aggregate (44%) compared with services (26%) (see Allayioti et al., 2024). The study also finds that across all HICPX items, the median effect of monetary policy shocks on total durable non-energy industrial goods (NEIG) is stronger than for services and other goods (**Chart 18**, panel b, dotted lines).[22] Focusing on items sensitive to monetary policy, certain services react strongly in relative terms,[23] while both services and durable goods show greater sensitivity than other goods.

Chart 18

The effect of monetary policy across sectors of the euro area economy

a) Impulse responses of services and goods consumption to monetary policy shocks | **b) Impulse responses of interest sensitive services and goods prices**



Sources: Panel a) ECB calculations based on Gareis, J., and Minasian, R., 2025, forthcoming ECB working paper. Panel b) Allayioti et al., 2024.
Notes: Panel a): Based on a model of local panel projections for annual three-digit COICOP items of household real consumption in the ten largest euro area countries for a period between 2002-2019. Panel b): Impulse responses obtained from item-specific Bayesian VARs, normalised to 25 basis points increase in the 1-year German Bund. The identification approach follows an internal instrument approach using the monetary policy shocks by Jarocinski and Karadi, 2020. Dotted lines correspond to the median impulse responses across all items within services, durable goods, and other goods, while the continuous line represent the median impulse responses of "sensitive" counterparts within each category. Impulse responses are significant based on the 68% credibility bands except for the dotted lines in Panel b).

Core inflation items sensitive to monetary policy have decreased more than non-sensitive items since the core inflation peak. HICPX inflation reached its peak of 5.7% in March 2023, with both sensitive and non-sensitive items contributing almost equally to the overall figure (**Chart 19**, panel a). Since then, the impact of

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[22] This is in line with previous evidence. See Mankiw, 1985 and Dedola and Lippi, 2005.

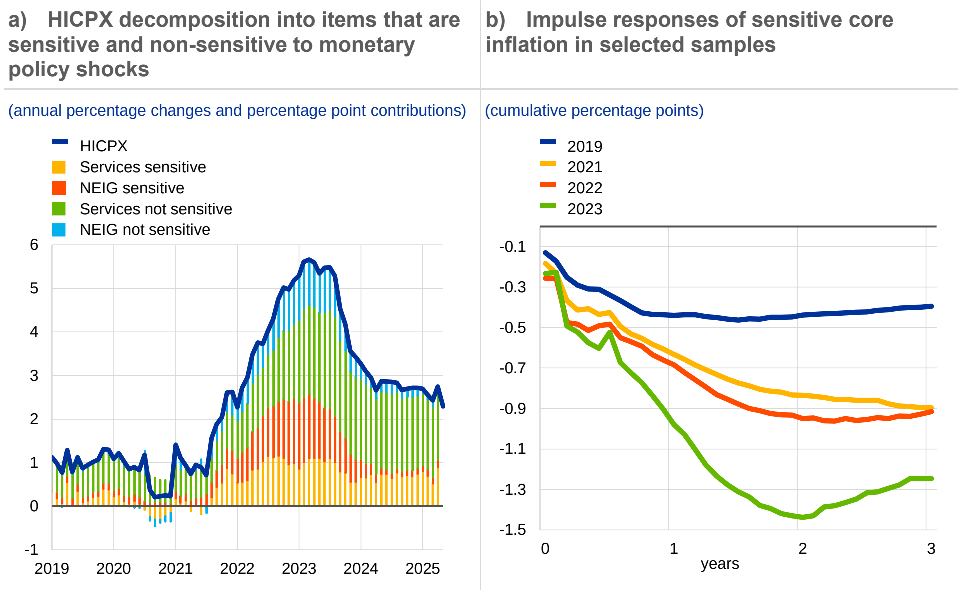
[23] Among services items, the peak impact is greatest for "Passenger transport by air", followed by "Combined passenger transport" and "Package holidays".

restrictive monetary policy, alongside the fading of large shocks, has gradually fed through to prices, particularly for the sensitive items. The contribution of sensitive items showed a marked decline, leaving non-sensitive items as the main driver of core inflation, particularly, non-sensitive services (e.g. rents, medical-related services, and some insurance items).

Empirical evidence also suggests that the effect of monetary policy shocks on prices can vary over time and has been particularly forceful in the recent period. Estimates across different samples indicate that the reaction to monetary policy shocks of items in the core consumption basket which are sensitive to monetary policy shocks has been stronger and faster in the most recent period than in the past. **Chart 19**, panel b illustrates this by showing the impact of the monetary policy shocks over different periods including: (i) a first sample that covers the period from 1999 to-2000 until the end of 2019 to capture pre-COVID-19 dynamics;(ii) periods ending in 2021 and June 2022, to cover pre-tightening periods that were governed by the COVID-19 pandemic, the re-opening of the economy and Russia's invasion of Ukraine; and (iii) a longer sample which includes the historical monetary policy tightening. Recent work by Zlobins, 2025 using a different methodology which employs time-varying parameter models also finds that the transmission of monetary policy to inflation has been stronger following the historically exceptional period of tightening in the euro area. The steep and decisive shift in policy stance in response to the surge in inflation has most likely been an important contributing factor, with potential non-linear effects linked to it. Second, the post-pandemic inflation surge has been characterised by a substantial increase in the frequency of price changes which amplifies the reaction of inflation to shocks in general (see Dedola et al., 2024 and **Box 1**).

Chart 19

Transmission of monetary policy to core inflation



Sources: Eurostat and ECB staff calculations.
Notes: Panel a): The latest observations are for May 2025 (flash estimate) for HICPX and April 2025 for the rest. Panel b): based on and Allayioti et al., 2024. Impulse responses are medians of the posterior distribution obtained from item-specific Bayesian VARs, normalised to 25 basis points increase in the 1-year German Bund. The identification approach follows an internal instrument approach using the monetary policy shocks by Jarocinski and Karadi, 2020. Impulse responses in Panel b) are significant based on the 68% credibility bands.

Monetary policy has also been an important driver of developments in house prices and the housing sector more generally. Accommodative monetary policy ahead of the normalisation that began in 2021 had a positive impact on residential property prices (see De Nora et al., 2022), while the 2022-23 monetary policy tightening contributed to a significant decline in the annual growth rate of both residential and commercial real estate prices, with a lag also in the annual growth rate of owner occupied housing costs (see **Box 2**). Tighter monetary policy also contributed to significant increases in the user cost of housing, mainly via a higher debt service cost (Battistini and Gareis, 2024). These impacts vary greatly across regions and countries, reflecting housing-related economic and institutional characteristics (Battistini et al., 2025).

The effects of fiscal policy on inflation and output

Since 2020, euro area governments have deployed a large set of discretionary measures to counteract the effects of the pandemic and subsequently the energy crisis and inflation surge on firms and households. Between 2020 and 2024, fiscal policies operated outside the fiscal framework perimeter, as a general escape clause was activated in response to the outbreak of the pandemic (Haroutunian et al., 2020).

In response to COVID-19, all euro area countries implemented large fiscal support packages. These included discretionary fiscal stimulus measures, which amounted in cumulative terms to more than 5% of GDP between 2020 and 2021

(**Chart 20**, panel a), as well as state guarantees for loans to firms and other liquidity support measures. A significant component of the discretionary measures focused on supporting firms, particularly to protect jobs. National government measures were complemented by the launch of a range of new facilities to be financed at the European level through debt issuance by the European Commission, the most important being the NextGenerationEU programme (Bańkowski et al., 2024).

By 2022, while pandemic-related measures were gradually being removed, fiscal support increased strongly in response to the spike in energy prices and inflation following Russia's invasion of Ukraine. At the euro area aggregate level, the gross cost of these measures was estimated at 1.7% of GDP in 2022, although with significant heterogeneity across countries. These fiscal measures were mainly aimed at capping energy prices, but also included transfers to households (**Chart 20**, panel b). Additional spending was allocated to refugees, defence and aid for Ukraine. As a result of declining pandemic-related support and increasing energy and inflation compensatory measures, total discretionary fiscal policy turned only slightly into tightening territory in 2022.

Afterwards, the gradual phasing-out of the energy and inflation-related support implied a somewhat larger fiscal tightening, particularly in 2023. Since then, most of these support measures have been gradually rolled back and few are expected to remain in place in 2025 and thereafter.

While precise classification is challenging, the ECB estimated at the time that slightly more than half of the total fiscal support in 2022-23 had a direct impact on prices by reducing the marginal cost of energy consumption.[24] Income support measures with *indirect* price effects made up the remainder.[25] While the inflationary effects of these two types of measures moved in opposite directions, in the short term the net impact on HICP inflation tended to be negative, as the direct price effects were more pronounced, given the somewhat higher share of those direct measures. As regards the type of measures, the most relevant – adopted in a large number of countries – are transfers to firms and households, most notably the subsidisation of energy price discounts, and cuts in indirect taxes, which have a more immediate, but also transitory impact on inflation (see "net indirect taxes" category in **Chart 20**, panel b).[26] Lastly, the share of targeted measures – those intended to directly support households based on clear means-tested income criteria – was very low, with most support taking the form of broad-based measures that benefited all households and firms.[27]

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24 Such measures included: (i) indirect tax cuts and equivalent measures, which lower prices but have reverse effects when withdrawn, thus generating a cliff-effect inflation profile; and (ii) gas and electricity retail price caps, whose impact on the inflation profile is smoother than for indirect tax measures. See Checherita-Westphal and Dorrucci, 2023.

25 In this case, some cumulated upside effects on inflation can be expected. These effects tend to be relatively less pronounced on impact and more lagged than those of the measures with direct price effects, since they operate via the disposable income channel. This can induce a more persistent impact on inflation.

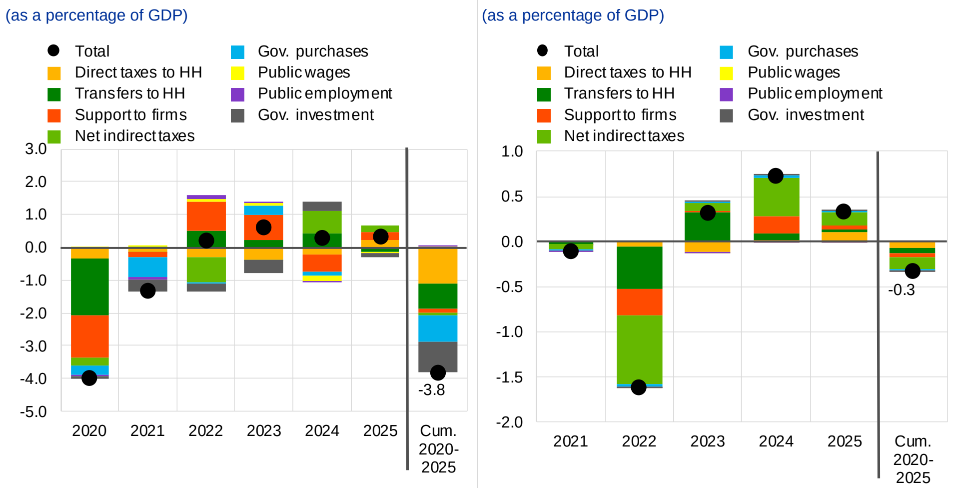
26 Lemoine et al., 2024, estimate that the energy tariff shield implemented in France helped to lower inflation by a cumulative 2.2 percentage points over 2022-23.

27 For more recent estimates see Ferdinandusse, M. and Delgado-Téllez, M. "Fiscal policy measures in response to the energy and inflation shock and climate change", Economic Bulletin, Issue 1, ECB 2024.

Chart 20

Euro area discretionary fiscal policy measures since the pandemic crisis

a) **Total discretionary measures** b) **Energy and inflation-related measures**



Source: Eurosystem/ECB staff estimates (March 2025 ECB staff projection database).
Notes: Negative (positive) numbers denote fiscal support/loosening (tightening). Discretionary fiscal policy measures are shown in annual changes, following the "fiscal stance" concept. The annual measures are expressed as percent of nominal potential GDP in the previous year. The cumulative numbers shown are the sum of annual figures for the respective periods. The classification of measures shown in the charts goes beyond the usual statistical recording and maps the main fiscal instruments into the relevant economic channels (also for purposes of macro model simulations as shown in **Chart 20**, panel a). Subsidies related to energy price caps are generally treated as indirect tax reductions. The latest observations are for 2025.

Model simulations reveal the substantial macroeconomic effects of discretionary fiscal policy measures since the pandemic, compared with a scenario without such measures (Chart 21, panel a).[28] An analysis carried out using the ECB's workhorse models (ECB-BASE and ECB: Basic Model Elasticities (BME)) shows that total discretionary fiscal policy measures supported real GDP, positively affecting its growth rate over the 2020-22 period. However, these measures also had a lagged and more persistent impact on inflation compared with a counterfactual scenario without fiscal policy support. As standard models may not be well-equipped to capture some types of price cap measures introduced by some governments, one should exercise caution when looking at these results when focusing on the energy-related fiscal compensatory measures.[29] These helped smoothen the peak impact of the energy shock on inflation in 2022[30] and sustain activity over 2022-23.[31] The removal of these measures is estimated to have led to a rebound in inflation in 2024, which is foreseen to continue at a slower pace in 2025 before fading out.[32] A partial equilibrium metric of HICP inflation, i.e. the HICP at constant tax rates, shows a very similar contribution of the tax rate in the period

28 See also a discussion on fiscal policy and inflation in Bankowski et al., 2023 and Angelini et al., 2025 for more up-to-date estimates.

29 Subsidies related to energy price caps are generally simulated as indirect tax reductions, which would likely tend to overstate the inflationary impact of their withdrawal

30 Estimates based on microsimulation models indicate that the impact of the (direct) energy support measures might have been even larger, with inflation up to 1.6 percentage points lower for the euro area in 2022. See Amores et al., 2023.

31 See also results and conclusions in Dao et al, 2023.

32 Dao et al., 2023 argue that given the low share of targeted measures, rebound effects and fiscal costs could be more pronounced if the energy price inflationary shock were more persistent and the euro area economies were overheated. However, these risks seem small given that there is no indication of overheated economies, while developments in energy markets are calm.

2023-24. Overall, the impact of the total discretionary fiscal policy measures on inflation is estimated to have peaked in 2024, as most of the energy support was withdrawn and the inflationary pressures from the previous years' fiscal stimulus had built up.

A modified version of the semi-structural Bernanke and Blanchard model (2023), estimated on euro area aggregate data and extended to include the effect of fiscal policy, attributes a somewhat smaller role to fiscal measures in shaping inflation.[33] Over the period from 2020 to 2023, this extended model shows that discretionary fiscal policy measures had an overall positive yet modest impact on inflation, stemming mainly from stimulus measures with a direct impact on demand, with offsetting contributions from measures directly affecting prices and the cost of production, such as indirect taxes and subsidies (**Chart 21**, panel b). Unlike the ECB-BASE/BME model simulations, which keep monetary policy unchanged, the extended Bernanke-Blanchard model indirectly accounts for monetary policy effects, particularly through the labour market (demand side) and inflation expectations channels. This partly explains the difference in the magnitude of the estimated fiscal contribution to inflation in the two sets of models.

[33] Bonam et al., 2025 use the Bernanke and Blanchard, 2023 model as implemented for the euro area by Arce et al., 2024 and expand it with a proxy for fiscal policy added in the wage growth and inflation equations. This proxy is regularly used in the Eurosystem and ECB staff projections to simulate the macroeconomic impact of fiscal policy, which is also referred to in this chapter.

Chart 21

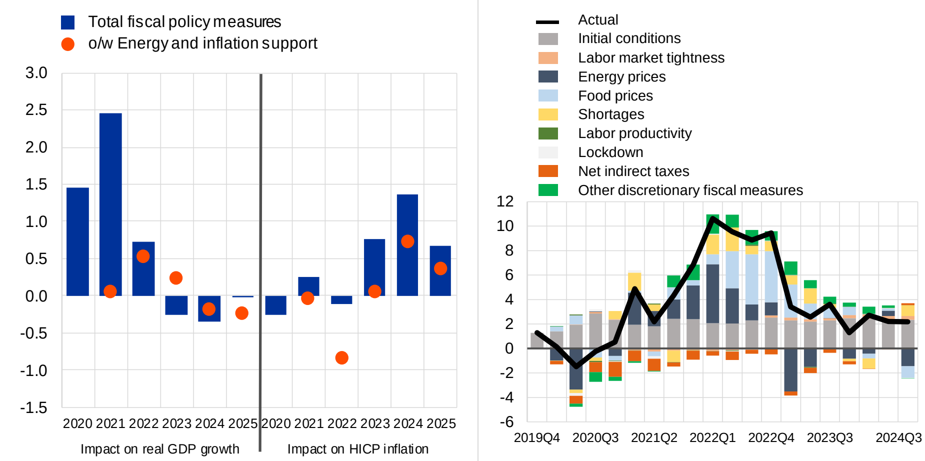
Impact of discretionary fiscal policy measures on euro area growth and inflation compared with a counterfactual of no fiscal policy support since the pandemic

a) Impact on GDP and inflation with ECB workhorse models

(percentage points deviations from the baseline)

b) Impact on inflation according to modified Blanchard-Bernanke model

(percentage points contributions)



Sources: Angelini et al., 2025 and Bonam et al., 2025.
Notes: Panel a): Fiscal "shocks" used in simulations are calculated compared to pre-COVID shock (2019), as shown in Chart 20. Growth and inflation impacts shown as averages between simulation results with ECB-BASE and BMEs. ECB-BASE was simulated under so called 'projection update' modality that keeps monetary policies, exchange rate and financial spreads fixed to their baseline values. BME simulations are conducted at individual country level, with macro results aggregated at the euro area level; spillover mode used, keeping the other assumptions and policies unchanged, including the interest rate channel. No persistency for real growth and inflation assumed in BME simulations after year T+4 (BMEs standard horizon). The latest observations are for 2025. Panel b): The figure shows a decomposition of the sources of inflation, based on the solution of the Bernanke-Blanchard (2023) model, extended to account for discretionary fiscal policy in Bonam et al. (2025) and using euro area macro data as in Arce et al. (2024). Bars show the contributions of the various shocks in each quarter. Effects of equation residuals are omitted. The grey bars show predicted values in the absence of shocks from 2020Q1 onward. The latest observations are for the third quarter of 2024.

Both fiscal policy and monetary policy played a key role during the pandemic and subsequent inflationary period. The events that unfolded since mid-2021 underlined how discretionary fiscal policy can impact short- to medium-term inflation developments..[34] Fiscal measures aimed at lowering the marginal cost of energy consumption have a direct and immediate downward impact on prices and, if rolled back in a timely manner, can help mitigate second-round effects and smooth the inflation profile over time, thereby supporting monetary policy. In practice, however, the sizeable discretionary measures adopted to combat the inflation surge were often broad-based and may not always have been phased out promptly, generating in some cases a non-negligible and persistent inflationary impact (**Chart 21**). Overall, public finances have recovered only gradually from the sharp increase in public debt following the response to the COVID-19 pandemic, leaving much lower fiscal buffers, especially in high-debt countries. Ultimately, the impact of fiscal policy and monetary policy on inflation also depends on how the two interact. Note that the analyses presented in this section do not explicitly consider such interactions, nor do they address how these interactions may have shaped inflation dynamics in recent years. A thorough theoretical analysis of the implications of monetary and fiscal policy interactions was conducted during the previous strategy review (Debrun et al., 2021)

[34] The previous strategy review concluded that fiscal policy can support monetary policy to achieve price stability in times when the ELB is binding.

and, more recently, by an European System of Central Banks working group on monetary and fiscal policy interactions (Bonam et al., 2024).

2.2.5 Inflation expectations

The high-inflation phase was expected to be relatively short-lived, supporting the timely return of inflation to the target.[35] Despite significant forecast errors from late 2021 to around October 2022, when inflation peaked and short-term inflation expectations adjusted sharply, the term structure of inflation expectations remained clearly downward sloping throughout the high inflation period across all agents, indicating that the inflation surge was expected to be temporary (**Chart 22**). After having increased to levels close to 2% at the beginning of the inflationary period, long-term inflation expectations stayed anchored close to 2%, suggesting that monetary policy had succeeded in maintaining the credibility of the inflation target (see **Box 4** for a more in-depth discussion on (de-) anchoring). The downward-sloping term structure of inflation expectations was observed across professionals (professional forecasters and monetary and financial analysts), consumers and firms. Market-based measures showed a similar profile, despite the inclusion of inflation risk premia which most likely turned positive during the high-inflation period (Burban et al., 2021, Boeckx et al., 2024, Grønlund et al., 2024, Gimeno and Ortega, forthcoming).[36] On the way down, inflation surprised less than on the way up and after October 2022 it moved down along (even more quickly than implied by) the inflation expectations term structure.

Beyond point forecasts, inflation expectations provided valuable insights on risks to the inflation outlook, pointing at times to upside risks. In the case of surveys, the relative stability of professionals' long-term inflation expectations masked in certain rounds an increasing share of respondents reporting longer-term inflation expectations of 2.5% or higher (Górnicka and Meyler, 2022). However, this fat tail had almost disappeared by late-2024. A similar development was recorded for consumers. Their expectations are typically right-skewed, but the skewness rose over the high-inflation period and normalised thereafter.[37] Turning to market-based measures, forward distributions can be obtained from inflation options.[38] In line with the rise in realised inflation in 2021 and 2022, the options-implied probability distributions increasingly reflected concerns that short- to longer-term inflation would

[35] The ECB monitors multiple measures of survey- and market-based inflation expectations as they are all relevant for macroeconomic dynamics (see Cecchetti et al., 2021; Reis, 2023). The survey measures cover professionals, firms and consumers.

[36] Positive premia are consistent with a consumption-based asset pricing interpretation when supply shocks are expected to dominate, as agents are willing to pay (positive) inflation risk premia (i.e. insure themselves against inflation) when inflation tends to be high and economic activity is low (and the marginal utility of consumption is high). However, risk premia often do not play a very significant role when it comes to very short-term inflation-linked swaps (see Anttonen and Laine, 2024).

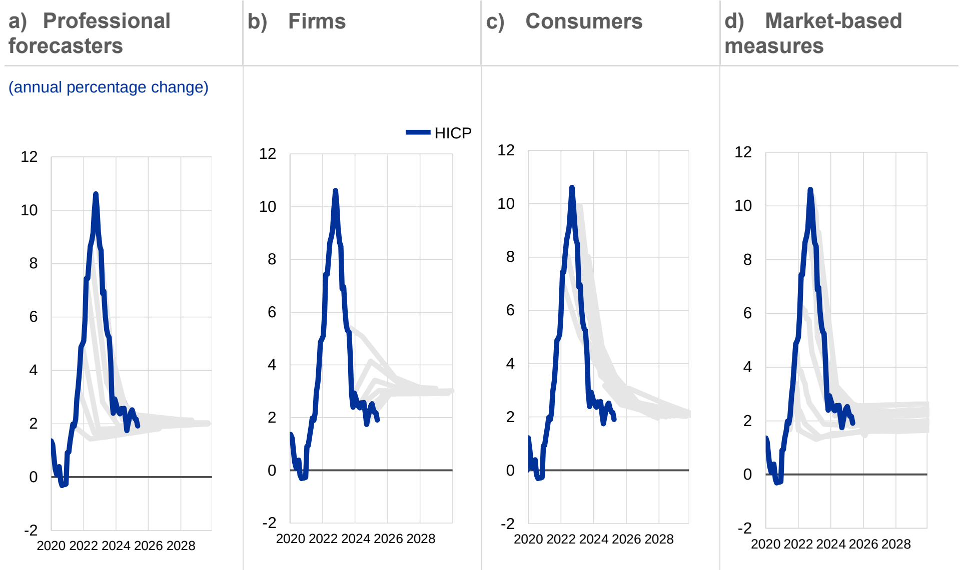
[37] The right tail of longer-term inflation expectations moved considerably less than that of one-year-ahead inflation expectations. Also, disagreement about future inflation rates is lower for consumers' longer-term expectations than for shorter-term maturities which may be indicative of a common "anchoring factor" linked to monetary policy and the credibility of the central bank that helps to align longer-term beliefs about inflation (D'Acunto et al., 2024).

[38] Similar to market-based measures entailing inflation risk premia, the probability derived from inflation options for inflation to end up in a given bucket at a certain horizon refers to a "risk-neutral" probability measure, which can differ from the "physical" or "real world" probability measure.

be persistently above target, peaking in 2022 before moderating more recently (Hilscher et al., 2022; Neri et al., 2022; Lehmus et al., 2023 and Garcia et al. (forthcoming)).

Chart 22

Term structure of inflation expectations across agents



Sources: SPF, SAFE, CES, Bloomberg.
Notes: Panel d): shows inflation paths implied by "fixings" and Inflation-Linked Swap ILS) rates. For details on ILS rates, see Camba-Méndez and Werner, 2017. Fixings are essentially inflation-linked swap (ILS) rates, but with shorter maturities. These market-based measures are taken at the cut-off dates of technical assumptions in (B)MPEs. The latest observations are for May 2025 (flash estimate).

Shorter-term inflation expectation measures were increasingly scrutinised by central bankers and analysts during the high inflation episode due to their unprecedented spikes and their role as a possible amplifier of inflationary shocks, for instance through wages. Survey evidence suggests that when inflation expectations increase, firms are more willing to increase wages although the instantaneous pass-through from expected inflation to expected wage growth is found to be small for both firms (Baumann et al., 2024 and Savignac et al., 2024) and consumers (Jain et al., 2024 and Hajdini et al., 2023).[39] What is difficult to distil empirically is the role played by backward-looking versus forward-looking components in inflation expectations shaping wage negotiations, especially as the pass-through from inflation and inflation expectations to wages is likely to be non-linear and timevarying.[40] In particular, wage increases are set for some time in many collective agreements, while there is more flexibility to catch up with increased price levels and changes in inflation expectations when a new contract is negotiated (D'Acunto et al., 2024).

39 Consistent with different wage and pension indexation practices, the pass-through from expected inflation to expected wage growth was also found to be heterogeneous across countries according to estimates based on the ECB Consumer Expectations Survey (higher in Belgium and lower in Italy, see Aprigliano and Di Nino, 2024).

40 This pass-through is also likely to vary across countries: the impact of actual inflation to inflation expectations is higher in economies with prevalent wage indexation (Grosse et al., 2023).

One possible additional shock propagation channel is that increasing inflation expectations make it easier for firms to raise their selling prices. Using the ECB's Survey on the Access to Finance of Enterprises, Baumann et al., 2024 find that higher inflation expectations feed into firms' plans to increase their selling prices in an attempt to at least partially compensate for expected cost increases. Moreover, increased consumer inflation expectations may have interacted with an increase in firms' pricing power to make the effects of the original supply shocks more persistent (Acharya et al., 2023). While in normal times, firms are hesitant to raise prices so that they do not lose customers, once consumers expect higher inflation, it is easier for firms to pass on cost increases (Anderson and Simester, 2010).

Inflation expectations reacted more strongly to shocks during the high inflation period. De Backer et al., 2023 show that, on average, inflation surprises have a significant impact on spot inflation-linked swap rates for short-term maturities (see also Miccoli and Neri, 2019; and Speck, 2016), and this impact is strongest and most significant when inflation is away from the target, as was the case during the high inflation period of 2021-24, shown in **Chart 23**, panel a.[41] One possible explanation for this non-linearity is that economic agents pay more attention to inflation in a high inflation regime (Weber et al., 2024), especially if they are used to a low inflation environment (Hubert, 2024), which may be related (at least in the case of consumers) to a higher impact of inflation on real household income and increased media attention (Galati et al., 2024). Indeed, **Chart 23**, panel b shows that consumers' attention to inflation increased with higher inflation. This implies that consumer inflation expectations respond more directly to changes in actual inflation in a high inflation period.

41 While the impact of inflation surprises is not statistically significant for any forward ILS rates, it is significant for the entire term structure of spot ILS rates. As a result, the significant impact on longer-term spot ILS rates are averages of the significant impact on the one-year ILS rate and the non-significant impacts on forward rates. Hence, they should not be interpreted as a sign of de-anchored longer-term inflation expectations. Still, a higher term structure of spot ILS rates is relevant as it implies overall cheaper financing conditions through a lower real yield curve, ceteris paribus. Note that real yields should be derived from (nominal yields and) ILS rates adjusted for their indexation lag (see Bernardini et al., 2024).

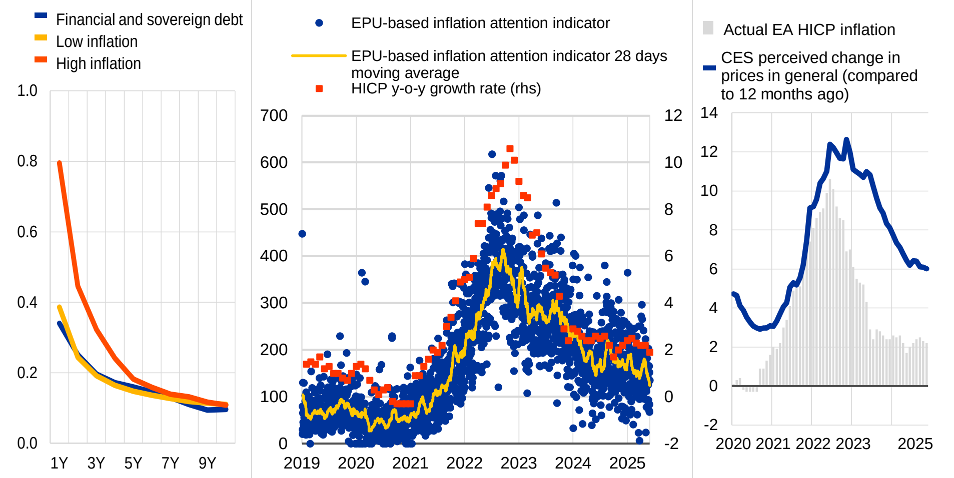
Chart 23

Responsiveness of inflation expectations to shocks, attention to inflation, and consumer perceptions of inflation versus actual inflation

a) Impact of inflation surprises on ILS spot rates (estimated coefficient)

b) Attention to inflation in the news (left-hand scale: index of relative number of articles, right-hand scale: percentage points)

c) Inflation perceptions (percentage points)



Sources: Panel a): Bloomberg, ESCB calculations based on De Backer et al. (2023) and Miccoli and N eri (2019), panel b): Dow Jones Factiva Database, Eurostat and ECB staff calculations, panel c): CES, Eurostat.
Notes: Panel a): estimated β coefficients from a linear model regressing changes in ILS rates of different maturities to inflation surprises:

$$\pi^k_{t>t0} - \pi^k_{t<t0} = \alpha + \beta(\pi_{t0} - \pi_{t0}|I_{t<t0}) + \varepsilon_t,$$

where $\pi^k_{t>t0}$ refers to the average k-year ILS rate over the five days following release of the HICP flash estimate (at time t0) and $\pi^k_{t<t0}$ is the average over the five days preceding the release. Panel b): The blue dots represent the inflation attention indicator reproducing the methodology of the Economic Policy Uncertainty index (EPU) from Caldara et al. (2020). Inflation related articles are counted based on the number of inflation related words they contain. The inflation-related articles proportion in the daily publications is then computed for each newspaper source, normalized by its standard deviation over the period of 1997-2010, before aggregation. The final indicator is scaled to have a mean of 100 over the period 1997-2010. The latest observations are for May 2025 (flash estimate) for HICP and 31 May 2025 for the rest. Panel c): The latest observations are for May 2025 (flash estimate) for HICP and April 2025 for CES.

Sluggish perceptions regarding past inflation likely added to the persistence with which shocks affected inflation. Consumers' inflation perceptions as reflected in the ECB Consumer Expectations Survey, responded quickly to increasing inflation but came down more sluggishly when actual inflation started to fall. (**Chart 23**, panel c). This sluggish response could add to the persistence of elevated inflation expectations, especially one year ahead, given the strong relation between the two (Gornicka et al., 2022; Baumann et al., 2024), even though some decoupling occurred during the disinflation phase (Marencak, 2024). Two factors mitigated the inflationary effect of sluggishly high inflation perceptions: a negative demand channel whereby consumers reduced their private spending and shopped around more actively (Bobasu et al., 2024 and D'Acunto et al., 2024) and a high level of trust in the ECB that dampened the effect of actual inflation on expectations (Stanislawska and Paloviita, 2024, Galati et al., 2024, Dreher, 2024 and Wauters et al., 2024).

Overall, the relative stability of longer-term inflation expectations during the high-inflation episode points to the notable credibility of the ECB inflation target, but various developments emerging for shorter maturities warranted careful monitoring. After increasing to levels close to 2% at the beginning of the inflationary period, long-term inflation expectations derived from the financial markets and surveys of professionals remained close to 2%, despite inflation reaching double digits. This underscores both the trust in the ECB and the effects of the decisive actions it took (see Workstream 2 report) At the same time, this period also saw shifts in inflation expectations to the right tails of survey distributions across agents with some respondents indicating higher future inflation, a stronger reaction to inflation surprises and a sluggish reaction of inflation perceptions during the disinflationary period.

Box 1
Drivers of inflation according to consumers, firms and professional forecasters

Prepared by Katarzyna Bańkowska, Colm Bates, Nicola Benatti, Dimitris Georgarakos, Johannes Groß, Georgi Kocharkov and Aidan Meyler

Understanding perceptions about the factors driving inflation is useful for monetary policy makers, as these beliefs significantly influence inflation expectations and subsequent economic actions (Andre et al., 2024). This box reports results from coordinated questions about the primary factor driving the change in the overall level of prices for goods and services in three surveys conducted by the European Central Bank - the Consumer Expectations Survey (CES), the Survey on the Access to Finance of Enterprises (SAFE), and the Survey of Professional Forecasters (SPF). This allows us to compare and explore the different perspectives of each group on the drivers of inflation in the euro area. The CES asked about the perceived drivers of inflation in June 2023, March 2024, and December 2024, while firms took the SAFE and professional forecasters the SPF only once in December 2024, but although professionals were also asked about the past (Georgarakos et al., 2024).

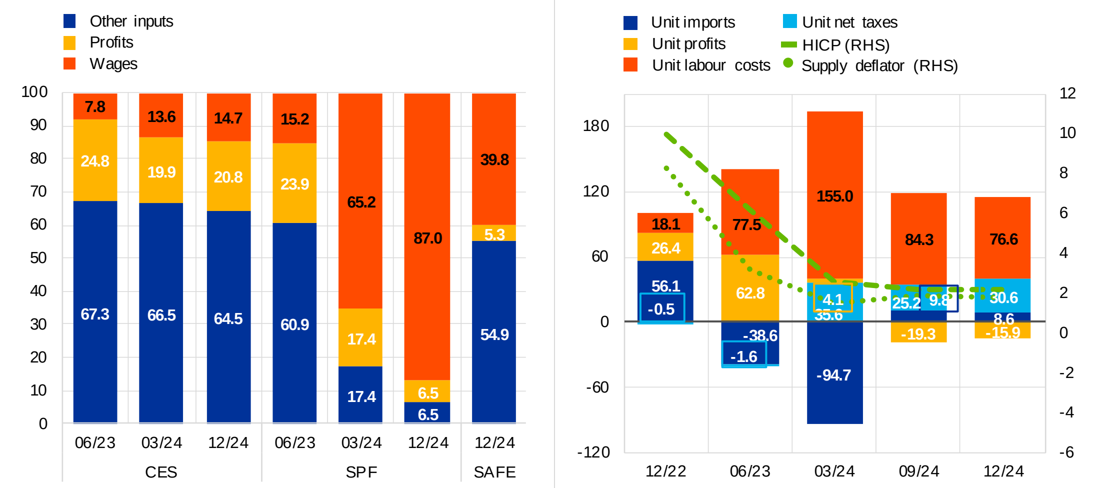
Chart A

a) Perceived main drivers of inflation

(percentage of respondents)

b) Contributors to supply deflator

(left-hand scale: percentage contributions; right-hand scale: annual percentage changes)



Sources: Panel a): CES, SAFE, and SPF. Panel b): Eurostat and ECB calculations.
Notes: Panel a): The chart shows the percentage of respondents choosing the main driver of inflation in June 2023, March 2024 and December 2024 for CES and SPF, and in December 2024 for SAFE. In CES, respondents were asked: "According to your view, what is the main factor driving the change in the general level of prices for goods and services in your country during the past 12 months:" with answer options: 1. "The main driver is firms' profits", 2. "The main driver is wage costs for firms", 3. "The main driver is other input costs for firms (e.g. energy, raw material or other business costs)". In SAFE, respondents were asked: "From your firm's perspective, what has been the main factor driving the change in the general level of prices for goods and services in the country it mainly operates in over the past 12 months:" with the same answer options as in CES. Forecasters in SPF were asked to rank the same three drivers of the euro area inflation. CES and SAFE calculations utilise population weights. In SPF, the highest ranked option is considered as the main driver of

inflation. Panel b): The chart shows the percentage contribution to the supply deflator of categories over time. December 2022 was chosen as the initial date point as this was – in quarterly terms - the highest Harmonised Index of Consumer Prices (HICP) since 2022. Negative values imply that the category contributed to the supply deflator negatively by the stated percentage amount (all categories add up to 100%). Small category contributions, which are not visible, are depicted as numbers in boxes with frames in the corresponding category colour.

In June 2023, according to consumers and professional forecasters, inflation was mainly determined by intermediate input costs, but over time wages took on a dominant role in professional forecasters' perceptions of (Chart A, panel a). In June 2023, 61% of professional forecasters and 67% of households believed that inflation was driven by other input costs, namely energy and intermediate goods. Over time, however, professional forecasters adjusted their view substantially: by December 2024, 87% identified wages as the main driver. In contrast, most consumers (65% in December 2024, down only slightly from 67% in June 2023) continued to attribute inflation primarily to other input costs. Firms' perceptions stood somewhat in between. In December 2024, 55% of firms that took part in the Survey on the Access to Finance of Enterprises identified input costs as the main cause of inflation, while 40% considered wage increases as the most significant driver. Only consumers thought that profits played a significant role (21% of consumers believed rising profits were the main driver of inflation in December 2024, see Coibion et al., 2023[42]).

The change in professional forecasters' perceptions reflects a shift in the actual drivers of inflation as reflected in national accounts data, while consumers' perceptions proved to be extremely sticky. According to a decomposition of the supply deflator, unit imports were the largest contributor to the initial inflation spike, accounting for 56% of the change in the deflator in December 2022 and underlining the inflationary role of the energy cost shock **(**Chart A, panel b**).** However, by March 2024 the influence of unit labour costs had increased, becoming by far the dominant contributor to inflation.[43] This shift can clearly be reconciled with the change in professional forecasters' perceptions, formed on the basis of a broader range of economic data and analytical tools (Link et al., 2023).[44] Consumers, however, did not adjust their opinions about the main driver of inflation over time, reflecting a lag from the height of the inflationary episode and stickiness in their perceptions. This stickiness, possibly due to their reliance on personal experience and salient price changes, can delay adjustments in economic behaviour, potentially having an impact on business cycle dynamics (Carroll et al., 2020).[45] Enhancing monetary policy communication strategies to address potential misconceptions and external narratives can help align public opinion with economic reality, thereby facilitating more informed decision-making by households and firms.

42 They argue that households often have a stagflationary/supply side view of inflation, while professional forecasters associate inflation with higher growth. In this sense, energy and other input costs are linked more with the supply side narrative of households.

43 Unit labour costs are a measure of total labour costs per unit of output calculated as the ratio of compensation per employee to labour productivity (defined as GDP per person employed). For details, see the ECB data portal documentation. Therefore, their inflationary contribution relates to the narrative documented in the surveys that wage changes may drive inflation.

44 They emphasise the different information frictions in the belief formation process of households and firms. A caveat in our analysis relates to the coarse survey measure of the perceived drivers of inflation. The unified question in all three surveys captures only the extensive margin on these drivers, i.e. what is the main driver. Future survey iterations may also consider more nuanced versions of the question.

45 They show that some degree of consumers' imperfect attention to or perception of aggregate shocks in standard macroeconomic models is necessary to account for aggregate consumption dynamics.

Box 2
Data and tools for monitoring and modelling price-setting and the extent and ways in which it is state-dependent

Prepared by Luca Dedola, Christian Höynck and Chiara Osbat

Introduction

The ECB's monetary policy strategy review 2020-21 mentioned that "changes to the economic analysis reflect the availability of new data and information sources". The microdata collected by the ESCB Price-setting Microdata Analysis Network (PRISMA) is one of these new datasets and is unique in providing evidence that could substantiate the inflation narrative. This box describes the new PRISMA data sources, how they complement each other, and presents the evidence they provided about firms' pricing during the low inflation period, the period when inflation surged and the subsequent disinflationary period. This evidence is not just anecdotal: it can be reconciled with models where firms set prices in a state-dependent way, but not with workhorse models where price-setting is time-dependent. This is important because these models imply a different reaction to shocks and different inflation dynamics when firms set prices in a state-dependent way.

PRISMA datasets

The Price-Setting Microdata Analysis Network (PRISMA) collect three kinds of microdata on prices that can be used to construct key statistics to monitor price-setting in a way that is informative about inflation dynamics and the transmission of shocks: (i) consumer and producer-level micro prices that are used by national statistical institutes (NSI) to compile the consumer price index (CPI) and the producer price index (PPI); (ii) consumer price scanner data covering fast-moving consumer goods; and (iii) web-scraped, product-level prices, which are also available to ESCB staff via the daily price dataset (DPD). Table A provides an overview of the PRISMA datasets.

Key aggregate statistics, such as the frequency and size of price increases and decreases, contain indirect information on the underlying drivers of inflation, such as the size of shocks. The PRISMA data also show how heterogeneous these statistics are across different subcategories of goods and services as well as across countries. This is also very important for calibrating structural models. In addition, other statistics, such as kurtosis, which measures the thickness of the tails of the price change distribution, are particularly useful for calibrating time-dependent structural models by appropriately rescaling the Calvo parameter (see Alvarez et al. (2016) and Auclert et al. (2024)). Furthermore, if the frequency indicators were available in real time, they could be used in forecasting to inform the decision on when to give more weight to non-linear models.

Each PRISMA dataset has its advantages and limitations, and they complement each other. The CPI data have the advantage of being the actual basis for computing the HICP and have the largest coverage across product categories, countries and time. However, they cannot be timely, as NCBs must specifically request updates from their respective national statistical institute (NSI) and then process them in a cross-country exercise.[46] The PPI data can shed light on business-to-business transactions, which are especially relevant when analysing price formation through production networks. However, compared with the CPI data, they suffer from even more limited availability across countries and there is no regular update. Web-scraped data cannot aspire to the same degree of representativeness as the CPI because they are collected from only a few locations for each retailer chain. They are not based on a representative survey and the shops can change over time. The main advantage of the DPD web-scraped data is their timeliness: updates are possible with a delay of only two or three days.

Table A

Overview of PRISMA datasets

Database	Type of data	Frequency and timeliness	Categories	Countries	Time
Consumer price index	Product-level consumer prices	Monthly; occasionally updated on demand	Covers majority of CPI basket[2]	Belgium, Germany, Greece, Spain, France, Italy, Latvia, Lithuania, Luxembourg, Austria and Slovakia	Sample varies by country
Producer price index	Product-level producer prices[1]	Monthly; generally cannot be updated due to constraints by national statistical institutes	Manufacturing sector	Belgium, Greece, France, Lithuania, Netherlands and Portugal	Sample varies by country[4]
Retail scanner	Barcode-level data representing all sales in almost the entire population of supermarkets. Contains both prices and quantities sold.	Weekly; generally cannot be updated unless a new procurement contract is in place	Fast-moving consumer goods	Germany, France, Italy, Netherlands (at two-digit zip code geographic disaggregation)	2013 to 2023
Household scanner	Barcode-level data representing all purchases recorded by a panel of households (includes household characteristics). Contains both prices and quantities bought.	Each shopping trip by a household is recorded; generally cannot be updated unless a new procurement contract is in place	Fast-moving consumer goods	Germany (including postcode of household residence)[3], France	France: 2008 to 2022 Germany: 2005 to 2022
Daily price dataset	Barcode-level data web-scraped from online shops	Daily; data are available with a delay of 2-3 days	Supermarkets, furniture, clothing, electronics, food delivery services	Germany, Spain, France, Italy, Netherlands; partial coverage of other countries for cross-country online shops	Starting date varies by shop starting in February 2022[5]

Notes: [1]Each price refers to a specific product sold by a firm to a specific customer in a specific market (domestic, intra-euro area and extra-euro area; the PRISMA price collection focused on domestic prices, except for Greece, Lithuania and Portugal, who collected both domestic and export prices). [2]Some excluded categories are energy, rents, communication services and package holidays as well as new and used cars, pharmaceutical products and ICT products, tobacco and alcohol. [3]Data up to 2018 have been analysed for research papers for other countries but are not available for new projects. [4]Sample varies a lot across countries; see Gautier et al. (2023) for details.[5]Some data are available as of 2020, with a much more limited coverage in terms of shops and countries.

