BANCO DE ESPAÑA
Eurosistema

01.05.2024

Reflections on monetary policy arising from the latest inflationary-disinflationary episode

London School of Economics
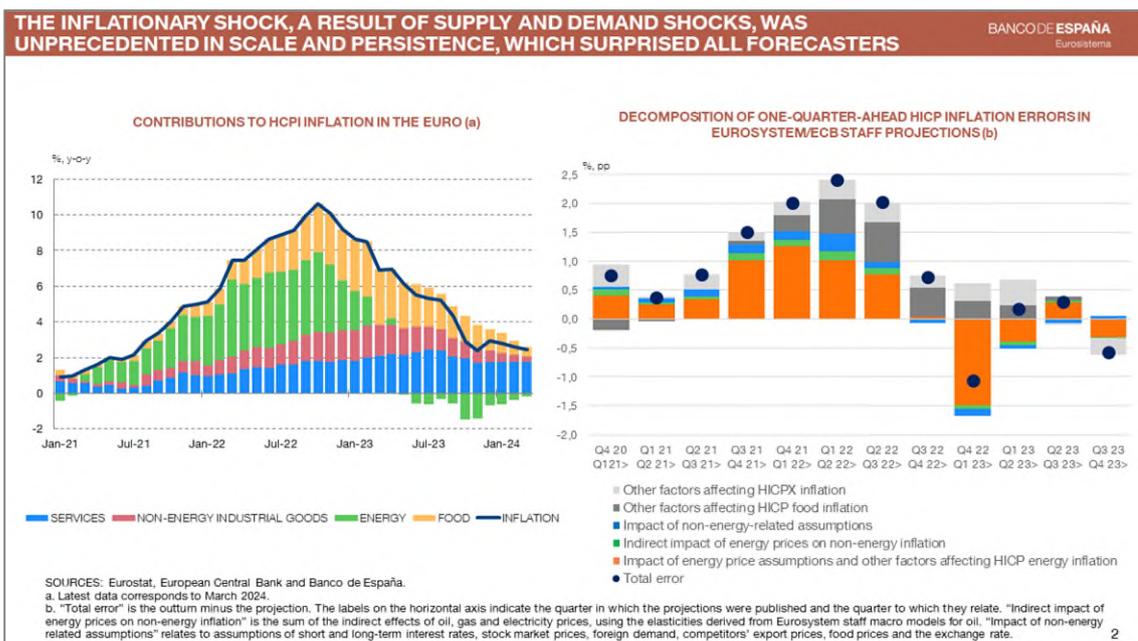London

Pablo Hernández de Cos
Governor

I would like to extend my heartfelt gratitude to Ricardo Reis for inviting me to participate in this event. It holds special significance for me, occurring just a month before the conclusion of my six-year term as Governor of the Banco de España.

Back in 2018, when I was appointed Governor, we were navigating a world economy characterised by low interest rates and subdued inflation. Ironically, many quipped, "*May you live in interesting times*!" Little did we know that these times would indeed prove to be extraordinary. First, on account the Covid-19 pandemic and then, the largest surge in inflation since the 1970s.

Today, I am honoured to share with you some insights gleaned from my policymaker perspective during the inflationary-disinflationary episode in the euro area and the European Central Bank's (ECB) response to it. In doing so, I will also point out some key aspects that, in my view, deserve in-depth analysis in the future.

1   Why has inflation been so high? Why did we underpredict it?

The annual rate of inflation in the euro area rose from very low levels in late 2020 to 10.6 % in October 2022, an unprecedented figure in the history of the monetary union.

This surge in inflation was caused by a series of exceptional shocks that impacted the various components of inflation (left-hand side chart of slide 1).

When the COVID-19 pandemic hit our economies in early 2020, the global supply system was undermined by lockdowns. In early 2021, as economies reopened, inflationary pressures emerged when the release of pent-up demand and excess savings accumulated during the pandemic (underpinned by synchronised and highly expansionary monetary and fiscal policies around the globe) confronted a supply system severely affected by restrictions and bottlenecks in global value chains.