Evidence on the frequency of price changes over the low and high inflation periods

For the recent inflation surge, updated PRISMA microdata on consumer prices for several euro area countries document a sharp rise in the frequency of price changes owing to a corresponding rise in the frequency of price increases. When inflation is low, there is little correlation between the frequency of price changes and inflation (Chart A, panel a). Underlying the rise in inflation in the second half of 2021 was an increase in the frequency of price changes, driven

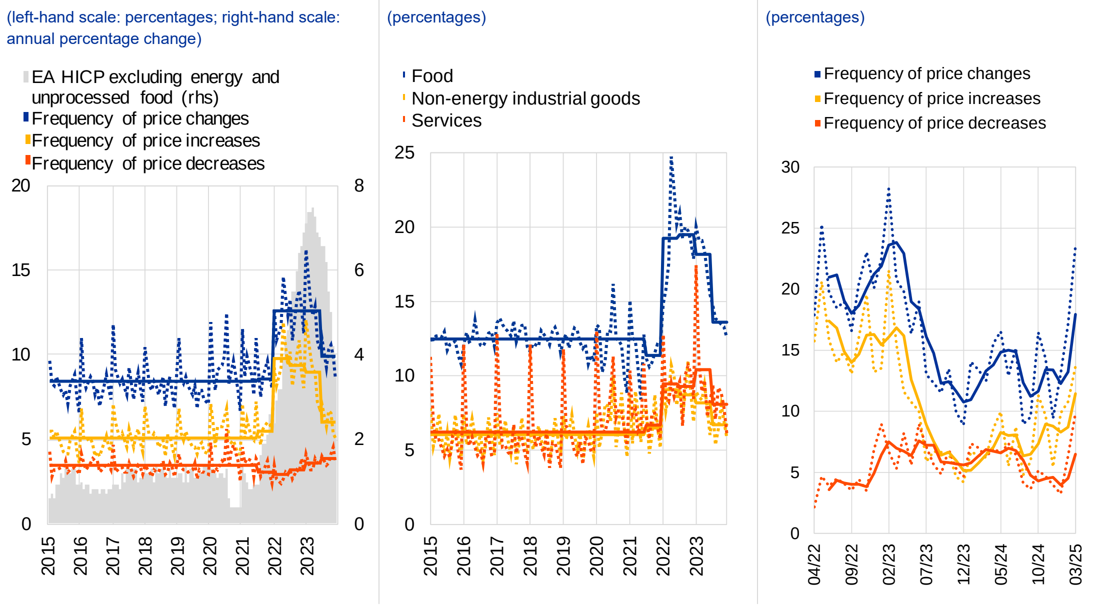
46 Furthermore, the collection of prices for CPI is evolving, with more and more countries relying, at least in part, on scanner and web-scraped data. As these sources are adopted two problems arise: comparability and coverage, as the NSIs typically have not shared price quotes based on scanner or web-scraped data with the NCBs.

by an upsurge in the frequency of price increases. Regarding the absolute size of the price changes, there is no strong link before or after 2022 (see Dedola et al. (2024) for details). This sharp rise in the frequency of price increases was common to all broad product categories underlying the HICP (Chart A, panel b). Gautier et al. (2024) document that, on average, the frequency of price changes was higher for food than for non-energy industrial goods (NEIG) or services. The same holds true for the more recent period: the rise in the frequency of price increases was sharper for food products than for NEIG or services. In the food sector, the frequency of price increases rose from around 8% on average before 2020 to close to 15% in 2022, whereas price decreases were a little less frequent than usual. For NEIG and services, the rise in the frequency of price increases was also significant, albeit smaller than observed for food (NEIG and services both recorded a rise of around three percentage points); the frequency of price decreases remained mostly stable. The seasonal spike in services in January 2023 was especially large, possibly related to underlying wage increases.

Chart A

Frequency of consumer price changes over time from various PRISMA databases

a) Repricing frequency for all sectors | **b) Repricing frequency by subcategory** | **c) DPD repricing frequency of food items**



Sources: Consumer price micro-datasets from the national statistics institutes of Austria, Estonia, France, Germany, Greece, Italy, Latvia, Lithuania and Spain based on “Price Stickiness in the Euro Area in Times of High Inflation” Gautier (forthcoming).
Notes: Panels a) and b) show the weighted average frequencies of price changes (excluding sales) for all sectors and by aggregate product category. VAT changes in Germany (2020-21) and Spain (2020-23) have been excluded. The solid lines plot the average over the period 2015-21 and half-year averages over the period 2021-23. The latest observations are for December 2023. Panel c) shows evidence based on the Daily Prices Dataset (DPD). The chart shows the average monthly frequency of price increases and decreases of food products across Germany, Spain and Italy (dotted lines) and its three-month moving average (solid lines). The latest observations are for March 2025.

The frequency of price increases fell in all three sectors during the second half of 2023. The evidence suggests that retailers adjust their prices more frequently when inflation is higher, rather than adjusting them at the usual frequency but by larger amounts. DPD provides further evidence on time variation in frequencies between April 2022 and March 2025. The frequency of food price increases (retrieved from online supermarkets in Germany, Spain and Italy) rose significantly in 2022 but has declined since its peak in February 2023. In 2024 it fluctuated around the corresponding pre-2020 levels, as gauged from PRISMA CPI microdata (Chart A, panel c). In the first months of 2025 the frequency of price changes of online food items rose again, this time reflecting a rise in the frequency of both price increases and decreases. Given the relative stability of food inflation, this rise seems consistent with more volatile idiosyncratic shocks, rather than larger aggregate shocks, as in 2022 and 2023. as in 2022 and 2023.

What models can account for state-dependent pricing and what are their implications for monetary policy?

In line with the evidence presented above, large inflationary shocks are predicted to temporarily increase the frequency of price adjustments in state-dependent pricing models. Price-setting is state-dependent when a firm's decision to change prices is based on optimisation, e.g. when the firm aims to balance a (fixed) cost incurred to reset prices (sometimes called "menu cost") against a loss from keeping them unchanged, leaving a gap with their reset values.[47] The size of the price gap is the relevant state of the economy for pricing decisions: when a firm's loss from the price misalignment is large enough relative to the menu cost – owing to large shifts in demand or nominal costs – the firm will change its price. Since the decision to change prices depends on the price gap, non-linear effects on the frequency of price changes are also possible, depending on the size of the cost shock.

Workhorse macroeconomic models used in policy institutions do not typically allow for variations in the frequency of price adjustment, thereby potentially missing non-linearities when shocks are large and inflation is high as a result. Workhorse models capture the price adjustment mechanism via a time-dependent pricing model in which the frequency of price adjustment is constant. Time-dependent pricing models are a good approximation when inflation is stable and aggregate shocks are small.[48] The absence of state-dependence means that these models are certain to miss the non-linear effects stemming from the shocks associated with the recent inflation surge. Moreover, to account for the latter, they will tend to greatly overstate the size of the underlying shocks (Blanco et al. 2024). This feature of workhorse macroeconomic models does not necessarily make them less useful in informing policy decisions (in the context of economic projections, for example), but they need to be complemented with a judgement-based adjustment that takes into account such non-linearities (by trying to readjust the parameters governing price-setting, for example). This is no easy task and in practice would need to be informed by some kind of underlying state-dependent price-setting model.

State-dependent price-setting models, which are particularly useful for policy analysis, also feature realistic input-output structures with important implications for the propagation of large shocks of different origin, e.g. demand or supply. These models match the micro evidence on the heterogeneity of price-setting across sectors and are therefore especially useful to trace the propagation of sectoral shocks (Kase and Rigato, 2025). They are also consistent with the evidence on the effects of aggregate monetary policy shocks, since they feature a substantial degree of real rigidities through realistic input-output structures, often augmented with stickiness in nominal wages. Specifically, the price stickiness of input suppliers reinforces the price stickiness of

47 Menu costs include any costs that occur as a result of a firm changing its prices. For instance, there is empirical evidence that changing prices in supermarkets is a complex process, requiring many steps and a significant amount of resources (see Levy et al (1997)). Specifically, the menu costs documented in this study comprise: "(1) the labour cost of changing shelf prices; (2) the costs of printing and delivering new price tags; (3) the costs of mistakes made during the price change process; and (4) the cost of in-store supervision of the price change process". For a more general assessment of the cost of changing prices, including information and decision costs, see also the evidence in Zbaracki et al (2004) and the model in Alvarez et al. (2011). Costain and Nakov (2024) provides a recent survey of state-dependent models.

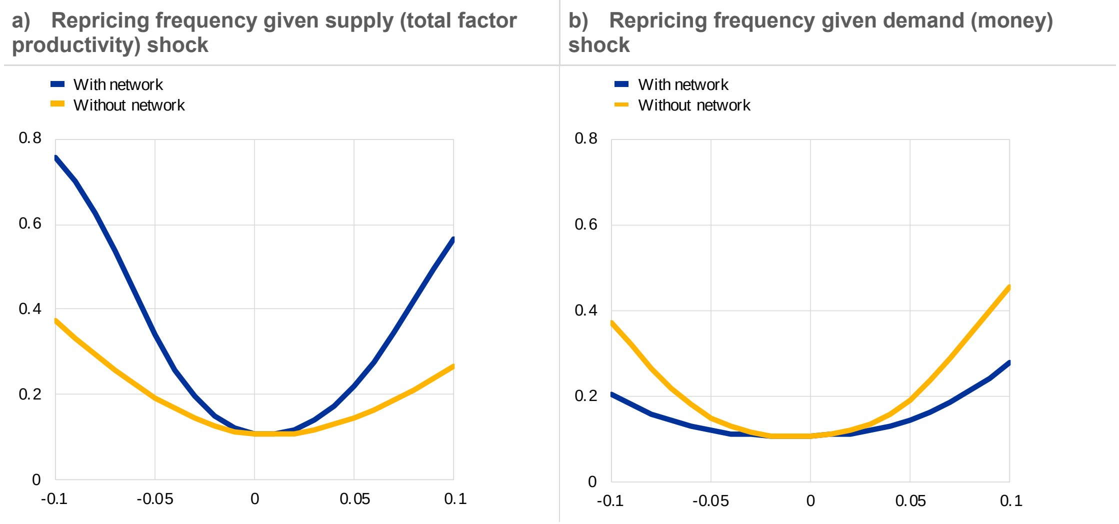
48 See Auclert et al (2024).

their buyers, so that in practice the stickiest sector of the economy matters more than flexible sectors for the slow macroeconomic adjustment.

State-dependent models with production networks imply a fast transmission of large sectoral supply shocks but a relatively flat Phillips Curve for demand shocks. Ghassibe and Nakov (2024) show that state-dependence magnifies the transmission of supply shocks via the network structure because of cascading effects (Chart B, panel a).

Chart B

Frequency of responses to supply and demand shocks with and without network structure



Source: Ghassibe and Nakov (2024).
Note: Panel a) refers to a supply (total factor productivity) shock and panel b) to a demand (money) shock.

However, in this model the real rigidities inherent in input-output networks slow down the transmission of monetary policy considerably and make the Phillips Curve flatter, even for large demand shocks relative to a state-dependent model without a network. Specifically, in the state-dependent network model, the frequency of price changes is much less responsive to the size of demand shocks than in the standard, state-dependent model (see Chart B, panel b).

An open issue for state-dependent models is whether there are asymmetric effects from large deflationary shocks relative to large inflationary shocks. Network models can generate an asymmetric response depending on the origin of the shock. One way to introduce asymmetries to the same shock would be through downward wage stickiness. However, there is little aggregate evidence in the data on large deflationary shocks, while micro evidence is at best mixed (see also the Workstream 2 report).

Conclusions and forward-looking implications

The new micro data confirmed the prediction of some academic studies that price-setting is state-dependent, in the sense that when cost shocks are large enough, the rate at which firms reset their prices increases significantly. This higher price flexibility leads to the faster pass-through of supply shocks to prices and relatively smaller changes in output. In short, large shocks can generate a particular form of non-linearity in the Phillips Curve. New research developed at the ECB and elsewhere points to important consequences of state-dependence in terms of the transmission of shocks and consequences for monetary policy (see also the Workstream 2 report).

Significant computational and estimation challenges remain in making state-dependent models and current workhorse policy models fully fungible. First, state-dependent models are inherently non-linear and thus their solution and estimation, with the relative high degree of resolution required for policy purposes, present significant challenges. Second, the empirical implementation of state-dependent models requires detailed micro data on price-setting at a granular, sectoral level at both the consumer and producer level. These data will have to be available not only as a cross-section but also as a time series to be able to estimate these models for monetary policy purposes.

Regular updates to key price-setting statistics, such as the frequency and size of price increases and decreases, can only be done by being able to access micro price data, leveraging harmonisation and standardisation done by PRISMA. Ensuring easier Eurosystem access to the micro data underlying HICP and PPI could be facilitated by an endorsement of the Governing Council.

Box 3
Taking account of owner-occupied housing (OOH) costs in consumer price inflation

Prepared by Moreno Roma

Introduction

The HICP includes rentals for housing paid by tenants, but it does not include costs specifically incurred by homeowners, such as acquisition or major repair costs. The ECB's monetary policy strategy review (MPSR) 2020-21 identified this omission as an issue affecting the representativeness and cross-country comparability of the HICP as the appropriate index for quantifying the ECB's price stability objective.[49] The Governing Council recommended including owner-occupied housing (OOH) costs in the HICP based on the net acquisitions approach. A tentative roadmap was proposed for an official HICP including OOH costs, with a first step giving more prominence in the ECB's inflation analysis to "analytical" indicators for an augmented HICP constructed within the ESCB.

On the roadmap to moving to an HICP including OOH costs

The proposed roadmap foresaw four main stages, taking the European Statistical System's (ESS) regular publication of quarterly, owner-occupied housing price indices (OOHPIs) as stand-alone indices three months after the end of the reporting quarter as a starting point. The first stage envisaged the construction by the ECB of an analytical index for internal purposes, which combines OOHPI with the HICP using approximated weights. The results of this analysis are discussed in the next section. A second stage envisaged Eurostat compiling OOH weights and publishing an experimental quarterly HICP including OOHPI. A third stage would entail publishing an official quarterly index of HICP including OOHPI, while a fourth and final stage would make this index

[49] See Workstream on inflation measurement (2021). This was already diagnosed in the first monetary policy strategy review 2003; see Camba-Mendez et al. (2003).

available on a monthly basis and in a timely manner, and it could then become the main index for monetary policy purposes.

An ESS Task Force[50] was created in 2022 to examine the ECB's recommendation and a corresponding report was published in 2023.[51] The Task Force concentrated on providing an overview of the feasibility of various approaches to measuring OOH and conducted a survey on this topic. There was no consensus among statistical institutes on the preferred methodology and preferences for one approach over another may also be related to the large heterogeneity of rental markets across euro area countries.[52] Not least because of the rather high inflation rates at the time of the report and related communication challenges, the ESS Committee (ESSC) "did not support the regular publication of the two experimental indicators, considering that this could be misleading and detrimental to the credibility of the HICP".[53] The ESSC concluded that additional research on the topic was needed in addition to renewed efforts to improve the timeliness and frequency of housing price indicators.

Assessing and forecasting owner-occupied housing costs

The MPSR 2020-21 concluded that "during the transition period, the quarterly stand-alone OOHPI index will play an important supplementary role in assessing the impact of housing costs on inflation and will thus inform the Governing Council's monetary policy assessments". To this end, the ECB estimated expenditure weights for OOHPIs based on publicly available official data, mainly from the national accounts, and compiled HICPs combined with OOHPIs as quarterly, chain-linked Laspeyres-type indices.[54] For the euro area, the OOHPI and imputed rents had an estimated weight across years of between 7-11% and 12-13% in the augmented HICP respectively. Given the magnitude of these weights, it would typically require strongly diverging dynamics to generate substantial differences between the inflation rates of HICP augmented with alternative OOH costs and the official HICP. However, for sub-components like core or services inflation, the weights and hence the potential impact can be substantially larger.

Assessing OOH dynamics requires an understanding of their underlying drivers (see Chart A, panels a and b). The net-acquisition based OOHPI comprises costs related to both the acquisition of dwellings and the ownership of dwellings, and their relative importance varies considerably across euro area countries.[55] The sub-components point to different drivers reflected in auxiliary indicators, such as residential property prices and construction costs, and the respective dynamics of these drivers can differ notably. In the period since 2011 when data has been available, the price index related to acquisition costs on balance saw stronger annual growth and earlier changes in direction than the index for costs of ownership. Rents generally display more muted and delayed dynamics than OOHPI and its sub-components, reflecting the often staggered adjustment and regulation of existing rents.[56]

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50 The European Commission's Directorate-General for Economic and Financial Affairs, the ECB and the OECD participated in this Task Force as observers.

51 See Eurostat (2023).

52 See Eiglsperger et al. (2024) for an overview of different measurement approaches and their respective shortcomings.

53 The two experimental indicators were based on the net acquisitions approach and an approximate rental equivalence approach.

54 See Eiglsperger et al. (2022).

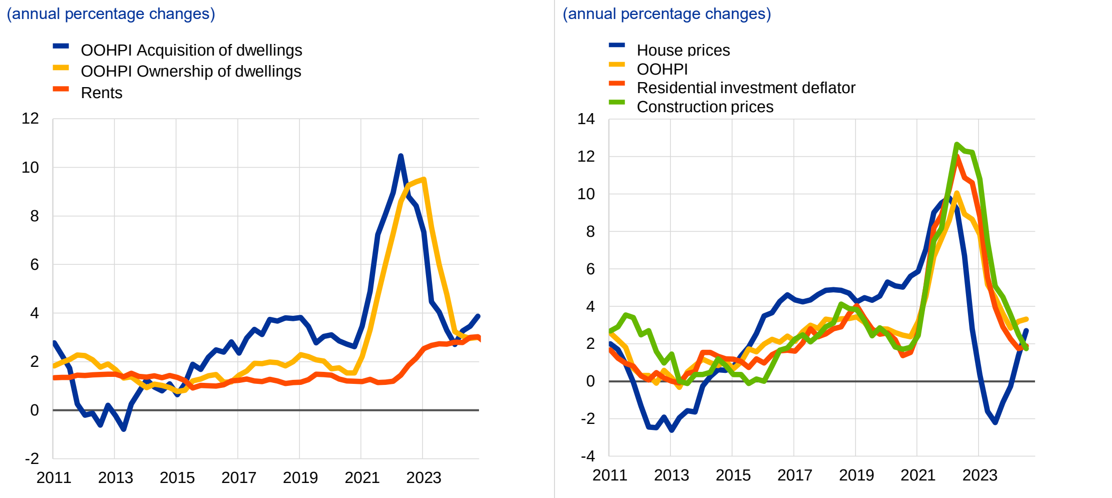
55 See Arioli and Gonçalves (2022).

56 See Arioli et al. (2023) for a discussion of rent dynamics and comparison with the United States.

Chart A

a) OOHPI components and rents in the euro area

b) House prices, total OOHPI, residential investment deflator and construction prices in the euro area



Source: Eurostat and ECB staff calculations.
Notes: Chart (a): The latest observations are for Q4 2024. Chart (b): The latest observations are for Q4 2024.

The ECB's economic analysis as part of the monetary policy strategy relies heavily on projections. Including OOH in the HICP therefore also requires the ability to project its developments. In this context, the Monetary Policy Committee tasked an Expert Group with devising ways of forecasting OOH. Given a lack of consensus in the ESS on the preferred approach to augment HICP, the work in the ESCB assessed the "forecastability" of both OOHPI and rents.

The Report of the WGF Expert Group on Owner-Occupied Housing considered two approaches for forecasting the OOHPI: (i) mapping OOHPI and its sub-components to housing-related variables that are already forecast in the Eurosystem/ECB staff macroeconomic projection exercises (namely residential property prices and the residential investment deflator); or (ii) building dedicated models. It was shown that the mapping approach had the advantage of simplicity but critically hinged on the quality of projections for house prices and the residential investment deflator, which had a history of being challenging to forecast. This means that in a mapping approach, the errors for the conditioning variables will carry over to the respective OOHPI sub-components, namely purchases of new dwellings and costs for self-build dwellings and major repairs. Given that the projection errors for house prices and the residential investment deflator are on balance larger than those for consumer price inflation, an HICP augmented with OOHPI would therefore likely imply larger projection errors and corresponding uncertainty than the HICP, unless errors and biases for OOHPI and HICP somehow offset each other.

Model-based forecasts for OOHPI provide an alternative to the mapping approach. Among other things, they exploit the existing thick modelling Phillips Curve machinery that is regularly applied in projection rounds for cross-checking conditional forecasts for HICPX, of which OOH would be a sub-component.[57] A real time, out-of-sample forecast evaluation exercise suggested that the Phillips Curve models generated OOHPI forecasts for the euro area that are slightly less biased than those of the mapping approach, but also suffer from large absolute forecast errors. BVAR

57 For a discussion on this, see Bobeica and Sokol (2019).

models that – by contrast with the Phillips Curve models – were set up to produce unconditional forecasts and to also allow for additional explanatory variables than those included in the Phillips Curve models performed better. This can be seen as confirmation that OOHPI modelling and forecasting would require different conditioning variables than HICP. All in all, higher uncertainty surrounding forecasts of the augmented HICP series is to be expected.

In practice, the forecast performance of the different approaches varies strongly across countries, and national central banks selected different preferred methods to forecast OOHPI and rents. Starting with the December 2023 Eurosystem staff macroeconomic projections exercise, OOHPI and rent projections are regularly provided by national central banks, while they are updated for the euro area aggregate (using a "delta approach", which considers the impact of changes in conditioning variables between two forecast rounds) in the ECB staff macroeconomic projection exercises. As more forecast vintages become available, an evaluation of the accuracy of the projections of OOH will be made part of the regular forecast evaluation.

Developments in the HICP series augmented with OOH compared with the current official HICP

HICP inflation augmented with OOHPI (Chart B, panel a) would yield a similar mean and volatility as the official HICP, but results for selected countries could show a larger wedge.58 For the euro area, the augmented series displays a small amplification in the cyclical movements but no major difference in terms of the timing of the inflation cycle, although it has to be acknowledged that the sample period is as yet still short. The difference between the augmented and actual HICP inflation series (red bar in Chart B, panel a) was between -0.2 and +0.3 percentage points.

HICP inflation augmented according to the rental equivalence approach (Chart B, panel b) would have a mean and volatility close to the current HICP, but exhibited a large wedge in the high inflation period (-1.2 percentage points, red bars).[59] Using actual rents as an estimate of imputed rents increases inflation dispersion across countries due to the heterogeneity of the rental housing markets across euro area countries. It also decreases the cyclicality of the resulting euro area inflation series to some extent given that rent prices are sluggish and slow-moving, and thus renders the augmented inflation measure somewhat more "sticky". The OOHPI compiled according to the net acquisitions approach picked up more quickly and would have been less prone to delaying the inflation signal of owner-occupied housing costs.

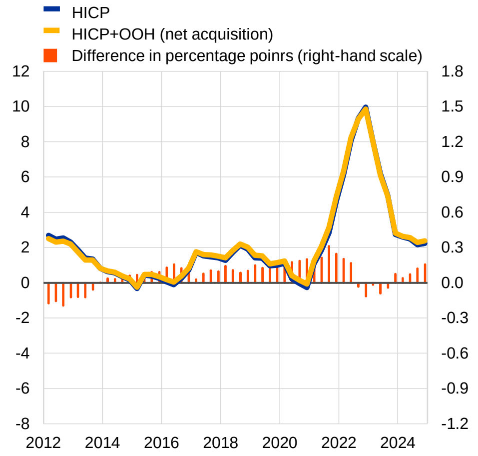
58 In the period from the first quarter of 2012 to the last quarter of 2024, for the euro area the average HICP rate augmented with OOHPI was 2.24% or 0.06 percentage points higher than the official HICP rate (0.14 percentage points higher in the case of HICPX). However, there are significant differences in the relative impact across countries, with a very high impact seen in Spain, but a lower impact seen in Italy and France, for example. In Germany, the difference between the HICP rate augmented with OOHPI and the official HICP rate has not exceeded 0.3 percentage points, with the exception of the high inflation period between 2021 and 2022; see Deutsche Bundesbank (2024).

59 In the period from January 2012 to April 2025, for the euro area the average HICP augmented with rent was 2.09% or 0.08 percentage points lower than the official HICP series (0.04 percentage points lower in the case of HICPX).

Chart B

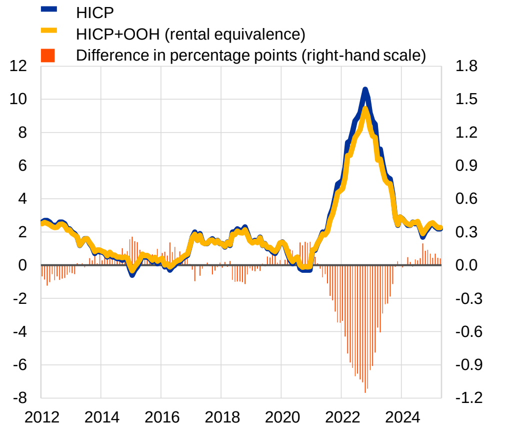
a) HICP and HICP+OOHPI (net acquisitions) - euro area

(percentage changes and percentage points)



b) HICP and HICP+OOH (rental equivalence) - euro area

(percentage changes and percentage points)



Source: Eurostat and ECB staff calculations.
Notes: Chart (a): The latest observations are for Q4 2024. Chart (b): The latest observations are for April 2025.

Conclusions

There is no agreement in European statistical circles on the preferred way to measure OOH costs in the context of the HICP, and the ESS does not yet intend to publish experimental augmented series. Against this background, it is already very useful that harmonised OOHPI indices are published. Timely publication and reliable information on the weight with which OOHPI should be included in the HICP are important. This allows practitioners to construct and analyse experimentally augmented HICP series and to consider their information content in monetary policy assessments. A dedicated Eurosystem Task Force made good progress in analysing and regularly projecting OOH costs and combining them with HICP(X) projections to obtain analytical augmented HICP series. These augmented series are used as a “helpful cross-check” when preparing monetary policy (see ECB, 2024).

For the available sample period, and abstracting from differences during the high inflation period, HICP augmented with OOH according to either the net acquisitions or the rental equivalence approach would mostly have yielded broadly similar numbers for euro area inflation as the official index. This also holds true for the inflation outlook included in the respective projections of the latest (Broad) Macroeconomic Projections Exercises, suggesting that there would have been no fundamentally different implications for monetary policy. Whether such limited differences are also observed in future depends, among other things, on the synchronisation of house price, rental price and inflation cycles across euro area countries and on the general level of inflation (high/low). For instance, in the event of a highly synchronised OOHPI surge across countries in the presence of otherwise low inflation, the augmented HICP inflation series could display larger differences to the official series. Housing market dynamics would then imply signals for euro area monetary policy directly through the targeted augmented measure of inflation. In this respect, series augmented via the net acquisitions and rental equivalence approaches could provide different signals if dynamics in the owner-occupied housing market and the rental market are characterised by differences in timing or stickiness. The implications for monetary policy of an augmented index in terms of both dynamics relative to the target and the sensitivity to interest rates thus warrant careful assessment.[60]

The ECB maintains its request to include OOH in the HICP[61] and reiterate that the publication of official experimental HICPs including OOH would be very welcome. While the prospect and timeline of official augmented HICPs remain surrounded by considerable uncertainty, this issue is important and should be resolved within an appropriate time horizon. The ECB will reach out to the ESS through the appropriate channels to underline its requirements in the field of HICPs augmented with OOH costs.

Box 4
Assessing developments in inflation expectations: experts, markets, households and firms

Prepared by Aidan Meyler, Colm Bates and Neil Lawton[62]

Inflation expectations play a central role in the ECB's economic and monetary analysis and were a topic of interest in the previous monetary policy strategy reviews (MPSRs). The MPSR 2020-21 pointed to two dimensions that warrant revisiting. First, it was expected that "the new symmetric two per cent inflation target would contribute to a more solid anchoring of longer-term inflation expectations". Second, it was proposed that economic analysis should give due emphasis to "the use of newly available granular data, including surveys of expectations such as the newly established Consumer Expectations Survey". This box addresses these two dimensions against the background of recent inflation developments.

1. Signals from surveys of professional forecasters and financial market measures

At the time of the MPSR 2020-21, there were growing concerns that longer-term inflation expectations in the euro area were becoming less well anchored to the downside. Corresponding signals came from a number of different anchoring metrics regarding these longer-term inflation expectations (their level, responsiveness to shorter-term developments, and the degree of uncertainty surrounding them) for both survey-based measures from professional forecasters and market-based measures of inflation compensation.[63]

In the period since the MPSR, survey-based measures of professional forecasters' longer-term inflation expectations showed a closer and stronger anchoring at 2%. Historically, there has been some correlation between trends in actual inflation and longer-term inflation expectations, but there are a number of arguments why developments since 2021 reflect something beyond this normal co-movement. Consideration of the histogram of individual point expectations from the ECB SPF (Chart A, panel a) may be informative in this regard. This shows that, first, after a slippage on

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60 See Banerjee et al. (2024) for a discussion of policy implications of the rental equivalence approach. See also Allayioti et al. (2024), "Monetary policy pass-through to consumer prices: evidence from granular price data", *Working Paper Series*, No 3003, ECB. The paper finds that rents are among the HICP items that are not sensitive to monetary policy shocks.

61 See ECB (2021).

62 Comments and suggestions from the Monetary Policy Strategy Review Workstream 1 group are gratefully acknowledged. Commented and approved for circulation by T. Westermann and W. Lemke.

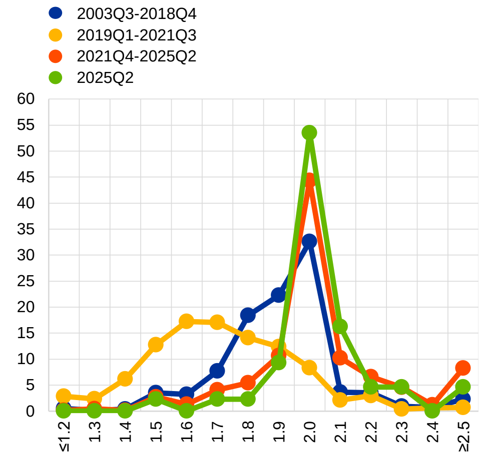
63 For a more detailed discussion of the different metrics see ECB (2021a). Corsello et al. (2021) point to a stronger sensitivity to negative inflation surprises after 2013.

the downside over the period 2019-21, the mode has shifted back to 2.0%.[64] Although the mean (or average) was 2.1-2.2% from the second quarter of 2022 until the fourth quarter of 2023 and there was an elevated probability associated with inflation being above 2.5 % during the high inflation episode, the mode did not increase above 2.0%. Second, the mode has become more pronounced at 2.0%, with the portion of respondents reporting longer-term inflation expectation of 2.0% increasing to above 50% in the second quarter of 2025. Third, the "tilt" of the distribution has changed from being more below 2.0%, which, in a steady state, would be compatible with the previous target of below but close to 2%, to being more symmetric around 2.0%.[65] Lastly, and perhaps most compellingly, disagreement has decreased in contrast to previous findings (Dovern et al. 2012 and Mankiw et al. 2004) that higher inflation has frequently been associated with higher disagreement in inflation expectations. Moreover, applying an anchoring indicator (which combines level and uncertainty dimensions) proposed by Naggert et al. (2023) to the euro area using SPF data suggests that, after 2019-21 when the indicator was driven by a difference between consensus expectations and the inflation target, a high degree of anchoring has been re-established.[66] Updated estimates of steady-state inflation expectations (see Chart 14 in ECB 2021a) suggest that, on top of a re-anchoring at 2%, shorter-term expectations now converge more quickly to steady-state again.

Chart A

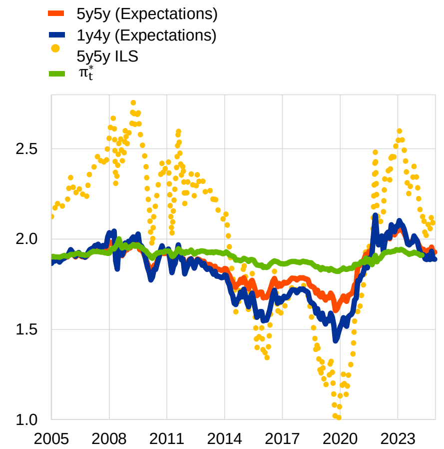
a) Histogram of point longer-term inflation expectations – selected periods

(point estimate; share of respondents in %)



b) Inflation expectations derived from model-based decomposition of long-term ILS

(annual percentage changes)



Sources: a) ECB SPF, and SPF. b) Refinitiv, Bloomberg, Burban et al. (2024) and ECB staff calculations.
Notes: a) SPF expectations for 4 or 5 years calendar year ahead. b) The green line displays adjusting end-point infinite horizon inflation expectations using the model of Burban et al. (2024). Inflation expectations (red and blue) are based on estimates from two affine term structure models using inflation-linked swap rates as in Joslin, Singleton and Zhu (2011) applied to ILS rates not adjusted for indexation lag; see Burban et al. (2021), ECB Economic Bulletin Issue 8, 2021, Box 4. The yellow dotted line displays the unadjusted 5y5y ILS. The latest observations are November 2024 (green line) and May 2025.

Longer-term inflation expectations derived from financial market-based measures, following a re-anchoring back to 2% from below, have been relatively stable at close to the ECB's 2% inflation target since the MPSR 2020-21, including during the high inflation episode. Longer-term inflation expectations implied by 5-year, 5-year inflation-linked swap (ILS) rates and the 1-year,

[64] For a more detailed discussion of the ECB SPF over its first 25 years, see Allayioti et al. (2024).

[65] For a more detailed discussion of the "tails" of the distribution see ECB (2022a).

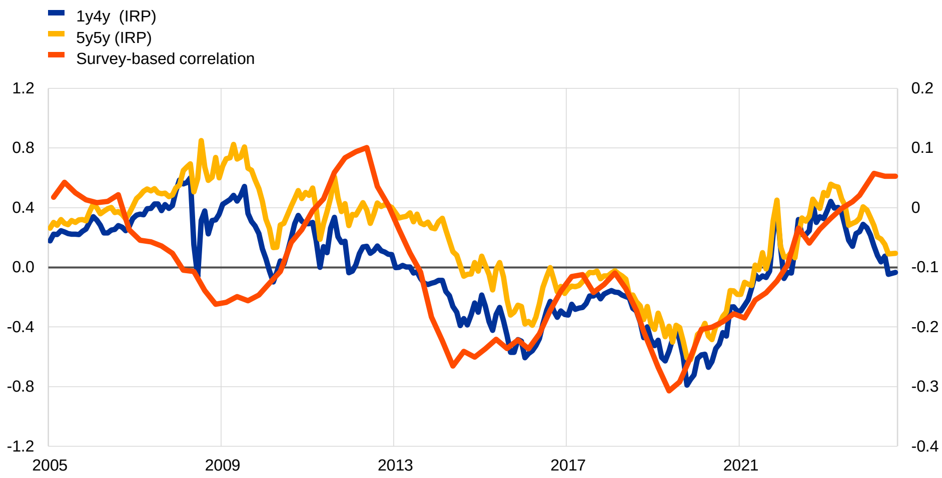
[66] Naggert et al. (2023) calculate a measure of anchoring that equals the sum of: a) the square of the difference between the average (or consensus) forecast and the inflation target; and b) the average of the squared differences between individual forecasts and the average/consensus forecast (or disagreement). For a more detailed discussion, see Allayioti et al. (2024) Section 3.1.3.

4-year ILS rate (a maturity closer to the longer-term inflation expectations in the SPF) have remained close to 2% since 2021 (Chart A, panel b).[67] In fact, the mean absolute deviation of 5-year, 5-year ILS implied expectations from 2% is just 2 basis points since the new symmetric inflation target was announced in July 2021. Models incorporating the term structure of ILS and additional information, such as inflation fixings and survey data, also broadly confirm that long-term inflation expectations have remained close to the 2% inflation target (see Boeckx et al., 2025; Grønlund et al., 2024; and Gimeno and Ortega, forthcoming).[68] Additionally, the model of Burban et al. (2024), which differs from the aforementioned models by allowing for a time-varying steady state inflation rate (as well as including survey information), confirms that expectations have remained anchored over the past two decades, including since the MPSR 2020-21 (Chart A, panel b – green line).[69]

Chart B

Comparison of survey-based estimated correlation of future GDP and inflation with term structure model-based estimates of IRP

(left-hand scale: annual percentage changes, right-hand scale: correlation)



Sources: Refinitiv, Bloomberg, ECB SPF and ECB staff calculations
Notes: The red line shows model estimates of the survey-based correlation between 5-year-ahead GDP growth and inflation using the approach in Allayioti et al. (2024), Box 2., with the sign of the correlation inverted. The inflation risk premium is based on estimates from two affine term structure models using inflation-linked swap rates as in Joslin, Singleton and Zhu (2011) applied to ILS rates not adjusted for indexation lag; see Burban et al. (2021), ECB Economic Bulletin Issue 8, 2021, Box 4.
Latest observation: Q1 2025 (monthly data for IRP, quarterly data for survey-based correlation).

Inflation risk premia can blur the signal on the market's central inflation expectation but provide relevant own information. The inflation risk premium embedded in long-term inflation compensation increased from negative territory pre-MPSR 2020-21 to a positive level during the inflation surge. Adopting a macro-finance asset pricing perspective, this is in line with market participants foreseeing the future macroeconomic environment more impacted by supply-side than demand-side shocks**.** This interpretation is corroborated by showing that the expected co-

67 ILS rates and other market-based measures of inflation compensation reflect not only financial market participants' actual inflation expectations but also inflation risk premia due to financial market participants being risk-averse and having to deal with uncertainty. The measures are decomposed into unobserved inflation expectations and risk premia following the approach of Burban et al. (2021).

68 Similar findings were also earlier reported in Cecchetti et al. (2022).

69 By allowing for a time-varying infinite horizon expected inflation rate, the model allows for potential deviations from anchoring at longer-term horizons. By bringing information from both market-based inflation compensation (inflation swap rates) and average inflation forecasts of ECB's SPF and Consensus Economics. into one model, the approach allows for a more comprehensive gauge for inflation expectations anchoring.

movement between long-term inflation and GDP growth expectations of SPF survey respondents behaves similarly to model-based estimates of inflation risk premia (Chart B).[70] Separately, balance of risk measures (BoR) derived from long-term options-implied inflation probabilities signalled concerns about upside risks during the high inflation period but have since returned toward neutral, following a similar trajectory to that of the BoR derived from the ECB's SPF.[71] This provides further indication of a strong anchoring of long-term market-based inflation expectations to the ECB's 2% inflation target.

2. Signals from households and firms

Inflation expectations of firms and households are important for obtaining a broader picture of such expectations in the economy. Whilst expectations of professional forecasters and market participants have featured prominently in regular analysis, the expectations of households and firms have been less explored, particularly at the pan-euro area level, even though they are likely to matter for wage and price setting and macroeconomic outcomes (particularly consumption and investment) more generally.[72] At the time of the MPSR 2020-21, the ECB Consumer Expectations Survey (CES) was still in its pilot phase, but its results for one-year, three-year and (more recently) five-year ahead expectations have since featured regularly in economic analysis. Similarly, the ECB Survey on the Access to Finance of Enterprises (SAFE) was enriched in June 2023 by collecting information on firms' inflation expectations at the one-year, three-year, and five-year horizons and has recently moved to a quarterly frequency. These data make it possible to assess differences between household and firm inflation expectations and those of professional forecasters and market participants, and the extent to which the independent and heterogenous measures of inflation expectations for households and firms provide reliable signals about anchoring risks.

Survey measures of household inflation expectations reflect a broad distribution of beliefs about inflation.[73] Aside from actual inflation, they can be influenced by economic sentiment and uncertainty.[74] The data suggest significant deviations in many instances from assumptions of "rationality" in forming expectations, particularly for consumers with lower levels of education or financial literacy. On average, euro area-wide inflation expectations have tended to be above 2% (although at longer horizons, such as three- or five-years ahead, median expectations have been relatively closer to 2% on average) – see Chart C, panel a, which shows the "term structure" of inflation perceptions and expectations in October 2022 (highest point of expectations) and May 2025 (latest available data).[75]

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70 See Allayioti et al. (2024), Box 2. See also Boeckx et al. (2025) who discuss supply and demand shocks' contributions to the dynamics of the risk premia and expectations components of inflation-linked swap rates.

71 For market-based measures, the BoR metric is defined as the difference between the risk-neutral probabilities assigned to inflation outcomes above versus below the 2% target level. See Garcia et al. (forthcoming) for a full discussion. For the SPF, the BoR metric is calculated as the difference between the mean of the aggregate probability distribution and the average point expectation.

72 Coibion et al (2018) survey the literature on the formation of expectations, inflation and the Phillips curve.

73 See D'Acunto et al. (2024) for a more detailed discussion.

74 See also Reiche and Meyler (2022) for a more detailed analysis and discussion.

75 The fact that consumers' mean expectations are above median expectations is a stylised fact. This owes to fact that the distribution of consumer expectations tends to have a long upper tail and also that many consumers, when uncertain about their expectations, tend to report numbers in multiples of five. For a discussion of this round number, round interpretation phenomenon see Binder (2017). Furthermore, survey mode (in-person, phone, online, etc.) may also influence results (Bruine de Bruin et al. 2017).

Understanding household inflation expectations is important, as what they believe about future inflation affects their behaviour.[76] D'Acunto and Weber (2024) provide an overview of the evidence on the relationship between consumer inflation expectations and saving, spending, borrowing and labour supply decisions. Sometimes these relationships can be complex. For example, Georgarakos et. al. (2024) argue that including perceived inflation uncertainty by consumers may resolve the different findings of the role of inflation expectations in spending decisions in the literature. Namely, while higher inflation expectations induce higher spending, higher inflation uncertainty induces lower spending. Furthermore, so called Randomised Control Trials (RCTs) can be used to identify the causal effects of inflation expectations on these decisions; see Coibion and Gorodnichenko (2024).

Assessing the degree of anchoring of long-term consumer inflation expectations and the role of the inflation target therein is challenging. When considering anchoring by the extent to which long-term inflation expectations respond to changes in actual inflation and short-term expectations (Georgarakos et al. 2023 and Galati et al. 2023, 2024), anchoring is less strong among households compared with financial markets and professional forecasters. D'Acunto et al. (2024) discuss that during the recent euro area inflation surge, a reduced degree of anchoring in household medium-term inflation expectations may have contributed to the enhanced pricing power of firms and hence more persistence in the dynamics of actual inflation. At the same time, the downward-sloping term structure of inflation expectations during the high inflation period suggest that the ECB's target has some traction for households when forming beliefs about future price changes. However, the evidence points to a limited impact following the introduction of the symmetric inflation target in July 2021 on consumer inflation expectations.[77] Overall, there appears to be scope for sharpening consumers' inflation expectations.

[76] Illustrations of the use of CES data in monetary and economic analyses at the ECB include: What do consumers think is the main driver of recent inflation (Baptista et al. 2024 and Georgarakos et al. 2023); understanding of inflation expectations at the peak of the inflation surge in October 2022 (Meyer et al. 2023); and gender differences in inflation expectations - What drives inflation expectations of women and men (Di Nino et al. 2023). See also Ferreira and Pica (2024) who conclude that understanding how people think about price increases (demand vs supply-side) is crucial for managing inflation expectations.

[77] This may be partly related to respondents not being aware of the change in target (Galati et al. 2024; Ehrmann et al. 2023). Galati et al. 2024 report that even when households were informed about the change in target there was no clear change in the pattern in median consumer inflation expectations. This could be because the change in target was subtle or because actual inflation was already close to 2% at the time. At the same time, Ehrmann et al. (2023) highlight that when consumers receive more extensive information on the target as well as an explainer of its background, they believe that the ECB is more likely to deliver price stability, and their inflation expectations are better anchored at the 2% target.

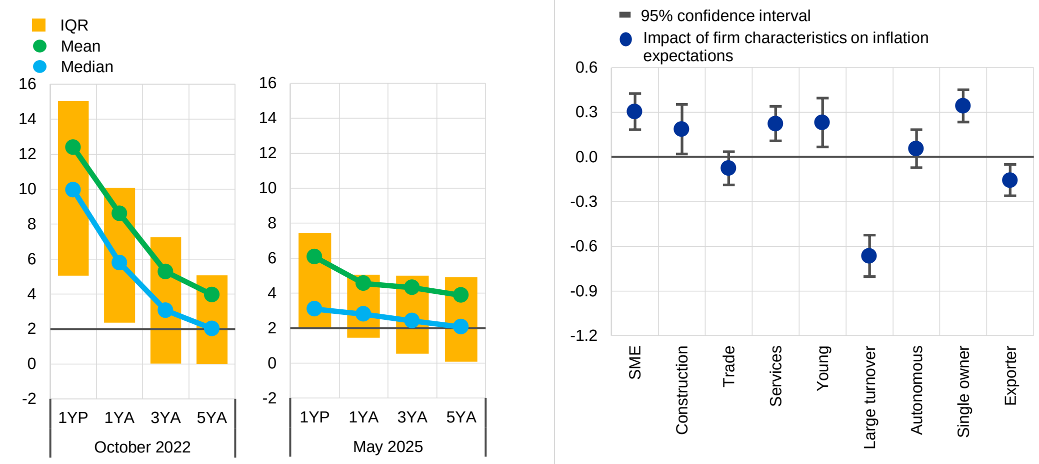
Chart C

a) **Term structure of consumers' inflation perceptions and expectations**

(annual percentage changes)

b) **Impact of firm characteristics on inflation expectations**

(coefficient of the regression)



Sources: a) ECB CES. b) Survey on the Access to Finance of Enterprises.
Notes: a) 1YP denotes inflation perceptions and 1YA, 3YA and 5YA denote 1-, 3- and 5-years ahead inflation expectations. Latest observation is May 2025
b) Survey-weighted median firms' expectations for euro area inflation in one year, three years' and five years' time. Latest observation is Q1 2025.

Firms' inflation expectations lie somewhere in between those of professionals and those of households. Firstly, as for households, they are characterised by high heterogeneity and statistical measures like their median and standard deviation tend to be between those of households and professional forecasters.[78,79] That is, firms' average expectations are higher than professional forecasters' and are closer to households'. Also, firms' expectations exhibit more disagreement/heterogeneity than professional forecasters and less than households'. Secondly, differences in firms' demographics, firms' choices and constraints, and cross-country macroeconomic environments account for most of the heterogeneity in inflation expectations by roughly equal shares (Chart C, panel b). A corollary of these two findings is that larger firms tend to have inflation expectations closer to those of professional forecasters. Lastly, local conditions such as the national rate of current inflation explain not only national inflation expectations but also euro area inflation expectations. In other words, firms extrapolate from local conditions to aggregate conditions.

In terms of recent developments, firms' shorter-term inflation expectations have declined while longer-term ones have been more stable. Specifically, firms' median inflation expectations at the one-year horizon have steadily declined from 5.1% in the second quarter of 2023 to 2.9% in the first quarter of 2025, while at the five-year horizon they have been relatively stable at close to 3%. As it can be argued that the dynamics and distribution of both firm and household inflation expectations are more relevant than their levels, the decline of firms short-term inflation expectations to a value consistent with their long-term inflation expectations is indicative of their

78 See Baumann et al. (2024) for a more detailed discussion and Savignac et al. (2024) for a discussion based on French firm data.

79 A unique measurement challenge faced by surveys of firms is to understand who is the appropriate representative within a firm to respond to the survey and to ensure their responses represent the view of the firm at large. With the ECB SAFE for example, the interviewee in each company is a top-level executive (general manager, financial director or chief accountant).

inflation expectations being anchored.[80] Furthermore, Bottone et al. (2022) show that communicating about the ECB inflation target may shape firm's inflation expectations and that the clarity of the symmetric target may contribute to more effective communication.

3. Conclusions and forward-looking implications

Newly available evidence on professionals', markets', households' and firms' inflation expectations behaviour by and large support the notion of inflation expectations anchoring since the MPSR 2020-21. Those derived both from survey-based measures of professional forecasters and market-based measures of inflation compensation have remained well anchored – especially in view of the high inflation developments seen in the recent past. Whilst there was an overshoot of 2.0% for both survey and (risk-adjusted) market-based measures of longer-term inflation expectations, this was small in magnitude (0.1-0.2 percentage points) and short-lived (around the turn of 2022). For households and firms, the anchoring of inflation expectations is probably best assessed through the term structure of the expectations curve rather than the precise level at various horizons. Their expectations are more heterogenous than those of experts. Their interpretation therefore requires considerable care and attention and deriving the implications for monetary policy from aggregate developments is challenging without more granular analysis and understanding. Memories and experiences from the recent inflation surge may still shape households' and firms views of future inflation risks and a reduced degree of anchoring in households' and firms' medium-term inflation expectations, in turn, risks more persistence in the dynamics of actual inflation. While much has been learned, policy makers still need to learn more about the interaction between expectations and decisions. A systematic and bold (e.g. scaling up field experiments) approach could facilitate this learning and make it possible to test the implications of alternative expectation formation theories.

80 ECB (2024) confirms the early findings of Baumann et al. (2024) in the context of the more recent higher frequency data, concluding that the increased frequency of the survey and the introduction of questions on firms' euro area inflation expectations have made SAFE more valuable for the ECB's monetary policy transmission assessment.

3 Looking ahead – the implications of structural factors for economic and inflation developments

3.1 Introduction

The strategy review 2021 emphasised the potential influence of structural factors in determining inflation outcomes. The focus was on understanding why inflation had been persistently low in the years before the review (Koester et al., 2021). Analysis underscored that low inflation had resulted from a series of disinflationary cyclical shocks. However, structural factors such as globalisation, digitalisation and demographics had also played a role in supressing inflation, in part by interacting with cyclical factors, and in a context in which the effective lower bound limited the ability of interest rate policy to counteract disinflationary forces. Climate change was also identified as potentially having an increasing impact on inflation, although this impact is difficult to quantify or project because of uncertainty about the characteristics of climate-related shocks (Coeuré, 2018).

In recent years there have been notable shifts in the structural factors shaping the economic environment. The most prominent development has been the changing global geopolitical and economic landscape. Geopolitical tensions have increased amid a shift towards more protectionist and interventionist policies. Other, pre-existing trends also appear to have accelerated. The effects of climate change are becoming evident more rapidly than anticipated, with rising global temperatures and extreme weather events occurring more frequently. Efforts to spur a green transition continue, particularly in Europe with the Fit-for-55 programme. Digitalisation has also reached a new phase with generative artificial intelligence (AI) models. And although the pace of adoption and impact of the new technology is uncertain, it seems plausible that it will enhance productivity. By contrast, despite the recent surge in migration that has boosted the euro area population and labour force participation rates, underlying demographic trends have remained relatively unchanged and the euro area continues to grapple with an ageing population.[81]

Structural factors shape inflation in different ways. First, they can cause persistent, gradual changes in the highly persistent or trend component of inflation – i.e. the slow-moving component of inflation – by directly affecting the price dynamics of goods and services or indirectly changing market structures, trend productivity or generating persistent shifts in labour and profit shares.[82] In general, the price effects

81 See also the 2024 Ageing Report by the European Commission. Another further economic development is the increase in public debt, which rose in the euro area to over 100% of GDP after the global financial crisis but which has fallen since to around 90%.

82 In the ECB's economic analysis, the concepts of underlying inflation and trend inflation are distinguished by the horizon over which shocks dissipate. Conceptually, underlying inflation reflects medium-term inflation developments linked to the business cycle, whereas trend inflation captures more persistent, longer-term components related to structural factors. See also: Bańbura et al (2023): "Underlying inflation measures: an analytical guide for the euro area".

of structural forces appear first as relative price shifts. The ECB will ultimately determine how such persistent relative price shocks influence overall inflation outcomes in the euro area. In general, structural factors are likely to provide headwinds or tailwinds that affect the inflationary environment and that monetary authorities need to understand. Second, they can have an impact on inflation volatility and uncertainty. Third, because structural factors impact segments of the economy and components of inflation differently, they can induce divergence in relative prices. Finally, structural forces affect the cyclical inflation process**.** By influencing the competitive environment in goods, services, and labour markets, structural factors can affect how inflation reacts to cyclical shocks. That could influence the sensitivity of inflation and wages to real developments and the interplay of wages, profits and productivity which have been central to understanding recent inflation developments.

This chapter discusses how evolving structural factors may influence the inflation environment. Section 3.2 outlines the potential implications for the persistent component of inflation. **Section 3.3** analyses the role that secular trends could play in shaping the frequency, size and nature of shocks and discusses the potential implications for inflation volatility and uncertainty. **Section 3.4** reviews how structural developments may affect the frequency and persistence of changes in relative prices **Section 3.5** analyses how structural changes impact the interaction between wages, profits and productivity growth as key determinants of the domestic inflation process. **Section 3.6** reviews developments in empirical estimates of the natural interest rate in the euro area and its drivers – including the role of structural factors.

For the purpose of this review, we have focused selectively on structural changes that could impact inflation in the future. Our analysis primarily covers global fragmentation and deglobalisation, climate change and the green transition, digitalisation and AI, as well as demographic trends. Other structural trends related, for example, to global health issues (e.g. pandemics) are also acknowledged but not explored at the same level of detail.

3.2 Structural factors that can affect trend inflation

The strategy review 2021 found that the trend or persistent component of inflation had declined – pointing to the importance of factors beyond the business cycle. The trend component refers to a highly persistent, slowly moving time-series component of inflation that is not directly affected by short to medium-term fluctuations, such as temporary cost-push shocks or the business cycle. The trend or persistent component of inflation is an unobserved variable and its estimates are necessarily model-specific. In the strategy review 2021, structural trends such as globalisation, digitalisation and demographic change were judged likely to have had a small dampening effect on inflation in recent decades. The co-movement of inflation rates across advanced economies had increased amid a growing internationalisation of goods, services, and financial markets (Attinasi and Balatti, 2021). Yet, the effect of globalisation on inflation trends had typically been small, and they were considered unlikely to be a main driver of low inflation in the decade before the strategy review 2021 (Koester et al., 2021; Kamber and Wong, 2020). Available evidence discussed in the strategy review 2021 pointed also to a negative but marginal impact of digitalisation on inflation (workstream on digitalisation 2021; Koester et al., 2021). Model simulations also suggested a potential disinflationary bias of demographic trends if monetary policy did not fully internalise the downward impact of ageing on the natural interest rate. At the same time, it was also recognised that the effects of these secular trends can normally be internalised and offset by the monetary authority. In the low inflation period, however, the effective lower bound limited the available monetary policy space (Koester et al., 2021), requiring the use of non-standard monetary policy measures. Overall, these structural factors have the potential to have a persistent impact on inflation developments, both in the level of inflation and on its volatility. In the strategy review 2021, the conclusion was that these structural factors mostly had a dampening effect on inflation, which possibly had an overall deflationary impact on long term trend inflation in the context of the effective lower bound and the asymmetric inflation target.

Since the strategy review 2021, estimates of long-term trend inflation have moved closer to 2%, albeit uncertainty has increased. Estimates of trend inflation based on a Phillips curve model have been climbing in recent years. That applies to a model estimated solely from inflation and output gap data and one that uses longer term inflation expectations to inform the movements of the trend (Bańbura and Bobeica, 2023, **Chart 24**, panel a). Compared with estimates at the time of the strategy review 2021, there is now less compelling evidence that the persistent component of inflation was falling in the run up to the pandemic. Model-based estimates suggest that since the previous strategy review the persistent component of inflation has risen, from around 1.8% to around 1.9% (**Chart 24**, panel b), suggesting better anchoring of inflation expectations at the ECB’s 2% medium term symmetric target agreed as the price stability target in the last MPSR, and that the deflationary impact of the structural factors detected in the last MPSR may be reverting. However, the uncertainty surrounding the estimates of trend inflation has increased substantially since 2020, with the 68% credible interval roughly doubling in size and tilting to the upside. Moreover, it should be borne in mind that econometric measures of unobservable trends may be subject to revisions, particularly at the end-of-sample points.[83]

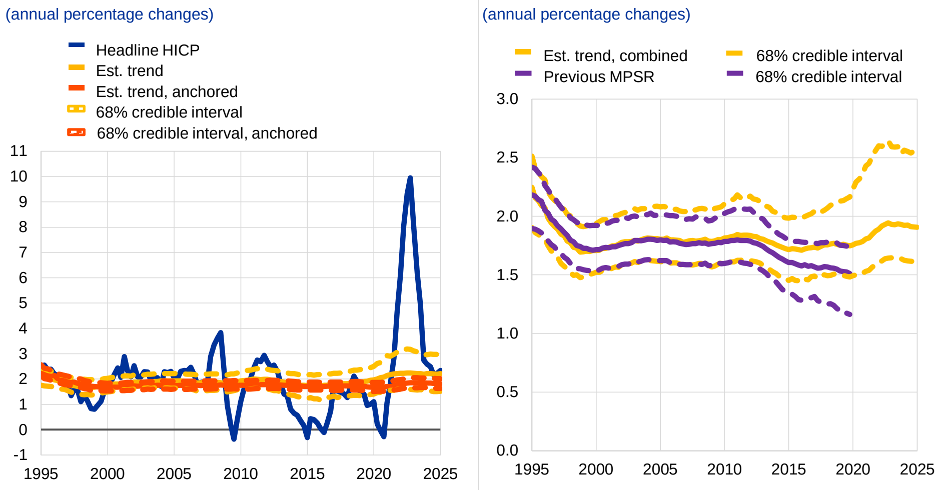
[83] These econometric estimates of the trend involve smoothing, taking into account adjacent – past and future – observations. Therefore, uncertainty and revisions tend to be larger at the end of the sample, where only limited or no future observations are available. As a consequence, higher outcomes of inflation in recent years has led to an upward revision of previous estimates that were based on the outcomes from the low inflationary period.

Chart 24

Trend inflation

a) Estimated trend components

b) Comparison of estimated trend components to the previous strategy review



Sources: Eurostat, ECB projections data base and ECB staff calculations.
Notes: Panel a): The latest observations are for the first quarter of 2025. Estimated trends from a Phillips curve linking inflation gap to output gap. The Phillips curve follows the approach by Chan, Clark and Koop (2018) and allows for time-varying coefficients and variances. In the "anchored" version the trend is linked to the five-year-ahead inflation expectations from the SPF, see also Banbura and Bobeica (2023); Panel b)The latest observations are for the first quarter of 2025 and for the fourth quarter of 2019. Estimated trends from a Phillips curve models as in panel a). The results from non-anchored and anchored specifications are pooled. "Previous MPSR" reports estimates based on the data available at the beginning of 2020 and reported in Box 2 in Koester et al. (2021).

Looking ahead, and in contrast to the previous strategy review, the newly emerging secular forces affecting the persistent component of inflation are no longer clearly disinflationary, but are pulling in different directions. However, assessing the direction and magnitude of this impact is complex for several reasons. First, developments in and the impact of these structural forces are strongly intertwined. Second, structural forces affect inflation through both supply and demand channels and, in many cases, the overall balance of supply and demand effects will be unclear. And finally, the impact of structural changes is highly dependent on how policy reacts. The following paragraphs look ahead at the potential implications of the major structural changes under way – fragmentation, climate change and the green transition, digitalisation and demographics – for longer-term inflationary pressures.

The transition to a more fragmented global economy could be one force shaping longer-term inflationary pressures. In the decades preceding the ECB's previous strategy review, the gradual increase in globalisation had tended to dampen inflation via increasing trade and financial integration (Lodge and Pérez, 2021). In recent years, however, this trend appears to be reversing. Amidst elevated geopolitical tensions, governments are increasingly concerned about strategic dependencies and tempted by inward-looking policies to boost economic resilience and protect national security (IRC, 2023; IRC taskforce on fragmentation, 2024). Fragmentation is evident in shifting trade and financial ties, with particularly sharp declines in flows between the United States and China and between the euro area and Russia (IRC taskforce on fragmentation, 2024, Bosone et al., 2024). The recent shift in US trade policies and imposition of additional tariffs on a large number of countries, including on the euro area and especially on China, contributes to these risks. Fragmentation is also influencing foreign direct investment and financial flows (Boeckelmann et al., 2024b), which may presage further shifts in trade networks (Qiang et al., 2021). Surveys indicate that many firms intend to adjust production location or suppliers in the future (Balteanu et al., 2024; Attinasi et al., 2023a). Overall, it is possible that the global economy will face a period of, possibly protracted, adjustment to global trading and financial linkages.

The implications of fragmentation, however, are not clear cut.[84] On the one hand, fragmentation may stoke inflationary pressures, as domestic suppliers shift away from cheaper foreign suppliers and re-shore part of the production. Clancy et al., 2024 show such an adjustment could increase inflation persistently. To date, however, there is little empirical evidence of a significant inflationary impact from de-globalisation (Ilkova et al., 2024). Yet model-based simulations suggest that further fragmentation could increase costs and prices, although the impact depends on the assumptions about the scope and magnitude of the increase in trade barriers (Attinasi et al., 2023b) as well as on how policy reacts (IRC, 2023, IRC taskforce on fragmentation, 2024; **Chart 25**, panel a). Stronger supply effects might be envisaged if they impair knowledge diffusion (Cai et al., 2022), or involve financial amplification (Berthou et al., 2018), and frictions to migration (Banerjee and Duflo, 2007). On the other hand, there may also be demand channels at play. Heightened concerns about geopolitical risks may encourage much stronger fiscal pressures for defence spending in the coming years. Conversely, a persistent increase in uncertainty associated with geopolitical risks may disincentivise investment and reduce aggregate demand also via precautionary savings (Caldara et al., 2020) and possibly inflation (Smith and Pinchetti, 2024; Anttonen and Lehmus, 2024). The implications for long-run inflationary pressures also depend on how aggregate demand adjusts in the face of lower productivity and real income growth. It is possible that negative demand effects on inflation outweigh the inflationary impact of shifting to more expensive suppliers (Ambrosino et al., 2024). This will depend also on how slow the realignment of supply chains is, compared with the persistence of uncertainty and precautionary behaviours.

84 Effects of policies reacting to structural challenges on the economy are discussed further below.

Chart 25

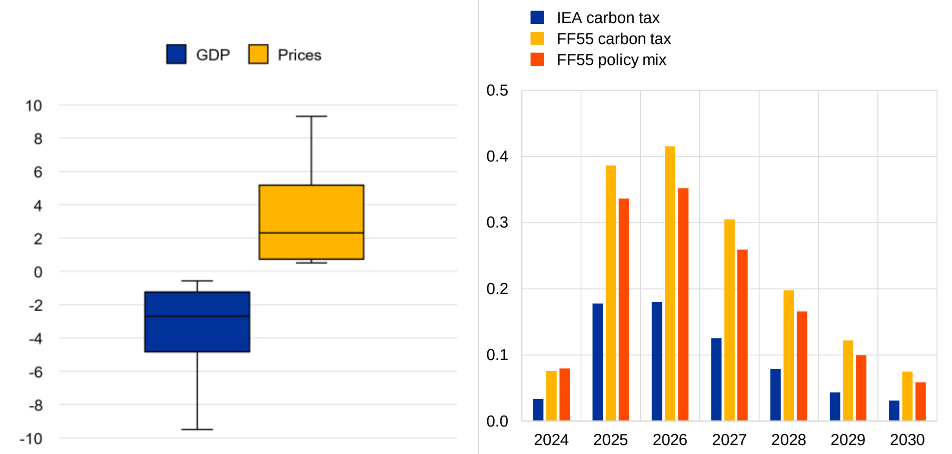
Macroeconomic impact of fragmentation scenarios and green transition

a) Effects of fragmentation on euro area real GDP and consumer prices

(percentage points)

b) Impacts of transition policies on inflation

(percentage point deviation from baseline with existing measures)



Sources: Panel a): Attinasi et al. (2023c), Lim et al. (2021), Felbermayr et al. (2023), Goes and Bekkers (2022), Cerdeiro et al. (2021), IRC taskforce on fragmentation (2024), Quintana (2025), OECD TiVA, EORA, and authors' calculations. Pnael b): Ferdinandusse et al. (2024).
Notes: Panel a): The chart shows peak impact on euro area real GDP and inflation across scenarios in cited studies. Whiskers show minimum and maximum, box refers to interquartile range.Panel b): The IEA carbon scenario is based on the International Energy Agency's 2022 World Energy Outlook and involves carbon taxes increasing steadily to $140/ tonne by 2030. This is insufficient to meet the fit-for 55 target. Two further scenarios are consistent with the fit-for-55 target, one using just carbon taxes and another using a policy mix that proxies the effect of regulation by an increase in total factor productivity of the "clean" energy sector and through higher elasticities of substitution between "dirty" and "clean" energy.

The recent acceleration of climate change may also affect developments in longer-term inflationary pressures if it is not reversed. There is evidence that climate change effects are materialising faster than expected, as the frequency and intensity of extreme weather has increased. In recent months and years, global and local temperatures have broken previous records. Major climate-related catastrophes are becoming annual events (see **Box 5**). Should the observed increase in heatwaves and floods persist, it could impact inflation persistently through supply channels, for example, by reducing agriculture output and energy supply or affecting supply chains (Kotz et al., 2024, Papadopoulos et al., 2025). However, climate change developments could also affect inflation persistently by suppressing income and thereby demand.

The green transition to mitigate the impact of climate change is another structural shift that could affect longer-term inflationary pressures. In the EU, policies and actions to spur a green transition are gathering pace with the Fit for 55 programme,[85] although there are pressures to deprioritize climate change on the political agenda. The package overhauls the Emissions Trading System (ETS), expanding its scope and enhancing the financial incentives for reducing carbon emissions, including to promote sustainable transportation, increase the proportion of renewable energy, and enhance energy efficiency. The carbon border adjustment mechanism, to be implemented from 2026, will impose a carbon price equivalent to the ETS (see **Box 5**) on imports of certain goods from countries with less stringent

[85] For further details, see the EU Commission's website for the European Green Deal, ETS2 and the carbon border adjustment mechanism.

climate policies. Other aspects of the fit-for-55 programme include a ban on new internal combustion engine vehicles from 2035 and a social climate fund.

The early phases of the green transition may also put upward pressure on inflation. Transition policies involve increasing the price of carbon both directly and indirectly which should transmit to headline inflation. There are also substantial investment needs to replace carbon-intensive capital (Nerlich et al., 2025). Model-based analysis of a range of transition policy scenarios suggests a varied effects on inflation, with the impact on inflation depending on the policy mix (Degasperi et al., 2024). In this early transition phase, greater policy ambition, and hence swifter decarbonisation, tends to result in stronger inflationary pressure (**Chart 25**, panel b).

Yet, the impact of the green transition on inflationary pressures in the longer run is less certain. Large declines in the costs of transition technologies – notably wind, solar and batteries – have resulted in competitive alternatives to carbon-intensive production and power generation. Over time, the greater share of low-carbon electricity sources, and the switch of passenger transport away from fossil fuels, is likely to affect the relative price of electricity and motor fuel within HICP energy, and possibly the weight of energy in the overall basket. For example, greater installation of renewable energy capacity is estimated to have already substantially lowered electricity costs in Spain (Quintana, 2024). Finally, even the upward impact of carbon taxes on inflation is uncertain. Some studies find downward impacts, as expectations of lower future income, driven by higher carbon prices in the future depress current demand (Bartocci et al., 2022, Ferrari and Nispi Landi, 2022), or if the costs of the transition turn out to be higher than the gains in energy efficiency (see Olovsson and Vestin, 2023). Moreover, stronger mitigation measures may lead to lower inflationary pressures in the long run if they successfully contain the impact of climate change.

Digitalisation and increased use of AI models may also influence longer-term inflationary pressures. The previous strategy review discussed how the adoption of new digital technologies is likely to have long-run effects on inflation directly, through falling prices of digital consumer products, and indirectly by causing structural changes in the goods and labour markets (Anderson and Cette, 2021). The pace of digitalisation has accelerated since the previous strategy review with the emergence of generative AI models. Yet so far, their deployment is limited. Firms are currently experimenting with AI in production and business models.[86] The utilisation intensity seems to be currently low, with a limited share of firms using the technology extensively (Deutsche Bundesbank, 2024; Dalla Zuanna et al., 2024; Consolo et al., 2024). Implementation has been very low in small firms, held back by high costs and lack of technical expertise (Lane et al., 2023).

AI is expected to enhance the supply potential of the economy, which could put downward pressure on longer-term inflationary pressures. The spread of digital technologies had a considerable impact on aggregate labour productivity growth in past decades, particularly between the late 1990s and early 2000s

[86] According to Eurostat, around 8% of surveyed euro area firms with at least ten employees were using at least one generative AI application in 2023, although adoption varied considerably across Member States.

(Deutsche Bundesbank, 2023, Falck et al., 2024), even though it was mostly frontier firms who benefitted from digitalisation at the firm-level (Anghel, Bunel et al., 2024). The productivity gains from digitalisation have slowed down markedly since then (Cette et al., 2015) but a number of microeconomic studies suggest that AI could renew the pace of productivity gains. They point to gains in specific occupations (see Noy and Zang, 2023; Brynjolfsson et al., 2023; Dell'Acqua et al., 2023), although the extent to which these affect aggregate productivity remains uncertain. The projected range of macroeconomic impacts over the medium-term is very large and mainly focuses on the US economy. Estimates vary between a modest gain in labour productivity of 0.1 percentage point per year over ten years, estimated by Acemoglu (2024), up to 0.9 percentage points. (Filippucci et al., 2024). Under the most favourable scenario, the OECD's estimates suggest an increase in such gains of around 1.4 percentage points per year, which, other things being equal, would essentially double the annual productivity growth as compared with the past decade (Briggs and Kodnani, 2023; Bergeaud, 2024).

However, the implications of digitalisation and AI on longer-term inflationary pressures will depend on how supply and demand channels interact. While AI is expected to increase the productive capacity of the economy, there may also be demand channels through which AI could also influence trend inflation. Aggregate investment may need to increase to support AI developments. Upward price pressures could also stem from increased energy demands: AI-related data centres are expected to increase global electricity consumption markedly in the coming years which could create price pressures in national electricity markets (Cipollone, 2025). Finally, consumption dynamics, will be affected through the impacts of AI on the labour markets. The impact of AI on employment and wages will depend on the balance between the automation of existing tasks and the creation of new tasks where human labour retains a competitive advantage (Hartmann, 2025). Moreover, the impact on inflation will depend on how firms and households adapt their expectations with regard to the outlook and impact of technology. For example, AI may initially be disinflationary if its effects are unanticipated. However, once households and firms understand and anticipate the future gains, they may consume and invest more, thus turning AI into an inflationary force (Aldasoro et al., 2024).

Demographics is another force that can affect longer-term inflationary pressures. Declining mortality and fertility rates continue to change the age-structure of the euro area population and point to a shrinking workforce in the years ahead. Significant inflows of migrants have boosted the workforce in recent years, but projections envisage that this surge is temporary, and that there is uncertainty about how migration flows will evolve. Projections from the European Commission envisage that the share of the population above 65 years of age and the old-age dependency ratio will rise.

Ageing is expected to lead to downward pressures on inflation in the longer term. One link between inflation and demographics lies in on the impact on the natural interest rate as lower population growth and higher longevity increased savings and reduced the natural interest rate (Carvalho et al., 2016; Gagnon et al., 2021; Jones, 2023; Deutsche Bundesbank, 2021). If monetary policy does not internalise the endogenous impact of the demographic transition, it may generate a "disinflationary bias".[87] Also Bobeica et al. (2017), for example, present empirical evidence for the euro area, Germany and the United States supporting theories such as Lis et al., 2020, that point to a net deflationary impact from demographic change. Qualitatively similar results can be found in Gajewski (2015) and Yoon et al. (2018), who provide empirical evidence for a panel of OECD countries.[88]

3.3 Implications of structural changes for the nature of shocks and inflation volatility and uncertainty

Some of the structural changes underway could generate greater inflation volatility and uncertainty, reflecting an increase in the magnitude and frequency of shocks, as well as a change in the transmission mechanisms of macroeconomic shocks. Inflation volatility was subdued prior to the last strategy review but rose sharply in the aftermath of the COVID-19 pandemic. Several structural changes to global markets, for instance an increase in the elasticity of global supply due to the integration of emerging markets in the global economy, improvements in macroeconomic policies and less frequent shocks, contributed to keeping inflation (and more generally macroeconomic) volatility exceptionally low prior to the last strategy review. Inflation volatility resurfaced after a sequence of shocks of unprecedented severity, such as the pandemic and the energy crisis, struck the euro area. After Russia's invasion of Ukraine, inflation volatility rose nearly fourfold (Lagarde, 2025). Looking ahead, the structural changes discussed in **Section 3.2** suggest that inflation may be more volatile now as compared with the pre-pandemic period. First, because these structural factors present possible new sources of shocks that could affect euro area inflation, or make shocks more frequent, such as climate change shocks. Second, these structural forces have set in motion structural transformations, technological changes and policy responses that could also affect inflation dynamics by changing the transmission mechanism of different shocks. In short, some of the factors that made the Great Moderation possible may partly be reversing. During this period of change, more volatile inflation outcomes may become the norm. In a new steady state, the outlook is less clear: for example, prices could respond less to some shocks, if economies end up becoming more insulated as a result of foreign spillovers or from gyrations in the prices of energy commodities.

During the transition to a more fragmented global economy, geopolitical tensions may be a source of volatility. Recent events, such as Russia's gas supply disruptions, have illustrated the potential for countries to exploit critical dependencies to weaponise supply chains and to provoke sharp input price fluctuations for geopolitical rivals (IRC, 2023; IRC taskforce on fragmentation, 2024;

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[87] See, for example, Beyer and Wieland (2019).

[88] However, according to Goodhart and Pradhan (2020), as the population ages, the ratio of elderly that consume but do not produce relative to their younger cohorts who are responsible for producing will increase. This could raise aggregate demand relative to aggregate supply, thereby putting upward pressure on inflation. Although this is not a widely accepted proposition there are some empirical analyses pointing to an inflationary effect of ageing (Aksoy et al., 2019; Juselius and Takáts, 2021).

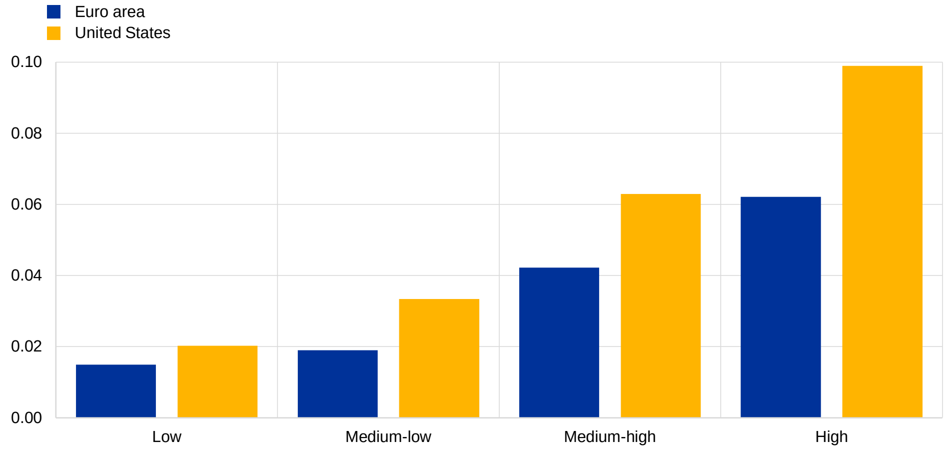
Alessandri and Gazzani, 2025). A further escalation of geopolitical tensions could increase the frequency of such large sector- or product-specific supply shocks. While such shocks are likely to affect relative prices in the first instance, they can result in aggregate inflationary effects (Smith and Pinchetti, 2024; Anttonen and Lehmus, 2024). Historically, large sectoral shocks were more likely to occur for goods located upstream in the value chain (**Chart 26**) which then feed through to the wider economy as production networks amplify the response (Aguilar et al., 2025).

Chart 26

Sectoral price volatility in a fragmented economy

More volatile sectors are located further upstream in the supply chain

(y-axis: standard deviation of annual PPI inflation across time, x-axis: degree of sectoral upstreamness)

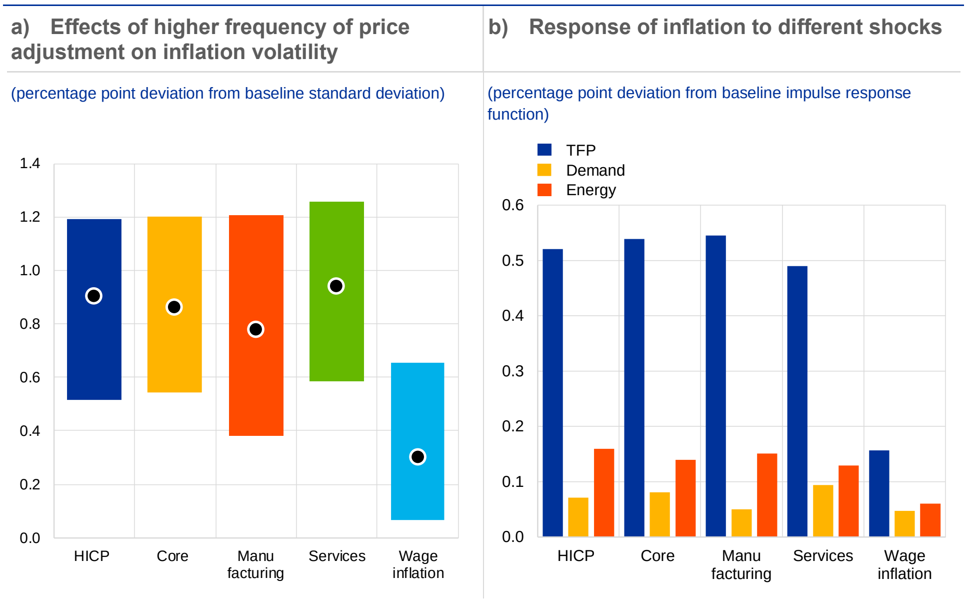


Sources: IRC taskforce on fragmentation, 2024, Boeckelmann et al., 2024, Bureau of Labour Statistics, Bureau of Economic Analysis and Eurostat.
Note: A sector has “low upstreamness” if the sectoral upstreamness of Antràs et al. (2012) ranges between 1 and 2, “medium-low” if between 2and 3, “medium-high” if between 3 and 4 and “high" if higher than 4.

Climate change may be another source of more frequent and more intense shocks, generating greater inflation volatility. The frequency and intensity of extreme weather events have increased and are set to increase further (**Box 5**). Future events might also compound with greater regularity, for example with heatwaves, droughts and wildfires occurring simultaneously. Such events have elements of supply shocks – reducing agricultural yields and the energy supply (by disrupting infrastructure), disrupting supply chains (such as the recent restriction of transit on the Panama Canal caused by drought, or car manufacturer’s production halts due to floods in its component supplier’s facilities (Papadopoulos et al., 2025)), and reduced labour efficiency or less attractive tourist locations in climates with high temperatures. However, the nascent literature on the inflation impact of extreme climate events has highlighted that such events also exhibit characteristics of demand shocks (Deutsche Bundesbank, 2022). Fluctuations in temperature can shift energy demand (for heating or cooling). Events that destroy property and production facilities can reduce income; higher uncertainty can also supress demand. So while there is general agreement in the literature that extreme weather events tend to increase food prices, core inflation can also fall as other factors weigh on broader demand, resulting in an overall insignificant, or occasionally negative impact on headline inflation (Parker, 2018; Ciccarelli and Marotta, 2024). The impact can also differ depending on the severity of the event, and between short and medium-run horizons (as demand impacts appear more persistent than the supply impacts), further increasing inflation uncertainty (Cantelmo et al., 2024; Faccia et al., 2021).

Chart 27

Impact of higher frequency of price adjustment on inflation volatility and transmission of shocks



Sources: ECB and Banco de España staff calculations, based on four multi-sector DSGE models.
Notes: Panel a) shows the difference in model-based inflation volatility when the frequency of price adjustment in the different models increases to match the empirical evidence shown in Chapter 2. Inflation volatility is measured as the standard deviation of the unconditional distribution of inflation in each model and it is shown as the difference with respect to the distribution in the baseline calibration of each model. Each bar represents the range of model-based inflation volatility stemming from the following models: Aguilar et al. (2025); Christoffel et al. (2025); Kase and Rigato (2025); Chafwehe et al. (2025). The black dots represent the average increase in inflation volatility stemming from these four models. Panel b) shows the average difference in the peak response of the different variables to the three shocks, after increasing the frequency of price adjustment. The average is taken across the four DSGE models. The total factor productivity (TFP) and the demand shocks are calibrated to increase real GDP by 1%, while the energy shock increases energy prices by 10%.

Both the digital and the green transition may be a source of increased price volatility. The use of AI is likely to put pressure on specific supply chains (semiconductors for instance) with episodes of price volatility, although the impact may be limited. As for the green transition, mismatches between supply and demand for fossil fuels, as both structurally decline, could lead to volatility in energy prices (Panetta, 2022), albeit the impact on headline CPI would decline over time as their importance in the economy falls. Conversely, the importance of transition-critical minerals will increase. Given the lead times to bringing new mines into operation, supply-demand imbalances are also likely. Indeed, there has already been a substantial cycle in lithium prices since the previous strategy review. Similarly, the share of variable solar and wind without suitable network upgrades, storage capacity and demand management technology could lead to more volatile electricity prices. Moreover, there is some evidence that an emission trading scheme leads to higher inflation volatility compared with a carbon tax (Santabára y Suárez-Varela, 2022).

Chart 28

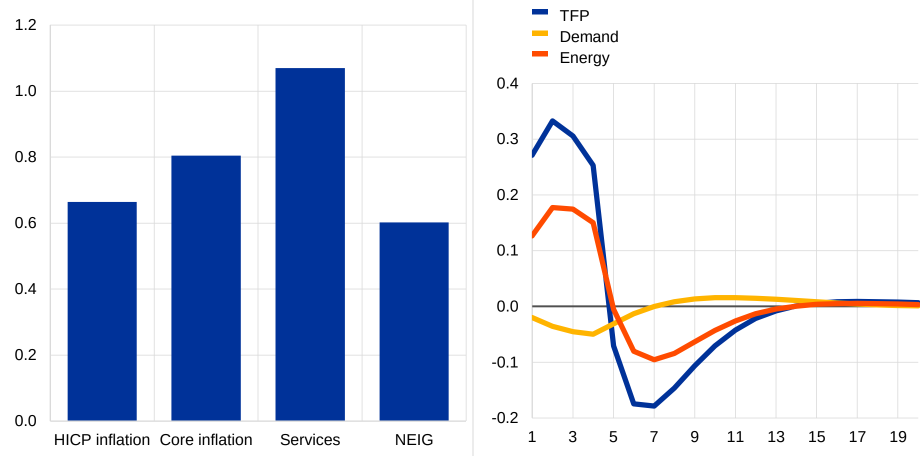
Effects of an increase in uncertainty on inflation volatility and transmission of shocks

a) Effects of higher uncertainty on inflation volatility

(percentage point deviation from baseline standard deviation)

b) Effects of higher uncertainty on the response of inflation to different shocks

(percentage point deviation from baseline impulse response function)



Source: Kase and Rigato (2025)
Notes: Panel a) shows the difference in model-based inflation volatility after an increase in firm uncertainty (50% increase in the standard deviation of idiosyncratic risk compared with the baseline model values). Inflation volatility is measured as the standard deviation of the unconditional distribution of inflation in each model, and it is compared to the distribution in the baseline model with the original values for risk. Panel b) shows that increased uncertainty compared with the baseline model leads to more frequent price adjustments, reducing price stickiness. After a negative total factor productivity (TFP) shock, prices adjust more quickly, potentially slowing the demand response for intermediate inputs, and resulting in higher inflation compared with the baseline. Similarly, less sticky prices amplify the effects of other shocks relative to the baseline.

In the presence of more frequent disruptive supply shocks, inflation volatility may increase further as firms adjust prices more frequently. A persistent increase in the frequency or size of shocks affecting the euro area may push firms to adjust pricing strategies. Larger shocks tend to induce more firms to adjust prices, as recent experience has shown (see **Chapter 2**; IRC taskforce on fragmentation, 2024; Ball and Mankiw, 1995; Rubbo, 2024).[89] Evidence from a broad range of state of the art sectoral/network models calibrated to match a similar change in the price setting frequency observed over the past few years indicates that this behaviour amplifies the impact of various shocks on inflation volatility (**Chart 27**, panel a). The increase in volatility would be broad based across different inflation sub-components, and it reflects mostly an increased reaction of inflation to supply shocks (**Chart 27**, panel b). In this environment, a supply shock, for instance an increase in input costs, directly raises firms' marginal costs. Since prices can adjust quickly, the higher marginal costs are immediately passed on to consumers in the form of higher prices, leading to a stronger inflationary response. By contrast, in the face of a demand shock, transmission is more muted as the shock impacts firms indirectly, via the output gap.[90] A number of factors may induce more frequent price adjustment. One is that in the face of high volatility and uncertainty, firms invest in their ability to adjust prices (Arndt and Enders, 2024; Khalil and Lewis, 2024). That would imply that

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[89] This is due to non-linearities in price adjustments: since they are costly, firms tend to adjust prices when faced with large shocks as compared with small ones (Ball and Mankiw, 1995; and Rubbo, 2024).

[90] Moreover, in standard models, the nominal interest rate would increase more, as both output and inflation will increase, and therefore, monetary policy will clamp down demand-driven fluctuations, effectively mitigating the impact on inflation.

prices could react not only to large shocks but also to smaller-scale frictions or geopolitical uncertainty and risks (Khalil et al., 2024).[91] A change in the frequency of price adjustment may also stem from greater digitalisation. Since companies that are more digitalised seem more likely to adjust their prices more often (Cavallo, 2018), widespread use of AI could make prices more sensitive to shifts in activity (dynamic pricing), possibly resulting in a larger and quicker pass-through of shocks to prices. So far, however, this is less likely to occur as the use of AI remains confined to large firms, which are more likely to cushion shocks to their marginal costs by varying their mark-ups (see Gal et al. 2019).

High levels of uncertainty are likely to contribute to inflation volatility. Recent inflation outturns were the result of a set of exceptional shocks that hit the euro area particularly hard. The combination and magnitude of shocks such as the pandemic and energy crisis should probably still be considered unusual. Moreover, on the positive side, the potential for rapid technological deployment to boost productivity could generate more favourable supply effects for the economy. Nonetheless, the outlook may still be that of more frequent and potentially larger shocks – which could result for example from geopolitical factors or climate change. In any case the outlook has become quite uncertain given fundamental changes since the pre-pandemic period – with geopolitics being a case in point. This environment with continuing high uncertainty is likely to amplify the volatility of inflation. Kase and Rigato (2025) show that in a state-dependent model of price adjustments, an increase in the risks facing firms (that is, an increase in uncertainty) causes them to adjust their prices more often, leading to a substantial increase in inflation volatility (**Chart 28**, panel a) and a faster pass-through of aggregate shocks to inflation (**Chart 28**, panel b).[92] The pass-through of supply shocks is found to be especially strong, as with high uncertainty, firms may need to adjust prices faster to avoid higher losses in the future after increases in their marginal costs. On the other hand, it cannot be excluded that the high uncertainty associated with these transitions could raise precautionary saving and, thus, persistently depress aggregate demand. In a context of persistently weak demand and economic growth, firms could choose not to pass through changes in costs to final prices but, instead, to absorb them via changes in mark-ups.

Finally, following a transition in which there is less dependency on foreign inputs and on fossil fuels, inflation volatility may turn out to be lower. Some of the changes brought about by structural forces may ultimately make the economy more resilient to shocks and help cushion inflation volatility. For example, there is a trade-off in reducing geographical diversification as it shields from global shocks (De Soyres and Franco, 2019) but results in higher reliance on fewer partners (Borin et al., 2021). More closed economies lose the benefits of diversification (Caselli et al., 2020), which may increase inflation volatility. The IRC taskforce on fragmentation (2024) suggests that in a fragmented world economy with reduced geographical

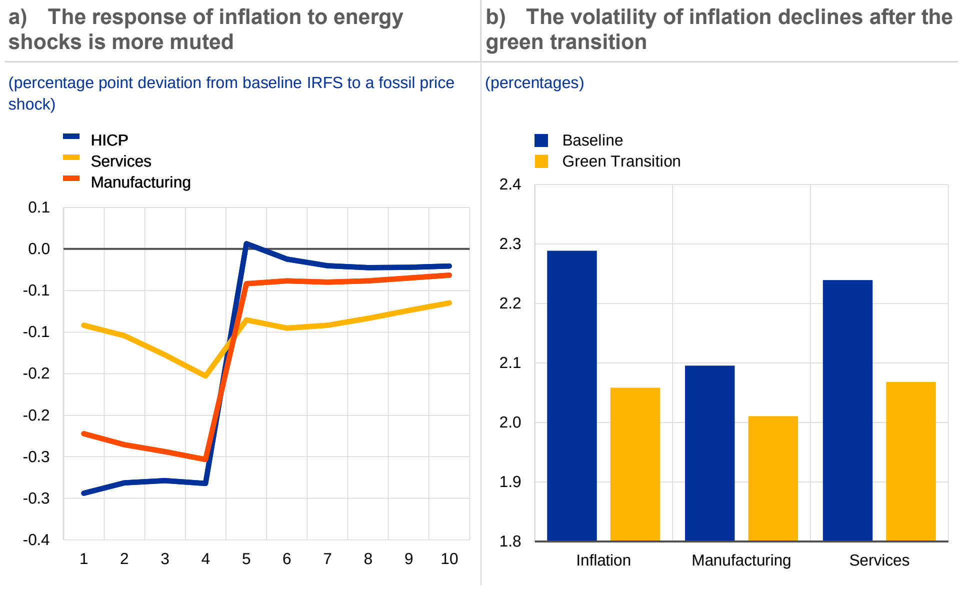
[91] Adams et al. (2024) document a steep rise in the pricing for the adoption of AI, which we might interpret as an investment in price flexibility.

[92] In the model, heterogeneous firms face more volatile idiosyncratic shocks, which reflect an increase in uncertainty. Firms are atomic, therefore the idiosyncratic shocks do not have a direct aggregate impact. However, the increased uncertainty changes the pricing frequency of the firms and therefore the response of the economy to aggregate shocks.

diversification, the idiosyncratic price shocks have a greater impact on firms with a less diversified supplier base, which, in turn, entails higher inflation volatility. At the same time, less dependence on foreign suppliers can insulate from foreign shocks, particularly if foreign suppliers become more volatile and less reliable in an uncertain environment. Kopytov et al. (2024), show that in a macroeconomic model with endogenous networks, producers would prefer to buy from more stable suppliers and that the reorganisation of the network tends to reduce macroeconomic volatility as fragmentation reduces the steps in the production chain and the amplification of shocks via production networks. Similarly, the green transition could ultimately dampen inflation volatility. By reducing the reliance of the services and manufacturing sectors on energy, the sensitivity of consumer prices to gyrations in the prices of energy commodities would also fall (**Chart 29**, panel a). An increase in the share of renewable energy makes the economy less vulnerable to shocks in international prices of carbon-intensive energy inputs, as energy is now produced domestically. This could reduce the volatility induced by external shocks (Hurtado and Dominguez, 2025). Model-based simulations (Chafwehe et al., 2025) suggest that, in an environment in which the share of fossil energy is 50% lower than under the baseline, inflation volatility will decrease. While both the services and manufacturing sectors benefit, it is particularly the energy-intensive industrial sectors for which volatility is reduced (**Chart 29**, panel b).

Chart 29

Change in inflation volatility and transmission of shocks after the green transition



Source: Chafwehe et al. (2025).
Notes: The green transition is modelled as an environment where the share of dirty energy is 50% lower (35%) and the elasticity of substitution between dirty and clean energy is 50% higher (3.6). A green transition lowers inflation volatility by reducing the reliance of the services and manufacturing sectors on energy. The inflationary consequences of a fossil price shock are also lower. As manufacturing relies more on (dirty) energy, the inflationary response after a green transition is relatively weaker.

3.4 Potential consequences of structural trends on relative price changes

Long-term structural drivers can lead to persistent deviations in relative prices, with relevant implications for monetary policy. Gaps between inflation rates across items can, for instance, reflect differences in sectoral demand, productivity, or the speed of adjustment to shocks, and they do not necessarily pose a challenge to achieving the inflation target. Yet trends in relative prices are informative for the likely persistence of a shock and for gauging the impact of secular forces on inflation. Indeed, sectoral dynamics can affect aggregate inflation, given differences in sectoral price rigidities, pervasive downward nominal rigidities and lags in the transmission of monetary policy (see Lane, 2024; Ball and Mankiw, 1995; Afrouzi et al., 2024).