This demand-supply mismatch rapidly impacted commodity prices, especially energy ones, which emerged as the main factor behind the inflation surge (green bar in the chart).

Inflationary pressures gathered pace in 2022, exacerbated by the impact on energy and other commodity markets of the Russian invasion of Ukraine. As a net energy importer, the euro area was particularly exposed to this shock. Other commodities, including food (yellow bars) (for which energy and energy-intensive products such as fertilizers are important production inputs) were also affected, spreading the inflationary pressures across the consumption basket.

For much of 2021 and 2022, these factors were further compounded by a depreciation of the euro, making imported goods and services more expensive.

In addition, the gradual materialisation of indirect effects of energy cost increases and supply-chain bottlenecks led to a steady increase in non-energy industrial goods and services inflation (red and blue bars).

In late 2022 inflation embarked upon a downward path supported initially by a sharp correction of energy inflation, and over time by the effect of monetary policy tightening and the gradual unwinding of adverse supply shocks.

In the euro area, this disinflationary process is fairly advanced but has yet to be completed. Inflation stood at 2.4 % in April 2024 and, based on ECB staff projections, the inflation rate will continue to ease, although with a somewhat bumpy profile in the short term. Indeed, energy base effects, the unwinding of crisis-related fiscal measures and the relatively slow moderation of services inflation, will cause inflation rates to fluctuate during 2024, before reaching our 2 % target in mid-2025.

Forecasting the dynamics of inflation, even within short-term horizons, during this period has been very challenging.

Indeed, forecasters were first surprised by the strength of the inflation surge, and then by the speed of its initial decline. The right-hand chart of slide 2 shows the quarter-to-quarter errors in ECB/Eurosystem staff inflation projections over time and decomposes them into various factors.

Large and rising positive forecast errors were observed until the second quarter of 2022, shortly after the start of the Ukraine war[1]. Forecast errors then began to decline after the third quarter of 2022 and especially during 2023, coinciding with the disinflationary process, when errors became small and even negative at times.

Initially the underprediction of inflation mainly reflected upward surprises related to the dramatic increase in energy commodity prices and their direct impact on consumer prices (orange bars).[2]

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[1] With Eurosystem/ECB staff forecasts broadly in the middle of the range of projections see Lane (2024) for more evidence on this issue.

[2] Aside from energy prices, supply bottlenecks also contributed to inflation forecast errors, especially in the second half of 2021, induced by stronger than expected economic recovery and supply chain disruptions.

In early 2022, food prices started to play a significant role as well, while the speed and intensity with which energy and food inflation passed through to core inflation (i.e. inflation excluding energy and food, labelled "HICPX" in the chart) was higher than expected. In 2023, the contribution to total projection errors coming from energy commodity prices was also significant, but in the opposite direction, contributing to an overprediction of inflation.[3]

An important takeaway from this exercise is that, even after controlling for the successive upward surprises in energy commodity prices and other technical assumptions underlying the projections, inflation forecast errors have remained positive and account for around 30 % of total forecast errors during the period 2020 Q4-2023 Q3.

This finding suggests that our main forecasting models, had a hard time capturing how the large shocks I have described are transmitted to inflation over time. This finding is not unique to ECB/Eurosystem projections, as it has also been observed in other jurisdictions.[4]

Our own research suggests possible reasons why model-based forecasts did not accurately capture the transmission of those large shocks to inflation.

For instance, econometric evidence and simulation exercises show that standard linear forecast models do not properly capture the transmission of large commodity price shocks to non-energy inflation[5]. In fact, large positive energy and food price shocks tend to increase core and food inflation, respectively, by a greater degree than is normally predicted by linear models.

Indeed, one possible explanation for these non-linearities is that, when facing large shocks to their input costs, firms tend to update their prices more frequently and hence pass on the cost increases to selling prices more quickly.[6] This makes inflation increase more intensively than in 'normal' times of low and stable inflation, thus further hindering the accuracy of linear model-based predictions.

All in all, a first key lesson from this inflationary episode is that central banks should endeavour to make their forecast machinery better equipped to handle large shocks and project their impact on inflation over the medium run.

In fact, we are already taking steps in that direction. Our efforts are multilayered, involving not only a revision of our more traditional forecasting models, but also the development of a diverse set of complementary tools and analysis techniques that inform our projections.

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[3] For a comprehensive analysis and monitoring of forecast errors by the Eurosystem during this period, see Chahad et al. (2022, 2023 and 2024).

[4] See, for instance, the IMF working paper by Koch C., and D. Noureldin (2023) for a worldwide analysis, including advanced and emerging economies, or Bank of Canada staff paper by Kryvtsov, O. et al (2023) and Reserve Bank of Australia (2022), among others, for a more country-specific analysis.

[5] As can be seen from simulations exercises for energy shocks in Burriel and Odhendal (2024) and González Mínguez, Hurtado, Leiva-León and Urtasun (2023), and for food shocks in Borrallo, Cuadro and Pérez (2024).

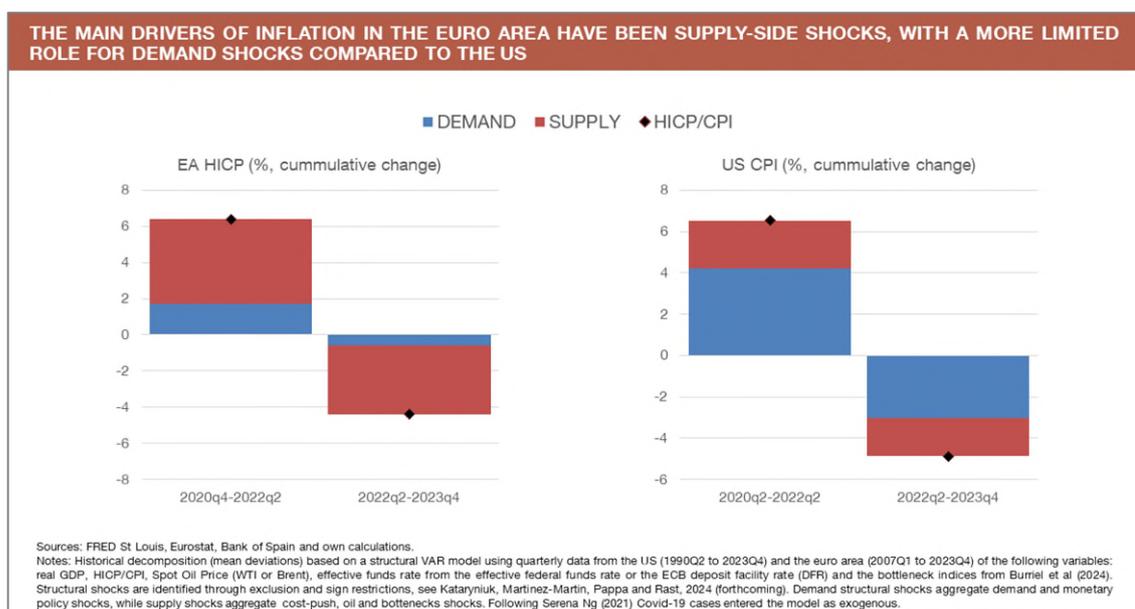[6] In a model with state-dependent price-setting, Costain, Nakov and Petit (2022) show how firms increase their frequency of price changes when inflation is higher. Empirically, the analysis of the microdata on consumer prices for Spain and other euro area countries reveals a notable increase in price adjustment frequencies during the inflationary episode (Gutiérrez and Roldán, 2024; Gautier et al, 2023). See also Dedola et al (2024).