Relative price changes diverged from previous long-term dynamics in the years after the strategy review in 2021. **Chart 30** plots relative price movements, with each sectoral price depicted in relative terms to the overall HICP price level. Pre-pandemic trends show a strong cumulative increase in the relative price of energy, a fall in the relative price of non-energy industrial goods, a mild upward trend in the relative price of food and only a small cumulative increase for services (Lane, 2022).[93] Some of these steady patterns changed since the last strategy review, reflecting the sectoral dislocations associated with the pandemic and the large energy shock. Energy and food price dynamics continued to outpace headline inflation, but relative price changes were more pronounced. Shocks to the energy sector widened relative price divergence as they then gradually fed through to other sectors (see **Chapter 2** for a more detailed discussion). Notably, the price of goods surged relative to services between 2020 and 2021, diverging from the previous trend in which services prices outpaced goods prices. Despite the large sectoral dislocations of the last few years, there is evidence that some of the outstanding gaps between relative prices are converging towards pre-pandemic levels (**Chart 31**). The gap vis-a-vis the long-term trend of relative prices in services versus goods has closed considerably as the pandemic shock has unwound. The gap between energy and non-energy prices has also narrowed. Food prices, on the other hand, are more persistently above general price levels, although in terms of growth rates the inflation rate of food items has moved towards that of non-food items.[94] The following paragraphs explore the factors driving the developments shown in **Chart 30**.

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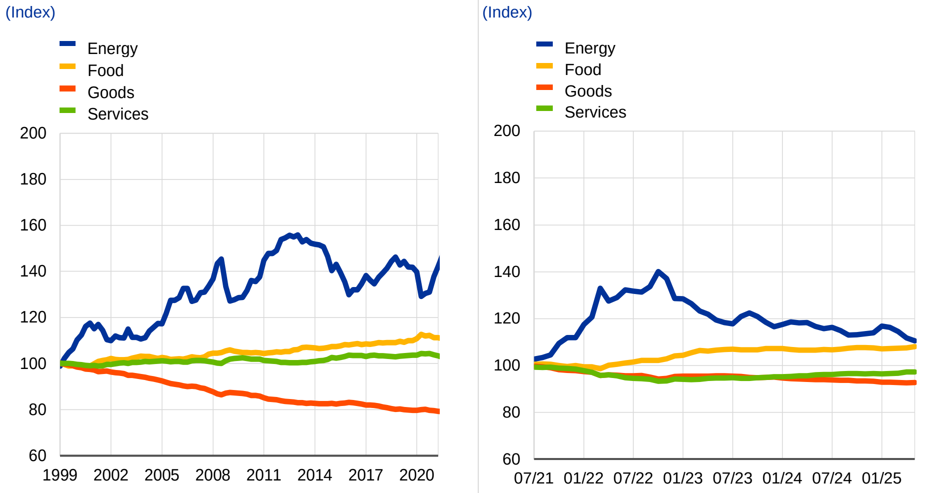
93 Developments in services are close to total inflation because of their high weight in the consumption basket and because the increase in food and energy were offset by non-energy industriali goods (NEIG), meaning that the overall price trend tracked services inflation closely.

94 In general, the gap between inflation rates across items was found to have a tendency to return to a “constant equilibrium value” in the long run (see Peach et al., 2004 for the United States and Amatyakul, 2024 for the euro area).

Chart 30

Price developments relative to HICP for different subcomponents

a) Until previous strategy review (index: 1998Q4=100) | b) Since previous strategy review (index: 2021 July=100)



Source: Eurostat.
Notes: Seasonally adjusted data for HICP, food, goods and services. Seasonally adjusted series for energy are not available. The goods category here only includes non-energy industrial goods (NEIG). The latest observations are for the second quarter of 2021 for panel a) and May 2025 for panel b).

Several structural factors linked to income, productivity and demographics are driving relative price movements in services inflation. In the long term, as income and the standard of living increase, people tend to shift their consumption towards services, which can lead to higher price pressures in that sector. Moreover, the price elasticity of demand for services is lower as consumers become more wealthy (Marto, 2024). At the same time, services generally benefit less from dampening price effects of productivity increases than goods (Baumol and Bowen, 1966). Demographics can also play a role: empirical evidence suggests that consumption baskets shift as populations age, with demand for services rising.[95] Looking ahead, it seems likely that demographic trends could continue to increase demand for services and push up prices by affecting wage growth in the comparatively high labour-intensive services sector. For this reason, the dynamics since the last strategy review in which goods exceeded services inflation are unlikely to persist. Indeed, recent developments show that the pre-pandemic trends are becoming reestablished (**Chart 31**).

Structural trends underlying goods prices relate to goods being typically more tradable and therefore subject to broader competitive price pressures. The negative trend in the relative price of non-energy industrial goods has long been understood as connected to the superior productivity performance of the manufacturing sector as compared with other sectors (Glejser, 1965). Global competition and lower production costs abroad will be a strong determinant of

95 There is substantial empirical evidence indicating that older individuals have different consumption patterns as compared with younger generations. On average, older age groups allocate a relatively larger share of their spending to services, particularly healthcare, long-term care, and housing-related expenses such as utilities and maintenance. By contrast, they tend to spend less on transportation, durable goods, and clothing than younger cohorts.

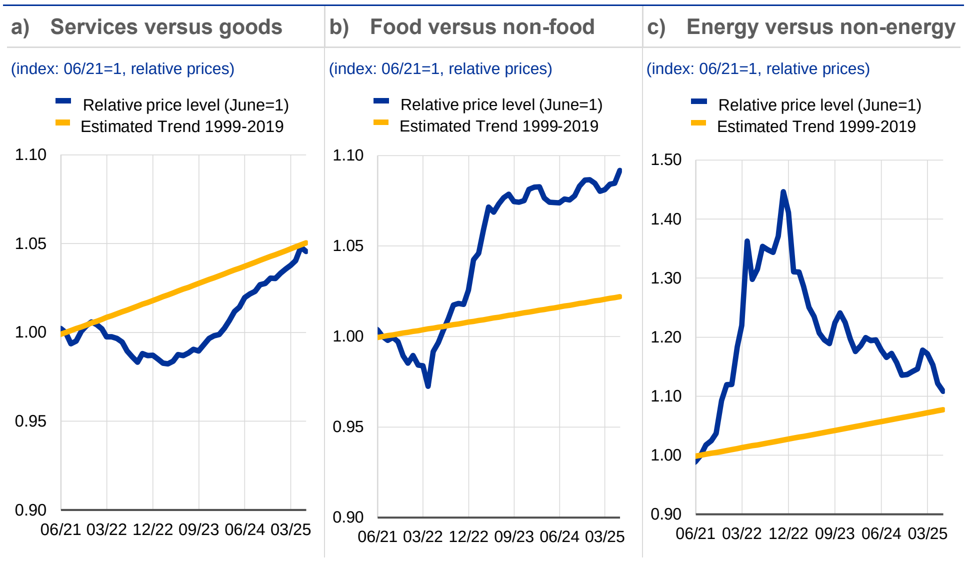
tradable goods prices in an open economy, because excess demand for goods can be absorbed by higher imports, thereby limiting price increases (Balassa, 1964; and Samuelson, 1964). Looking ahead, unfolding structural trends could have opposing impacts on goods inflation. Deglobalisation due to geopolitical and trade fragmentation could push up the prices of tradable goods (see **Section 3.3**). Digitalisation and developments in AI could affect services and goods prices differently, as shown by Gazzani and Natoli (2024) for the United States, with a negative impact on goods inflation. However, the extent of their effect remains uncertain and depends on how quickly these technologies are adopted in the production process. Climate change and its mitigation measures could also impact goods and services prices to different extents, both via exposure to sector specific consequences of climate change or via exposure to sector specific mitigation policies as for instance in the energy transition involving higher carbon taxes (Parker, 2018; Kuik et al., 2023).

Structural drivers affecting food inflation are both global and domestic in nature. Global agricultural commodities have been impacted in the long term by rising global incomes, which has created inflationary pressures on food in the euro area. At the same time, trend productivity growth in agriculture tends to be lower than in other sectors, which, according to the Baumol effect, is inflationary. Looking ahead, extreme weather events, and the unfolding climate crisis more broadly, could drive up food prices. For instance, using projections from state-of-the-art climate models, Kotz et al. (2024) estimate that global warming will cause global increases in annual food inflation of between 0.9 and 3.2 percentage points per year by 2035. Since the last strategy review, the increase in food prices has continued to be stronger than the increase in the general price level. Shocks linked to rising geopolitical tensions or extreme weather events have pushed prices higher over the period (see **Chapter 2** for a more detailed discussion).

Notwithstanding large cyclical swings, there are also long-term determinants when it comes to energy prices. Global factors play a larger role in determining prices in the energy component compared with other HICP items and, as global energy consumption is rising (especially in developing economies) prices are pushed up amid supply constraints. Also, the green transition is likely to pose some upward pressure on energy prices until technological advancements pay off (Andersson et al., 2025). The rapid development of AI, which relies on energy intensive data centres, may pose structurally higher demands on energy.

Chart 31

Development of relative prices



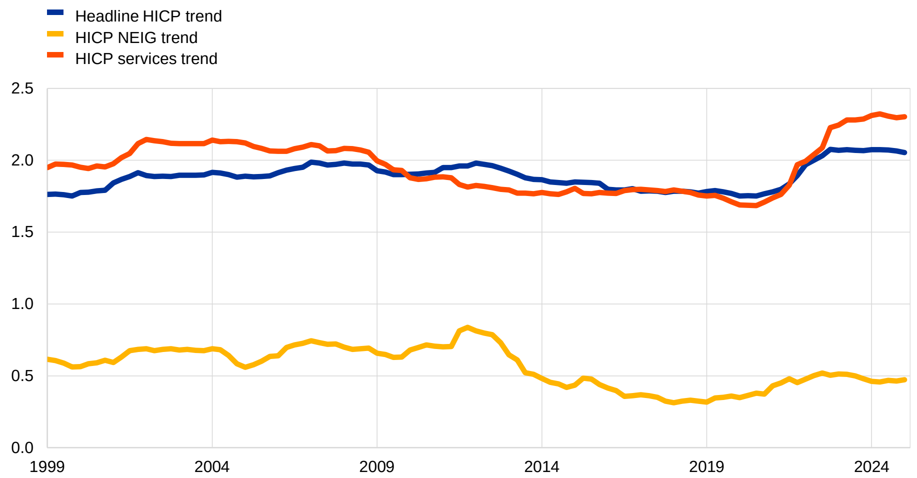
Source: Eurostat.
Notes: Seasonally adjusted data for HICP, food, goods and services. Seasonally adjusted series for energy are not available. The goods category here only includes non-energy industrial goods (NEIG). The latest observations are for May 2025.

The structural drivers of relative prices generate differences in inflation trends across components, which are not necessarily incompatible with the trend in total inflation at the target. There are considerable differences between trends in inflation components – the trend in services inflation seems to lie considerably above the trend in goods inflation and it also exhibits some increase since the previous strategy review (**Chart 32**). This can reflect structural shifts in preferences by consumers, but given the unprecedented nature of the sectoral dislocations over this period, caution is needed when distinguishing between permanent or persistent but still temporary shifts.

Chart 32

Estimated sectoral trend inflation

(annual percentage changes)



Sources: Eurostat, ECB projections data base and ECB staff calculations.
Notes: Estimated trends from a Bayesian VAR with HICP energy, unprocessed and processed food, NEIG and services. The weighted average of the trends in HICP components is assumed to be equal to the five-year-ahead inflation expectations from the SPF (up to a measurement error), see Banbura et al (2025). The latest observations are for the first quarter of 2025.

Overall, if structural factors are responsible for larger and more frequent shocks, greater inflation variability is also likely to go hand-in-hand with increased divergence in relative prices. In a fragmenting trading system, sector-specific or product-specific supply shocks risk becoming more frequent, resulting in greater variation in inflation across the components of the price basket. Green transition policies are also likely to impact sectors differently: agriculture and tourism are highly exposed to climate change and several of the high-emission sectors (such as agriculture, steel, cement and air transport) are vulnerable to higher carbon prices during the transition. Productivity shocks in these sectors as they adjust may drive divergences in relative prices. The nature of the shocks hitting the euro area may also affect the degree of heterogeneity in inflation.

3.5 The interaction of wages, productivity, profits and prices in a changing economy

The interaction between wages, productivity[96], profits and prices is a key determinant of how different shocks transmit to domestic inflation. The mechanisms that govern this interaction can themselves be considered a structural characteristic of the economy. But they are, in turn, also influenced by structural changes in the economy, including globalisation, digitalisation, or demographics. Labour market institutions and their changes over time play an important role in the

[96] For a discussion of productivity developments in the euro area see for example: Lopez-Garcia, P. et al (2024): “The impact of recent shocks and ongoing structural changes on euro area productivity growth” Economic Bulletin, Issue 2, ECB, 2024.

interaction mechanisms as they shape the relative adjustment of prices versus quantities or of labour versus capital remuneration in response to shocks.

The economy's reaction to a large-scale terms-of-trade shocks depends on the interaction of wages, productivity and profits and can change over time. Such large-scale shocks have been rare and were last observed in the 1970s. When comparing the reaction of domestic price pressures (via the GDP deflator)[97] following the deterioration of the terms of trade after the second quarter of 2021 with the deterioration triggered by the even larger shock resulting from the OPEC oil embargo after the fourth quarter of 1973, it can be seen that there is a more moderate reaction after 2021 (**Chart 33**, panel a). This was due especially to a weaker reaction of nominal and real wage growth: while real consumer wage growth, measured by nominal wages per employed person divided by the private consumption deflator, strongly increased after the terms of trade shock in 1973, real wages decreased in the euro area after the terms of trade shock in 2021 (Battistini et al., 2022). These differences point to changes in the interaction of wages, productivity and profits, as both episodes started from relatively low unemployment rates. There are a number of structural and institutional differences that explain the disparate economic reaction in the recent period. While collective bargaining coverage remains very high in the euro area,[98] labour relations have evolved and wage indexation is no longer a prominent feature of euro area labour markets and central banks in advanced economies now have clear mandates for price stability, expressed as an explicit inflation target.

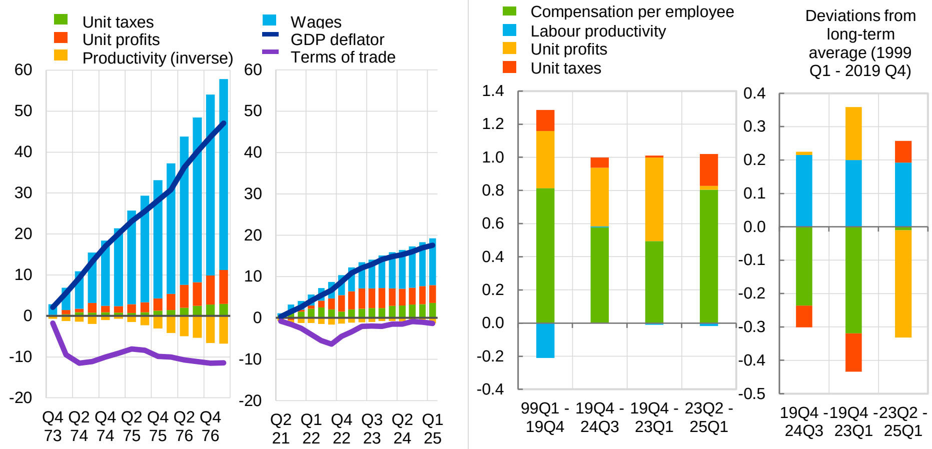
97 The interaction of wages, profits and productivity and their contribution to domestic price pressures in the euro area can be assessed based on the GDP deflator. The GDP deflator can be broken down into unit profits (gross operating surplus per unit of real GDP), unit labour costs (compensation of employees per unit of real GDP) and unit taxes (which reflect taxes on production net of subsidies per unit of real GDP). The contribution of unit labour costs results from the contribution of wage growth and productivity growth, which can be displayed separately.

98 See Gornicka and Koester eds., 2024.

Chart 33

Interaction of wages, profits, productivity and prices

a) GDP deflator: a comparison between the effects of terms of trade shocks in the 1970s and the recent period	b) GDP deflator: recent developments in perspective
(cumulated changes in percentage points)	(left-hand side: relative contributions of components of the GDP deflator; right-hand side: average deviations from long-term average (1999Q1 to 2019Q4) in percentage points)



Sources: Panel a) Eurostat, ECB area-wide model database and ECB staff calculations. Panel b) left-hand side: Eurostat, ECB area-wide model database and ECB staff calculations; right-hand side: Eurostat and ECB staff calculations.
Notes: Panel a): The terms of trade reflect cumulated changes in export over import deflators. See: Wage share dynamics and second-round effects on inflation after energy price surges in the 1970s and today (Battistini et al., 2022). Panel b): For reasons of additivity, the contribution of labour productivity is derived as the residual between the contributions from unit labour costs and compensation per employee. The latest observations are for the first quarter of 2025.

While the impact of supply-shocks on inflation is typically buffered by adjustments in profit margins, the recent period saw some change in this phenomenon. The buffering role of profits in reaction to supply shocks is a feature of ECB structural workhorse models, which is anchored in past empirical regularities. However, in the recent inflation surge, rather than buffering, unit profits reacted quickly and accounted for the bulk of the growth in the GDP deflator around its peak in the first quarter of 2023 (**Chart 33**, panel b). By contrast, the contribution of wages was substantially below its historical average in the phase of building up domestic price pressures and reached its historical average only in the period between the second quarter of 2023 to the first quarter of 2025 (disinflation phase), at which point the buffering role played by profits emerged. Productivity0 developments remained lower than historical averages over this period and contributed to higher price pressures. These patterns do not necessarily reflect an underlying structural change in the interaction of wages, profits, productivity and prices, but need to be seen in the specific context of the pandemic and energy crises.[99]C On the firm side, the confluence, size and duration of the shocks incentivised more frequent price changes (see **Box 2**) and as demand held up even in the face of higher prices, firms did not need to squeeze their profits in response to cost-push shocks. On the worker side, wage bargaining rigidities, government measures including job retention schemes (that cushioned the effects of low productivity on wage costs and delayed

[99] See for a discussion also “Inflation and wage dynamics through the lens of a DSGE model with labour market frictions” by P. Juvonen, J. Nelimarkka, M. Obstbaum, L. Vilmi (mimeo – BoF), which is also discussed in chapter 4.

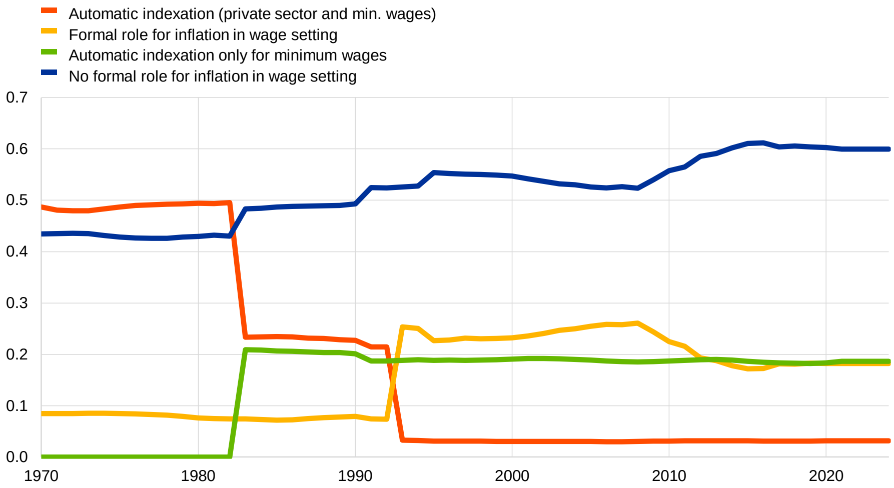
wage demands), and energy-related transfers delayed the quick restoration of real incomes via higher wages.

The risk of wage price spirals in the recent inflation surge was contained by a solid anchoring of inflation expectations combined with an only limited role of wage indexation. By contrast with the 1970s, economic agents can nowadays rely on monetary policy pursuing medium-term inflation targets which provides boundaries for the implications of collective wage and price setting on inflation developments (**Chart 34**). In the 1970s, the absence of such targeting was aggravated by the prevalence of wage indexation to inflation in many euro area countries. This institutional feature was substantially reduced after the experience of wage price spirals from a full and automatic indexation for more than 50% of the private sector employees in the 1970s to a negligible feature by the introduction of the euro (Koester and Grapow, 2021).

Chart 34

Wage indexation in the euro area

(share of total private sector employees in the euro area in percentages)

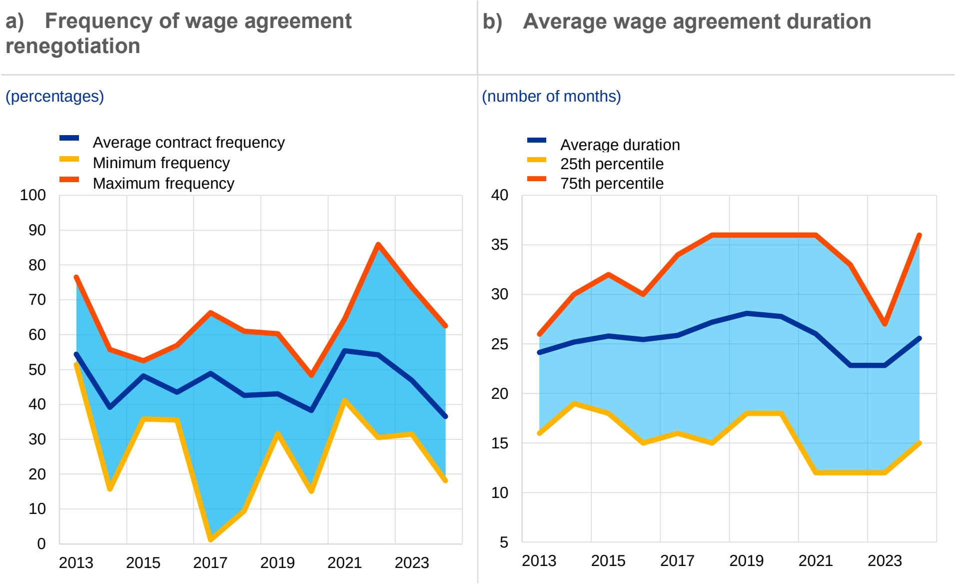


Source: Koester and Grapow (2021).
Note: The euro area changing composition uses the euro area 12 until 2006 and then adds countries according to their joining date, adjusting the weighting accordingly.

The diverging frequencies of price and wage setting after the exceptional energy price shock in 2021 and 2022 help to understand the pattern in profit and wage contributions (Botelho et al., 2025). While the frequency of price changes increased substantially and amplified the reaction of prices to the supply shock (see **Section 3.3** and **Box 2**), micro data on wage agreements from the wage tracker database point to an only very limited change in the frequency of contract renegotiations and average wage agreement durations (**Chart 35**). In a period of rapidly rising input costs and uncertainty about the duration of the cost surge, fast selling price adjustments and suspended buffering can create a self-sustained process through herd behaviour. On wages side, the government support initially limited the need for more frequent wage renegotiations and shorter than usual contract durations. These different reaction patterns implied corresponding movements in the profit and wage shares, with the latter first declining and only at a later stage recovering.

Chart 35

Frequency of wage agreement renegotiations and average wage agreement durations – insights from the wage tracker



Sources: Wage tracker calculated based on micro data on wage agreements provided by the Deutsche Bundesbank, the Banco de España, the Dutch employer association (AWVN), the Oesterreichische Nationalbank, the Bank of Greece, the Banca d'Italia, and the Banque de France.
Notes: The frequency of contract renegotiation is calculated as the share of wage agreements renegotiated in each year weighted by the number of workers covered. The light blue area shows the minimum-maximum range based on country estimates. The average of wage agreement renegotiation is the weighted average duration of individual wage agreements, and the light blue area shows the range between the 25th and 75th percentile based on the individual wage agreements. For details see Botelho et at. (2025).

Wage setting features do not seem to have changed significantly as a result of the recent inflation surge. Unions have voiced demands to strengthen the indexation of wages to inflation in some euro area countries, but so far this has not led to any substantial institutional change in the wage setting process, as illustrated in **Chart 34**. Moreover, in some countries, such as Germany wage increases to compensate for high inflation have often been passed on to workers in the form of larger than usual one-off payments rather than permanent and dynamised increases in base wage rates (**Chart 36**, panel a). This introduces an element of flexibility in the wage-setting process, reducing the risk of second-round effects and of painful adjustments of wage pressures by shedding employment (see also the discussion in Consolo et al., 2021). At the same time, the government-controlled instrument of minimum wages can be a source of dynamic wage growth. The pressure to maintain purchasing power in the face of large inflation shocks is largest for low wage earners and in some countries such as France there is even a formal indexation of minimum wage growth to consumer price inflation (Dreher et al., 2019; Koester and Grapow, 2021; Koester and Wittekopf, 2022). This can trigger second-round effects on the distribution of wages through wage floor effects, with workers pushing for stronger wage increases to keep their relative distance to minimum wages.[100]

[100] See e.g. Gautier, E., Fougère, D., & Roux, S. (2016). The impact of the national minimum wage on industry-level wage bargaining in France.

Since the last strategy review there has been a stark decoupling of growth and employment from the Okun's law relationship (see **Chapter 2**). This has further exacerbated the procyclicality of labour productivity and its contribution to unit labour costs, which reflects, among other things, the impact of labour market policies, such as employment protection, job retention schemes, and working time accounts, which incentivise firms to adjust the number of hours worked per employee rather than making changes to the workforce (Lewis and Villa, 2023). These policies dampened productivity growth more than would have been the case in a normal cyclical fluctuation.[101] During the post-pandemic period, a decrease in the relative price of labour, labour shortages and an ageing workforce were additional special reasons for not dismissing workers.[102] Higher profit margins and lower real wages enabled firms to digest the costs of lower productivity growth (Consolo and Foroni, 2024). Increased labour force participation helped alleviate potential labour shortages, but these increasingly came at a lower intensive margin in terms of reduced average hours worked.[103]

Chart 36

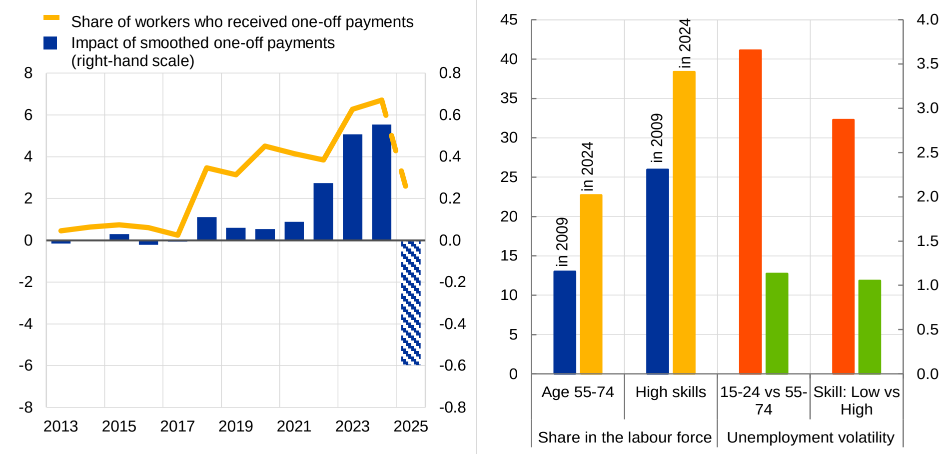
Role of one-off payments and secular factors affecting the cyclicality of labour productivity

a) Impact and share of workers affected by one-off payments

(percentages and percentage points)

b) Ageing and upskilling of the labour force and the cyclicality of labour productivity

(left-hand scale: share in the labour force in %; right-hand scale unemployment volatility coefficient)



Sources: Eurostat, Eurosystem and ECB calculations.
Notes: Panel a): The impact of smoothed one-offs is the difference between the ECB wage tracker, including smoothed one-off payments and the ECB wage tracker excluding one-off payments. Panel b): Ageing and digitalisation trends are captured by an increase in the cohorts of elderly and high-skilled workers. Unemployment rates for these two groups are less volatile and their respective Okun's elasticities suggest that they are likely to make employment adjustment stickier at times of output fluctuations.

Structural trends such as ageing and the upskilling of the labour force can make employment less cyclical, thereby making productivity growth more cyclical in the future. The importance of labour hoarding and therefore decoupling

[101] The number of euro area workers in job retention schemes was substantial and reached levels of 1/3 of all employees in some euro area countries (see Chart 4 in Botelho et al. (2021)). As a result, job retention schemes across euro area countries had a significant impact of wages and disposable income (see Dias da Silva et al. (2020)).

[102] See Consolo et al. (2024) for firms evidence on the rationale for labour hoarding.

[103] See Berson and Botelho (2023) for a characterisation of the key adjustment in the labour force.

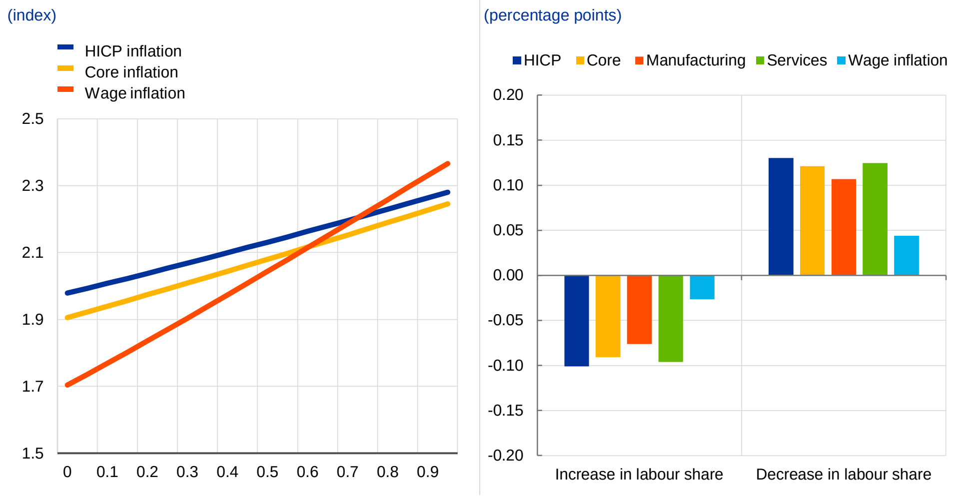
from Okun's law might hence become even more pronounced in the future (**Chart 36**, panel b). A higher resilience of the labour market is not only likely to become a more regular feature during downturns triggered by large negative supply shocks but possibly also during those triggered by negative demand shocks. However, in the case of downward demand shocks there might at least be some balancing between lower productivity growth and more moderate wage demands, helping to contain inflationary pressures. The historical regularity in many models by which excessive wage increases trigger counter reactions in terms of higher productivity growth via employment shedding may therefore not continue with the same intensity as in the past. Factor substitution alleviating labour supply constraints via more structural increases in productivity requires investment in capital and innovation and may only be triggered by the necessary changes in relative prices and bargaining power in the case of very large shocks (see **Section 3.3**).

Chart 37

Model based analysis of the link between wage indexation and the labour share and inflation volatility

a) Wage indexation and inflation volatility

b) Labour share and inflation volatility



Sources: Panel a): Christoffel et al. (2025), mimeo. Panel b): Aguilar et al. (2025) and Kase and Rigato (2025), mimeo.
Notes: Panel a): Changes in inflation volatility after variations in the degree of wage indexation. Sectoral wages are indexed to the core inflation rate of the previous period. The baseline model assumes a wage indexation coefficient of 0.6. Panel b): Changes in inflation volatility after an increase or a decrease in the labour share of 5 percentage points. in the steady state of the models. The chart shows the average change in volatility across both models.

While the wage bargaining process and the labour share seem to be reverting to the pre-inflation surge situation, model-based analysis may indicate possible implications for inflation stemming from substantial changes in these economic features. One key institutional factor identified for avoiding a wage price spiral in the recent high inflation episode were low and stable levels of wage indexation. However, if structural trends lead to changes in bargaining power, this could, for example, result in a more automatic compensation of inflation via indexation. Even with long-term inflation anchored to 2%, model-based simulations (Christoffel et al., 2025) show that an increase in wage indexation makes marginal costs for firms increase faster after an inflationary shock, leading to further larger increases in prices. This increases wage growth and inflation volatility (**Chart 37**, panel a). Changes in workers' bargaining power, manifesting in the labour share, could emerge, for instance, from automation, AI, or demographic trends. A shift to a more service-and labour intensive economy (partly due to a loss of industrial base because of competitive issues linked to energy prices but also fragmentation) could, for example, imply a general increase in the wage share but not necessarily in the bargaining power and thus the responsiveness of the wage share.[104] Model-based analyses building on Aguilar et al. (2025) and Kase and Rigato (2025) show that a permanent increase or decrease in the labour share of 5 percentage points may have a limited impact on inflation volatility (**Chart 37**, panel b). With a higher labour share, inflation may become even less volatile. This is because with higher wages as a share of output, there is more room to absorb the impact of different shocks, especially supply side shocks, as workers have higher mark-ups which can accommodate the disturbances. Thus, wages may not react as strongly, and the impact on inflation would be smaller. While the differences are small, a permanent decrease in the labour share implies somewhat stronger effects on inflation volatility than an increase after different shocks are realised, reflecting that in this case workers may want to be compensated more after inflationary shocks as they have smaller mark-ups and that there is a higher risk of lower real wages. However, overall, even substantial changes in the labour share way beyond what was observed during and after the pandemic do not seem to be an important source of concern for inflation volatility.

3.6 Developments in r* and its drivers

3.6.1 Empirical estimates of r*

Empirical estimates suggest that the euro area natural (or neutral) interest rate – r* – may have edged up slightly since the MPSR in 2021, but remain at a relatively low level, implying that concerns related to the effective lower bound persist. The natural interest rate – the real interest rate consistent with output being at its potential level and inflation stabilising – can serve as a benchmark to assess the degree of restrictiveness or accommodation of monetary policy, but it is unobservable. Estimates of r* are generally fraught with model-specification and measurement issues and are surrounded by very large statistical uncertainty, including over recent years, when the euro area was hit by unprecedented shocks.[105] Notwithstanding these challenges, empirical estimates suggest that the euro area r* increased from somewhat negative levels before 2020, to slightly positive levels in 2024 (**Chart 38**). However, this pick-up is mostly observed in the more cyclical measures (using market data or semi-structural models) that may reflect the developments in the monetary policy cycle. It is unlikely that slower-moving, structural drivers, together, have raised r* in the past years. Latest available econometric estimates continue to point to a level for r* in the euro area that is

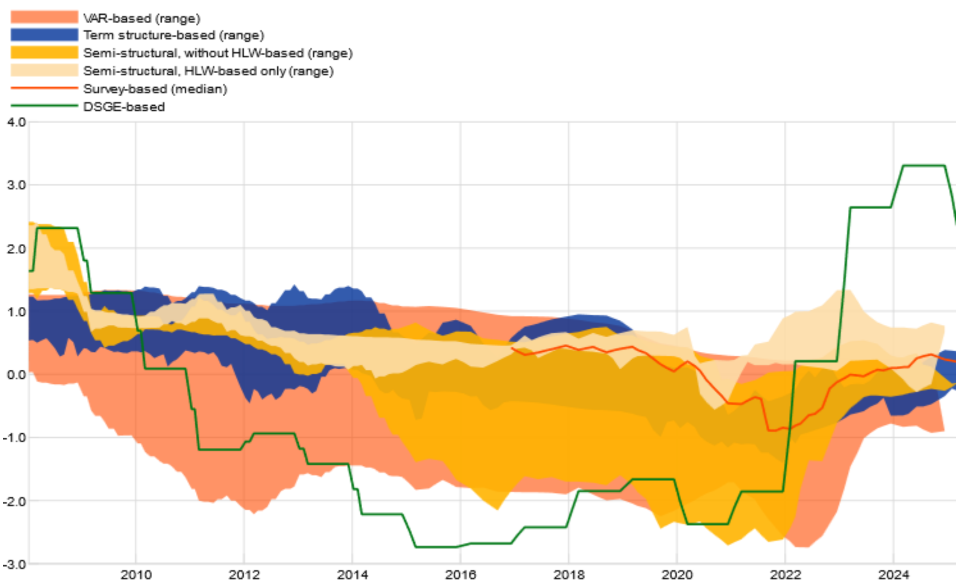
[104] On shifts in the wage and profit share linked to secular factors see for example, the discussion in Kouvavas et al., 2021, Autor et al., 2023 or Ciapanna et al., 2024 and for a discussion of changes in workers' bargaining power, see Lombardi et al., 2023.

[105] For a detailed discussion on the different methodologies and respective conceptual definitions, see Brand et al (2018),

measurably lower than before the global financial crisis. These r* estimates are more consistent with r*-assumptions in the model-based exercises to gauge lower-bound risks conducted as part of the previous strategy review.[106] This result implies lingering risks of interest rates becoming constrained by the effective lower bound again.

Chart 38

Real neutral rates in the euro area



Sources: Eurosystem estimates, ECB calculations, Federal Reserve Bank of New York and Consensus Economics.
Notes: Survey-based estimates include the following: the estimate from the Survey of Monetary Analysts, which is the median of respondents' long run expectations regarding the ECB's deposit facility rate, less expectations of inflation in the long run (starting in the second quarter of 2021); and the Consensus Economics estimate, which is the 10-year ahead expected 3-month interbank rate, less expectations of inflation in the long run. Term structure-based estimates are derived from Geiger and Schupp (2018), Joslin et al. (2011), Ajevskis (2020), Brand et al. (2021). Semi-structural estimates without HLW-based are derived from: Brand and Mazelis (2019), including stochastic volatility in the output gap, a long-term interest rate, asset purchase effects and the effective lower bound), Grosse-Steffen et al. (2024) and Fiorentini et al. (2018). Semi-structural, HLW-based measures are derived from Holston et al. (2023), Carvalho (2023), Kortelainen and Vilmi (2024) and a Berger et al. (2025) multi-country replication of Holston et al. (2023). VAR-based estimates are derived from Goy and Italianer (2024), Battistini et al. (2024), a Deutsche Bundesbank (2025) replication of Del Negro et al. (2017) and a Deutsche Bundesbank (2025) replication of Johannsen and Mertens (2021). One DSGE-based estimate is derived from Gerali and Neri (2019). The latest observations are as follows: Survey-based: all for the first quarter of 2025. Semi-structural HLW-based: Third quarter of 2024 for Holston et al. (2023) and the Bundesbank replication, the fourth quarter of 2024 for all others. Semi-structural without HLW-based: Second quarter of 2024 for Fiorentini et al. (2018), fourth quarter of 2024 for Grosse-Steffen et al., and the first quarter of 2025 for all others. Term structure-based: all for the first quarter of 2025. Structural (DSGE): First quarter of 2025.

3.6.2 Determinants of r*

3.6.2.1 Decomposition of econometric estimates of r* into explanatory factors

The decline in r* since the 1990s across advanced economies can be attributed to factors related to saving-investment decisions and risk-liquidity

[106] See "The ECB's price stability framework: past experience, and current and future challenges", Occasional Paper series, Nº 269, ECB, September 2021. Model-based exercises estimate that, for a r* between 0% and 1%, the probability of hitting the effective lower bound stands between 30% and 19%.

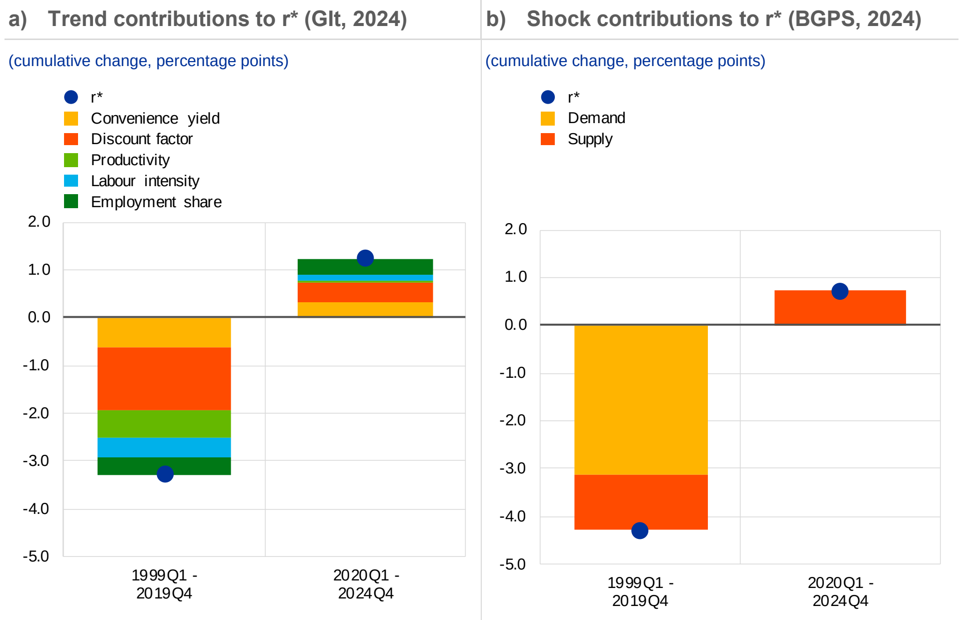
conditions. The vast literature largely attributes the decline in r* to structural drivers of saving-investment decisions, such as slower productivity growth and demographic aging (Cesa-Bianchi et al., 2023; Obstfeld, 2023), as well as rising income inequality (Platzer and Peruffo, 2022), with rising public debt ratios only partially mitigating the decline (Rachel and Summers, 2019). Other key factors reflect risk and liquidity aspects related to asset supply and demand, such as rising risk aversion and decreasing discount rates, which induced a relative scarcity of safe assets (Caballero et al., 2017; Farhi and Gourio, 2018). All these factors feature significant global co-movements (Del Negro et al., 2019; Ferreira and Shousha, 2023).

Empirical models suggest that the decline in r* between the introduction of the euro and the start of the pandemic increasingly reflected downward pressures stemming from financial factors and weakening demand, which only partly reverted after the pandemic. In the absence of an all-encompassing framework (Blanchard, 2019), recent empirical models combine semi-structural approaches similar to Holston et al. (2017) with trend-cycle decompositions in the spirit of Del Negro et al. (2017) to disentangle a limited number of drivers. Focussing on the contributions from trends linked to observable variables – such as Berger et al. (2025) and Bundesbank (2024) – Goy and Italianer (2024) indicate a rising relevance of financial factors, such as the convenience yield and discount rates, in the decline of r* between 1999 and 2019 (**Chart 39**, panel a). Disentangling the impact from identified shocks proxying underlying forces, Battistini et al. (2024) consistently point to a prominent contribution from weakening demand to the decline of r*, with a smaller role for supply shocks, over the same period (**Chart 39**, panel b), in line with evidence from structural models such as Neri and Gerali (2019). The slight pick-up in r* in the wake of the pandemic reflects a combination of factors, also stemming from a partial reversal of financial and supply factors.

Demonstrating clear-cut empirical evidence in support of structural drivers behind r* is challenging and may even be convoluted by policy-endogenous effects. Results using country panel data can vary, depending on the proxies chosen. While in country-panel regressions Carvalho et al. (2025) find empirical evidence in support of life expectancy, working age population growth, government debt, pension spending and financial factors affecting r*, as expected, Borio et al. (2022) find little evidence of a role for the most commonly considered savings- and investment-related variables. Instead, like Rogoff et al. (2022) they identify some degree of endogeneity of r* to monetary factors. Overall, the differences in these findings are indicative of the econometric challenges of identifying an empirical impact from fundamental drivers that move slowly in general and comove significantly across countries, as was highlighted by Kiley (2020). The latter challenge applies even more if one accounts for the possibility that monetary and fiscal policies may also be important drivers of r*, as in Benigno et al. (2024); see also **Section 1.2.3**.

Chart 39

Historical decomposition of r* according to different models



Sources: Eurosystem estimates, ECB calculations
Notes: In panel a), the model extends the framework by Del Negro et al. (2017) allowing for further drivers of r* according to an augmented Euler equation (Goy and Italianer, GIt, 2024). The model is estimated on euro area data for nominal short and long-term risk-free rates, HICP inflation, long-run inflation expectations, non-financial credit yield, productivity per hour, average hours worked and employment share of population between the first quarter of 1999 and the fourth quarter of 2024. r* is calculated as the trend nominal short-term rate minus the trend HICP inflation. In panel b), the model extends the framework by Del Negro et al. (2017) allowing for time variation in parameters and volatilities and the identification of shocks through sign restrictions, also correcting for outliers (Battistini, Gareis, Pinilla-Torremocha and Stoevsky, BGPS, 2024). The model is estimated on euro area data for real GDP, HICP inflation, unemployment rate and short-term nominal risk-free rate between the first quarter of 1980 and the fourth quarter of 2024. r* is calculated as the trend nominal short-term interest rate minus the trend HICP inflation.

3.6.2.2 Demographics as a slow-moving driver of r*

The global demographic transition towards an older population tends to exert a downward impact on r* and this factor is likely to continue having a dampening effect in the years ahead. In the case of the euro area, the old age dependency ratio (ratio of individuals aged 65 or older over individuals aged 20 to 64) increased from 24% to 39% between 1980 and 2024 and is predicted to increase further to 61% by 2050, roughly in line with the median for OECD economies.[107] These developments result from both lower mortality and fertility rates and, by affecting capital supply and demand, tend to exert a downward pressure on r*. On the one hand, increased life expectancy incentivises households to save more to smooth consumption over their longer retirement, thereby raising capital supply. On the other hand, the growing scarcity of the effective labour force induces firms to adjust their investment, thereby depressing capital demand.[108] Both factors tend to

[107] See United Nations (2024) medium variant projections.