This strategy includes elaborating specific models for certain components, such as commodities, or introducing new techniques, such as non-linear econometric models.

Additionally, we have learnt that complementing the baseline projection scenarios with alternative scenarios (characterized, for example, by paths for key external assumptions that differ from those in the baseline) are extremely helpful in a context of high uncertainty like the one we are still experiencing. [7]

2   How should monetary policy respond in a context of negative supply-side shocks?

My second point concerns the nature of the shocks that dominated the inflation surge in the euro area.

THE MAIN DRIVERS OF INFLATION IN THE EURO AREA HAVE BEEN SUPPLY-SIDE SHOCKS, WITH A MORE LIMITED ROLE FOR DEMAND SHOCKS COMPARED TO THE US

Sources: FRED St Louis, Eurostat, Bank of Spain and own calculations.
Notes: Historical decomposition (mean deviations) based on a structural VAR model using quarterly data from the US (1990Q2 to 2023Q4) and the euro area (2007Q1 to 2023Q4) of the following variables: real GDP, HICP/CPI, Spot Oil Price (WTI or Brent), effective funds rate from the effective federal funds rate or the ECB deposit facility rate (DFR) and the bottleneck indices from Burriel et al (2024). Structural shocks are identified through exclusion and sign restrictions, see Kataryniuk, Martinez-Martin, Pappa and Rast, 2024 (forthcoming). Demand structural shocks aggregate demand and monetary policy shocks, while supply shocks aggregate cost-push, oil and bottlenecks shocks. Following Serena Ng (2021) Covid-19 cases entered the model as exogenous.

Research shows that the main drivers of inflation in the euro area have been supply-side shocks, with a more limited role for demand shocks.[8] This is in contrast to the US case, where inflation was dominated by demand-side forces (see slide 2).

The nature of the shocks driving inflation is not an academic curiosity, and in fact determines how central banks respond to those shocks in practice.

Indeed the ECB Monetary Policy Strategy Review back in 2021 stated: "As different types of shock may move inflation and real economic activity in the same direction (as in the case of demand shocks) or create a temporary trade-off (as in the case of supply shocks), the medium-term orientation provides the policy flexibility to assess the origin of shocks and

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[7] Recent external evaluations of central banks' forecasting procedures stress the importance of complementing the baseline scenarios of projection exercises with alternative scenarios that, among other aspects, convey the degree of uncertainty surrounding the baseline. See e.g. Milesi-Ferretti, Onorante and Vidalis (2023) for an independent review of the Banco de España's macroeconomic projections, and Bernanke (2024) for the recent independent review of the Bank of England's economic forecasting.

[8] See, for instance, Arce et al. (2024), Banbura et al. (2024) and Kataryniuk, et al. (2024).

look through temporary shocks that may dissipate of their own accord, thus avoiding unnecessary volatility in activity and employment."

The above paragraph encapsulates two key considerations when confronting adverse supply shocks.

First, in the face of a negative supply shock, inflation increases while output typically falls below potential. That introduces a meaningful trade-off for monetary policy: an aggressive reaction to quench inflationary pressures may produce an excessive contraction in economic activity. That justifies being more patient in the face of supply shocks as opposed to situations in which inflation is more demand-driven[9].

Of course, patience does not mean inaction. This brings me to the second consideration. Whether a central bank should look through temporary supply shocks hinges critically on whether such shocks are expected to have a very transitory effect on inflation or, instead, are expected to affect inflation over the medium-term, which is the relevant horizon for monetary policy.

As mentioned before, the adverse supply shocks that hit the euro area back in 2021 and 2022 had rather persistent effects on inflation, affecting the medium-term inflation outlook and therefore justifying a forceful monetary policy response by the ECB once it started.

By raising interest rates in response to such a shock, the central bank reduces the deviation of inflation from target not only during the energy inflation spike, but also after it. In sum, an active monetary policy response to energy (and more generally, supply) shocks produces less inflation volatility than an alternative 'looking-through' policy.

This analysis shows how important it is for central banks to have an accurate assessment of how ongoing supply shocks are likely to affect inflation over the policy-relevant horizon. In this regard, the lesson to be learned is closely related to the previous one. It is of paramount importance for central banks to improve their forecasting tools and their knowledge of how different shocks are passed through to inflation over the forecast horizon. This will allow us to better decide how patient or impatient to be in the face of different types of shocks, whether supply ones or otherwise.

This lesson is particularly relevant in the case of supply shocks, as there are good reasons to believe that they may become more frequent in the future.[10] In this respect, having a better understanding of the macroeconomic transmission of supply shocks strikes me as a key issue to be addressed in upcoming monetary policy strategy reviews by central banks around the world.

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[9] For further elaboration of this point, see Tenreyro et al (2023).

[10] See for example Lagarde (2023).

3 How should monetary policy respond in a context of high uncertainty?

In practice, central banks do not know how persistent a given supply shock will be. Nor do they know whether a supply shock will be followed by another. Theory is far from providing a clear answer as to how monetary policy should react in a highly uncertain environment.

The classic Brainard (1967) attenuation principle states that monetary policy should be conservative in the face of uncertainty about the impact of underlying shocks on inflation and/or the impact of any policy mis-calibration on inflation.[11] Indeed, the greater the uncertainty, the higher the probability that a more aggressive monetary policy response to shocks may move inflation and output away from target.-[12]

An alternative strand of literature, usually referred to as 'robust control', provides guidance pointing in the opposite direction. If shocks are persistent and second-round effects materialise, it pays off to be more aggressive and keep longer-term expectations well-anchored.[13] Indeed, the experience of the 1970s showed that shocks can be concatenated, especially when they originate on the supply side of the economy, with strong additive effects on economic variables. In this case, theory suggests that monetary policy should be more reactive in order to prevent backward-looking behaviour from becoming embedded in economic expectations.

My own takeaways from the extensive literature on monetary policy and uncertainty are: (i) monetary policy should not be paralysed in the face of uncertainty (i.e. central banks need to remain pre-emptive and forward-looking); (ii) there is no general rule for monetary policy to be either attenuated or more activist in an uncertain environment; and (iii) a risk management approach is crucial.

The latter requires pragmatism and judgement, which must be based on a critical examination of the evidence and the realisation that patterns observed in the past can change rapidly. In this respect, as I mentioned earlier, when making decisions in the present it is crucial to be well equipped not only with a baseline projection scenario, but also with alternative scenarios and simulation exercises easing the different assumptions underlying the baseline scenario.

The ECB's reaction to the current inflationary and disinflationary episode, which has been fraught with uncertainty, has been based to a large extent on these principles. The concepts of optionality, gradualism and flexibility that have guided our policy are a good example of this approach. Indeed, we have responded to this new context by increasing optionality and emphasising that we will act in a data-dependent manner in order to deliver on our mandate of price stability.

Finally, I would like to emphasise the importance of supply-side policies in making economies more resilient to supply shocks. Achieving this calls for a more balanced approach to policymaking, a topic I will address in the last part of my speech.

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[11] See H. Pill speech on "Monetary policy with a steady hand" on 9 February, 2022.

[12] It will depend on the degree of persistence of the shocks that hit the economy, as shown by Ferrero et al (2019).

[13] For empirical evidence showing that central banks' excessive caution may shift inflation expectations away from their inflation target, see Dupraz et al. (2023).