[108] This downward impact on capital demand occurs in the empirically relevant case of complementarity between labour and capital. This impact might be dampened if, for example, capital and labour are sufficiently substitutable to foster the adoption of automation technology (Basso and Jimeno, 2021; Acemoglu and Restrepo, 2022) or the increasing scarcity of labour is compensated by human capital formation (Ludwig et al., 2012).

depress r*.[109] Such a downward impact on r* was initially considered small and not visible enough within the time horizon relevant for monetary policymaking.[110] However, recent literature has recognised demographic change as a key driver of the downward trend in observed real interest rates since the 1980s, contributing to maintain an environment of a chronically binding effective lower bound on the short-term nominal interest rate.[111]

The demographic transition may explain a decline of around 1.5 percentage points since the mid-1980s and this trend is set to continue (**Chart 40**).[112] The main demographic driver of downward pressure on r* is longer life expectancy, as its permanent rise increases the overall willingness to save for the foreseeable future. Although ageing individuals might dissave to finance consumption during retirement, bequest and precautionary saving motives combined with general equilibrium forces imply that the high stock of accumulated wealth relative to income depresses r*.[113] From this perspective, the retirement of the baby-boomers is only a transitory phenomenon, not material enough to counteract the effect of longer life expectancy.

A variety of factors can further strengthen the downward impact of the demographic transition on r*. Looking ahead, additional dampening effects on r* might occur, for instance, from the phasing-out of pay-as-you-go pension systems, thus incentivising private savings, and from population aging in the rest of the world depending on the degree of financial openness.[114] For instance, assuming no financial integration of emerging economies, as in Lisack et al. (2021), the dampening impact from demographics would plateau past 2030, as advanced economies' aging trend is then expected to slow down. In an integrated global capital market as in Papetti (2021b), the rapid aging of two large countries such as China and India, could explain a stronger, continued downward pressure on r*, as these two countries keep aging well beyond 2050, pushing up the overall willingness to save already over 2025-2050 (**Chart 40**). Greater substitutability between labour and capital, higher intertemporal elasticity of substitution in consumption, higher productivity and labour market participation by relatively older individuals, compared with commonly estimated values, are generally deemed to only partially mitigate this decline in r*.[115] Finally migration of younger-age cohort workers into advanced-economy labour forces are unlikely to have measurable effects on r*, on account of financial integration (r* being determined globally) and because, at the global level, ageing follows broadly similar trends (Bárány et al., 2023).

[109] For a review, see Lee (2016).

[110] See Miles (2002), Mojon, (2002), Bean (2004), Krueger and Ludwig (2007), Kara and von Thadden (2010).

[111] See Eggertsson et al. (2019).

[112] See Bielecki et al. (2020), Lisack et al. (2021) and Papetti (2021a).

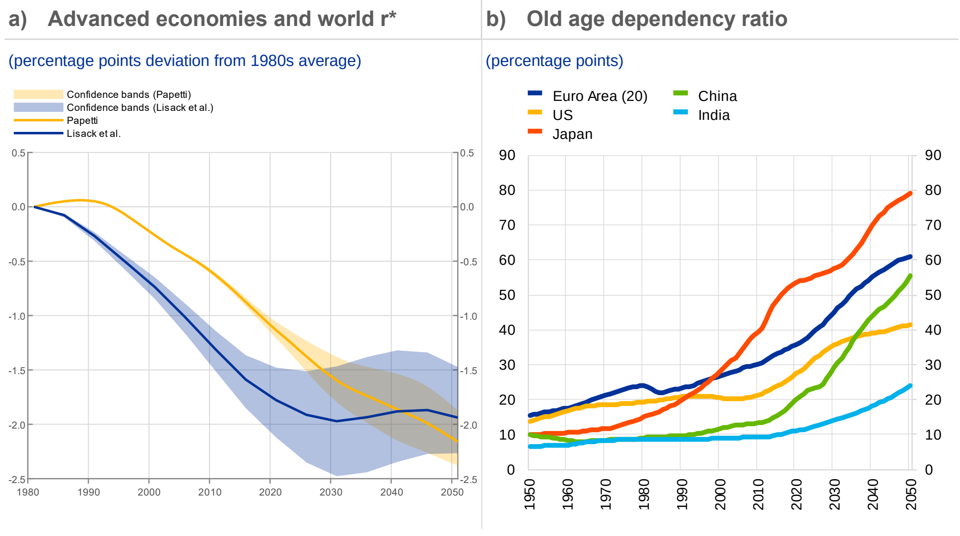
[113] On the relevance of dissaving, see Goodhart and Pradhan (2020); Mian et al. (2021); on the prevalence of general equilibrium effects, see Lisack et al. (2021), Auclert et al. (2021), Blanchard (2023).

[114] See Papetti (2021b), Carvalho et al. (2025).

[115] See Papetti (2021a).

Chart 40

The impact of demographic change on r* based on overlapping generations models



Sources: Papetti (2021b); Lisack et al. (2021), United Nations World Population Prospects 2024.
Notes: Demographic projections from United Nations (2024). The solid lines show results of the medium variant of the projections. Shaded areas show the rang of results using the lower 95 percentile and upper 95 percentile of the probabilistic projections. Countries included in Papetti (2021b): Austria, Belgium, Germany, Spain, Finland, France, Ireland, Italy, Netherlands, Australia, Canada, China, Denmark, United Kingdom, India, Japan, Sweden, United States. Countries included in Lisack et al. (2021): Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK, Australia, Canada, Japan, New Zealand, United States. The old age dependency ratio is defined as the ratio of individuals aged 65 or older over individuals aged 20 to 64.

3.6.2.3 Policy-endogenous drivers of r*

Some commentators have suggested that monetary policy may also affect r*. Hillenbrand (2025) suggests that the past decline in r* may have been due to monetary policy easing, i.e. suggesting that r* responds to monetary policy in a manner that undermines its effectiveness. At the same time, recent empirical analysis indicates that monetary policy shocks can significantly affect the level of r*. **Chart 41** highlights the endogenous accumulated impact of monetary policy shocks on r* over the past 20 years, with a substantial effect beginning with the onset of the global financial crisis in 2008 and persisting until 2016. Although this influence has gradually diminished since then, it remains notable to the present time. Specifically, tighter (looser) monetary policy is estimated to exert downward (upward) pressure on r* estimates. This relationship can be observed, for example, between 2009 and 2012, when r* is estimated to have fallen strongly in the wake of the global financial crisis.[116]

One potential channel of influence on r* is through the impact of monetary policy on total factor productivity growth.[117] Monetary policy affects demand as

[116] These estimates are based on a vector autoregression model with drifting parameters that are allowed to be sensitive to monetary policy shocks. The model simultaneously estimates (i) a measure of r*, (ii) the monetary policy shocks, and (iii) the relationship between the two by employing information on interest rates and inflation. These estimates suggest that a 100-basis point unexpected increase in the policy rate is associated with a 1 basis point contemporaneous decline in r*.

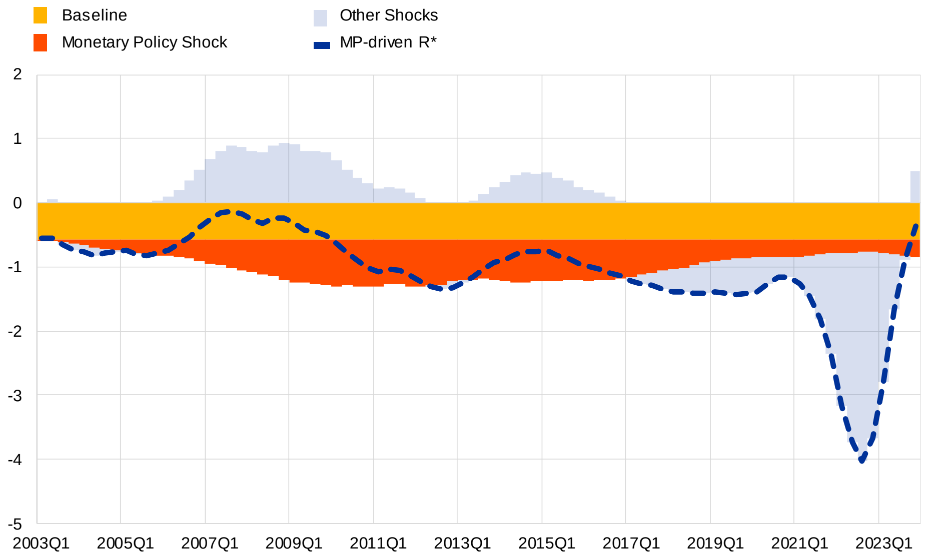
[117] Elfsbacka-Schmöller and McClung (2024) show analytically the endogeneity of the natural rate in a New Keynesian model with endogenous growth through research and development.

well as financing, which influences research and development initiatives and other innovation decisions by firms. As innovation is a major engine of long-term growth, episodes of expansionary monetary policy may raise investment in innovation, thus increasing growth and r*.[118]

Chart 41

Decomposition of estimated r* into monetary policy and other underlying shocks

(percentage points)



Sources: ECB calculations

Notes: The chart plots the accumulated effect (from the baseline) of monetary policy and other shocks on r*. The estimates are obtained using an extension of the model proposed in Leiva-León, Uzeda and Sekkel (2024). The employed VAR model jointly estimates r*, monetary policy shocks and their relationship. The monetary policy shocks are identified using the instrumental variable approach. r* is defined as the estimated slow-moving component of the real interest rate. The model is estimated based on euro area data for HICP inflation, inflation expectations, short- and long-term interest rates, and monetary policy surprises that are used as the instrument. The sample corresponds to the period between the first quarter of 2003 and the fourth quarter of2023. The monetary policy-driven R* measure is modelled as the sum of three elements: (i) an initial condition referred to as the "baseline"; (ii) the accumulation of monetary policy shocks from the initial condition until each time period; and (iii) the accumulation of other non-identified shocks, also from the initial condition until each time period in the sample.

Another channel through which monetary policy may lower r* is through precautionary savings in combination with lower-bound constraints. In the periods in which monetary policy is constrained by the effective lower bound, the central bank cannot provide the adequate degree of monetary policy easing, with recessionary and deflationary consequences. That increases households demand for savings even in periods outside of the effective lower bound, depressing r*. If a central bank operates a monetary policy that minimises the negative impact of the effective lower bound, that reduces this demand for savings and may increase r*.[119]

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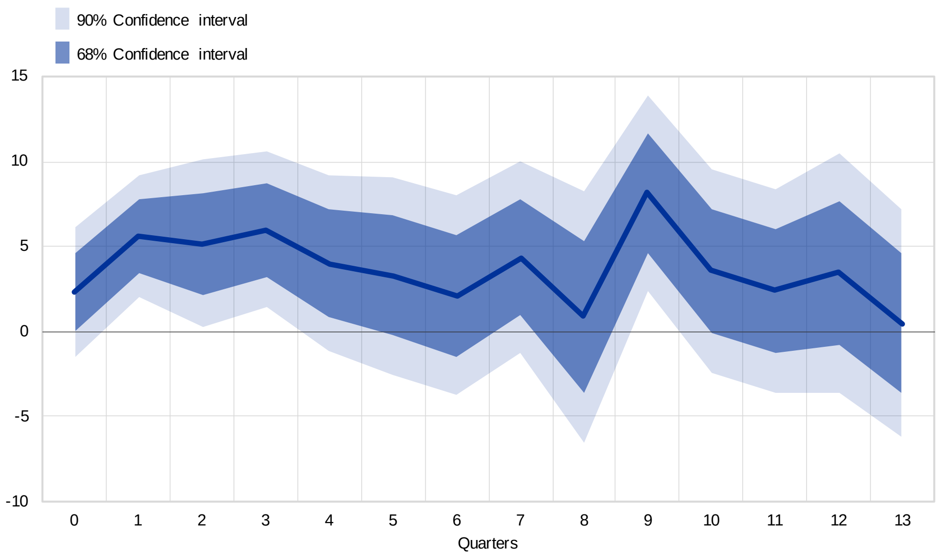
118 Elfsbacka-Schmöller and Spitzer (2022) show that in an estimated DSGE model for the euro area, cyclical shocks, particularly to demand during the Financial Crisis and the sovereign debt crisis, significantly reduced innovation investment and total factor productivity growth, indicating persistent effects of short-run demand. Elfsbacka-Schmöller, Goldfayn-Frank and Schmidt (2024) show using firm-level survey data that monetary policy affects innovation investment both through rate hikes and cuts and via forward guidance, and that the recent euro area rate hike episode is associated with a pronounced reduction in firms' innovation investment. Ma and Zimmermann (2023) show the persistent effects of monetary policy shocks via the innovation channel by means of local projections. Jorda, Singh and Taylor (2024), demonstrate the long-run effects of monetary contractions using local projections.

119 See Fernandez-Villaverde et al. (2024).

Chart 42

Impulse-response functions (IRF) of r* to a **1 percentage point increase** in the government debt-to-GDP ratio

(Basis points)



Sources: Campos et al (2024)
Notes: Campos et al (2024) estimate the local projection associated with the lagged public debt-to-GDP ratio Dt−1. They use the natural rate estimated by Lubik and Matthes (2015) as their measure of r*. The control variables include four lags of the change in r*, three additional lags of the public debt-to-GDP ratio, and four lags of the federal funds rate, the GDP deflator, and the unemployment rate. The shaded areas represent the 68% and 90% confidence intervals using Eicker–Huber–White standard errors.

Likewise, fiscal policy can affect r* insofar as the demand for risk-free liquid assets is not perfectly elastic. This can be the case, for instance, if markets are incomplete and households or firms or both demand debt for precautionary reasons.[120] In this case, an expansionary future fiscal policy that leads to an increase in the long-run stock of debt generates an increase in the natural rate (**Chart 42**). Yet, in the case of a monetary union with heterogeneous fiscal authorities, a worsening in the risk profile of some national bonds may also reduce the overall stock of risk-free debt, thus putting downward pressure on the natural rate. Finally, fiscal policy may also influence r* via the endogenous growth channel. Specifically, fiscal policy can increase aggregate demand, which in turn raises innovators' investment in research and development, aggregate total factor productivity growth and thus the natural rate.[121]

3.6.3 A forward-looking perspective on r*

Gauging future r* developments is challenging, as the trajectory or impact of key secular trends is unknown. Building on the previous section, the following trends seem to be key to gauging the future developments in r*: i) demographics, ii) climate change and the green transition, iii) fiscal and structural policies, iv) geopolitics and global fragmentation, and v) digitalisation and AI. As the previous

[120] See Rachel and Summers. (2019) or Campos et al. (2024).

[121] See Elfsbacka-Schmöller and McClung (2024).

sections already highlighted, future developments in these global "megatrends" are hard to project, and even more so their impact on the euro area economy and on r*.

Within the structural drivers considered in this section, demographics are among the least uncertain, likely continuing to push r* downwards over the coming decades. Given current and past fertility rates and expected mortality rates, and absent major disasters, the developments in the population size and age composition are relatively predictable. Based on the most recent population projections, the increase in the old age dependency ratio is projected to increase from 39% in 2024 to 61% by 2050, thereby increasing desired savings and depressing r*. An accelerated ageing process for large emerging economies such as China or India, if combined with an increasing financial openness of these countries, could further depress the global neutral rate and affect the euro area r* further to the downside.

By altering the structural trends of the economy, climate change and carbon-transition policies may affect r* via different channels, complicating judgement about the plausible magnitude and sign of the effects. Climate change itself (the increase in physical risks) and public policies (for transition, mitigation or adaptation) may have opposite effects on the main drivers of the saving and investment behaviour that ultimately affect r*. Given the uncertainty surrounding both climate developments and the type of climate transition policies that will be achieved (and whether orderly, disorderly, or delayed), the sign and magnitude of the overall effects on r* are hard to predict (Mongelli et al., 2024). One can however highlight the channels and mechanisms at play. First, the reaction of total factor productivity to climate change and transition policies is ambiguous. Climate-related damages may reduce total factor productivity growth and r* by redirecting resources away from innovation towards mitigation and reconstruction, and heat waves that may lower labour productivity.[122] Climate change can increase risk, uncertainty and inequalities, exacerbate fiscal stress, thereby raise precautionary savings and deter investment ex-ante and depress r* (Cruz and Rossi-Hansberg, 2024; Islam and Winkel, 2017).[123] At the same time, increasing investment needs due to capital destruction would result in higher r* (Cantelmo, 2022).[124] Orderly transition policies can mitigate downward effects of climate change on r* (Benmir et al., 2020). Innovation driven by tax incentives, regulation and R&D subsidies could potentially increase productivity and r* in the long run.[125] But not necessarily so, for instance because productivity effects depend on the degree of substitutability of "green" versus "brown" energy

122 See for instance Bilal and Rossi-Hansberg (2023) for the impact of acute physical risks, and Burke et al. (2015), Tol (2018) or Day et al. (2019) for the impact of chronic physical risks.

123 As vulnerability to climate change varies across countries and households, increased physical risks would drive inequalities upwards, thereby favouring precautionary saving and decreasing r*.

124 It might be hard to judge the interaction of opposing ex-ante and ex-post effects, not to mention the fact that due to financial factors the impact on productivity and capital might not translate into equivalent changes in the return on safe assets on which r* is based.

125 The potentially positive impact of an orderly climate transition on productivity originally relates to Porter (1991) and has been studied more recently, for instance, by Calel and Dechezleprêtre (2016) or Gugler et al. (2024). Its upwards effect on r* in the long-run has been highlighted by Holzmann et al. (2024) and Jezequel-Royer and Levieuge (2024).

inputs for production.[126] All these opposing effects leave the sign of the overall impact on TFP and r* undetermined.

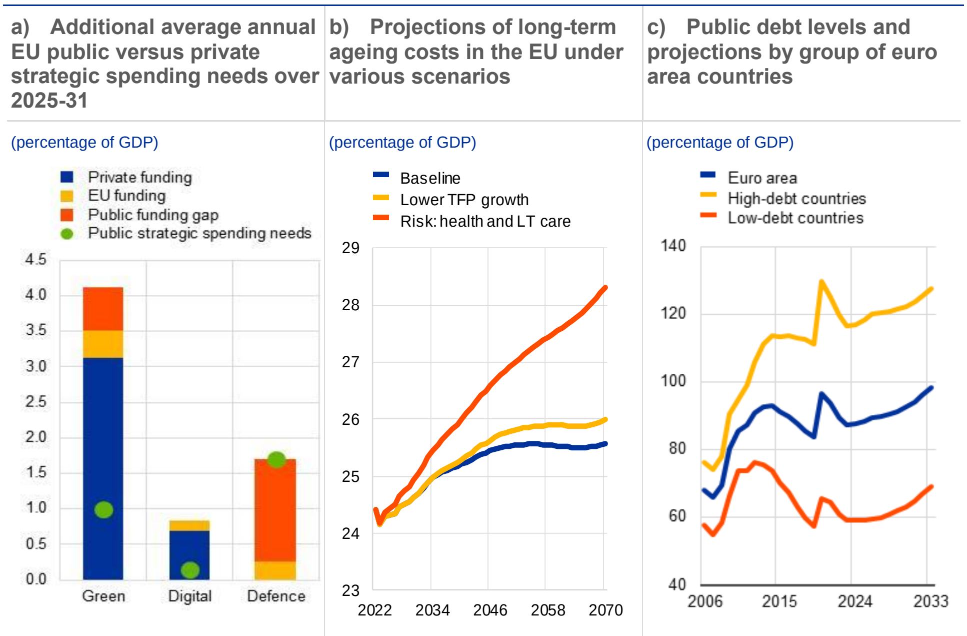
The response of fiscal policy to secular trends and geopolitical developments may also produce significant fiscal pressure that is not neutral for inflation or r*. Public expenditure is likely to rise due to the structural factors discussed in this section: climate change and digital transition (the need for green and digital investments), defence spending (to address geopolitical risks), and ageing (**Chart 43**). On the one hand, additional public spending could increase aggregate demand, raise debt levels and reduce fiscal space, which could be inflationary, especially if non-Ricardian effects and non-linearities associated with high debt levels are strong.[127] On the other hand, supply-side fiscal policies, such as investment in strategic and productive sectors, could boost potential output and potentially mitigate inflationary pressures. Overall, particularly fiscal pressure on defence spending could lead to upward pressures on the natural rate.

[126] Based on Golosov et al. (2014), with total factor productivity growth being driven by technology growth minus relative energy price growth, Casey et al. (2024) show that increases in the relative prices of brown versus green energy could, by decreasing total factor productivity, have a limited negative impact on r*.

[127] Fiscal stimulus tends to be more inflationary in regimes with high debt (see Checherita-Westphal and Pesso (2024) for an analysis across euro area countries; Cevik and Miryugin (2023) for samples of advanced and emerging economies). Direct positive effects on inflation (Konradt, McGregor and Toscani, 2024) and inflation volatility (Santabárbara and Varela (2022)) may also result from measures such as higher energy (carbon) taxes.

Chart 43

Long-term fiscal challenges



Sources: Panel a): Dorrucci et al. (2024), updated. Panel b): Ageing Report; Panel c): ECB staff calculations based on the ESCB toolkit on debt sustainability analysis.

Notes: Panel a) shows the European Commission's official estimates for green and digital investment plus defence expenditure over 2025-31. The choice of this period accounts for the reform of EU fiscal governance, which envisages the adoption by Member States of fiscal-structural plans lasting up to seven years (2025-31). Additional strategic spending needs are defined as the difference between total needs (with cut-off date of 12 March 2025) and historical benchmarks (for green investment the average for the period 2011-20, for digital investment the average for the period 2014-20, and for military expenditure 2024). For other methodological aspects related to strategic investment in the green and digital transitions, see Dorrucci et al. (2024), footnotes 1 and 3. Defence expenditure needs are updated to reflect the European Commission's proposals on REARM Europe objectives as set in March 2025 (hereby shown as an annual cap, announced by the European Commission for the period 2025-2028).

The EU funding of defence expenditure includes the new EU instrument for up to €150 billion, the repurposing of cohesion funds for up to €50 billion, and a larger share of defence expenditure expected for the next multiannual financial framework (MFF), which will start in 2028.

Panel c) shows medium-to-longer run debt paths under the "No fiscal policy change scenario with ageing costs (risk scenario)" starting from the March 2025 ECB staff macroeconomic and fiscal projections over 2024-27. Thus, public debt projections account for ageing costs (panel b), but not for the additional strategic spending needs (panel a). High-debt group refers to the GDP-weighted average of government debt in countries with a debt-to-GDP ratio in 2023 higher than 90% (Belgium, Greece, Spain, France, Italy and Portugal).

Fiscal policy choices and their impact on interest rates will be shaped by developments in the EU governance framework. First, the Next Generation EU programme and associated investments and reforms aim to foster progress in the digital and green transitions and to enhancing the competitiveness and resilience of the EU.[128] Second, national fiscal policies will need to comply with the sustainability requirements of the new EU framework on economic governance, which took effect in 2025.[129] This is particularly important for high-debt countries, which tend to be

[128] The proposals listed under Draghi (2024) and Letta (2024) are in the same vein. For an analysis of the macroeconomic effects of Next Generation EU on the euro area, see Bankowski et al. (2024).

[129] For an overview of the reformed EU framework from a monetary policy perspective, see Haroutunian et al. (2024) and for potential effects on euro area growth and inflation under a range of scenarios, including relative to the Eurosystem's baseline projections, see Bouabdallah et al. (2024).

less resilient to shocks.[130] The new EU framework implies that, at the euro area level, the impact of a restrictive fiscal stance on domestic demand and inflation might be mitigated by the incentives for investment and reforms under the new fiscal rules, as well as by the flexibility granted for new defence spending over 2025-28.[131]

The forward-looking impact of euro area fiscal policies on r* remains ambiguous, ultimately depending on the inflation and confidence effects of fiscal policy. On the one hand, investment in the green and digital transition and the need to address geopolitical risks will likely entail higher strategic public spending. To the extent that this were to lead to higher productivity growth, an increase in the supply of safe assets, and a shift in the balance between savings and investment towards the latter, it could put upward pressure on r* (Szoke et al, 2024; Nerlich et al, 2025; Schnabel, 2025). On the other hand, already elevated and increasing public debt levels in many euro area countries, if not reduced over the medium term in line with the revised EU governance framework (Bouabdallah et al. 2024, 2025), could decrease confidence, reduce the stock of risk-free government bonds and put downward pressure on r*.[132] These possible effects are particularly relevant for the euro area, where heterogeneous fiscal authorities issue bonds with different risk profiles and investors can easily substitute between different euro area government bonds.

Box 5
Integrating climate change into economic analysis, modelling and forecasting

Friderike Kuik, Christiane Nickel, Miles Parker

The Eurosystem has carefully followed up on the commitments it made in the strategy review in 2021 with respect to integrating climate change into economic analysis, modelling, and forecasting. In the area of forecasting, commitments included the introduction of technical assumptions for carbon pricing and a regular assessment of the impact of climate-related fiscal policies on the projections' baseline. For modelling, the commitments included the integration of climate risks into the Eurosystem's workhorse models and scenario analysis for transition policies. As for the economic analysis, one explicit commitment was the assessment of the impact of climate change on potential growth. This box reports on progress in these three areas and provides proposals for future priorities.

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[130] Fiscal adjustment, by reducing debt overhang and sovereign debt sustainability risks, helps create the fiscal space required to implement counter-cyclical stabilisation policies, which can support the common monetary policy's pursuit of price stability, and limit market fragmentation that may otherwise hamper the transmission of monetary policy. See also the in-depth discussions in the Strategy review analysis of monetary fiscal-policy interactions in 2021 and more recently in Checherita-Westphal et al. (2024). For further euro area evidence of the impact of higher government indebtedness on sovereign risk, as captured by sovereign yield spreads, see Burriel et al. (2024) for the period 2009 to mid-2014 and Attinasi, Checherita, Nickel (2009) for the 2007-09 economic crisis. High debt economies also tend to face higher interest rate-growth differentials (r-g) on government debt. This holds on average over longer periods and it is usually exacerbated in crisis times (see empirical evidence in Checherita-Westphal and Domingues-Semeano (2020), Escolano et al. (2017), Turner and Spinelli (2011)).

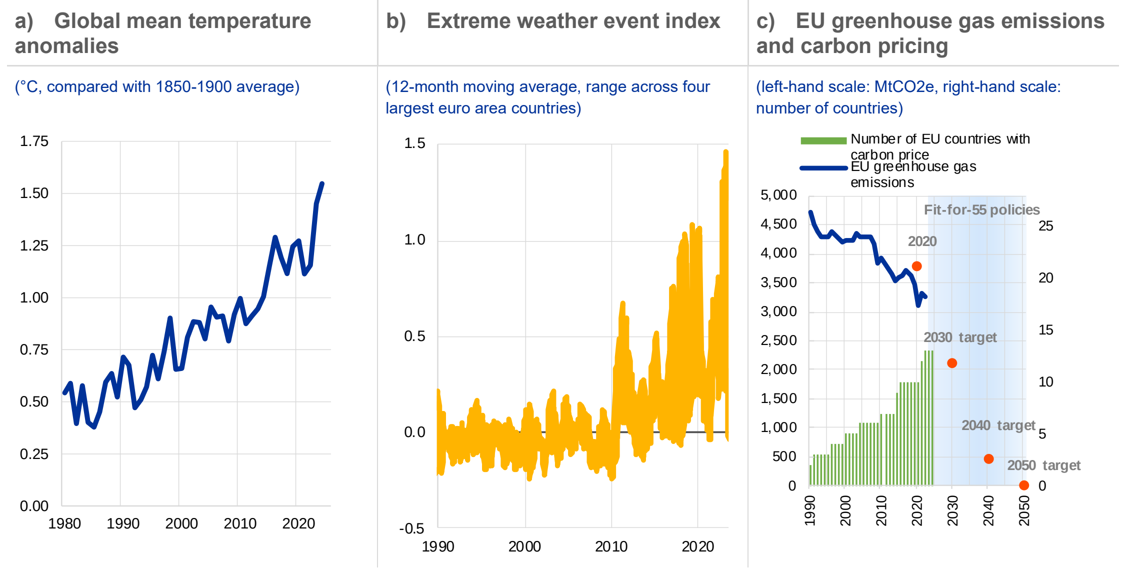
[131] For an overview of the fiscal implications of euro area governments' medium-term fiscal-structural plans under the revised Stability and growth pact, including the debt implications of the so-called national escape clauses allowing for higher defence spending over 2025-28, see Bouabadallah et al. (2025).

[132] See Reis (2025) for an explanation of the various channels through which fiscal policy may impact (different definitions of) the natural rate of interest.

Since 2021, the changing climate and especially the structural transformation of the economy have become increasingly relevant for central banks' macroeconomic outlook. Global mean temperatures have risen to around 1.2-1.3°C above pre-industrial temperatures, approaching the Paris Agreement threshold of 1.5°C (Chart A, panel a).[133] Climate change has already led to extreme events such as heatwaves, droughts or extreme flooding occurring more often and with higher intensity (Chart A, panel b). With climate change accelerating, its effects are gradually materialising into macroeconomic outcomes, which is likely to intensify over the coming decades – possibly in a non-linear and irreversible way, with dramatic implications for global economic developments, geopolitics and migration. On the other hand, the transition to a net-zero economy is moving into a critical phase in the EU, with a range of new policies being implemented over the next few years (Chart A, panel c). Some of these policies will have important (but likely temporary) macroeconomic consequences that need to be captured in macroeconomic projections and modelling. This explains the urgency to now being able to understand, model and forecast the effects of the transition to net-zero, while progressing in our understanding of near-, medium- and long-term consequences of climate change.[134]

Chart A

Accelerated climate change and higher certainty about EU climate policies



Sources: Copernicus, IFAB, World Bank carbon pricing dashboard, ECB staff calculations.
Notes: Panel a): Average across six global temperature datasets. The latest observation is for 2024. Panel b): European Extreme Events Climate Index (E3CI), combining seven extremes, including extreme max/min temperature, drought, extreme precipitation, hail, fire, extreme wind. Standardised anomaly with respect to the reference values (1981-2010). For each individual category, an index above 1 indicates an extreme event. The aggregate is calculated across the arithmetic average across all seven categories. An increasing average score indicates increasingly frequent and severe extreme events. The latest observation is for December 2024.

Macroeconomic models are now able to capture the green transition in a simplified way and have been used to conduct scenario analysis. The ECB's New Area-Wide Model (NAWM) has been extended to a version that can differentiate between developments in "clean" and "dirty"

133 Copernicus Climate Change service. The Paris Agreement aims to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels." This goal applies to long-term temperatures, typically measured over decades or longer, although the Paris Agreement itself does not provide a specific definition. 2024 was the first calendar year in which the average global surface temperature exceeded 1.5°C above the 1850-1900 average. Individual years exceeding the threshold do not mean that the long-term target has already been missed.

134 The latter is particularly relevant in light of global efforts to mitigate climate change still being insufficient to meet the goals of the Paris Agreement, see UN emissions gap report 2024.

energy sectors (NAWM-E). The effects of a carbon price scenario were evaluated in a model intercomparison exercise across six different macroeconomic models. In addition, the NAWM-E was used to analyse the impact of different carbon pricing scenarios on euro area growth and inflation. This has been complemented by efforts across the Eurosystem, where models were also developed in which the energy(-intensive) sector is split into a "clean" and a "dirty" part. Other Eurosystem efforts have gone further and developed models with a higher sector disaggregation, such as the Deutsche Bundesbank's environmental multi-sector model EMuSe (Hinterlang et al., 2023). So far, Eurosystem macroeconomic models do not yet incorporate any effects due to higher temperatures or extreme events, but a scenario analysis was developed based on empirical approaches. Scenario analysis provides a useful tool to deal with the substantial uncertainty surrounding the future paths of the green transition and climate change. Nonetheless, translating decades-long climate scenarios into horizons relevant for monetary policy remains challenging, an issue that the short-term scenarios recently prepared by the Network for Greening the Financial System aim to address.

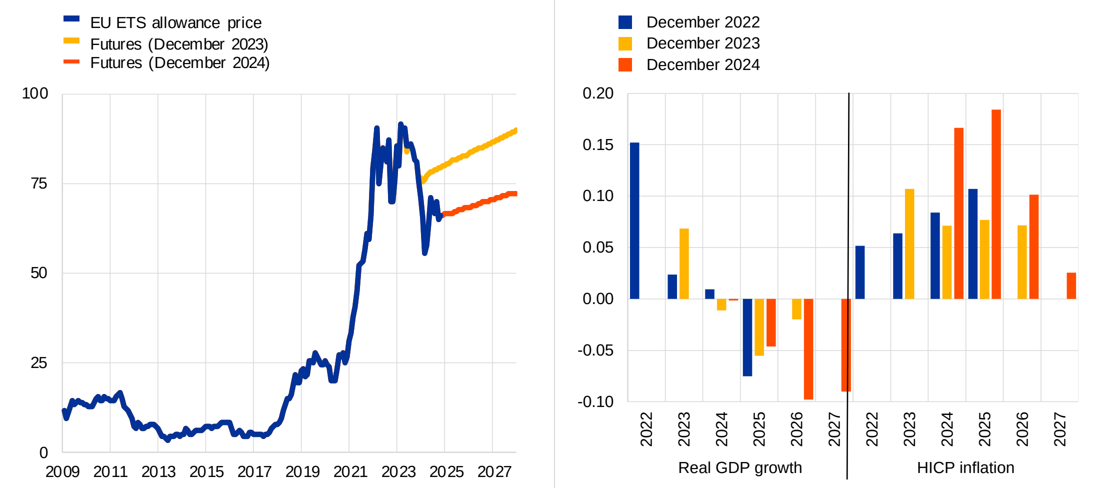
As green policies are being adopted at the national and EU level, the Eurosystem/ECB staff macroeconomic projections are gradually incorporating their effects. As of September 2021, the EU Emissions Trading System (ETS) spot and futures prices were introduced as common assumptions (Chart B, panel a). Few NCBs use these directly in their forecasting models or in satellite models to inform potential judgement, however many NCBs indirectly take into account the prices of the EU ETS, using dedicated assumptions for wholesale electricity prices.[135] The revenues from the EU ETS are considered by most NCBs. In addition, the effects of green discretionary fiscal measures, reflecting national emission reduction policies including changes in carbon prices, are assessed on an annual basis in the Eurosystem staff macroeconomic projections for the euro area (Chart B, panel b). In December 2024, additional assumptions were incorporated into the new, separate EU ETS 2, which is estimated to impact euro area headline inflation in the range of 0.0 to 0.4 percentage points in 2027. As more details on the implementation of the policies that have been adopted as part of the EU climate policy package "Fit-for-55" (including the EU ETS 2) emerge, the assessment of their macroeconomic impact will need to be reviewed carefully in forthcoming macroeconomic projection rounds (also see below).

[135] To date, the main impact of the EU ETS was on wholesale electricity prices, as allowances need to be surrendered for electricity generated from fossil fuels (especially coal and gas). Going forward, the price will increasingly apply to other sectors, either through the phase-out of free allowances or a gradual phase-in of emissions into the system (including energy-intensive industries, aviation, maritime shipping), and the macroeconomic impact of the EU ETS will likely reach further. The new emissions trading system, ETS2, will become fully operational in 2027 and will address CO2 emissions from fuel combustion in buildings, road transport and some small industries not covered by the existing ETS.

Chart B

Transition policy assumptions and effects in the Eurosystem/ECB staff macroeconomic projections

a) Allowance prices under the EU Emissions Trading System	b) Impact of green discretionary fiscal policies on growth and inflation
(Euro/tonne CO2)	(percentage points)

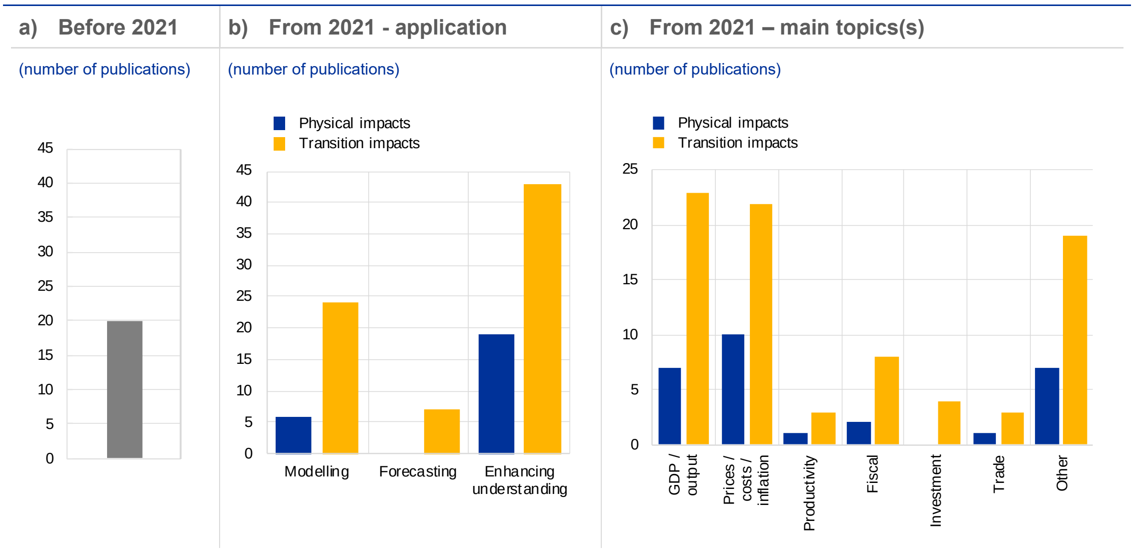


Sources: Refinitiv, Eurosystem staff macroeconomic projections for the euro area, December 2022, December 2023, December 2024, ECB staff calculations.
Notes: Panel a): Futures depict the assumptions used during the December 2023 and 2024 Eurosystem staff macroeconomic projections for the euro area.
Panel b): If the combined impact of all measures in a given year and country for a given variable is below 0.1 percentage point it is reported as zero.

Eurosystem publications document progress in better understanding the macroeconomic consequences of climate change, often going beyond the commitments made in the strategy review in 2021 (Chart C). Many publications focused on understanding the impacts of transition policies, most prominently the effects of carbon pricing on growth and inflation, and some publications also examined the role of different policy mixes (including the use of revenues from carbon pricing) or the effects of changes in the energy system and the role of renewable energy. Increasingly, publications have also documented progress in understanding the macroeconomic implications of a changing climate, including the effects of increasing average temperatures and extreme events. Overall, the focus of many publications was on the effects on GDP growth, (potential) output, inflation (including energy costs), and to a lesser extent on government budgets, investment, productivity, and trade. So far, the Eurosystem has published less literature on the impacts of climate change on labour markets.

Chart C

Summary of Eurosystem publications with relevance to modelling, forecasting and understanding macroeconomic effects of climate change



Source: ECB staff calculations, based on MPSR members' input, ECB library input.
Notes: Panel a) includes publications from 2015 onwards. Panels b) and c) include all relevant publications submitted through the MPSR WS1 stock-take. 60 submissions in total. One publication could be relevant to several applications (panel b) / topics (panel c).

The main priority going forward should be the continued inclusion of transition policies in forecasting and models.[136] As the ambitious "Fit-for-55" policies are gradually phased in between 2026 and 2030, it will be important to understand the macroeconomic effects and to regularly re-assess and include these effects in the Eurosystem/ECB staff macroeconomic projections for the euro area. This particularly concerns developments in the two EU emission trading systems (ETS1 and ETS2) and the carbon border adjustment mechanism. Macroeconomic models may need to be further adapted to fully reflect their implications, including at the sectoral level. Beyond that, it will be important to comprehensively understand the structural consequences of the green transition, and its linkages with other structural developments such as geopolitical fragmentation and digitalisation (see **Chapter 3**). In addition, it will be increasingly important to further deepen the analysis of the macroeconomic effects of the physical consequences of climate change, including climate change adaptation. Building on this, amid a highly uncertain environment, alternative climate scenarios to reflect climate-related risks should increasingly be integrated into macroeconomic models and the analytical framework used for the Eurosystem/ECB staff macroeconomic projections for the euro area. Finally, the economic implications of biodiversity loss and the degradation of nature should increasingly be explored, ideally in collaboration with climate scientists.

136 See also the ECB's 2024/25 Climate and Nature Plan

4 Implications of the changing inflation and economic environment for the analytical toolkit and inflation forecasting

4.1 Introduction

Against the background of the findings in chapters 2 and 3 on the changing inflation and economic environment, this chapter examines implications for the analytical toolkit and inflation forecasting. It first looks at the performance of the staff inflation projections during the period since the last strategy review and discusses potential ways to improve forecasting accuracy (**Section 4.2**). This is followed by a review of the current tools for assessing uncertainty and ways to better account for it, especially by extensive scenario analyses with recommendations of guiding principles for them (**Section 4.3**). Finally, **Section 4.4** documents the progress that has been achieved and the remaining gaps with respect to improving the analytical toolkit. It includes a discussion of the modelling of non-linearities and long-term economic drivers. It also discusses sectoral analyses and generally calls for an increase in the granularity of models and data for monetary policy analysis. Three boxes complement the analysis. The first compares the forecasting performance of ECB/Eurosystem staff inflation projections with financial market expectations (**Box 6**), the second assesses of the role of measures of underlying inflation as a cross-check for the medium-term inflation projections (**Box 7**), and the third presents the work of the CHaMP Research Network on enhancing the modelling of monetary policy transmission in a framework allowing for cross-country and cross-sectoral heterogeneity (**Box 8**).

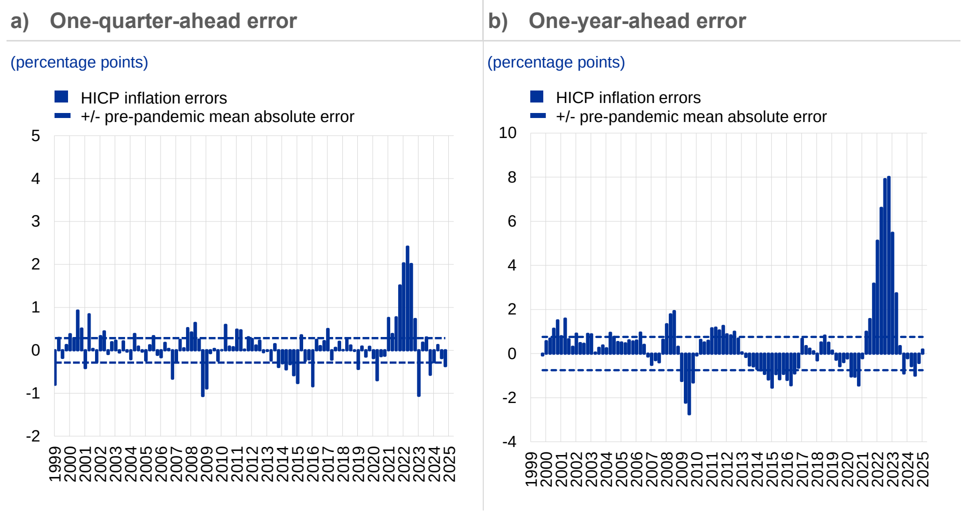
4.2 Forecast accuracy and ways to improve it

Accurate inflation projections are key for monetary policy. They enable the ECB to anticipate risks of notable deviations from the medium-term 2% inflation target and to proactively adjust its monetary policy stance in order to counter such risks. For these reasons, it is important to regularly check the performance of Eurosystem/ECB staff inflation projections and benchmark them against forecasts from other sources. Understanding the origin of errors and the lessons that can be drawn from them is crucial for ensuring a constantly good forecast performance. Transparently communicating the drivers of these forecast errors to the public is important, as demonstrated in the dedicated box featured in the June 2025 projections article.

In 2021 and 2022 inflation significantly exceeded the Eurosystem/ECB staff projections, but their accuracy has improved again since 2023. Inflation turned out to be much higher and more persistent in 2021-22 than had been projected, largely driven by the confluence of (partly new) extraordinarily strong supply and demand shocks at the global level, as identified in **Chapter 2**. From a historical perspective the inflation forecast errors during the inflation surge period were unprecedented – at times almost ten times larger than the average errors at the one-quarter ahead horizon and the one-year ahead horizon over the previous twenty years (**Chart 44**). With the easing of inflation over the course of 2023 and 2024, projections errors have turned partly negative but have overall normalised. The chart also highlights the fact that limited errors are a normal feature of inflation forecasts. ECB/Eurosystem staff projections use a suite of models, are conditional on a set of assumptions, and include an element of judgement. Hence, beside shocks, forecast errors may stem from model misspecification, errors in the conditioning assumptions and misguided judgement.

Chart 44

Errors in Eurosystem/ECB staff projections for headline HICP inflation



Sources: Eurosystem/ECB staff macroeconomic projections for the euro area and Eurostat.
Notes: An error is defined as the outturn for a given quarter minus the projection made for that quarter in the previous quarter (for example, the outturn for the fourth quarter of 2022 minus the figure projected for that quarter in the September 2022 ECB staff macroeconomic projections). The latest observations are for the first quarter of 2025.