4 Why has the sacrifice ratio apparently been so low and how does it relate to (anchored) inflation expectations?

A striking feature of this episode is that the disinflation process has taken place without a major loss of economic activity.
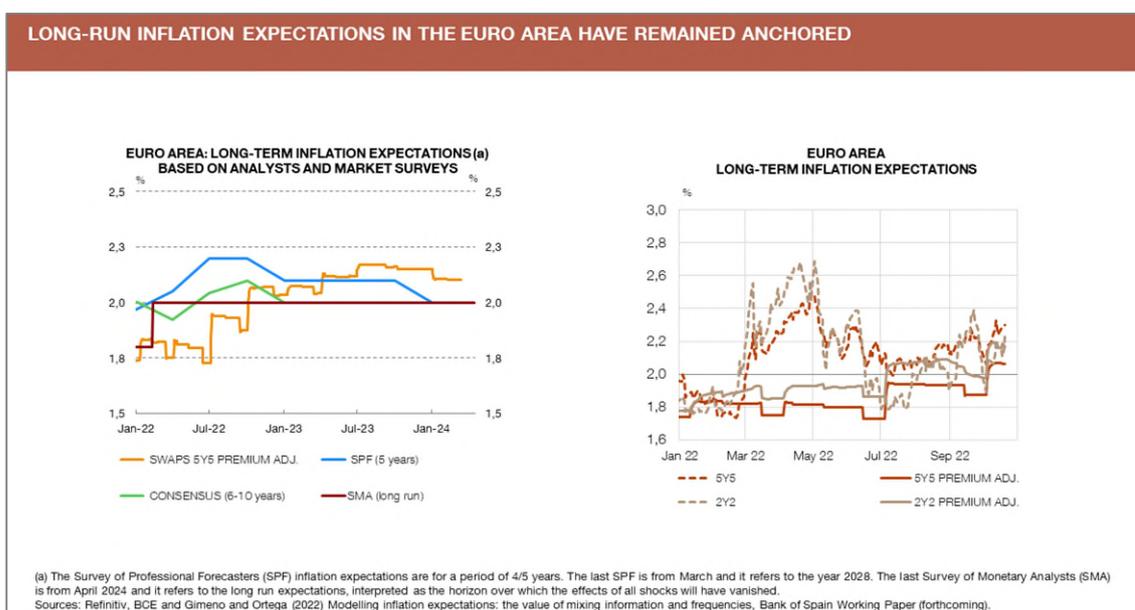
Of course, much of the disinflation is due to the dissipation of the very supply shocks that created the inflation surge in the first place (and which adversely affected output), meaning that some of the headwinds to activity have also subsided.

But the disinflation also reflects the ECB's forceful monetary policy response.

It is true that euro area GDP decelerated notably in 2023, growing by an anaemic 0.4%, and that the outlook for this year is also relatively weak. But given the scale of the monetary tightening, it can be argued that the 'sacrifice ratio' of bringing inflation down has been relatively low so far.

The US case is arguably even more puzzling, given the relatively minor role of supply shocks there. In sum, disinflation on both sides of the Atlantic has happened with apparently little impact on employment and activity, in what is commonly referred to as "the immaculate disinflation".

Let me now highlight two possible reasons why the sacrifice ratio appears to have been so low so far.

LONG-RUN INFLATION EXPECTATIONS IN THE EURO AREA HAVE REMAINED ANCHORED

EURO AREA: LONG-TERM INFLATION EXPECTATIONS (a) BASED ON ANALYSTS AND MARKET SURVEYS

SWAPS 5Y5 PREMIUM ADJ. — SPF (5 years) — CONSENSUS (6-10 years) — SMA (long run)

EURO AREA LONG-TERM INFLATION EXPECTATIONS

5Y5 — 5Y5 PREMIUM ADJ. — 2Y2 — 2Y2 PREMIUM ADJ.

(a) The Survey of Professional Forecasters (SPF) inflation expectations are for a period of 4/5 years. The last SPF is from March and it refers to the year 2028. The last Survey of Monetary Analysts (SMA) is from April 2024 and it refers to the long run expectations, interpreted as the horizon over which the effects of all shocks will have vanished.
Sources: Refinitiv, BCE and Gimeno and Ortega (2022) Modelling inflation expectations: the value of mixing information and frequencies, Bank of Spain Working Paper (forthcoming).

First, the severity of the output-inflation trade-off crucially depends on inflation expectations. In the New-Keynesian Philips curve, a rise in inflation expectations *shifts* the relationship between the short-term output gap and inflation upwards. This implies that stabilising output at potential does not suffice to bring inflation back to target: instead, the central bank must depress output below potential in order to achieve the inflation target.

In the case of the latest inflationary episode, there was a very real risk that the sharp and persistent rise in inflation would eventually lead to a de-anchoring of medium- and long-term inflation expectations above target.[14] However, at least in the euro area, inflation expectations over medium- and long-term horizons have remained broadly anchored to the ECB's 2% target (slide 3). This fact is one of the main reasons why the sacrifice ratio has been relatively small compared to previous inflationary episodes where supply shocks predominated, such as the oil price shocks of the 1970s and the subsequent costly disinflation.

Second, the output-inflation trade-off also depends on the *slope* of this relationship, i.e. how much output has to fall to bring inflation down (for given inflation expectations). In the basic New Keynesian model, this slope is higher the higher the frequency with which firms adjust their prices to changes in their cost and demand conditions.

Earlier I argued that one consequence of the recent episode of high inflation was that firms changed their prices more frequently, accelerating the transmission of shocks to inflation. But by the same token, faster repricing by firms implies that inflation is more sensitive to changes in aggregate demand.[15] In other words, the Phillips curve becomes steeper, allowing the central bank to achieve the same reduction in inflation with smaller output losses, hence reducing the sacrifice ratio.

The optimal monetary policy prescription in this situation has been analysed by a joint team of ECB, Banco de Chile and Banco de España researchers: the central bank should "strike while the iron is hot", in other words, fight inflation by countering firms' inflationary aspirations, thereby achieving a lower sacrifice ratio.[16]

All in all, in my view, the recent inflationary episodes vividly illustrate the crucial importance for central banks of acting and communicating in a way that keeps inflation expectations well anchored to their objectives in the face of inflationary shocks.

5   How has monetary policy transmission worked?

The last monetary policy tightening has been exceptional in terms of both its size and speed[17] and followed a long period of unconventional expansionary monetary policy and negative interest rates. Furthermore, since the previous interest rate hiking cycle in 2005, there have been structural changes in the euro area economy and its banking system. Banks are now better capitalised and have higher liquidity ratios than in the past. Moreover, the last monetary policy tightening took place in a context of adverse supply shocks, weak growth and high uncertainty, in contrast to the positive demand shocks that predominated during the 2005 monetary policy tightening cycle.

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[14] As argued in the BIS Annual Report 2022 and Carstens (2022), in the context of an inflationary episode such as the recent one, the risk of a transition from a low- to a high-inflation regime should not be underestimated.
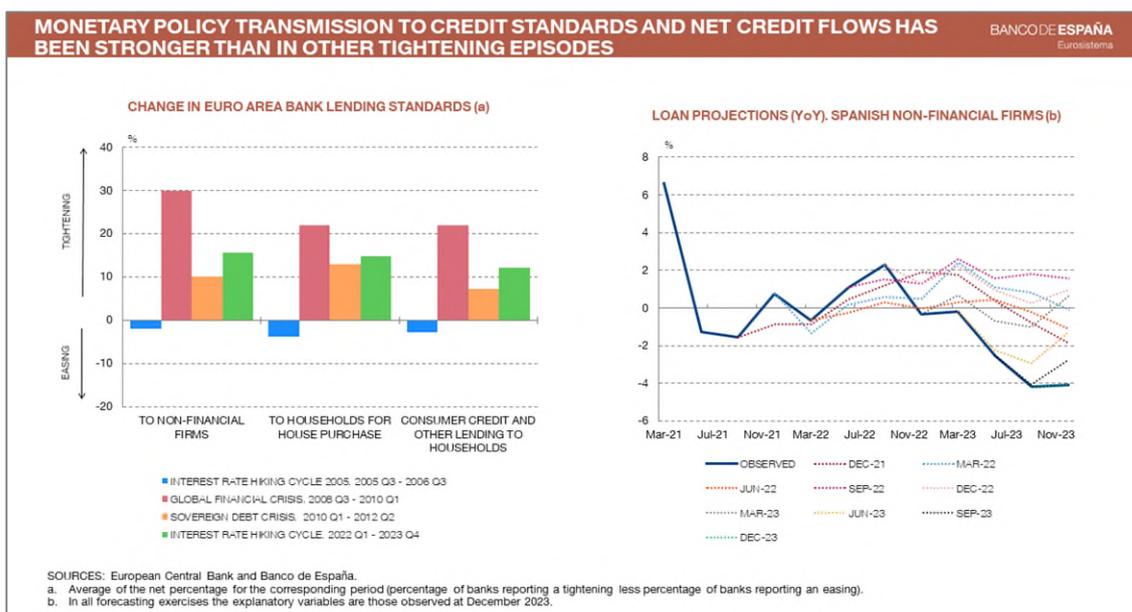
[15] Cavallo et al. (2023) show how the frequency of price changes increases dramatically after a large shock.