Large errors occurred across forecasters and economies during the high-inflation period. By and large, the entire forecasting community significantly underestimated euro area HICP inflation over 2021 and 2022. This is shown in **Chart 45** which depicts the projection errors for the euro area by Eurosystem/ECB staff in comparison with errors by other forecasters. The broad picture of strong under-predictions in inflation projections has been common to all forecasters in the period from mid-2021 up to end-2022, with the Eurosystem/ECB staff projections falling broadly in the middle of the range of projections.[137] Similarly, the Federal Open Market Committee and the Bank of England failed to accurately predict inflation developments in their respective countries in this period (see Chahad et al., 2022 and Bernanke, 2024). At the same time, analysis shows that staff inflation projections have been as accurate, or even slightly more accurate than real-time

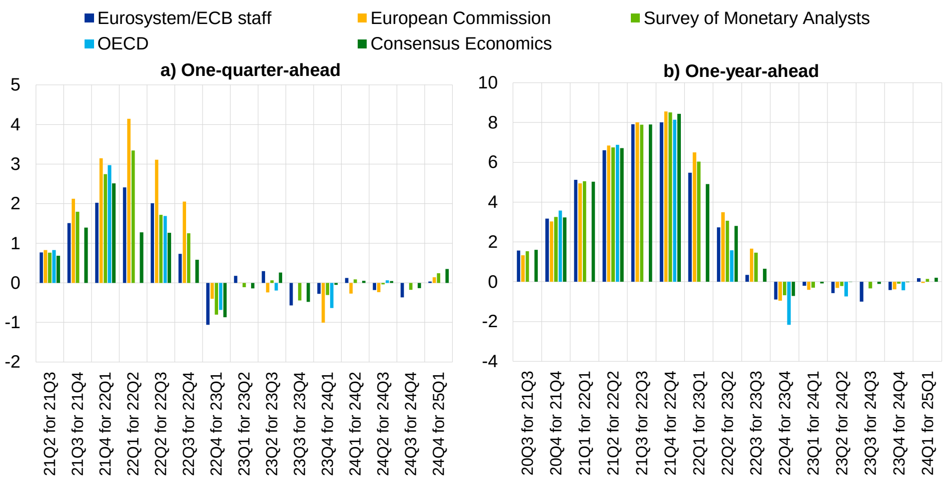
137 The timing of the finalisation of the forecasts of different institutions and the underlying assumptions may differ. For example, forecasts from Consensus Economics usually have at least one additional HICP inflation release available before they are finalised. As a result, the comparison across forecasters should only be viewed as indicative.

market-based forecasts and those from private forecasters over a long sample period (see Chahad et al., 2024, and the **Box 6** on the comparison of the performance of ECB/Eurosystem staff projections against financial market inflation expectations).

Chart 45

Errors in the HICP inflation projections from different forecasters

(percentage points)



Sources: Eurosystem/ECB staff projections, Consensus Economics, Survey of Monetary Analysts, European Commission, OECD and Eurostat.
Notes: Errors are calculated as the outturn minus the projection. The labels on the horizontal axis indicate the quarter in which the projections were published and the quarter to which those projections relate (for example, "21Q1 for 21Q2" denotes projections for the second quarter of 2021 that were published in the first quarter of 2021). For forecasters other than Eurosystem/ECB staff, errors are shown for publications with a cut-off date close to that of the relevant Eurosystem/ECB staff projections. For the Survey of Monetary Analysts, the data represent the median of survey respondents' replies, while for Consensus Economics, the data represent the mean. Quarterly projections by the OECD are only available twice per year, so no errors are shown in the first and third quarters. These forecasts are not directly comparable with one another or with the Eurosystem/ECB staff macroeconomic projections, as they were finalised at different points in time. Additionally, they use different methods to derive assumptions for fiscal, financial and external variables, including oil, gas and other commodity prices. The latest observations are for the first quarter of 2025.

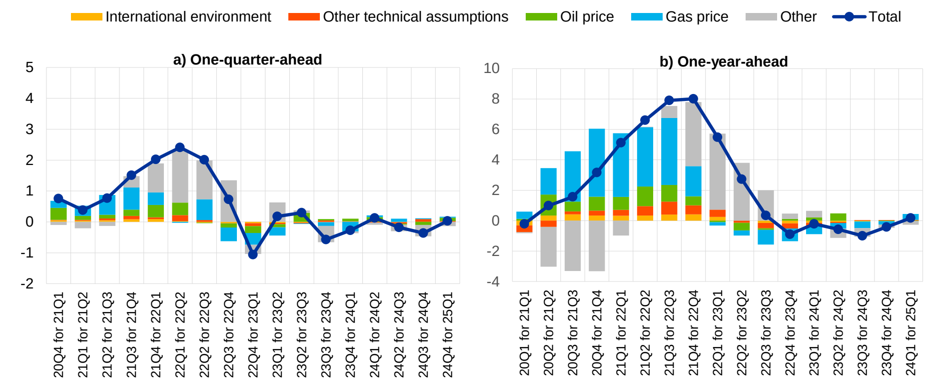
4.2.1 The role of assumptions in inflation forecast accuracy

Errors in conditioning assumptions, especially those related to energy commodity prices, accounted for a significant share of the errors in staff inflation projections during 2021-2022, but thereafter other factors also played a role (Chart 46). In principle, the importance of errors in assumptions could be quantified by using models to construct counterfactual paths for inflation under a scenario in which forecasters have perfect foresight about how energy prices and other conditioning variables would actually evolve over the projection horizon. However, this is not easy to do, as Eurosystem/ECB staff projections are not derived from just one single model. Accounting for errors in assumptions in the analysis of projection errors can be done by using a number of different models and the results are therefore model-dependent. Moreover, the Eurosystem/ECB staff projections are not purely model-based but also include judgement (**Section 4.2.2**). Nevertheless, one way to carry out such a counterfactual exercise is by using Basic Model Elasticities (BMEs) from NCB macroeconomic projection models, which summarise the key relations between assumptions and projection variables, though in a simplified way[138]. This exercise, which should be seen as an approximation, suggests that errors in energy price assumptions – and particularly in gas price assumptions – played a very significant role in the large errors made in the initial stages of the inflation surge (blue and green bars in **Chart 46**).[139] Subsequently, however, the importance of other factors grew, which partly underscores not only the difficulty of accurately capturing the complex transmission of shocks in energy commodity prices[140] to core HICP inflation, but also the role of other factors, such as global supply bottlenecks, the post-pandemic demand dynamics and possible non-linearities in an environment of high inflation (see also the discussion in **Chapter 2**). The analysis highlights that the interest rate assumption (included in other technical assumptions in the red bar in **Chart 46**) has played a limited role in the forecast errors in recent years. Over a longer sample, the analysis by Chahad et al. (2024) suggests that errors in assumptions can account for up to 50% of the Root Mean Square Error for headline HICP inflation – particularly the assumptions for oil prices, food prices, and export prices of trade competitors, with the latter being also relevant for core HICP inflation during the inflation surge.

Chart 46

Decomposition of errors in staff projections for HICP inflation at different horizons using BMEs

(percentage points)



Sources: Eurostat, Eurosystem/ECB staff projections and ECB calculations.
Notes: "Total" is the error calculated as the outturn minus the projection. The labels on the horizontal axis indicate the quarter in which the projections were published and the quarter to which those projections relate (e.g. "20Q4 for 21Q1" denotes projections for the first quarter of 2021 that were published in the fourth quarter of 2020). The decomposition is based on the latest BMEs. "International environment" refers to errors in assumptions for foreign demand and competitors' export prices; "other technical assumptions" refers to errors in assumptions for the exchange rate, international food commodity prices, market interest rates and stock prices; "other" refers to errors which are not explained by errors in assumptions. Some caution in the interpretation of the results is needed, as the errors are decomposed using elasticities from macro-models while they are related to a short-term projection horizon for which NCBs use different tools. The latest observations are for the first quarter of 2025.

[138] See "A guide to the Eurosystem/ECB staff macroeconomic projection exercises" (2016).

[139] For a similar exercise, see also Chahad et al., 2024. It is important to note that gas price assumptions were only added to the official set of assumptions in the context of the December 2021 projections when the decoupling of gas from oil prices became very evident, and that gas price BMEs only became available in late 2022. However, several NCBs were already using gas price assumptions in their short-term inflation projections before December 2021. Electricity price assumptions were added at a later stage and no BMEs are available for them. In general, the analysis based on the BMEs should be seen more as illustrative because the NCBs use a wide set of tools to predict inflation developments in the short-term, also at a more granular level, and the BMEs offer only an approximation.

[140] As there are no BMEs for electricity prices, errors in these price assumptions could also have played a role.

4.2.2 The role of other factors for forecast accuracy

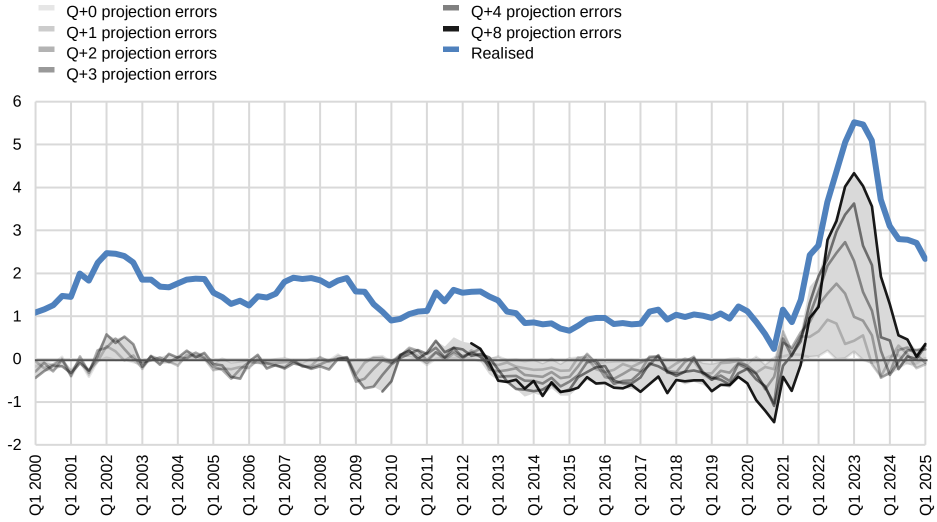
The part of the errors unexplained by the assumptions gives an indication of the combined effect of all other factors contributing to forecast errors, which could inter alia be related to models, judgement, non-standard shocks, indirect effects or the forecasts of other variables. According to the BME exercise, these other factors played an important role in projection errors in the later stages of the inflation surge. However, it is difficult to obtain a quantitative assessment of these factors individually. This is because these factors are not orthogonal and are difficult to disentangle from each other and because they might differ from country to country. One convenient way to quantify the role of assumptions and other factors in forecast errors is to perform counterfactual exercises as done above with the BMEs. However, since the ECB/Eurosystem staff inflation projections are not based on just one single model, the practical assessment of the actual role of different factors is more complex. These include among other factors those related to models, judgement, non-standard shocks and forecasts of other variables.

If the projections tend to systematically over- or underpredict inflation, the models and procedures should be adjusted to try to eliminate unwarranted bias. Recent analysis finds that over a longer sample period Eurosystem/ECB staff inflation projections are unbiased, but points to evidence of occasional and state-dependent biases (Chahad et al., 2024, and Granziera et al., 2024). In particular, a bias is observed in projections of HICP inflation excluding energy and food in the decade before 2020 (**Chart 47**), when the projections overestimated realised core inflation for an extended period of time. Some of the bias disappears after adjusting for errors in the conditioning assumptions, but part is left unexplained, reflecting properties of models (linearity, mean-reversion), and other factors. These factors may also reflect judgement, which is an element that is present in ECB/Eurosystem staff projections. Judgement consists of an “adjustment” to entirely model-based projections, that is made on the basis of off-model information. Generally, a judgement-based adjustment relies on satellite models or expert knowledge and addresses factors that are difficult to capture in the mainstream projection models such as the effects of unprecedented events (e.g. the COVID-19 pandemic or the Russian invasion of Ukraine) or preannounced changes in fiscal or structural policies not fully captured by the model (see **Chapter 3**).

Chart 47

HICP inflation excluding energy and food and ECB/Eurosystem staff projection errors

(annual percentage changes, percentage points)



Sources: Eurostat, Eurosystem/ECB staff projections, ECB calculations.
Notes: The blue line indicates the realisations of year-on-year HICPX inflation expressed as a percentage. The grey lines illustrate ECB/Eurosystem staff HICP projection errors in percentage points, defined as realised year-on-year HICPX inflation minus the corresponding projection at various horizons from Q+0 (lightest grey) to Q+8 (darkest grey). The grey shaded area encompasses the entire range of these projection errors across the different time horizons. The latest observations are for the first quarter of 2025.

The role of expert judgment was heightened in the high-inflation period and is likely to have mitigated forecast errors. According to a qualitative assessment by Eurosystem staff, judgement has been used more in the projections over recent years than in normal times. For example, judgement was used to account for effects of supply bottlenecks, fiscal and monetary policy, and non-linear responses to exceptional shocks, such as those seen in energy prices. Overall, staff assessed that judgement mitigated rather than amplified errors during the inflation surge.[141] On the other hand, misaligned judgement may also contribute to forecast errors and, especially in more stable periods, it is important to use judgement cautiously in order to avoid potential biases (Bernanke, 2024, also warns of risks related to extensive use of expert judgement). Currently there are no formal procedures in place to provide a systematic bottom-up quantitative assessment of the role of judgement in the Eurosystem/ECB staff projections, which is an area where further development would be warranted.

The series of large (and in part unprecedented) shocks that probably altered transmission mechanisms and caused shifts in economic relations during the high inflation period (discussed in Section 2.2) posed challenges for forecast models. The evidence suggests that firms adjusted prices more frequently in order to pass on rising costs (see **Box 2**). The broadening of inflation from energy prices to services prices was amplified by strong post-pandemic demand, leading to a stronger pass-through of cost shocks. Additionally, a heightened feedback loop between inflation and short-term expectations, along with an increased frequency of

[141] As an example, analysis performed at the Banco de España concluded that "judgement" improved RMSEs when forecasting inflation eight quarters ahead, but less so after the pandemic, see Chart 2 in the "External evaluation of Banco de España macroeconomic projections (2023)".

price adjustments, contributed to the faster-than-normal pass-through of sectoral shocks, affecting e.g. the Phillips Curve relationship. Given the benefits of hindsight, it is possible to analyse the magnitude of these complex changes, which ECB/Eurosystem staff and forecast models faced in real-time during projection rounds. Commonly used linear models were not equipped to capture these effects in their full complexity, meaning that the limitations of such forecast models explain part of the sizeable projection errors in the high inflation period. As a reaction, models accounting for time-variation and non-linearities have been developed and taken into use within the Eurosystem and may be used as satellite models or as cross-checking tools for the projections (see also, **Section 4.4**).[142] However, it should also be cautioned that over-fitting models to rather exceptional experiences could impair the accuracy of forecasting during more normal times compared with commonly used linear models.

As an example, model counterfactuals show that increasing the pass-through from energy prices to core inflation would have improved the forecast performance during the period of high inflation. To investigate this, a counterfactual exercise was conducted using the ECB-BASE model, aiming to replicate the December 2021 forecast while incorporating full knowledge of the actual outcomes of key conditioning assumptions, and fiscal, financial and external variables, as well as the paths for HICP energy and food inflation. While this counterfactual exercise suggests that headline inflation would be largely accounted for under these assumptions, a significant forecast error remains for HICP inflation excluding food and energy. To better understand this gap, the effects of amplifying the transmission from energy prices to core inflation were examined.[143] This exercise reduced the average counterfactual error for HICP inflation excluding energy and food from 2.6 percentage points to 1.3 percentage points over the four quarters with the highest errors (counterfactual period from the third quarter of 2022 to the second quarter of 2023). Ongoing work at the ECB shows that structurally embedding energy directly into the production function helps capture this effect more systematically. This approach links energy costs to marginal costs, thereby strengthening the transmission to core inflation dynamics.

Inflation forecast accuracy also depends on the forecasts of other variables. Unexpected economic shocks may affect forecast accuracy through drivers of inflation, such as the GDP deflator, GDP developments or wage growth.[144] These variables may be used as inputs in inflation models and therefore errors forecasting the variables may be passed onward leading to errors in inflation forecasts. As an illustration errors in the GDP deflator, reflecting developments in its components, became substantial in the course of 2022, driven initially mostly by errors in productivity projections (with labour productivity turning out substantially lower than foreseen) and subsequently by higher than anticipated unit profit growth[145]

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[142] Examples include Lenza et al., 2023. The model toolkit has also been extended to include both fixed- and time-varying-parameter versions of Phillips curve and BVAR models.

[143] In this exercise the pass-through parameter for energy prices in the core price equation was doubled.

[144] Analysis in Fagandini et al., 2024 suggests that their indicator for wage-sensitive inflation points to an important role for wages as a driver of HICPX inflation in the euro area since mid-2023.

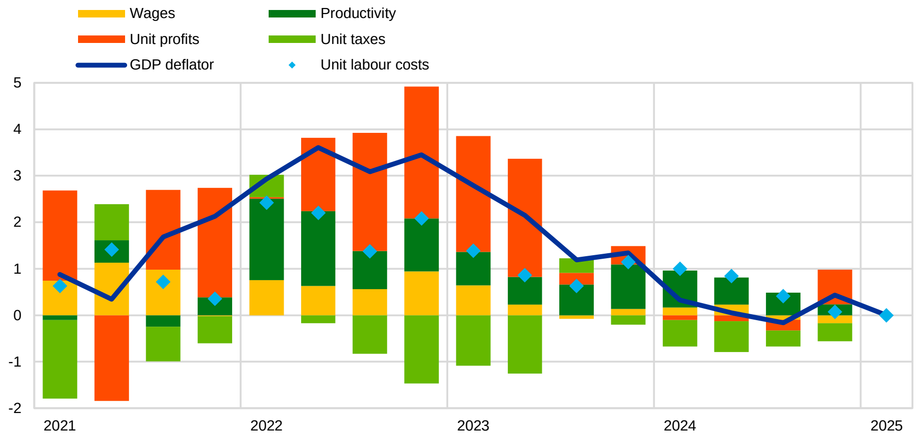
[145] The measure of unit profits could have also covered developments in intermediate input costs.

(**Chart 48**). Wage growth, on the other hand, was only slightly higher than expected.[146] While these errors were likely driven by the same factors as the inflation projection errors, some might have also genuinely contributed to the inflation error. Therefore, improved monitoring and forecasting of these variables would have a positive impact on inflation forecasts as well as an analysis of their forecast accuracy.[147]

Chart 48

Decomposition of one-year-ahead projection errors for the GDP deflator in Eurosystem/ECB staff projections

(percentage points)



Sources: Eurosystem/ECB staff projections, Eurostat and ECB staff calculations.
Notes: Errors are calculated as the outturn minus the projection. A positive contribution from productivity means lower than projected productivity growth. The outcome is taken from the national account release of 6 June 2025. The latest observation refers to the outcome for the first quarter of 2025 projected in the June 2024 staff macroeconomic projections for the euro area.

Given the sectoral origins of many of the shocks faced in the recent years, a higher degree of granularity is seen as advantageous in the projection exercise. One concrete area where this has become evident is the energy sector, with shocks in oil, gas, and electricity prices all having played an important part in the surge in energy prices. Short-term inflation projections by NCBs that feed into Eurosystem/ECB staff projections have been made more granular. The Eurosystem/ECB projection process was therefore able to adjust relatively quickly to the changing situation, by incorporating of additional energy price assumptions and subcomponent-specific forecasts, including for the medium term. Model development on this front has been carried out by both the NCBs and the ECB. One practical example of this is the new ECB Short-term Inflation Projection model, used as a cross-checking tool for NCBs short-term projections for energy inflation (Banbura et al., 2025). Recent model developments are a key theme in **Section 4.4**.

146 Revisions to the GDP deflator and its components may also lead to errors.

147 One concrete example of recent developments is the ECB wage tracker, a measurement tool that helps to analyse current and future wage pressures in the labour market, see Bates et al., 2024 and Górnicka and Koester (2024).

4.2.3 Recommendations for further developing forecast practices

Given the large contribution of external (energy) assumptions to forecast errors in the past few years, it is important to understand whether there are any ways to improve the related practices. In particular, it should be noted that current practices for setting external assumptions are a result of previous comprehensive internal analyses and some events cannot be forecasted. The set of assumptions could potentially be complemented with new variables if new factors are found to be useful for forecasting purposes.

- For **energy price assumptions**, analysis conducted before the inflation surge failed to find forecasting models that could consistently outperform futures for the oil price assumptions, while an internal analysis of the accuracy of oil price assumptions conducted in 2022 suggested that the futures continued to outperform the random walk. The latter analysis could be repeated regularly without substantial costs and could also cover gas, electricity and CO2 price assumptions, as they may gain in importance owing to the energy transition. The current practice of using a ten-day-average when setting assumptions could also be reviewed. Moreover, the role of oil-refining margins and the potential for common assumptions for them could be explored.

- For **other assumptions**, attention should be paid to those related to euro-area food prices, including their reaction to energy commodity prices, supply bottlenecks and climate change. In light of the evolving trade conflict and ongoing trade fragmentation, the accuracy of assumptions related to the export and import prices of trade partners also continues to be of essence. Strong volatility in oil and gas commodity price changes may also call for a more disaggregated approach for euro area import price projections.

- At the same time, it is impossible to fully hedge against the occurrence of large and relatively unforeseeable shocks such as the Russian invasion of Ukraine, which have strong effects on commodity prices. Agility in the projections process in terms of how to respond to such events remains of the essence, as was seen in the past episode of high inflation regarding energy prices. For example, consideration could be given to updating the baseline with new assumptions if there are large movements closer to the publication date.

- **In a similar vein, the experiences of the past few years have highlighted the importance of quantifying the role of different factors in projection revisions and errors**. As mentioned previously, there are currently no formal procedures in place to provide a quantitative assessment of the role of judgement in the Eurosystem/ECB staff projections. However, within the WGF, work is currently under way on finding formal ways to quantify the role of different factors affecting forecast revisions and errors using the various models employed by the ECB and NCBs. The work is aimed at improving the use of model-based forecast evaluations, which would serve as a basis for defining and measuring judgement in the Eurosystem/ECB staff projections. The experiences of the high inflation period has led to enhanced collaboration and information-sharing within the Eurosystem, and work is ongoing on several fronts (including various expert groups under the WGF) to develop procedures and models in order to improve forecast performance.

In times of large shocks models that handle time-variation and nonlinearities are useful, but in normal times linear models have performed well. The recent developments in the modelling toolkit are discussed in detail in **Section 4.4**. In addition to developments in inflation forecast tools, improved monitoring and forecasting of other variables (including wages, GDP and the GDP deflator) could have a positive impact on inflation forecasting.

The experience from the recent past highlights the need for comprehensive risk assessment around the baseline projections. High uncertainty regarding the magnitude, persistence and effects of the large shocks experienced in the past few years means that the risks surrounding baseline forecasts grew increasingly large. While the sensitivity analysis can cover more "standard" uncertainties, especially as regards the technical assumptions, scenarios can also be an effective way to represent risks entailed in specific events when uncertainty is high or hard to quantify (see **Section 4.3**).

Box 6
Comparing the performance of ECB/Eurosystem staff inflation projections against financial market inflation expectations

By N. Lawton, G. Martorana, J. Paredes and F. Schupp

Accurate inflation forecasts are essential for central banks, making frequent evaluation of their performance crucial. Market-based measures of inflation expectations, in addition to other indicators, can provide a useful cross-check for ECB/Eurosystem staff inflation projections.[148] **For the euro area, these market-based expectations are typically derived from** *inflation fixings and inflation-linked swaps (ILS).*[149] Taken at face value, the prices of these contracts can be considered to be market-based forecasts of year-on-year inflation rates.[150] **While market-based inflation forecasts and ECB/Eurosystem staff projections are typically closely aligned, there have been periods when there were larger differences, such as during the inflation surge across 2022-23.** Analyses in this box focus on the comparison between ECB/Eurosystem staff projections and inflation fixings. It should be noted that the comparability of the forecast quality suffers from the fact that it is difficult to align published forecasts and market expectations, as ECB/Eurosystem staff projections are typically published quite some time after their cut-off dates (especially for technical assumptions).[151]

The relative performance of market-implied inflation forecasts and ECB/Eurosystem inflation projections varies across different sample periods and projection horizons (Chart A, panel a). Between 2013 and 2024, market-implied inflation forecasts showed greater accuracy on

[148] See Work stream on inflation expectations (2021) or Chahad et al., 2024.

[149] Fixings are swap contracts tied to monthly euro area inflation releases, available from the current month up to 23 months ahead. For the first year, they represent year-on-year inflation rates. In contrast, ILS contracts have fixed maturities of 1 to 30 years, with reference months changing monthly. In the euro area fixings and ILS are linked to the euro area's *HICP excluding tobacco*.

[150] It is important to note that rates for inflation compensation will reflect both genuine inflation expectations and inflation risk premia, although for shorter maturities (especially up to 1 year) these premia are typically estimated to be small. See for example Burban et al., 2021 for a discussion.

[151] See also "A guide to the Eurosystem/ECB staff macroeconomic projection exercises" (2016).

average at shorter horizons of up to nine months (dark blue line), while staff forecasts on average outperformed market-implied inflation forecasts at horizons beyond 12 months (light blue line).[152] **The outperformance of market-based inflation forecasts at shorter horizons likely reflects their good performance during times of high energy inflation (as detailed below), while the outperformance of staff forecasts at horizons beyond the short-term might reflect the fact that market-based measures at longer horizons are more susceptible to distortions stemming from inflation risk premia.**[153,154]

The greater accuracy of market-implied inflation forecasts at shorter horizons appears to be due to their relative performance during the period of high inflation between 2022 and 2023 (the difference between the dark blue line versus the red and yellow lines, Chart A, panel a). This may be attributed to the ability of market participants' to quickly incorporate notable data surprises or events that have a significant impact on inflation and inflation volatility (such as commodity price fluctuations) into their projections, whereas ECB/Eurosystem staff projections typically follow a fixed schedule with certain cut-off dates for the assumptions, the use of a ten-day-moving average for commodity price assumptions and the exchange rate, and a set of assumptions that is adjusted only from time to time.[155] However, ECB/Eurosystem staff have also reacted flexibly to such events when required, for example by introducing ad hoc changes to the set of energy assumptions from December 2021 in light of rapidly rising energy prices. The establishment of a new common framework for energy commodity price assumptions was introduced, later in June 2022, following the Russian invasion of Ukraine. By that time, the contribution of both gas and electricity amounted to roughly half of the HICP energy inflation component.

ECB/Eurosystem staff projections mostly outperformed market-based forecasts in the low inflation period between 2016 and 2020, and consistently beyond horizons of one year over the full sample period (the yellow, green and light blue lines in Chart A, panel a). The lower accuracy of market-based inflation forecasts appears to be rooted in the weakened efficiency of markets in the period between 2016 and 2020 (yellow line), **as suggested by statistical analyses.**[156] One rationale for this weakened efficiency is a potential decline in demand for short-term inflation protection, as inflation had been persistently low since 2013, which may have contributed to a deterioration in the price signal**. However, it should be noted that since inflation**

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152 When comparing market-based inflation forecasts with ECB/Eurosystem staff projections, it is crucial to consider the timing of the input data cut-off dates for the staff projections, as they usually do not coincide with their publication dates. Typically, the cut-off dates for the staff projections and technical assumptions are between two and three to four weeks before the Governing Council meeting, respectively. Throughout this box, we align fixings with the macroeconomic projections cut-off date for the staff projections. Note that while this choice aligns the information sets underlying the two forecasts as much as possible, some misalignments remain as the technical assumptions underlying staff forecasts are not updated again on the cut-off date for the macroeconomic projections.

153 In addition, further distortions might stem from technical factors such as low market liquidity. Taking such distortions into account by means of a model-implied decomposition of ILS rates into genuine inflation expectations and inflation risk premia, empirical results suggest that market-based forecasts of euro area inflation perform equally aswell as ECB/Eurosystem staff projections, including at longer horizons. See Grønlund et al.(2024).

154 The results presented are in line with findings by Anttonen and Laine (2024), who also find that fixings statistically significantly outperformed Eurosystem staff projections at horizons of two and three months.

155 See Sections 4.2.1 and 4.2.3 for a further discussion on assumptions used within ECB/Eurosystem staff inflation projections.

156 Following Anttonen and Laine (2024), the exercise examined the variation in 11-month, 12-month, and 13-month swap prices within a month and their evolution over time. The 12-month swap, traded since 2004, served as a mature benchmark, while 11-month and 13-month fixings, introduced only in 2016, represent the newer fixings market. The assumption is that higher covariance within months indicates greater market efficiency.

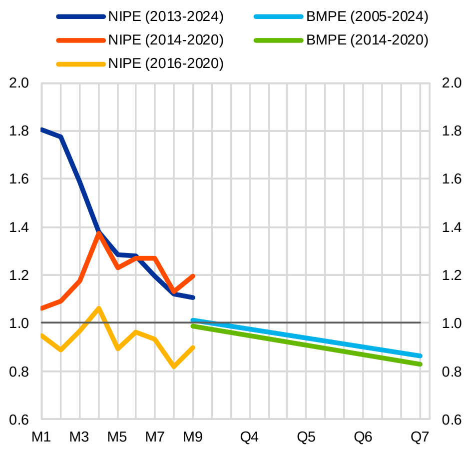
returned to lower levels in 2024, financial market forecasts have continued to show a similar forecasting performance over shorter horizons compared to staff projections when assessing the respective RMSFEs (e.g. the three-month RMSFE in 2024 was 0.17 percentage points for ECB/Eurosystem staff projections compared with 0.22 percentage points for inflation fixings), suggesting that market-based forecasts do not necessarily underperform when inflation is closer to the target.[157]

Chart A

Comparison of forecast errors and the role of energy prices in forecast divergence

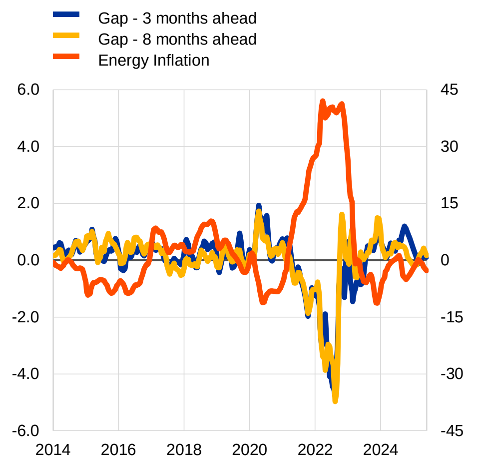
a) Relative forecast error: Eurosystem staff projections versus market-based inflation compensation

(Theil's U)



b) Historical (normalised) gap between ECB/Eurosystem staff projections and fixings three-months and eight-months ahead, and HICP energy inflation

(left-hand scale: percentage points, right-hand scale: annual percentage change)



Sources: LSEG, FENICS, Bundesbank and ECB calculations.
Notes: In panel a), Theil's U is computed as the ratio of the mean squared forecast error of the staff projections and financial market inflation forecasts for each respective maturity. A value of 1 indicates that both forecasts perform equally well, while values above 1 indicate better performance of market-based measures vis-à-vis the (B)MPE and vice versa. The full sample period (2013-24) includes fixings of up to nine months ahead. Beyond 12 months, the ECB/Eurosystem staff projections is compared with ILS given the longer available sample size where fixings at such maturities are only available from the end of 2018. In panel b), the blue and yellow lines show the (normalised) gap (three-period rolling average) between the ECB ECB/Eurosystem staff projections and fixings for the three-month and eight-month forecast horizon respectively. The red line is year-on-year energy inflation as measured by the HICP energy component. The latest observations are for December 2024 (panel a) and June 2025 (panel b).

The gap between ECB/Eurosystem staff projections and market-implied inflation forecasts fluctuates mainly owing to energy price changes, with market-based forecasts typically falling below the ECB/Eurosystem staff projections during low and negative energy inflation periods, and vice versa (Chart A, panel b). During the periods preceding and following the inflation surge, market-based forecasts generally fell below the level of the ECB/Eurosystem staff inflation projections. Conversely, in the high inflation period from 2022 to 2023, market-based forecasts frequently surpassed the ECB/Eurosystem projections to the upside. Such divergences appear to be closely linked to energy price inflation, with strong energy inflation or deflation leading to greater divergence. In fact, there is a negative correlation of close to 80% between energy inflation and the difference in three-month ECB/Eurosystem staff projections and market-based inflation forecasts. This indicates that energy prices are a crucial factor in explaining the differences between market-based forecasts and staff projections, particularly over shorter time horizons.

[157] To compute RMSFEs for 2024, forecast accuracy for the Eurosystem staff projections was evaluated against the HICP rather than HICPxT due to data availability. For fixings, the evaluation was completed against the HICPxT.

Additionally, this is in line with market-based forecasts incorporating information more flexibly than ECB/Eurosystem staff projections, as previously mentioned. Of course, the quicker incorporation of incoming data by markets is not necessarily limited to only energy prices and could potentially extend to other less volatile components of the inflation basket.

In summary, the relative forecast accuracy between ECB/Eurosystem staff projections and financial market-based inflation forecasts is conditional on the inflation environment, the forecast horizon and the prominence of energy inflation. Over the available sample period, market-implied forecasts seem to have slightly performed better at shorter horizons especially in the high inflation period, seemingly reflecting the fact that financial markets more quickly adapted to major energy price developments affecting the inflation outlook during the surge. On the other hand, ECB/Eurosystem staff projections provided more accurate forecasts during periods of lower and more stable inflation and generally for horizons beyond one year.

The results of this box highlight the usefulness of financial market-based forecasts as a cross-check for the ECB/Eurosystem staff projections. With this in mind, one key advantage for policymakers stemming from market-based forecasts is that they continue to provide an updated set of expectations in the period following the finalisation of staff projections and before the dates of Governing Council monetary policy meetings. On the other hand, market-based inflation forecasts do not allow for a strong understanding of the drivers underlying changes in inflation forecasts, as is the case with the ECB/Eurosystem staff projections. Ultimately, market-based measures of inflation expectations should be viewed as a complementary tool to staff forecasts in addition to various other cross-checking tools. Additionally, evaluating the usefulness of market-based measures of inflation expectations in existing inflation forecasting tools can help enhance predictive accuracy and provide a more comprehensive view of inflation dynamics.

Box 7
The role of underlying inflation measures in complementing information on the inflation outlook

Marta Bańbura and Elena Bobeica

Introduction

Underlying inflation has always been an important concept for central bankers and it has become even more relevant since 2021, amid surging inflation and high uncertainty. The previous strategy review concluded that the Eurosystem's public communication should regularly and consistently refer to measures of underlying inflation (see ECB, 2021). Since then the heightened level of uncertainty, the unprecedented size of the inflationary shocks and the resulting large forecast errors have elevated the role of underlying inflation in the conduct of the ECB's monetary policy. The ECB took a pragmatic approach under the data dependence framework and introduced a three-pronged reaction function whereby policy rate decisions were based on the assessment of the inflation outlook in light of the incoming economic and financial data, the dynamics of underlying inflation and the strength of monetary policy transmission (Lagarde, 2023; Monetary Policy Strategy Assessment 2025, Workstream 2 report). This box focuses on the second pillar of the reaction function, namely the dynamics of underlying inflation, and highlights both benefits and challenges of using underlying inflation as a complementary cross-check for the inflation outlook. It is worth noting that the concept of underlying inflation differs from that of long-term trend inflation when it comes to the horizon over which shocks dissipate: while underlying inflation reflects medium-term developments linked to the business cycle, the long-term trend inflation captures more persistent, longer-term components related to structural factors (as described in **Chapter 3**).

Underlying inflation is an unobservable variable that aims to capture the more generalised developments across prices, abstracting from volatile or idiosyncratic relative price movements, and serves as a signal for where headline inflation will settle in the medium term. In practice, underlying inflation is proxied or estimated and there are two broad categories of measures: (1) exclusion-based measures, where certain items are omitted according to simple rules, such as high volatility or greater sensitivity to global factors rather than to domestic fundamentals, and (2) model-based measures, which capture more complex channels and dynamics. The ECB monitors a rich set of measures belonging to each category, including the HICP excluding energy and food and the Persistent and Common Component of Inflation (PCCI).[158]

The unobservable nature of underlying inflation means that its measurement comes with inherent uncertainty. The width of the monitored range can shed light on the level of this uncertainty. In the case of the euro area, the period between mid-2022 and mid-2023 marked a peak in how dispersed the various measures were, with a range exceeding 4 percentage points. An additional aspect to be considered is that several indicators, including the PCCI, are subject to revisions, in particular at the end of the sample period. While such changes are generally very limited, there were more notable revisions around mid-2022.

Signalling properties of underlying inflation

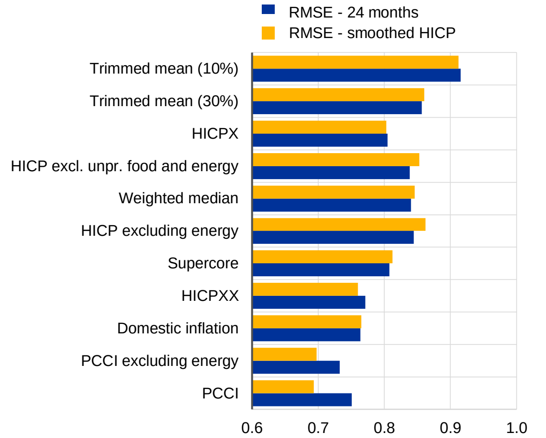
Measures of underlying inflation provide useful information about future headline inflation, with some measures performing better than others. Chart A shows the root mean squared forecast error (RMSFE) for each measure vis-à-vis inflation two years ahead and vis-à-vis a smoothed inflation rate. Forecasting performance is normalised to the predictive power of current headline inflation: that is, a ratio below unity means that the measure does a better job than current headline inflation in forecasting future inflation. The PCCI measures have the best predictive power over the entire sample period, including when focusing on the most recent period (Chart B). Most exclusion-based measures perform less well. The picture is consistent across various evaluation criteria and forecasting horizons. However, it is important to note that the relative accuracy tends to vary over time, as evident from the changes in the optimal forecast weight shown in Chart B. A similar assessment was put forward in the previous strategy review, together with the recommendation that a broad range of measures of underlying inflation should be monitored. The occurrence of extraordinary large shocks since then has allowed for a better understanding of how the various measures of underlying inflation adjust to shocks. This has shed light on the speed and sequencing of the disinflation process, which is essential for understanding the inflation process and calibrating monetary policy and goes beyond assessing overall predictive power. Specifically, external shocks were a prominent feature of the post-pandemic economic landscape. PCCI measures captured their impact in a more timely way and also provided a powerful signal that these shocks would ultimately fade out, providing evidence that they had superior forecasting properties.

[158] The PCCI belongs to the second category and is extracted from granular price data at the item-country level via a factor model, see Bańbura and Bobeica (2020). A more detailed discussion of various measures can be found in Ehrmann et al. (2018), and Bańbura et al. (2023). Other model-based measures include e.g. ICARIS (Le Bihan et al., 2024), Albacore (Goulet Coulombe et al., 2024) or Multivariate Core Trend inflation (Almuzara and Sbordone, 2024), and Underlying Composite Inflation (Banca d'Italia Economic Bullettin, April 2024).

Indicators such as services inflation or domestic inflation featured a more delayed adjustment to shocks and served to highlight that convergence to the medium-term inflation target would not be immediate. For these reasons, monitoring different measures, understanding their properties and what drives the differentials between their levels (which at times can be substantial given that these measures adjust to shocks at different speeds) is useful for a more comprehensive assessment of inflation developments and outlook.

Chart A

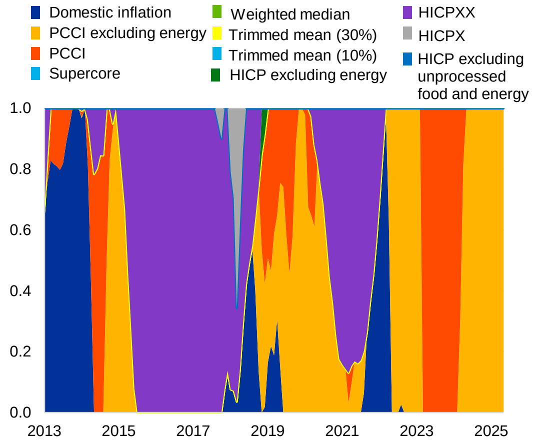
Predictive properties of measures of underlying inflation for HICP inflation



Sources: Eurostat and ECB calculations.
Notes: RMSFE 24 months and RMSFE smoothed HICP are the root mean squared forecast errors of each measure with respect to headline inflation 24 months ahead and the two-year moving average of inflation covering two years of future data respectively, divided by the RMSFE of headline inflation. A ratio lower than unity indicates that the measure performs better than headline inflation. The sample covers the period from April 2001 to April 2025.

Chart B

Measures of underlying inflation measures selected in an optimal forecast combination



Sources: Eurostat and ECB calculations.
Notes: Optimal weights for combining the 11 underlying inflation measures are assigned to minimise forecast errors for headline inflation 24 months ahead (RMSFE 24 months ahead over a three-year rolling window). The latest observations are for May 2025.

Link between underlying inflation and staff inflation forecasts

Underlying inflation can be helpful as a first unconditional and judgement-free cross-check for the inflation narrative embedded in the projection exercises and risks surrounding the baseline. Such a cross-check could be undertaken by looking both at the levels and at the dynamics of underlying inflation. When considering the *levels*, it should be noted that in certain circumstances underlying inflation might also be affected by temporary and volatile factors.[159] As shown in Chart C this has been the case in the recent inflation episode – energy and supply bottleneck shocks had a sizable impact on measures of underlying inflation. Correcting for such impacts renders the measures more indicative of medium-term developments (see Lane, 2024). Nevertheless, even after such a correction the level of the measures was elevated throughout 2022 and higher than the medium-term projections. In general, a wide gap between underlying inflation and end-of-horizon inflation projections warrants a careful assessment and attention to incoming data irrespective of caveats related to the level of underlying inflation. With levels distorted by recent economic dislocations, monitoring the *changes* in underlying inflation (alongside developments in wages, profits and expectations) might be more informative for assessing risks to the outlook for inflation. While such changes have not always gone hand in hand with the revisions

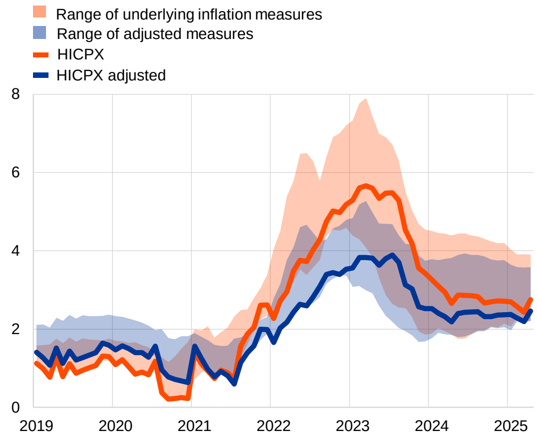
[159] A real-time forecast evaluation suggests that the level of underlying inflation does not outperform the staff projections in forecasting inflation two-years ahead, even if some measures like the PCCIs come close.

to medium-term inflation projections, over the recent high inflation period there seems to have been some connection (see Chart D). Overall, given that underlying inflation is an unconditional gauge of medium-term inflationary pressures, it can provide a useful input for assessing whether the inflation profile embedded in the projections is consistent with the latest information.

Chart C

Measures of underlying inflation and their counterparts free of the impact of energy and supply-side bottlenecks shocks

(annual growth rates)

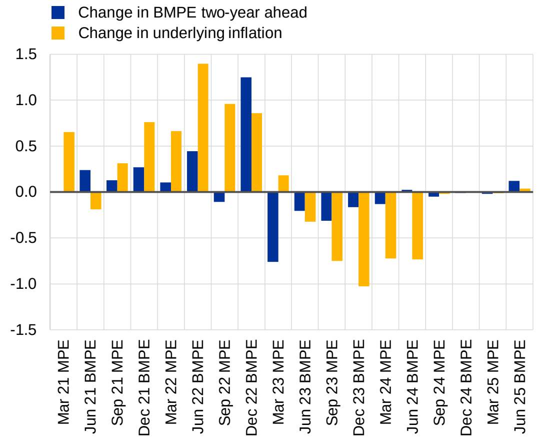


Sources: Eurostat and ECB calculations.
Notes: The range is over the measures considered in Charts A and B. The 'adjusted' measures abstract from energy and supply-bottlenecks shocks using a large SVAR, see Bańbura et al. (2023b). The latest observations are for April 2025.

Chart D

Revisions in two-year ahead staff inflation projections and changes in measures of underlying inflation

(percentage points)



Sources: Eurostat, ECB calculations and staff projections.
Notes: Underlying inflation figures refer to changes in the level of the average of the range at the cut-off date of each projection round compared with the cut-off date of the previous rounds. Revisions in staff projections refer to changes in projected two-year-ahead headline inflation.

4.3 Complementing baseline forecasts to increase their robustness

Increased uncertainty owing to large shocks challenges macroeconomic forecasting and monetary policy design. In the presence of large and new shocks and ongoing underlying structural trends, the euro area has faced an increase in uncertainty, which poses a significant challenge for macroeconomic forecasting and for the design of monetary policy. The increase in uncertainty reflects both the more frequent and larger shocks as well as their transmission, as larger shocks might entail non-linear reactions and even structural changes, if these shocks have a permanent component. This section looks at the existing measures of forecast uncertainty, in particular the use of scenarios in the staff macroeconomic projection exercises. It also presents some principles that could guide the conduct of scenario analysis in the future. The terms "risk" and "uncertainty" are used interchangeably in this section.

4.3.1 Assessing existing measures of forecast uncertainty

The Eurosystem utilises a comprehensive toolkit to account for forecast uncertainty. This toolkit includes market-based sensitivity analyses, density forecasts, quantitative risk assessment (QRA) based on a survey among Eurosystem/ECB staff, and scenarios of discretionary risk events. Each of these tools covers different aspects of uncertainty (see also Lane, 2024).

Sensitivity analyses assess the implications for real GDP growth and HICP inflation of individual alternative paths of technical assumptions, on which the projections are conditioned. The impact of alternative paths of technical assumptions is quantified in isolation and irrespective of the nature or origin of underlying (structural) shocks. Typically, these sensitivity analyses include alternative paths for energy prices (oil, gas and a synthetic energy price index) and for exchange rates, and are carried out using the BMEs, the ECB-BASE, and the NAWM(II). Alternative technical assumption paths are derived from option-implied densities or simple random walk assumptions. Assessing these option-implied densities through the lenses of macroeconomic projection models results in conditional model-based densities or probability distributions around the baseline projection. In this case the results from the sensitivity analyses provide a market-based risk assessment that might not correspond to the staff assessment of the balance of risks and uncertainties surrounding the baseline.

Model-based densities, densities based on past projection errors, and the survey-based density forecast are used to assess risks surrounding the baseline projections. Conditional and unconditional model-based densities stemming from traditional forecasting models or quantile regressions complement symmetric ranges around point forecasts derived from past projection errors that the Eurosystem communicates to the public.[160] [161] Furthermore, the internal survey-based density forecast, the so called QRA, summarises staff views on the main risks surrounding the respective country projections in Eurosystem staff macroeconomic projections and the euro area projections in ECB staff macroeconomic projections. The QRA includes a ranking of the main risk events in terms of deviations from the central projections (upside or downside risk events) and a manual assessment of the volatility factor. The results from the QRA represent the staff judgement-based assessment about variance and skewness around the baseline.

Scenario analysis explores complex "what if?" questions by quantifying the macroeconomic impacts of hypothetical events that diverge from the baseline narrative. Specifically, it examines the macroeconomic consequences of hypothetical events or economic conditions that depart from the baseline narrative. The spectrum of hypothetical events or economic conditions ranges from political and economic shocks –such as wars, financial crises, disruptions to oil production, or tariffs on trade – to specific economic assumptions that might alter the transmission of shocks, such as an alternative assessment of underutilisation or labour market

160 See Box 6 Illustrating the uncertainty surrounding the projections in the March 2023 ECB staff macroeconomic projections for the euro area.

161 The report of the WGEM/WGF expert group on Macro at Risk examines further how structural models can incorporate non-linearities to generate tail risks.

slack. A typical scenario would consist of one or two broad sets of changes compared with the baseline: (i) additional shocks over the projection horizon, and/or (ii) changing features of the macroeconomic propagation mechanism. As discussed below, the scenario analysis is part of the staff risk assessment to the extent that the risk events quantified in the scenario analysis are incorporated in the QRA. The results from the scenario analysis are not associated with a specific likelihood assessment.

No single tool can fully capture overall forecast uncertainty, which highlights the importance of including different uncertainty measures. As each tool covers different aspects of uncertainty, none of them is sufficient by itself alone to account for overall forecast uncertainty. The following characteristics of uncertainty measures are important: (i) ease of interpretation and communication to the Governing Council; (ii) ability to tell a narrative, i.e. ability to shed light on the mechanisms through which the risk could have an impact on the economy; (iii) forward-looking nature; and (iv) ability to assess the probability of risk factors (**Table 1**).

Table 1

Characteristics of existing uncertainty measures

(yes/no indicate whether a characteristic is fulfilled or not)

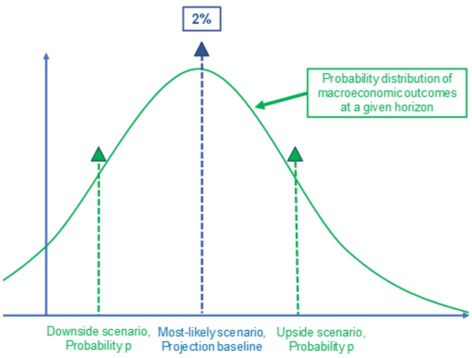
	Sensitivity analysis	Density forecasts / past projection errors	Density forecasts / model-based	QRA	Scenarios
Easy to interpret and to communicate to the Governing Council	yes	yes	no	yes/no	yes
Narrative-based: informs on the mechanisms through which the risk would affect the economy	no	no	no	no	yes
Forward-looking	yes	no	yes	yes	yes
Enables the probability of risk factors to be assessed	yes	no	yes	yes	no

Scenario analysis – being intuitive, narrative-based and forward-looking – might offer an advantage over other tools for measuring uncertainty, if scenarios could be combined with an assessment of their likelihood. None of the existing measures fulfils all characteristics. The scenario analysis is probably the only tool that can circumvent its drawback, namely the inability to assess the probability of risk factors. In theory, a small number of scenarios combined with corresponding probabilities could provide insight into the forecast distribution. For instance, a symmetric forecast distribution can be represented by one downside and one upside scenario with equal probabilities. Multi-modal or skewed distributions can be represented by a medium-impact/high-probability scenario or by a high-impact/low-probability scenario (see **Chart 49**). Furthermore, in uncertain times with the frequent occurrence of large and unusual shocks, it is conceivable that the conditions underlying the baseline projection might not materialise, which could call for focussing less on the baseline projection and for adding alternative scenarios (Bernanke, 2024).

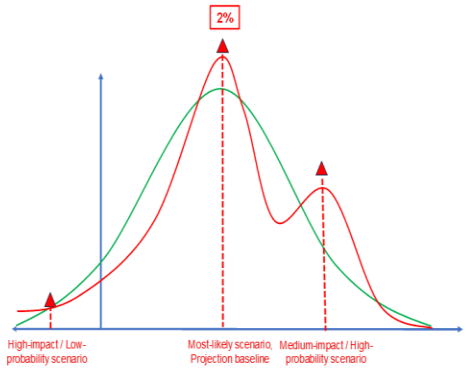
Chart 49

Two probability distributions around the same 2% inflation baseline

a) Symmetric distribution



b) Multi-modal and skewed distribution



Sources: The chart uses an analogy to the literature on numerical integration regarding Gaussian quadrature. For details, see Miller, A.C. and T. Rise (1983), "Discrete approximations of Probability Distributions", Management Science, Vo.29, No.3.

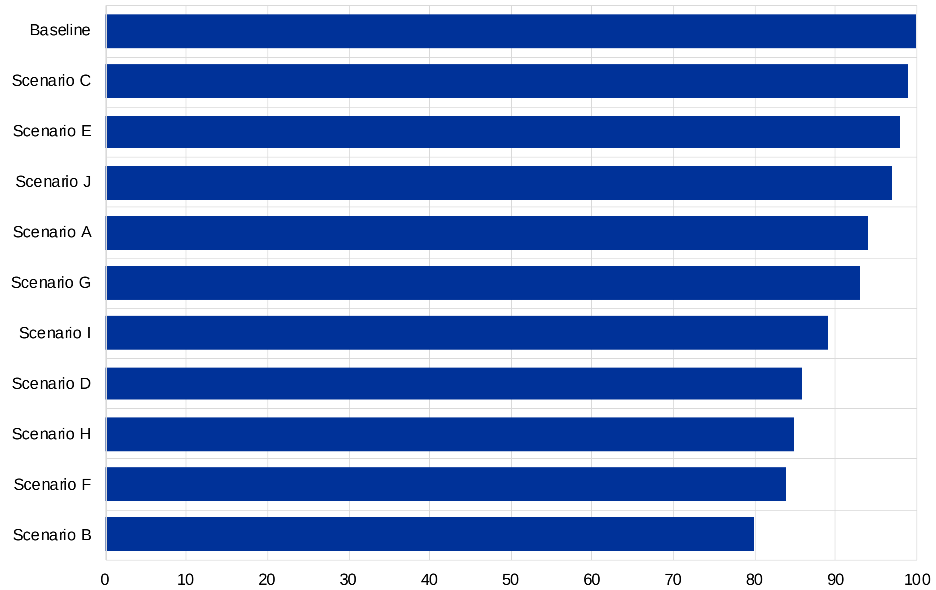
The QRA could potentially be used to form a subjective view of the likelihood of scenarios, using inter alia statistical information about the density of joint outcomes for GDP growth and inflation. As it is a staff survey about the volatility and skewness of the distribution of outcomes around the baseline, the QRA could also shed light on the relative likelihood of considered scenarios. However, it ultimately relies on subjective expert judgement, which cannot be assessed through a formal statistical analysis. To establish a framework for formal statistical analysis, ECB staff have developed a judgement-free approach to estimating the joint unconditional density of real GDP growth and HICP inflation (see **Chart 50** for an example). This approach has two key features: first, it evaluates the likelihood of joint growth and inflation profiles across various scenarios, capturing their dynamic interactions and providing more accurate estimates than isolated analyses. Second, it uses baseline projections as the most likely outcome while incorporating relevant risk information from the data. This framework highlights the relative likelihood of scenario outcomes based on historical patterns and baseline projections, without incorporating judgement. Importantly, it does not assess the likelihood of specific shocks, but focuses solely on the likelihood of scenario outcomes regarding growth and inflation.[162] While this approach may not encompass the entire information set available to ECB staff or policy makers, it serves as a valuable component in the comprehensive evaluation of the relevance of scenarios.

[162] To this end, the framework developed by ECB staff uses two widely used and complementary statistical tools to estimate the distribution of the joint profiles of scenario outcomes in terms of real GDP growth and HICP inflation based on historical regularities. These tools are (i) factor-augmented quantile regressions and (ii) copulas (see Battistini, Chahad and Fonseca, 2025). Each tool estimates a specific likelihood of the joint profile of growth and inflation in each scenario, and then centres it around the baseline projections (so that the profiles in the baseline represent the mode of the distribution). The framework computes the likelihood of each scenario as the average of the likelihoods produced by the two tools.

Chart 50

Illustrative example of the relative likelihood of the *joint profiles* for GDP growth and inflation across different scenarios

(percentage, relative to the baseline density)



Source: ECB.
Notes: The chart shows the likelihood (relative to the baseline) of the outcomes (in terms of the joint paths of real GDP growth and HICP inflation) of illustrative scenarios, regardless of (i.e. not conditional on) the shocks and the models used to produce the scenarios. The estimated likelihoods are based on the historical distribution of the joint profiles for growth and inflation (adjusted so that the baseline is the mode, i.e., the most likely scenario). As such, these estimates can shed light on the relative likelihood of each scenario outcome given historical regularities and the baseline projections without judgement.

4.3.2 The use of scenarios since the pandemic

The ECB/Eurosystem approach to scenarios and sensitivity analysis has evolved significantly, particularly during the COVID-19 pandemic, highlighting the value of narrative-based scenarios in economic forecasting (Ciccarelli et al., 2025**)**. Before the pandemic, in the context of the ECB/Eurosystem staff macroeconomic projections, the ECB regularly published projections ranges based on past projection errors and sensitivity analyses, and only occasionally included ad hoc scenarios related to international shocks. However, the COVID-19 pandemic marked a turning point in the use of scenarios. During those highly uncertain times two scenarios reflecting varying assumptions about the evolution of the pandemic complemented the baseline: a mild scenario which assumed that the pandemic restrictions would be lifted earlier than foreseen in the baseline, and a severe scenario which assumed stricter restrictions compared with the baseline. This provided insight into what was driving changes and supported discussions of different options for policy action. In fact, for the June 2020, Eurosystem staff initially worked on three pandemic scenarios and only in the course of the projection exercise was it decided which scenario would be the baseline projection. This approach underscores the main advantage of scenarios, which is that they come with a narrative and, in this respect, offer a guide as to the likely evolution of the economy.

Scenarios have proven essential in evaluating the economic impact of geopolitical tensions, by capturing risks that the sensitivity analysis overlooked. Lately scenarios have been instrumental in assessing the impact of geopolitical tensions, such as the war in Ukraine and potential conflicts in the Middle East. For instance, the ECB developed scenarios to evaluate the effects of the war in Ukraine and rising energy prices on inflation. This provided insights where standard sensitivity analysis failed to account for extreme developments (**Chart 51**). The war in Ukraine and subsequent rises in energy prices led to a significant and unexpected surge in inflation. This could not have been foreseen in the central projections, given that they are conditioned on oil and gas price futures as expected by markets and on other more technical assumptions. Nor could it have been foreseen by the sensitivity analysis (**Chart 51**). Scenario analyses, however, assumed energy price spikes similar to those that materialised. Specifically, the assessment of scenarios helped by pointing to the risk of much larger increases in energy commodity prices and consequently much higher inflation in 2022 (the Ukraine war scenario published in March 2022 already foresaw inflation reaching 7% in 2022, and around 8% in the scenarios published in June and September 2022). In this respect, the inflation scenario was useful for informing the ECB's policy and its public communication. Recent scenarios related to US import tariffs have been valuable for navigating the unpredictable landscape of US trade policy.

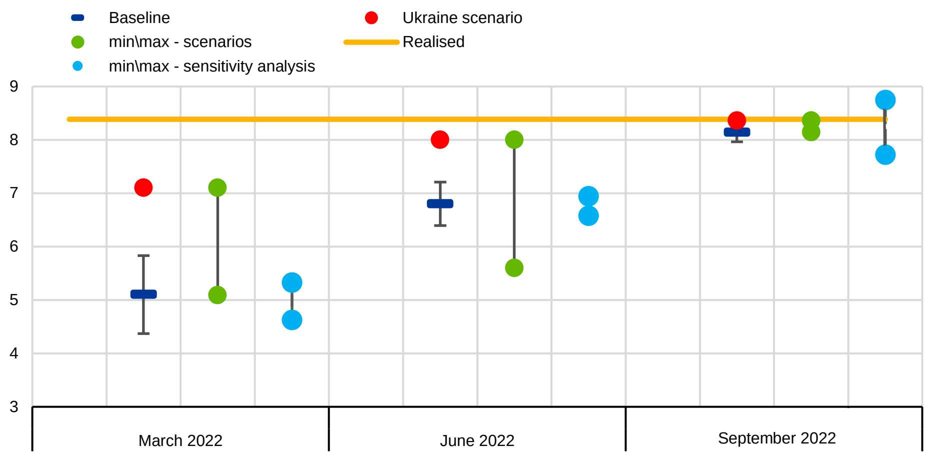
Scenario analyses now incorporate alternative macroeconomic assumptions to address uncertainties in the transmission channels. Besides risk events stemming from the international environment, the scenario-like analyses have recently also covered alternative assumptions about macroeconomic propagation, such as a stronger or weaker wage-price pass-through than assumed in the baseline projection, and differing evolutions of profit mark-ups, consumer confidence and productivity growth. The need for of such scenarios stemmed from the high uncertainty surrounding the transmission of new and large shocks.

Retrospective assessments of scenarios reveal their limitations in predicting developments with precision, yet they effectively highlight risks and inform policy decisions when combined with sensitivity and risk analyses. In retrospect, it is not easy to assess how those scenarios compared with actual developments. This is because scenarios are very specific and do not unfold in exactly the same way as assumed. For example, in the Ukraine scenarios, assumed energy price hikes came close to actual developments, but the underlying assumptions of this scenario – such as a disruptive halt of Russian gas deliveries to Europe – never materialised. However, as pointed out above, comparing the scenario analysis with the sensitivity analysis for 2022 reveals that the Ukraine scenarios helped to highlight the risks associated with much higher energy prices, which the sensitivity analysis did not take into account (see **Chart 51**). This speaks in favour of using scenario analysis to complement the assessment by including aspects not included in the baseline projections. For instance, a specific scenario can be confirmed or rejected as events unfold. Should the course of events confirm the narrative of a scenario, its quantitative estimates could be incorporated into the baseline projection, as was done during the pandemic. Together with sensitivity and risk analysis, scenarios provide a robust toolkit for preparing for contingency or emergency planning and to give policymakers potential courses of action for alternative futures.

Chart 51

HICP inflation in 2022: alternative scenarios and sensitivity analysis

(annual percentage changes)



Source: Eurosystem/ECB staff projections and ECB calculations.
Notes: The ranges surrounding the respective baseline refer to a measure of uncertainty based on past projection errors, after adjustment for outliers, showing the 90% probability that the outcome of HICP inflation will fall within this interval. For the min\max ranges, "min/max – scenarios" refers to the highest and lowest outcome from various scenarios including scenarios on the war in Ukraine, higher inflation expectations, real wage catch-up etc, while "min/max – sensitivity analysis" refers to the highest and lowest outcome from sensitivity analyses related to energy prices, exchange rates and market interest rates.

4.3.3 The future use of scenarios

The usefulness of scenarios was underpinned by the findings of the Bernanke report[163], which are in a general sense also relevant for the Eurosystem. The Bernanke report underlines the importance of scenario analysis for enhancing the forecasting and decision-making process within the Bank of England. It also argues that "scenario analysis can help policymakers adjust their strategy to account for risks […] Under a policy approach known as risk management, policymakers might choose to take out some 'insurance' against bad outcomes." While a risk management approach might be useful for quantifying an optimal policy path under selected scenarios, in a highly uncertain world it is not possible to account for all possible contingencies (see **Chapter 4** of the Workstream 2 report). Furthermore, the implementation of such a risk management approach might require some information about the likelihood distributions of the scenarios and how these distributions map onto the risk distribution around the baseline projection. As argued below, such information is not given owing to the intrinsically subjective nature of the likelihood assessment of any given scenario.

Scenarios continue to be one of the main tools for assessing the risks and uncertainties related to alternative events or narratives. The alternative

163 Bernanke (2024).

narratives reflect the major sources of uncertainty in the minds of policymakers and forecasters. Examples include

- alternative narratives regarding major policy changes, such as measures that are likely to be introduced by a new administration;
- narratives regarding developments associated with ongoing or prospective crises, such as conflicts and pandemics, and the reaction of economic agents;
- alternative assumptions about the nature and strength of transmission channels, such as the impact of standard or non-standard monetary policy measures, including expectation formation, financial amplification effects, economic uncertainty, the strength of the exchange rate or wage-price pass-through, and the non-linear transmission of shocks
- alternative hypotheses underlying the baseline, for example the strength of TFP growth or labour force projections.

Since countless alternative scenarios are conceivable, a structured approach to the selection of scenarios is needed. The selection criteria should be guided by the relevance of the scenarios, which would in principle be based on three factors:

- potential impact;
- likelihood;
- implications for monetary policy.

It is important to distinguish between the potential impact of a scenario and the likelihood of its occurrence. A useful way to frame this difference comes from financial economics. The potential impact is the loss given default, while the likelihood is the probability of a default. A given scenario would be expected to have a specific impact on the variables of interest, irrespective of the likelihood of its occurrence.

The potential quantitative impact of a scenario is generally estimated for a core set of variables focused on the euro area aggregate. The main variable of interest is the impact on HICP inflation; other variables of interest are underlying inflation, GDP and the unemployment rate. There may be additional variables of interest depending on the specificities of the scenario.

A clear scenario design is a prerequisite for the quantification of the potential impact of a scenario. There is not one single design for scenarios. There is ample scope for a broad range of different designs, e.g. for an intensification of a specific crisis or the election of a new administration. The exact definition of an alternative scenario may thus require a consensus-building process. It is therefore important that the alternative scenario is intuitive and representative for a given event. The definition of the scenario comprises typically a set of conditioning variables, while alternative paths for just one individual variable are typically captured by sensitivity analyses.

The likelihood of any scenario is in principle gauged by a subjective assessment. The likelihood assessment may be informed by objective indicators, but it remains subjective. The likelihood of a scenario is generally independent of its potential impact. However, the subjective likelihood may depend on the exact design of the scenario, which in many cases evolves over time and thus must be frozen at a certain cut-off point. The potential impact of the scenario is quantified by staff who could also provide their qualitative assessment of its likelihood (high, medium or low). Assuming the likelihood of a scenario were known, and disregarding the uncertainties around the potential impact, a risk averse monetary policy would attach greater importance to scenarios with potentially high impacts on inflation. As an illustration, a hypothetical scenario which entails a 10% probability of a 1 percentage point impact on inflation, compared with the baseline, would be more relevant than a scenario with a 50% probability of a 0.2 percentage point impact. Put differently, scenarios with a relatively low impact, even if considered very likely to occur, are captured by general baseline uncertainties and are less relevant given that they only have minor implications for monetary policy. In contrast, scenarios with a potentially high impact entail the risk of significant monetary policy mistakes. However, extreme tail risk scenarios, such as major natural disasters or the deployment of nuclear weapons in the escalation of a conflict, would only be relevant if there were a consensus that such scenarios were relevant from the monetary policy perspective. The scenarios selected based on their potential impact, likelihood and relevance for monetary policy could then inform a risk management approach to monetary policy (see **Chapter 4** of the Workstream 2 report).

To be useful for the monetary policy deliberations of the Governing Council, scenarios need to be communicated to the Council in an intuitive way and should ideally illustrate some risks from the staff's overall risk assessment. To this end, it is necessary to avoid any proliferation of scenarios that could result from a likely diversity of views about countless possible alternative narratives and their respective relevance. It appears practical to limit scenarios to a small number. The selection of these scenarios would need to be based on the three factors discussed above, namely potential impact, likelihood and implications for monetary policy. The selected scenarios could be used to illustrate some risks underpinning the staff's overall risk assessment in an intuitive way. For example, if staff assessed risks to GDP growth and inflation to be tilted to the downside, the selected scenarios would contain corresponding macroeconomic impacts and could be used to intuitively illustrate some of these downside risks.

There are several operational aspects regarding the selection, preparation and likelihood assessment of the scenarios. The selection should be based on relevance, in line with the criteria discussed above. Scenarios should be selected by the Monetary Policy Committee (MPC)/Forecast Steering Committee in Eurosystem/ECB staff projection exercises at an early stage of the projection exercise, even though information about the relevance criteria may still be incomplete at that time. There may be some continuity and repetition of relevant scenarios in successive projection exercises. Nevertheless, scenario analysis provides a framework for dealing with unexpected risks that might unfold during projection exercises (e.g. the Russian invasion of Ukraine on 22 February 2022).

Therefore, the early preparation of scenarios should not come at the cost of constraining the agile deployment of additional relevant scenarios, even quite late in the projection process.

A structured and collaborative approach to scenario analysis ensures clarity, coherence and robustness in economic projections, particularly during Eurosystem projection rounds when both NCB and ECB staff contribute to the process. The scenario process should ideally begin early in a projection exercise, with NCBs either contributing directly to the scenario analysis in a bottom-up approach, as was done during the pandemic for example, or having the option to provide complementary analysis from an early stage on. At the time of scenario selection, an outline should already be available, including a proposal for scenario definitions and the envisaged modelling approach. Staff would then prepare the analysis of a limited number of selected scenarios, carefully considering their relation to the baseline and weighing the costs and benefits of a collaborative approach involving both ECB and NCB staff. Further discussion may also be warranted later, if the underlying event or narrative of a scenario is still evolving and requires further assessment.

Overall, scenarios serve as a useful tool for assessing risks and uncertainties related to alternative events as part of the staff projection. To guide their future use in a systematic but context-specific approach, the following considerations are relevant. First, scenarios should be selected based on their relevance in terms of their potential impact, likelihood and implications for monetary policy. Second, the design of scenarios must be clear and intuitive, with a focus on core variables such as HICP inflation, GDP growth, and unemployment rate. Third, while the likelihood of scenarios is inherently subjective, objective indicators can inform the subjective assessment. Fourth, whenever possible, scenarios should be selected by the MPC at an early stage (or by the Forecast Steering Committee in ECB staff projection rounds), they should be limited in number and should illustrate staff’s risk assessment focusing on the most relevant risks. Fifth, especially in the context of emerging major or novel risks, a collaborative approach aimed at exploiting the entire technical capacity of the Eurosystem should betaken. Involving both NCB and ECB staff in the design or analysis of some scenarios, when appropriate, would ensure clarity and coherence in Eurosystem-wide economic projection exercises, allowing for agile responses to emerging risks; at the same time, such an approach should be deployed selectively since it would also add considerably to capacity needs, complexity, coordination costs and timeline challenges.

4.4 Analytical toolkit and priorities for model development

This section describes the main lessons since the last strategy review for economic modelling, and takes a look at the main direction being taken or planned for developing models. It also identifies some remaining gaps.[164] The section focuses on the so-called “core’” and ”satellite” models used specifically for

[164] The lessons learned and the ongoing directions for developing models have been obtained from the replies of Eurosystem modellers to a targeted questionnaire conducted specifically for this report.

policy activities, as well as on the procedures used in the context of the macroeconomic projections and policy preparation. With respect to the Review of macroeconomic modelling in the Eurosystem carried out in the context of the previous strategy review, the scope of this chapter is confined to providing an update on the modelling gaps identified since then. This exercise includes identifying the research activities that are useful to complement the core models in the policy process and that, over the next few years, could become part of a "core" framework of models for preparing policy. In fact, most of the modelling initiatives are currently directed towards developing satellite models more than generating new core models for the projections. The Eurosystem suite-of-models approach should make it possible to establish modelling frameworks that are resilient to uncertainty and can also lay the groundwork for the next generation of core models.[165]

4.4.1 Main lessons learned in relation to the Eurosystem analytical toolkit

Recent economic shocks have highlighted the need to better capture atypical economic fluctuations and increasing the granularity of models and data in monetary policy analysis. The lessons learned fall into two main categories: (i) the euro area and the global economy experienced unusual sources of fluctuations that were not always adequately captured by existing models, and (ii) greater granularity in models and data can improve the quality of monetary policy analysis. These insights align closely with the analysis in **Section 4.2**.

Supply chain disruptions were particularly large and had an unusual impact on the euro area and the global economy. It proved challenging to characterise supply driven cycles and, consequently, economic dynamics were more difficult to interpret and predict.

The strong fluctuations in gas and electricity prices were another important new analytical component. Before the Russia's invasion of Ukraine, global gas price and wholesale electricity price dynamics had been broadly neglected in the projection models, with minimal information loss, also because the correlation with oil prices was very high. Recent developments have encouraged modellers to reconsider this view.

In addition, the high inflation environment led to potentially strong indirect and second-round effects for inflation dynamics. More generally, recent events have highlighted the relevance of non-linearity/state dependence for inflation dynamics (see **Box 2**).

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165 Model development is a primary activity of the Eurosystem central banks, and it is also carried out in a broader context than the projection exercises. The modelling function across the ESCB has been coordinated through the activities and initiatives of the Working Group on Econometric Modelling (WGEM), a substructure of the MPC, in cooperation with its sister substructures: the Working Group on Forecasting (WGF) and the Working Group on Public Finances (WGPF). The WGEM has a double mandate to assist the MPC in fulfilling its tasks: (i) to promote improvements in the macro-econometric modelling toolkit to meet the needs of the Eurosystem, and (ii) to assess analytical and technical issues of interest to the MPC. Among the most valuable activities of the group, prominence is given to Expert groups that regularly tackle modelling issues of relevance for the MPC and the monetary policy preparation.

There has also been an increase in the use of sectoral and micro data. Most Eurosystem modellers have stressed how, for the recent real-time and ex-post assessment of economic developments, it was useful to rely on sectoral and microeconomic data sources and on models describing the economy at higher granularity levels than traditional macroeconomic models. Wider access to sectoral and micro data on inflation (and the adoption of related models) has made it possible to obtain a better understanding of the unusual transmission mechanisms of shocks hitting the euro area and the global economy. The analysis at a high granularity level has also made it possible to better calibrate judgement.

These lessons, which we have learned over the previous five years, point towards: (i) the inclusion of new inputs into the Eurosystem model toolbox and (ii) the development of new models (or enhancement of old models). We illustrate the practical implications of these lessons with examples below.

4.4.2 Including new inputs in the Eurosystem toolbox

Expanding the Eurosystem's toolbox with enhanced data usage and new measurements has improved the characterization of the relevant variables and mechanisms and has helped to refine model structures. These new inputs serve two main purposes: (i) they make it possible to measure emerging economic phenomena or provide a more precise assessment of existing ones, facilitating the development of coherent economic narratives, and (ii) they help to reassess commonly accepted elasticities and, in some cases, challenge existing model frameworks.

Regarding the enhanced use of existing data, several Eurosystem central banks have indicated that there is a more relevant role for global gas and electricity prices, and they will rely more on input-output tables and other sectoral data as well as an enhanced use of high-frequency indicators for more timely signals on economic developments.

Micro data on prices are used to study the state-dependence of price dynamics across sectors. Collective work in continuing the Eurosystem's PRISMA Network provides an example in **Chart 52**.[166] If prices are sticky, at a given point in time, there is a price gap between the actual price set by a retailer and its frictionless value. The greater the price gap, the more likely it is that the firm will adjust it. When the price gap is negative, the likelihood that prices will be adjusted upwards is higher than the likelihood of downward adjustments for positive gaps. Across sectors, state-dependence is much lower for services.

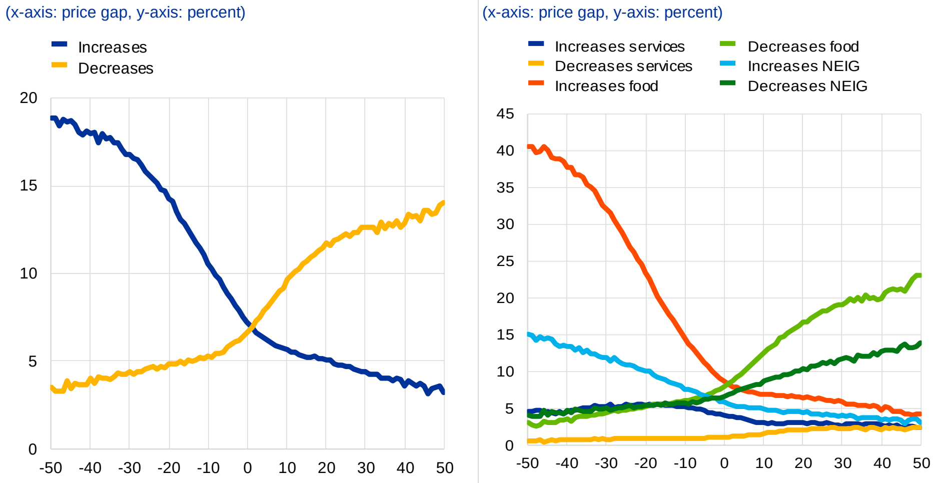
[166] Gautier et al. (forthcoming) "Price Stickiness in the euro area in times of high inflation". The work uses micro price dataset with the information used to compile national HICPs for Austria, Estonia, France, Germany, Greece, Italy, Latvia, Lithuania, and Spain.

Chart 52

State-dependence in consumer price adjustment in the euro area

a) **Frequency of price changes according to the price gap**

b) **Frequency of price changes according to the price gap by sector.**



Source: Gautier et al. (forthcoming) "Price Stickiness in the Euro Area in Times of High Inflation". Micro price dataset with the information used to compile national HICPs for Austria, Estonia, France, Germany, Greece, Italy, Latvia, Lithuania and Spain.
Note: The price gap refers to the percentage difference between each outlet's price and the price of competitors that have adjusted their prices in each month.

Another example of the enhanced use of existing data is the study of new trends in energy markets, which suggests that the elasticity of domestic inflation to global energy prices has changed (Quintana, 2024). Renewable energies can contribute to lower electricity prices and reduced volatility in the energy component of inflation through the decoupling of the price of fossil fuels and the price of electricity. However, the generation of renewable energy reduces wholesale electricity prices and extreme fluctuations only after certain thresholds are exceeded.[167] The effects are mainly observed when the percentage generated from inframarginal technologies is high, which in the euro area appears to be the case e.g. in Spain. It should be stressed, of course, that some energy sources (e.g. wind and solar energy) produce electricity only under certain weather conditions (e.g. when the wind blows, or the sun shines). This can lead to significant volatility in the supply of electricity. Therefore, not only will the electricity generated will no longer respond to demand, but demand will also have to adapt to the electricity generated in a flexible manner and prices will have to adjust to balance supply and demand.

Regarding new measurements, the impact of global supply bottlenecks on the euro area is stimulating the development of new indicators based on new data sources[168]. In the same vein, several uncertainty indices have been developed to

[167] See, for example, Cevik, S and Ninomiya, K. (2022), "Chasing the Sun and Catching the Wind: Energy Transition and Electricity Prices in Europe", IMF Working Paper, WP/22/220.

[168] For instance, Banco de España updates monthly and daily Supply Bottleneck Indices for seven economies (the United States, the United Kingdom, Spain, Germany, France, Italy, and China) based on textual searches in national newspapers, as explained in Burriel, P., Kataryniuk, I., Moreno Pérez, C. and Viani, F. (2024), "A new supply bottlenecks index based on newspaper data", Vol. 20 (2), International Journal of Central Banking, pp. 17-67, April..

assess the impact of trade, macro, political or financial uncertainty, following the seminal paper by Baker, Bloom and Davis (2016).[169]

Another important development is the use of survey-based[170] and firm-level[171] measures of capacity utilisation to measure Total Factor Productivity (TFP), potential output and the output gap. These analyses aim to reduce the pro-cyclicality of TFP measures and extract a cyclical component of real activity which is positively correlated with inflation irrespective of the source of shocks. [172] Moreover, capacity utilisation as a firm-level measure of slack can be used to develop an extended indicator that correlates more positively with inflation in the presence of strong supply shocks, can be decomposed into supply and demand contributions, and can be calculated for services and manufacturing separately. An estimate of sectoral output gap and potential output growth is produced by assuming that the distance between capacity utilization and its historical average represent the output gap (**Chart 53**).[173] Notice that the potential output series implied by the output gap shown in the chart leads to a volatile estimate of potential output growth. The series is thus smoothed using a Hodrick-Prescott filter before obtaining the growth rate estimates. The smoothing leads to part of the acceleration in services value added seen after the pandemic being attributed to potential output growth during the pandemic itself.[174]

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[169] See Baker, S., Bloom, N. and Davis, S. J. (2016), "Measuring Economic Policy Uncertainty", Quarterly Journal of Economics, November.

[170] See Comin, D. A., Quintana, J., Schmitz, T. G., and Trigari, A. (2024), “Revisiting productivity dynamics in Europe: a new measure of utilization-adjusted TFP growth”, forthcoming in the *Journal of the European Economic Association*.

[171] Survey-based output gap and potential output growth estimates are a good complement to currently used estimates. These measures are based on a data-driven approach that i) produces directly comparable estimates for all euro area countries, ii) provides sectoral-level information otherwise unnoticed in aggregate estimates and iii) reduces estimation uncertainty due to the lack of revisions to the survey data. See Gonzales-Torres Fernandez, G.et al. (2024).

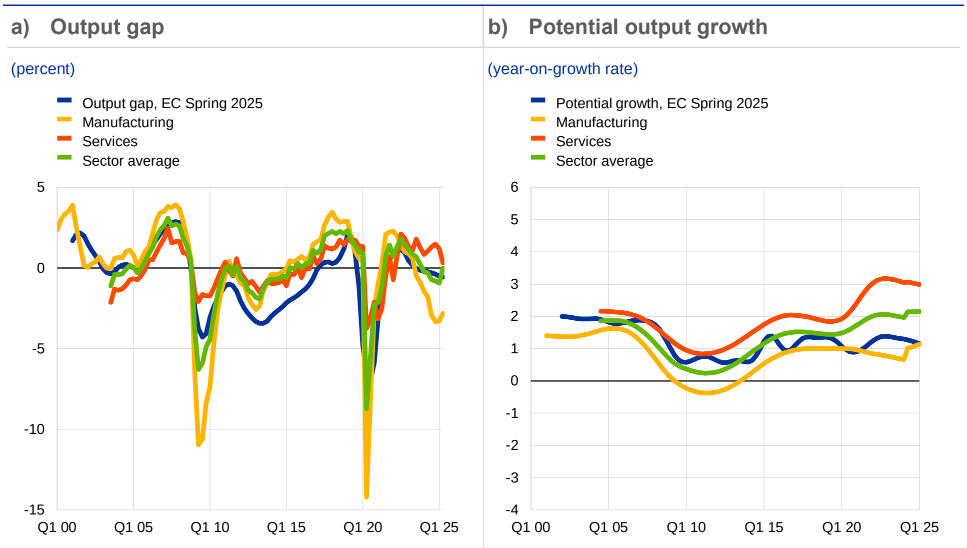
[172] Pönkä, H., and Sariola, M. (2021): “Output gaps and cyclical indicators: Finnish evidence”, Bank of Finland Economic Review No 6. This paper presented a novel method to derive the output gap based on Principal Component Analysis, accounting also for sectoral information such as capacity utilization in the manufacturing sector and services turnover.

[173] Gonzales-Torres Fernandes, G., Glumiel, J. E. and Szorfi, B. (2024), “Potential output in times of temporary supply shocks”, ECB Economic Bulletin, Issue 8/2023.

[174] For alternative estimates see or instance, Bandera, N., Bodnar, K., Le Roux, J. and Szörfi, B. (2022), “The impact of the COVID-19 shock on euro area potential output: a sectoral approach”ECB WPS N. 2717.

Chart 53

Estimates for overall euro area, sectoral output gaps and potential output growth



Sources: ECB and European Commission business surveys.
Note: The sector average represents the value added-weighted output gap for manufacturing and services in the left-hand side panel, and the growth rate of the value added-weighted average potential output for manufacturing and services in the right-hand side panel.

Some effort has also been made to integrate alternative data sources (such as textual data, Google searches and mobility indicators) for the purpose of nowcasting, forecasting and causal analysis. For example, work conducted at the European Central Bank suggests a new way of transforming text into data and shows that the text contained in the introductory statements of the ECB press conferences adds information content to that of autoregressive models for euro area inflation (Araujo et al., 2024). The literature is also expanding to study the full scope of the communication of ECB presidents during post-meeting press conferences at a high frequency, based in particular on advances in facial and vocal recognition software and natural language processing. These methods not only make it possible to quantify the spoken word of ECB presidents, but also to measure facial and vocal expressions at a very high frequency. Work at Banca d’Italia has been devoted to developing new models for nowcasting industrial production (based on lubricant oil), consumption (based on payment data) and touristic activity (based on payment data and google searches).[175] Finally, recent work has been devoted to developing HaWAI – an index of economic activity at a weekly frequency. The index has been constructed for the euro area and its Member States, relies on a harmonised approach in terms of both data and econometric methodology and can accurately track developments in economic activity and provide insights on heterogenous developments across the euro area.[176]

175 See Crispino and Loberto (2023), Flaccadoro, Rondinelli and Villa (2023) and Fruzzetti and Ropele (2024).

176 See Banbura, M., Eraslan, S., Giammaria, A., Leiva-Leon, D. and J. Paredes (2024): “Introducing HaWAI – harmonized weekly activity index for the euro area and its member states”, Report based on the work of the WGEM Expert Group on Tracking Economic Conditions at High Frequency.

4.4.3 Ongoing and future model development

In line with the lessons learned, the granularity of the analysis of the inflation dynamics and related variables has been increased. Progress has been faster for reduced form models rather than structural micro-founded models, but the latter are catching up. A higher granularity can help to evaluate the source of cross-sectoral and cross-country heterogeneity, in order to provide a better sense of the inflation determinants in the presence of different type of demand or supply shocks, and to draw the monetary policy implications.

Short-term inflation projection models are being enhanced to incorporate more granular data. In particular, priority has been given to the implications of global gas price dynamics, and the models have been designed with more careful characterisation of the cross-correlation among HICP subcomponents. In addition, more granular information about services related items and food items has been incorporated into the analyses. These tools may help to improve the accuracy of inflation projections and to craft more sophisticated and informative narratives of the inflation drivers (Banbura et al., 2024). Several new tools are available. For example, the Deutsche Bundesbank is developing a granular nowcasting model of inflation which includes high-frequency variables (e.g., web-scraped data for clothing and footwear, booking data for package holidays or energy prices). Web-scraping of energy and travel related prices is also done regularly at Banca d'Italia for nowcasting purposes.[177] Increasing the granularity has also proven to be very important in identifying the heterogeneous contribution of the items included in the HICP basket to the disinflation process (i.e. latecomers, etc.) (Corsello and Neri, 2025). Similarly, Banque de France and OeNB have developed models of web-scraped data for food components (e.g. fruit, vegetables and meat/fish).[178]

One noteworthy development is the inclusion of the sectoral dimension in structural micro-founded models, which allows for a more plausible characterisation of the transmission mechanism of shocks. The ECB and several national central banks are developing sectoral models (see Hinterlang et al., 2023 and other examples). These models are typically not used for projections, but their analysis is useful in building a narrative based on scenarios and simulations around the baseline. For example, **Chart 54** shows some results from a dynamic stochastic general equilibrium (DSGE) multi-country model with input-output linkages and rich sectoral heterogeneity, including six main countries (the four main euro area countries, rest of the euro area and rest of the world) and 44 sectors within each region, developed by the by Banco de España.[179] This model could favour an improved understanding of the transmission of energy shocks to inflation. The chart portrays the impact of a 10% shock in imported energy prices. Panel a) shows that, neglecting production networks (No Input Output, yellow line) leads to a major understatement of the inflationary consequences of the shock. Panel b) shows how

[177] See Corsello and Palumbo (2024), “Nowcasting Italian electricity and gas consumer inflation via webscraping”, unpublished internal note, Banca d'Italia.

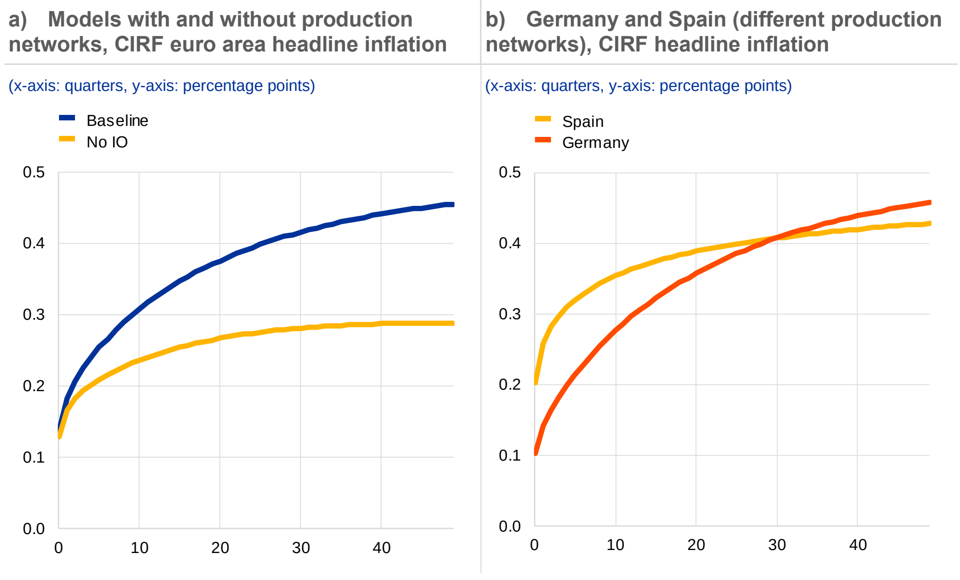
[178] See Beer, Ferstl, and Graf (2025), “Improving disaggregated short-term food inflation forecasts with webscraped data”, OeNB Working Paper 262.

[179] Aguilar, Domínguez-Díaz, Gallegos, and Quintana (forthcoming), “The Transmission of Foreign Shocks in a Networked Economy”.

heterogeneity in production networks can give rise to cross-country heterogeneity in inflation dynamics: more integrated production networks (such as those in Germany compared with those in Spain) cause higher inflation in the medium run and a more sluggish adjustment toward the long-run equilibrium.

Chart 54

The transmission of foreign shocks



Source: "The Transmission of Foreign Shocks in a Networked Economy". Aguilar, Domínguez-Díaz, Gallegos, and Quintana (Forthcoming).
Notes: Panel a): Cumulated Impulse Response Function (CIRF) of EA headline inflation and sectoral contributions to a 10% increase in imported energy prices, with and without input-output linkages. Panel b): CIRF of headline inflation in Germany (DE) and Spain (ES).

The ECB is also investing significantly in structural micro-founded models with sectoral and country heterogeneity. This investment includes a two-sector (manufacturing; services) New Keynesian model with firm heterogeneity, entry, and exit dynamics, and a disaggregated energy sector to study, among other things, the productivity dynamics associated with sectoral reallocation and a calibrated multi-country model with I-O linkages á la Baqaee-Farhi to study climate risks. Several other projects to develop semi-structural and structural model with a rich country and/or sectoral dimension are relatively advanced across the Eurosystem.

Sectoral and heterogeneous agent models have also been developed in the context of the ChaMP Research Network to enhance the analytical toolkit for modelling the transmission of monetary policy in a heterogenous monetary union. Box 8 illustrates the characteristics of a suite of sectoral models and their comparative advantages that improve our understanding of how monetary policy transmits to the European economy amid unprecedented shocks, structural changes and shifting inflation dynamics. [180] These new toolkits help provide valuable insights into how shocks are transmitted through production networks, while accounting for

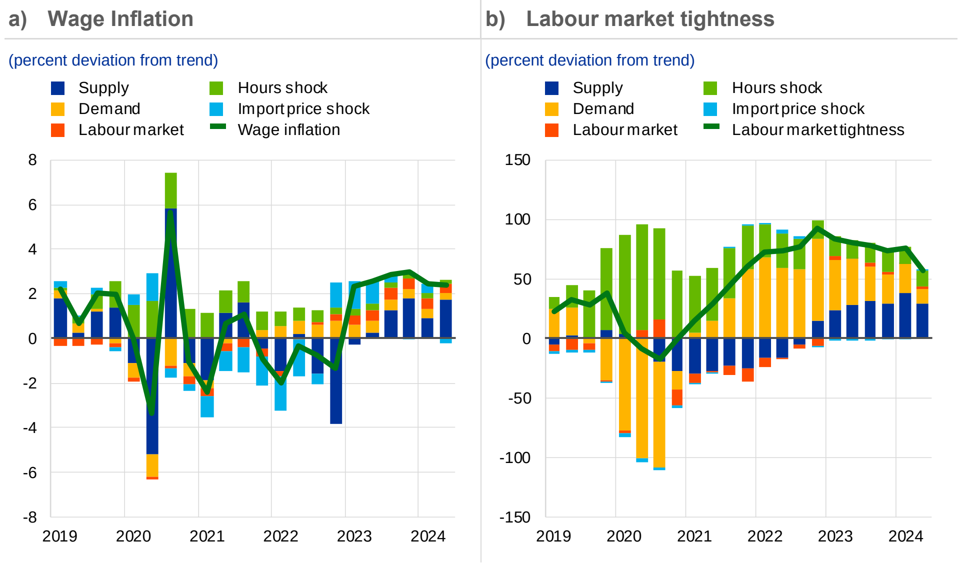
[180] ChaMP Research Network: Enhancing the analytical toolkit for modelling the transmission of monetary policy in a heterogenous monetary union.

sectoral heterogeneity and, therefore, enhancing the realism and policy use of structural models.

The development of more sophisticated structural and semi-structural models also encompasses the analysis of labour markets. Chart 55 presents a shock decomposition of euro area wages and labour market tightness based on a newly developed DSGE-model with search and matching features in the labour market.[181] The analysis concludes that shocks originating in the labour market are not important drivers of wages (and consumer prices). Results also show that factors outside the labour market, such as supply and demand shocks in the goods market or fluctuations in import prices, have quite a significant impact on wage fluctuations. The changes in import prices first had a dampening effect on wages in the high inflation period but have more recently added wage pressures.

Chart 55

Factors that have influenced price and wage developments and labour market tightness in the euro area



Source: Juvonen, Nelimarkka, Obstbaum and Vilmi (forthcoming): "Which factors have influenced price and wage developments and labor market tighteness in the euro area".
Notes: The shock decompositions are obtained using a small-open economy DSGE model with frictional labour market, wage rigidity and adjustment of working hours. The model is fitted to the euro area data (2000Q1-2024Q2). Variables are shown as deviations from their trend components. The series are decomposed to trend, (cyclical) model and measurement error components in the estimation. Wage inflation is the (annualised) growth rate of the model component.

The second major direction taken by model development consists of incorporating non-linearity in the Eurosystem modelling toolbox. During and in the immediate aftermath of the pandemic, modelling efforts were characterised by the attempt to "hedge" the time-series models against the unprecedented volatility experienced by economic variables. Moreover, several central banks have

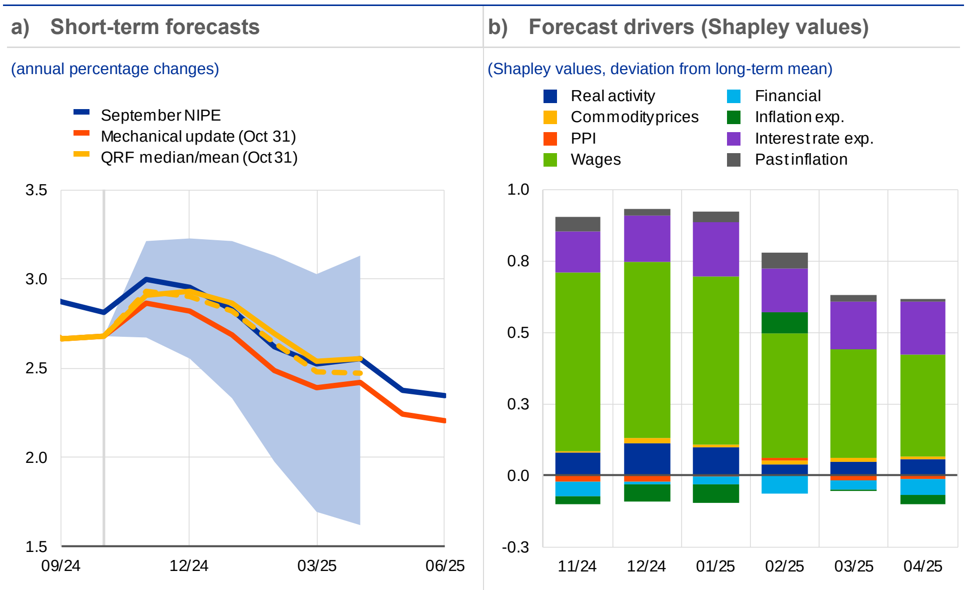
181 Juvonen, Nelimarkka, Obstbaum and Vilmi (2025): Drivers of post-pandemic price dynamics and labour market tightness in the euro area, Bank of Finland Economics Review. See also Oinonen & Vilmi (2024): What factors have influenced the dynamics of euro area prices and wages? Bank of Finland Bulletin, which shows a decomposition of the recent euro area inflation dynamics obtained in the context of a Bernanke-Blanchard type model of the euro area.

developed forecasting models including time-varying features in the shock properties (stochastic volatility) and in the transmission mechanisms of the shocks to variables.

More recently, the study of non-linearity has been taking advantage of the progress made in machine learning. New tools have been developed with the aim of capturing general forms of non-linearity that cannot be included in more traditional parametric models. For example, researchers at Oesterreichische Nationalbank have developed a novel core inflation index for the euro area, defined as Albacore, which weights the price index's subcomponents so that the aggregate indicator has the best ability to predict future headline HICP inflation (Greso and Klieber, 2024, or Goulet Coulombe et al., 2024 for a more detailed presentation of the methodology). In addition, **Chart 56** presents an example of the short-term inflation forecasts (panel a)) and the related drivers (panel b)) from the quantile regression forest, a new machine-learning model which was introduced at the ECB in 2023 for the real-time assessment of inflation (Lenza et al., 2023). Recent model development is extending its scope to the services and non-energy industrial goods components of HICP.

Chart 56

Inflation density forecasts from the Quantile Regression Forest

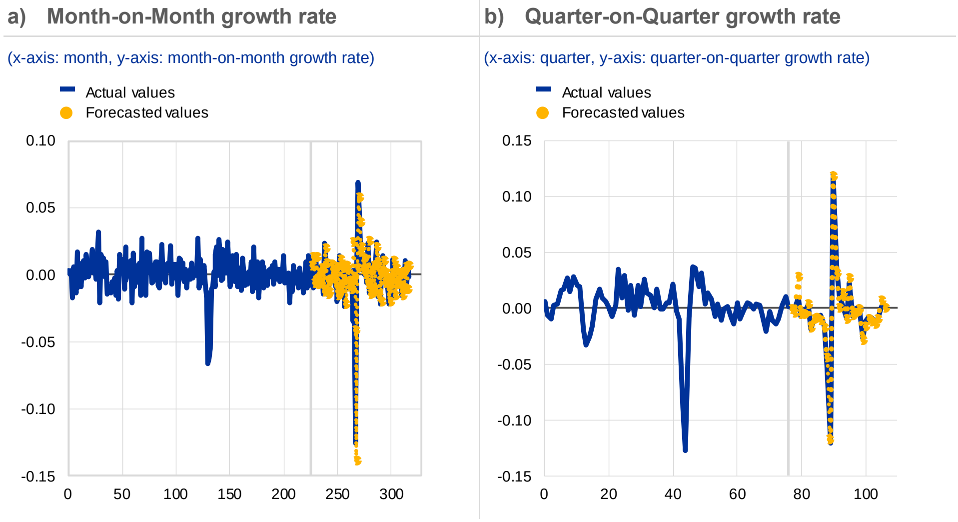


Source: Lenza, Moutachaker and Paredes (2023): "Density forecasts of inflation: a quantile regression forest approach", ECB WP 2830.
Notes: Panel a): Quantile Regression Forest (QRF) short-term forecasts for HICPex inflation with data cut-off for QRF in September 2024. The light-blue shaded area denotes the QRF 5-95 percentiles range. The dashed yellow line is the mean; the solid yellow line is the median. Panel b): Shapley values contribution, presented in deviation from the long-term mean. Small differences might appear due to base effects as the model is estimated on annualised growth rates.

The unpredictable behaviour of global trade has led researchers to explore whether trade patterns follow complex, non-linear trends. Chart 57 is based on the preliminary results of a Deutsche Bundesbank project, which aims to forecast month-on-month and quarter-on-quarter growth rates of global goods trade. The predictions are derived by means of a set of models including linear models AR(1), AR(2), and AR(1)-X, as well as machine learning approaches, which make it possible to capture non-linearities, such as random forest, XGBoost and long short-term memory neural networks (LSTM). The predictors are pre-selected using a regularisation method (smooth clipped absolute deviations, SCAD method) from a set of about 140,000 variables, comprising trade data, price indices, financial variables, sectoral production, survey data, GDP components, etc. The preliminary results show that the AR(1)-X model performs best on monthly and quarterly data for most forecast horizons. However, a forecast combination dominates each single forecast.

Chart 57

Global Trade forecasts



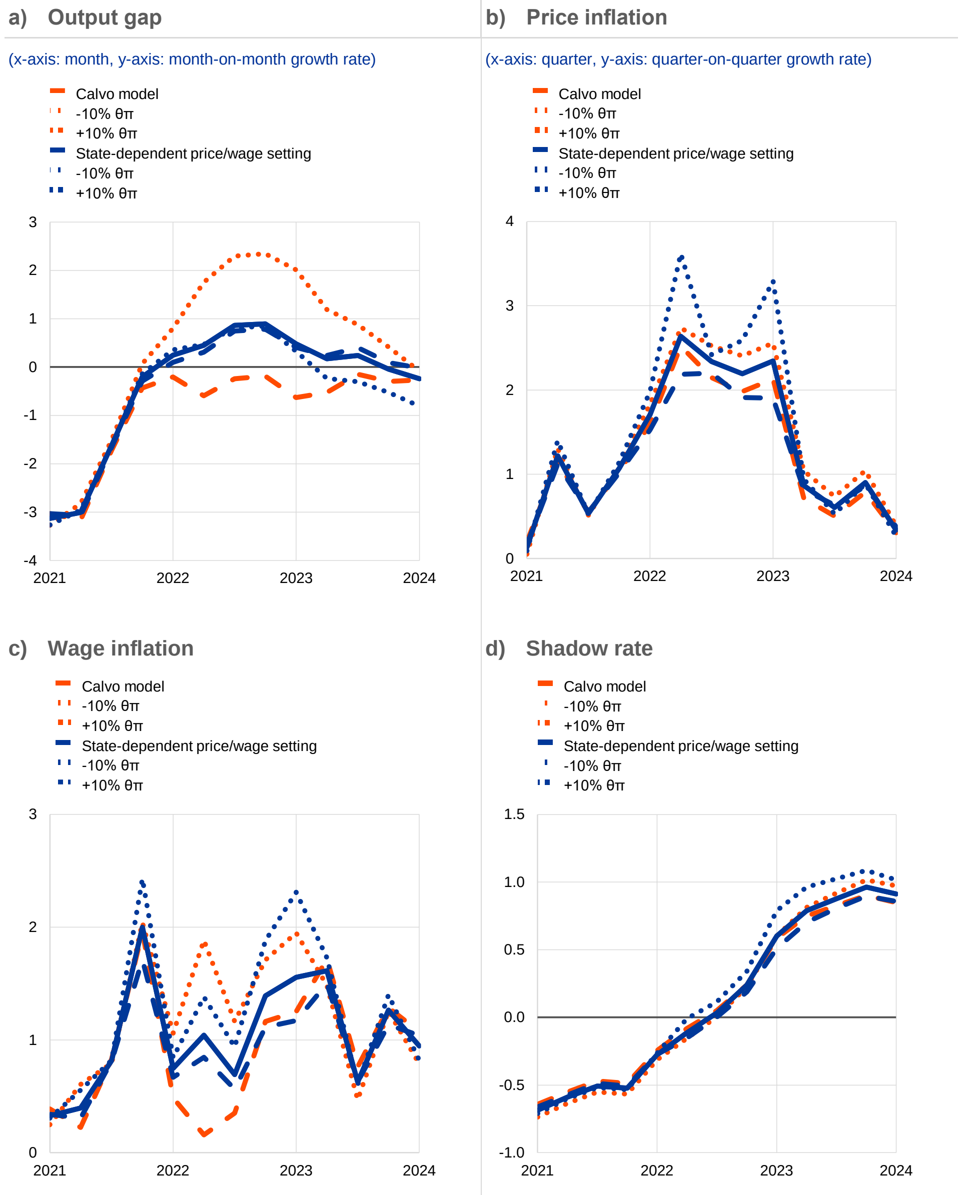
Source: Preliminary Bundesbank calculations.
Notes: Panel a): one-step forecast of the month-on-month growth rate of the global merchandise trade volume as provided by the CPB Netherlands Bureau for Economic Policy Analysis. Panel b): one-step forecast of the quarter-on-quarter growth rate. Forecasts are based on a combination of forecasts of a set of models: AR(1), AR(2), AR(1)-X, random forest, XGBoost and long short-term memory neural networks (LSTM). Predictors are pre-selected from a set of ca. 140,000 variables using the regularization method SCAD (Smooth Clipped Absolute Deviations).

Some progress has also been made to model specific forms of non-linearity in the context of structural models. Chart 58, for instance, shows the counterfactual paths for the output gap, price inflation, wage inflation and the policy rate over the period 2021-23 based on different assumptions regarding the state-dependence of the parameters governing the frequency of price and wage adjustments in the economy.[182] The different counterfactual paths prove the relevance of incorporating an empirically plausible amount of state-dependence in the euro area economy models. The analysis also shows that the response of output and prices to standard monetary policy shocks depends on the inflation regime. Specifically, in a state of high inflation monetary policy is more effective in reducing inflation and has lower impact on output, which implies a smaller "sacrifice ratio". Therefore, while a non-state-dependent model implies that a stronger stance against inflation leads to a large recession, the same policy stance in a state-dependent model preserves the soft landing with a lower inflation outcome.

[182] Based on Ascari, Carrier, Grimaud, Gasteiger and Vermandel (2024): "Monetary policy in the Euro Area: When the Phillips Curves… are Curves", unpublished manuscript. (contact: alex.grimaud@oenb.at).

Chart 58

Counterfactual paths based on different assumptions regarding the state-dependence of the frequency of price adjustments



Source: Ascari, G., Carrier, A., Gasteiger, E., Grimaud, A., & Vermandel, G. (2025). Monetary policy when the Phillips curves are curves.
Notes: Counterfactual simulations in the state-dependent model (blue lines) and the model with Calvo pricing (red lines) during the 2021Q1-2023Q4 period, with different monetary policy stance. The dotted lines correspond to cases with a -10% change to the estimated reaction of the deviation of inflation from target in the Taylor rule, the dashed lines refer to cases with a +10% change in the same parameter. Plan lines are overlapping by construction.

Given the medium-term orientation of model development, Eurosystem research plans over the next three to five years will continue to focus on topics similar to those just mentioned. In particular, efforts to incorporate non-linearity and a higher level of granularity will continue. Several central banks have also indicated that more effort will be devoted to modelling structural trends, with a particular focus on demographic trends in order to better estimate potential growth, as well as the inclusion of demographic considerations in the economic models.

These developments are in line with improving the estimates of potential output and the associated output gap in the context of the annual supply side review (ASSR).

4.4.4 Remaining gaps and evolution in the use of models

While it appears that research efforts have focused on the areas identified in monetary policy strategy review 2020-21 (related, in particular, to the need to introduce heterogeneity and non-linear dynamics to explain the monetary policy transmission mechanism), some gaps remain, and some new ones have emerged owing to the events in the last five years. The previous Eurosystem strategy review concluded with a set of recommendations for future modelling (Darracq Pariès et al., 2021). Those recommendations were designed to make model development robust against the background of a rapidly changing economy, and to prepare for long-term and structural aspects (such as climate change and endogenous growth) or the use of alternative expectation formation, as well as to better assess monetary policy transmission, including the treatment of non-standard measures, non-linearities and the interaction with fiscal and financial policy.[183]Some of the main focus areas described above were therefore already part of the recommendations made in the previous strategy review. Lessons learned in recent years have helped to speed up some model development in those areas, such as including non-linearity and higher granularity in the economic analysis compared with other aspects which have been temporarily delayed.

The gap requiring the most urgent attention relates to modelling the structural trends affecting the euro area and the global economy. This topic is still part of the research plans, but more progress is expected. The distinction between cyclical (short-term) and structural (long-term) economic factors is a recurring theme in Eurosystem policy analysis. In today's rapidly evolving geopolitical and economic environment, estimates of structural trends can become obsolete very quickly, while new ones emerge unexpectedly. Shifts in defence spending and competitiveness, for example, have recently gained prominence. This underscores the necessity to continuously monitor and adapt our analytical frameworks to accurately distinguish between transient fluctuations and enduring structural changes.

Chapter 3 of this report identified several structural forces which can be relevant in terms of affecting the long-run inflation dynamics and the core benchmark for monetary policy (r*) – some are new since the last strategy review (like geopolitical uncertainty) and some already existed then but may re-appear in a new guise (e.g. generative AI, or demographics). These also include long-term fiscal challenges, such as defence spending, and the interaction of monetary and fiscal policies. Some of these elements are often hard to quantify because they are recent phenomena, but even when they can be quantified, it is hard to assess their evolution and impact. That’s why, sophisticated analysis potentially mixing empirical and more conceptual approaches is needed to

[183] Investing or enhancing models that explicitly consider the interaction of fiscal and monetary policies is permanently on the Eurosystem agenda. See, e.g., ECB (2021) and Bonam et al (2024) as valid recent examples of the consideration constantly given to the topic.

appropriately assess the impact of these phenomena. The current analytical toolkit seems less well-equipped to deal with the structural trends and their spillovers to and from cyclical fluctuations than it is to deal with other dimensions. More research efforts are needed.

Another area requiring investment is the "recalibration" or further development of the structural models used for the monetary policy preparation. The analytical developments and findings of recent Eurosystem initiatives, such as the ChaMP Research Network or the joint Expert Group on monetary policy transmission of the Working Group on Econometric Modelling (WGEM) and the Working Group on Forecasting (WGF) through ESCB models and empirical literature, provide a solid benchmark to validate the current models or advocate for changing some of their features that are crucial for the transmission of monetary policy shocks to the economy.[184] Two of the ingredients mentioned above, namely heterogeneity and non-linearity, stand out with prominence from these analyses. First, there is abundant evidence of heterogeneous effects across countries, sectors and domestic demand components reflecting differences in structural economic characteristics. Second, monetary policy effects are under some circumstances better captured by allowing for non-linearity and state-dependency, as the strength of the monetary policy transmission can vary over time and depend on the underlying shocks and state of the economy.[185]

Besides developing new models, the analytical contributions from the economic analysis can also be enhanced thanks to changes in the use of models. For example, the development of new satellite models, such as those including the sectoral dimension, could be used more actively to decompose the baseline projections into their main drivers. A more plausible description of the transmission mechanisms might favour more plausible shock decompositions.

The ECB and Eurosystem staff's new modelling toolbox should also be more resilient in the face of big unexpected shocks. Scenario analysis should be more meaningful and further exploited in the context of an enriched modelling toolbox which is able to better portray the transmission of shocks in regimes characterised by relatively extreme events.

Many of the newly developed models are meant for cross-checking the results of the core projection models, and protocols should be developed to fully exploit the potential of this large set of new models without unnecessarily complicating the process. In this context, several open questions remain about the principles for accepting a model for cross-checking and, in general the entry and exit of models from the analytical toolbox. It is also important to come to a shared agreement on how to best structure the cross-checking and whether the latter has the potential to change the baseline, in response to large deviations from the

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184 See https://www.ecb.europa.eu/pub/research-networks/html/champ.en.html, and Bobasu, Ciccarelli, and Notarpietro (eds.), 2025, "Monetary Policy Transmission: A reference guide through ESCB models and empirical benchmarks", WGEM-WGF report, (forthcoming).

185 In the context of nonlinear price and wage dynamics, see Erce, Linde and Trabandt (2024) for a useful reference, particularly in responding to supply shocks. Link to recent IMF working paper: https://www.imf.org/en/Publications/WP/Issues/2024/12/20/Monetary-Policy-and-Inflation-Scares-559408

outcomes of cross-checking models. As mentioned in the introduction to this chapter, the current effort of experimenting more with “satellite” models than with renewing the “core” models is a conscious strategy to identify alternative research-based tools that – currently useful complements to the core models in the policy process – will, in the next few years, become part of a “core” framework of models for policy preparation. This strategy adopted by the Eurosystem is creating modelling frameworks that are robust to uncertainty and preparing the groundwork for the next generation of macro models.

The Eurosystem model development is moving in broadly complementary directions across institutions, leaving considerable degree of scope for knowledge and information sharing. It is very desirable to continue fostering the knowledge sharing. The Review of Macroeconomic Modelling in the Eurosystem prepared for the previous strategy review had already devoted a full chapter (see chapter 6) to this topic. It contained several proposals for alternative sourcing and organisational strategies to close the knowledge and analytical gaps identified in a cooperative way. The recommendations made are still valid, in terms of information sharing, organisational strategies, and modelling infrastructure. There is certainly a need to revamp those proposals in the light of recent technological advances, including the use of AI and large language models, which make it even more compelling to adhere to the same technical standards across the board.

Box 8
ChaMP Research Network: Enhancing the analytical toolkit for modelling the transmission of monetary policy in a heterogenous monetary union

C. Osbat, M.T. Valderrama

The Challenges for Monetary Policy Transmission in a Changing World (ChaMP) Research Network aims to improve our understanding of how monetary policy transmits to the European economies amid unprecedented shocks, structural changes and shifting inflation dynamics. The role of production networks in the transmission of aggregate and sectoral shocks is of particular interest in the research carried out by the Network.

Models with production networks and sectoral heterogeneity are an important addition to the Eurosystem’s analytical toolkit: depending on their set-up they can provide information on non-linearities in the transmission of monetary policy shocks, on the dampening or amplification effects of shocks to inflation arising from the network structure, or about the distributional effects of monetary policy.

A robust approach to capturing the effects of such heterogeneities is to rely on a suite of models that focuses on different layers of heterogeneity and different channels. Multisectoral models are very complex, and it is impossible to develop a single one accounting for **many types of heterogeneity**. That’s why the ChaMP approach is to develop different models that differ based on: 1) The level of sectoral disaggregation; 2) the types of heterogeneity in labour skills, consumption and income distribution; 3) the level of country disaggregation; 4) whether the foreign block is modelled with a mechanism for exchange rate determination and 5) the nature of price setting, i.e., whether the frequency of price changes is constant, like in most standard models, or state-dependent. All projects allow for heterogeneity in input shares and price rigidity across sectors.[186] **Table A** provides an overview of the models, highlighting their key contribution to the analytical toolkit.

Table A

Overview of new ChaMP multi-sector models with production networks

Authors	Reference area	Price setting	Labour market characteristics	Key contribution to the analytical toolkit
Ghassibe and Nakov	Euro area; rest of the world as group	Spectrum of pricing rules from fixed menu costs to Calvo pricing	(Homogeneously) sticky wages	Modelling nonlinear Phillips Curve: when shocks are large prices become more flexible, The network amplifies upstream supply shocks but attenuates demand shocks (including monetary policy).
Kase and Rigato	Euro area; rest of the world as group	Random menu costs	(Homogeneously) sticky wages	Quantify the differential impact of a large shock in a model with a relatively stylised production network, simple enough to be not only calibrated but also partially estimated.
Christoffel et al	Euro area; rest of the world as group	Quadratic adjustment costs	Sector-varying sticky wages; wage indexation; frictions in labour reallocation across sectors	Including sticky wages and frictions in reallocation it makes it possible to model persistent inflation, especially in core inflation.
Aguilar et al	Euro area Big 4, rest of euro area and rest of the world as groups	Calvo pricing	Country-varying sticky wages	Analysing the cross-country heterogeneity in the transmission of shocks, albeit limited to the four largest countries, and to have a micro-funded foreign block, which includes exchange rate determination in equilibrium
Rubbo et al	20 Euro area countries; rest of the world as group or any sub-groups of partners	Calvo pricing	Country-sector-varying sticky wages; households offer labour in different occupations in segmented labour markets and consume income-dependent heterogeneous baskets	The extremely high degree of disaggregation and heterogeneity makes it possible to study how aggregate and very specific sectoral shocks (including AI adoption or defense) affect various population segments, and thereby different euro area countries.

Three models refer to the euro area as a whole and consider alternative price-setting mechanisms. Ghassibe and Nakov (2024) and Kase and Rigato (2025) model the nonlinearity of the Phillips Curve arising from large shocks. They introduce various flavours of state-dependent pricing in models with production networks, with different sectoral disaggregation. One important result is that the production network amplifies supply shocks and attenuates demand shocks.[187]. Christoffel et al (2025) also model the euro area, highlighting the impact of heterogeneous price rigidity as well as wage rigidity and also incorporate real rigidities.

Two models analyse the euro area not as a whole but as its component countries, making it possible to study the differential impact and spillover of shocks across countries. Aguilar et al (2025) analyse the transmission of energy shocks, calibrating a dynamic model of the euro

[186] The latter are calibrated using the PPI or CPI PRISMA data documented in Gautier et al. (2023) and Gautier et al. (2024).

[187] The results are illustrated in Box 2 on price setting.

area as a network comprising Germany, France, Italy, Spain, the rest of the euro area and the rest of the world. The inclusion of a production network, along with price and wage rigidities amplifies and prolongs the effects of oil shocks as the initial energy costs pass through subsequent stages of production, each characterised by some price stickiness, thereby increasing the persistence of core inflation compared to a model without the input-output network.[188]

Building on Rubbo (2023) and Rubbo (2024), the ChaMP Workstream 2 cross-country project introduces a dynamic, calibrated model that represents each euro area country separately and also incorporates additional layers of heterogeneity: Each industry in the network employs many types of workers and many different types of capital, delivering both labour and capital income to different types of households. In turn, households in each income class consume different baskets of goods.

This model's high degree of disaggregation and heterogeneity makes it possible to study how the transmission of monetary policy affects various population segments, depending on their exposure to changes in labour demand, consumer price inflation, and asset income. It also makes it possible to study the transmission of very specific shocks arising in a sector in a country. One of the priorities for future development is introducing a more differentiated rest of the world block, making it possible to also model the impact of foreign sectoral shocks.

188 This model was already used for policy analysis, and is the basis for the results in Chart 4.3.2.

5 Summary and conclusions

Before the previous strategy review in 2021, inflation was persistently below 2% due to cyclical and structural drivers, amid an asymmetric inflation target. Cyclical developments, an underestimation of economic slack and less well-anchored longer-term inflation expectations, in combination with monetary policy in the euro area being constrained by the effective lower bound, played an important role in the long period of subdued inflation. Disinflationary structural trends such as globalisation, digitalisation and demographic factors also contributed to dampening inflation, as they could not have been easily offset by interest rate policy in an effective lower bound environment.

Following the conclusion of the previous strategy review, a series of unprecedented and initially mostly supply-driven sectoral shocks pushed inflation up to record high levels. Key events triggering such shocks were the pandemic and the Russian invasion of Ukraine. Energy, food and supply chain disruptions played an especially important role for the initial surge in inflation. These coincided with increased demand as the economy reopened after the pandemic. New meta-analyses performed in the context of the 2025 Monetary Policy Strategy Assessment across a broad range of available models show that, on average, the contribution assigned to supply factors, both global and domestic in nature, played a more prominent role in the latest inflation surge as compared with demand factors, particularly in the initial phase of the inflation spike.

For the transmission of shocks to inflation in the euro area, changes in the price-setting frequency related to state-dependent pricing and the interconnection of the economy played an important role. Sectoral shocks in a high inflation environment implied stronger passthrough as firms reset prices more frequently. The analyses included in this report provide some evidence of a slight steepening and upward shift in the Phillips curve in a high inflation environment. They also show that the transmission of supply/sectoral shocks were amplified in an interconnected economy.

Sectoral shocks turned into shocks to the overall price level, but they travelled with different speeds across the economy. Indirect effects from energy and food price spikes passing through into core inflation led to the broadening of inflationary pressures. Once supply shocks reversed and demand abated, inflation fell sharply. Yet, services inflation was particularly persistent, as it reacted to shocks in a more delayed fashion compared with goods, for example. In general, services prices tend to be changed less frequently as compared with other items, and in particular some items such as insurance, rents and services provided by the public sector, adjust in a staggered, and mostly backward-looking manner. Strengthening wages, which themselves react with a lag to inflation and economic activity, have been added to the inflation persistence in the services sector, which is more labour intensive.

Amid a buoyant labour market, the post-pandemic acceleration in wages primarily reflected real wage catch-up considerations. As nominal wages adjusted only with a delay to past inflation, real wages initially fell. This subsequently led to high wage demands, supported by the resilience and tightness of the euro area labour market. At the same time, the role of labour market tightness as a driver of wage growth is estimated to have been weaker by most models (in contrast to the United States), but it increased somewhat during the post-pandemic period even when considering alternative measures of slack, such as hours worked, participation and vacancy rates. Wages reacted to price shocks in a staggered manner, resulting in a faster initial response of profits.

Anchored inflation expectations are essential for absorbing an inflation shock and avoiding excessive and persistent second-round effects. While the rise in short-term inflation expectations during the surge in inflation may have amplified inflationary pressures, there was no passthrough to longer-term inflation expectations, which have shown – on average – a close and strong anchoring at 2%. This followed a period of concern at the time of the MPSR in 2021 over longer-term inflation expectations in the euro area becoming less well anchored in response to protracted deviations of actual inflation from the target – at the time to the downside. In addition to a reanchoring at 2%, experience since 2021 also suggests that shorter-term expectations converge more quickly towards the steady state again. While these experiences suggest that the new symmetric inflation target announced in July 2021 might have had a positive impact on anchoring, the inflation surge had come with some unanchoring risks to the upside, as shown by a higher share of respondents expecting inflation to be above target. Newly available and enriched surveys for households and firms complement the information on inflation expectations from markets and professional forecasters. Household medium-term inflation expectations remained somewhat above 2% and show a larger responsiveness to actual inflation and short-term expectations, pointing to a lower degree of anchoring compared with markets and professional forecasters. At the same time, the downward sloping expectations curve in the period of high inflation suggests that the ECB’s target has gained traction in household expectations.

The strong monetary policy response was crucial for anchoring longer-term inflation expectations and bringing inflation back towards target after the inflation surge. It reinforced the credibility of the ECB’s inflation target, helped prevent wage-price spirals, and assisted in closing the inflation gap without large output costs. Together with the analyses of the role of monetary policy for inflation developments in Workstream 2 of this report, the analyses in this report illustrate how monetary policy has transmitted differently across inflation items and has tended to have stronger effects on items identified as sensitive to monetary policy during the recent period of high inflation. For example, the transmission of monetary policy was faster and stronger for durable goods consumption than for services, while the effect on services consumption appears more persistent. This report also demonstrates how fiscal policy can help cushion the impact of inflation – especially if measures are targeted, tailored and temporary.

The full inclusion of owner-occupied housing (OOH) costs in the Harmonised Index of Consumer Prices (HICP) has not yet been achieved but remains desirable. As emphasised in the previous strategy review (and also as far back as the strategy review in 2003), the inclusion of the costs related to owner-occupied housing in the HICP would better reflect the inflation rate that is relevant for households (workstream on inflation measurement in the ECB's monetary policy strategy review 2021). Therefore, monetary policy assessments have been taking into account inflation measures that include initial estimates of the cost of owner-occupied housing, as they are helpful cross-checks in the wider set of supplementary inflation indicators. While it is already useful that harmonised owner-occupied housing price indices based on the net-acquisition approach are published, timely publication and official information on the weights with which these indices should be included in the HICP are important. However, there is so far no agreement among circles in the European Statistical System on the preferred way to measure OOH costs in the context of the HICP and therefore the system does not yet intend to publish an experimental fuller series. The ECB would still like to include OOH costs in the HICP and has emphasised that official experimental HICPs, including the OOH costs, would be very welcome from a policy analysis perspective.

Since the previous strategy review, there have been significant changes in some of the structural factors shaping the euro area economic environment. Among the most notable changes are the geopolitical shifts and the possible fragmentation of global production networks. The recent shift in US trade and security policies and imposition of additional tariffs on a large number of countries, including on the euro area and especially on China, contributes to these fragmentation risks. In other areas of the economy, existing trends seem to have accelerated. The effects of climate change are materialising more strongly than expected, while transition policies in Europe are showing results in terms of reducing dependencies on fossil fuels. Digitalisation has also reached a new phase with the emergence of generative AI models, although the pace of adoption and the potential impact remain highly uncertain. Demographic trends , which already played a prominent role in the previous strategy review, continue to be an important structural driver for the years to come with ageing of the euro area population progressing, albeit with some uncertainty surrounding the outlook for migration. All of these factors have the potential for a persistent impact on inflation developments, both at the level of inflation and inflation volatility. In the previous strategy review, the conclusion was that these structural factors primarily had a dampening effect on inflation, which possibly had an overall deflationary impact on long-term trend inflation in the context of the effective lower bound and the asymmetric inflation target.

For the purpose of this monetary policy strategy assessment, we have focused specifically on four structural changes that could impact inflation in the future. Our analysis primarily covers global fragmentation and deglobalisation linked to geopolitical tensions, climate change and the green transition, digitalisation and AI, as well as demographic trends. Other structural trends related, for example, to global health issues, such as the pandemic, are also acknowledged but not explored in the same level of detail.

In contrast to the previous strategy review, the newly emerging secular forces affecting the persistent component of inflation are no longer clearly

disinflationary but are now more two-sided. Global fragmentation has the potential to stoke inflationary pressures by disrupting supplies, relocating and shifting production capacity, increasing defence spending and pushing firms to rely on more expensive inputs, all of which will push up inflation during a transition phase to a more fragmented world. The green transition seems likely to put upward pressure on inflation, particularly in its early stages, as carbon prices increase and investment moves towards shifting production and power generation to greener methods. Yet, the longer-run impact of the green transition is less clear cut and could well be negative: declines in the costs of transition technologies, including power generation, could, over time, reduce the relative price of energy and dampen inflationary pressures. By contrast, increased use of digital technologies could moderate labour shortages and boost productivity, putting downward pressure on unit labour costs and inflation, although that will partly depend on how new technologies affect the labour market and wage bargaining. In short, the euro area is likely to face both structural headwinds and tailwinds for inflation in the years ahead and there is a much less clear case for structural factors putting downside pressure on longer- term inflation developments than during the 2020/2021 MPSR.

Since the previous strategy review, estimates of the highly persistent component of inflation have moved closer to 2%, albeit uncertainty surrounding these estimates has increased. The previous strategy review found that the trend or persistent component of inflation had declined – pointing to the importance of inflation drivers beyond the business cycle. Since this decline was not a direct consequence of business cycle developments or other transitory fluctuations, it posed concerns regarding the perceived inflation target or the perceived ability of the ECB to meet this target. More recent estimates suggest that trend inflation has increased somewhat, although the uncertainty surrounding these estimates is also very large and econometric measures of the unobservable trends may be subject to revisions. However, the move closer to 2% suggests better anchoring of inflation expectations at the ECB’s 2% medium-term symmetric target, agreed as the price stability target in the last MPSR, as well as the possibility that the impact of some of the structural factors discussed above may be reverting.

If there are more frequent disruptive supply shocks, inflation volatility could increase further as firms adjust their prices more frequently. The recent period of high inflation was accompanied by a rise in the frequency of price adjustments. Faced with sharp increases in marginal costs, firms responded more swiftly by changing their prices more often. Evidence from a broad range of state-of-the art sectoral/network models calibrated to match a similar change in the price-setting frequency observed over the past few years indicates that this behaviour amplifies the impact of various shocks on inflation volatility.

If structural factors are responsible for larger and more frequent shocks, greater inflation variability is also likely to go hand-in-hand with increased divergence in relative prices. In a fragmenting trading system, sector-specific or product-specific supply shocks risk becoming more frequent, resulting in greater variations in inflation across the components of the price basket. Green transition policies are also likely to affect sectors differently: agriculture and tourism are highly exposed to climate change and several high-emission sectors, such as agriculture, steel, cement and air transport, are vulnerable to higher carbon prices during and after the transition. Productivity shocks in these sectors as they adjust may drive divergences in relative prices. The nature of the shocks hitting the euro area may also affect the degree of heterogeneity in inflation.

Increases in the price-setting frequency of firms, together with a stable and staggered wage-setting process, help explain the extraordinary behaviour of profits and wages during the inflation surge and the disinflation phase – which could repeat in the future. Anchored long-term inflation expectations, low levels of wage indexation to inflation and large government income supports limited wage adjustments in the face of rapid and frequent price increases following exceptional shocks, which – contrary to the experiences after large terms of trade shocks in the 1970s – prevented the emergence of a wage-price spiral. The diverging frequencies of price and wage setting after the exceptional energy price shock help to understand the pattern in profit and wage contributions. While the frequency of price changes increased substantially and amplified the reaction of prices to the large supply shock, microdata on wage agreements from the wage tracker database point to only very limited changes in the frequency of contract renegotiations and average contract durations. These different patterns of reaction implied corresponding movements in the profit and wage shares, with the latter first declining and only at a later stage recovering. Looking ahead, this pattern could repeat itself especially in the case of very large supply-driven shocks – given the experience of more flexible price setting and stable wage setting in reaction to such large shocks.

Structural trends might make productivity growth even more cyclical in the future. The stark decoupling of growth and employment from the Okun's law relationship over the past few years reflected the impact of labour market policies dampening labour productivity growth (e.g. short-time work schemes) more than would have been the case in a normal cyclical fluctuation. During the post-pandemic period, a decrease in real wage growth and the relative price of labour, labour shortages and an ageing workforce were also additional special factors for not dismissing workers. These factors depressed productivity growth, explaining the higher than usual upward impact on unit labour cost growth and domestic price pressures, throughout both the inflation surge and in the disinflationary phase. Higher profit margins and lower real wages enabled firms to absorb the costs of lower productivity growth. Structural trends such as ageing and the upskilling of the labour force may make employment even less volatile, thereby making productivity even more cyclical in the future.

While the labour share and wage bargaining process are normalising, changes in these features could affect inflation in the future. Despite some small changes in the wage bargaining process during the inflation surge, the duration and frequency of wage negotiations has reverted to the pre-inflation surge situation. Likewise, the labour share is recovering gradually. However, should workers successfully push for more wage indexation to prevent real wage losses in the event of future price shocks, inflation volatility could decrease. If labour should become a less important share of output, for instance resulting from automation, AI, or demographic trends, evidence from structural models included in this report indicates that inflation volatility would increase as firms may be less able to absorb other shocks – although the effects on volatility are expected to be comparatively small.

Empirical estimates suggest that the euro area natural interest rate – r* – may have edged up slightly since the previous strategy review, but remains at a relatively low level, implying that concerns related to the effective lower bound persist. Estimates of r* are generally fraught with model-specification and measurement issues and are surrounded by very large statistical uncertainty, including over recent years, when the euro area was hit by unprecedented shocks. Notwithstanding these challenges, empirical estimates suggest that the euro area r* increased from somewhat negative levels before 2020, to slightly positive levels in 2024. However, this pick-up is mostly observed in the more cyclical measures (using market data or semi-structural models) that may reflect the developments in the monetary policy cycle. It is unlikely that slower-moving, structural drivers, together, have raised r* in the past years. Latest available econometric estimates continue to point to a level for r* in the euro area that continues to be measurably lower than before the global financial crisis. These r* estimates are more consistent with r*assumptions in the model-based exercises for gauging lower-bound risks conducted as part of the previous strategy review. This result implies lingering risks of interest rates becoming constrained by the effective lower bound once again.

Gauging future r* developments is challenging, as the trajectory or impact of key secular trends is difficult to predict. Within the main structural drivers, demographics are among the least uncertain, likely continuing to push r* downwards over the coming decades. By altering the structural trends of the economy, climate change and carbon transition policies may affect r* via different channels, complicating judgement about the plausible magnitude and sign of the effects. Some secular trends and geopolitical developments may also produce significant fiscal pressures that are not neutral for inflation or r* and could lead to upward pressures on the natural rate. However, the forward-looking impact of euro area fiscal policies on r* remains ambiguous, ultimately depending on the inflation and confidence effects of fiscal policy.

The changing economic and inflation environment also has implications for the analytical toolkit and inflation forecasting. These implications are assessed on the basis of three main themes. First, the accuracy of past forecasts is analysed, along with strategies to enhance the accuracy of future projections. Second, the toolkit is reviewed to identify ways to complement baseline forecasts and increase their robustness in an environment of high uncertainty. Finally, recent progress in model developments is presented, with an eye towards assessing any remaining gaps.

Four important recommendations for further developing forecast practices can be derived from the experiences during the past few years. First, given the large contribution of external assumptions to forecast errors in the past years, assessing possible improvements of these assumptions is one key area. This includes energy price assumptions but also food prices, and in light of the ongoing trade fragmentation, other international prices. A second point is the better quantification of the role of different factors in projection revisions and errors, including the role of judgement. Third, particularly in times of large shocks, models that can handle time variation and nonlinearities have proven useful. Fourth, experience from the recent past emphasises the need for comprehensive risk assessment in terms of baseline projections. While the sensitivity analysis can cover some of the more "standard" uncertainties, particularly as regards the technical assumptions, scenarios can also be an effective way of reflecting alternative developments in specific events, especially when uncertainty is high and hard to quantify.

Increased uncertainty due to large shocks poses challenges to macroeconomic forecasting, which the Eurosystem aims to address using a comprehensive toolkit to complement baseline forecasts and to increase their robustness. This increase in uncertainty reflects both the more frequent and larger shocks as well as their transmission to the economy, as larger shocks can entail non-linear reactions and even structural changes if these shocks are permanent. The Eurosystem toolkit used to address these uncertainties includes market-based sensitivity analyses, model-based density forecasts, quantitative risk assessments based on a survey among Eurosystem/ECB staff, and scenarios of specific events. No single tool can fully capture overall forecast uncertainty and the following characteristics are essential for any tool used by the Eurosystem: (i) easiness to interpret and to communicate to the Governing Council; (ii) ability to tell a narrative, i.e. ability to inform about the mechanisms through which the risk could impact the economy; (iii) forward-looking nature; and (iv) ability to assess the probability of risk factors.

In addition to measures of underlying inflation, financial market forecasts can also be useful as a cross-check against the ECB/Eurosystem staff macroeconomic projections for the euro area. The analyses included in the report show that underlying inflation as an unconditional gauge of medium-term inflationary pressures can provide a useful input for assessing whether the inflation profile embedded in the projections is consistent with the latest information. New analyses included in this workstream report also reveal that the relative forecast accuracy between ECB/Eurosystem staff macroeconomic projections and financial market-based inflation forecasts depends on the inflation environment, forecast horizon and the prominence of energy inflation.

Specific scenarios are also useful for assessing risks and uncertainties related to alternative events as part of these staff forecasts. To steer future use of such scenarios using a systematic but context-specific approach, the following considerations are relevant. First, scenarios should be selected based on their relevance with respect to potential impact, likelihood, and implications for monetary policy. Second, the design of scenarios must be clear and intuitive, with a focus on core variables such as HICP inflation, GDP, and unemployment. Third, while the likelihood of scenarios is inherently subjective, objective indicators can also inform the subjective assessment. Fourth, only a limited number of scenarios selected by the Monetary Policy Committee at an early stage (by the Forecast Steering Committee in the Macroeconomic Projection Exercise rounds) should illustrate staff's risk assessment, focusing on the most relevant. Fifth, particularly in the context of emerging large or novel risks, a collaborative approach aimed at exploiting the entire technical capacity of the Eurosystem should be taken. Involving both NCB and ECB staff in the design or analysis of some scenarios, where appropriate, would ensure consistency and coherence in the Eurosystem-wide macroeconomic projection exercises, allowing for agile responses to emerging risks. That said, this approach should be taken with caution, as it could also considerably increase capacity needs, complexity, coordination costs and also pose timeline challenges.

Turning to the assessment of the analytical toolkit, recent economic shocks have highlighted the need for capturing atypical economic fluctuations better and for increasing the granularity of models and data in monetary policy analysis. The granularity of the analysis of inflation dynamics and related variables has improved in the Eurosystem's modelling toolkit. Progress was faster for the reduced-form models than for the structural micro-founded models, but these latter models are catching up. A noteworthy development is the inclusion of the sectoral dimension in structural micro-founded models, which allows for a more plausible characterisation of the transmission mechanism of shocks. A second major milestone in model developments is the incorporation of non-linearity in the Eurosystem's modelling toolbox.

The Eurosystem has fully followed up on the commitments made in the strategy review in 2021 with regard to climate change in economic analysis, modelling and forecasting. Core macroeconomic models are now able to capture the green transition in a simplified way and have been used to conduct scenario analysis. Thus far, Eurosystem macroeconomic models do not yet incorporate any effects due to higher temperatures or extreme events, but scenario analysis was conducted based on empirical approaches. As green policies are being adopted at the national and the EU level, the Eurosystem/ECB staff macroeconomic projections are gradually incorporating their effects accordingly.

While important progress has been made in developing the Eurosystem's analytical toolkit, some gaps still need to be addressed. First, parts of the Broad Macroeconomic Projection Exercise could be improved – which also includes refining the assumptions. Second, modelling structural trends that affecting the euro area and the global economy has become more important and pressing in today's rapidly evolving geopolitical and economic environment. Third, understanding the modelling of fiscal-monetary interactions better is also crucial. Fourth, more investment is needed to recalibrate or redevelop the structural models used to prepare monetary policy decisions. The analytical findings of recent initiatives and expert groups of the Eurosystem and the ESCB provide a solid benchmark for validating the current models or for advocating for changing some of their key features which explain the transmission of monetary policy shocks. Fifth, while using scenarios besides the baseline projection scenario is already at an advanced stage, a systematic but context-specific approach to selecting and designing these scenarios ought to be considered by exploiting developments in the toolbox and expertise across the Eurosystem. Sixth, with regard to climate change, the main priority going forward should be to continue considering transition policies in forecasting and modelling. Furthermore, the economic implications of biodiversity loss and the degradation of nature should increasingly be explored, ideally in collaboration with climate scientists.

Looking ahead, the changing economic and inflation environment calls for perseverance in terms of further improving the toolkit for inflation assessment and forecasting. The direction, size and frequency of shocks hitting the euro area, as well as their transmission to economic growth, have seen important changes since the previous strategy review. Looking ahead, ongoing structural shifts relating to geopolitical developments, digitalisation and the threat to environmental sustainability suggest that the economic and inflation environment will remain characterised by exceptionally high levels of risk and uncertainty, with potential upside effects on inflation volatility and the persistence of shocks. Such an environment continues to pose wide-ranging challenges in terms of analysing and forecasting inflation, thus requiring continued efforts to further improve the analytical toolkit of the Eurosystem to provide the best possible economic analyses as input for monetary policymaking.

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