[16] Karadi P., A. Nakov, G. Nuno, E. Pasten, and D. Thaler (2024).

[17] Between July 2022 and September 2023 (i.e. in 14 months) policy rates rose by 450 bp and were accompanied by a significant reduction in our balance sheet.

All these features may potentially have altered the strength and speed of the monetary policy transmission mechanism in the euro area in the recent tightening process compared with previous tightening cycles.[18]

The evidence accumulated so far shows that, the unprecedented scale and speed of the last rate hiking cycle in a context of adverse supply shocks, weak growth and high uncertainty appears to have contributed to amplifying the tightening of financing conditions through higher risk premia and tighter credit standards. As a consequence, non-linearities may have emerged, as the observed slowdown in credit flows has been more intense than predicted by linear models based on historical patterns[19] (slide 4).

MONETARY POLICY TRANSMISSION TO CREDIT STANDARDS AND NET CREDIT FLOWS HAS BEEN STRONGER THAN IN OTHER TIGHTENING EPISODES

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CHANGE IN EURO AREA BANK LENDING STANDARDS (a)

LOAN PROJECTIONS (YoY). SPANISH NON-FINANCIAL FIRMS (b)

SOURCES: European Central Bank and Banco de España.
a. Average of the net percentage for the corresponding period (percentage of banks reporting a tightening less percentage of banks reporting an easing).
b. In all forecasting exercises the explanatory variables are those observed at December 2023.
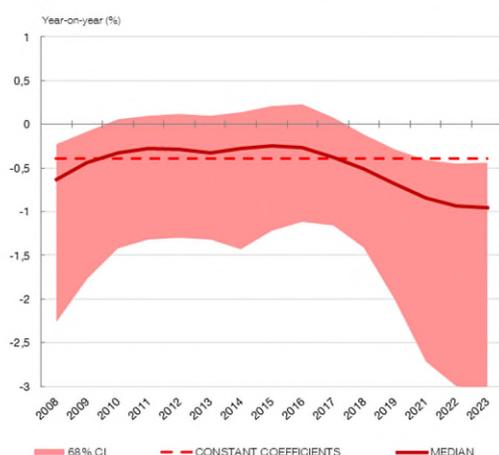
However, there is also evidence that the strong growth in nominal income, in a context of robust employment and profit growth, has slowed the increase in the percentage of vulnerable indebted households and firms. As a result, the credit risk deterioration still falls short of what would be expected on the basis of historical regularities, following a worsening economic outlook, higher interest rates and rising bankruptcies. All in all, these results suggest there is a lack of amplification mechanisms across the banking system for the transmission of monetary policy tightening in the current cycle.

As to the evidence on the second link of the monetary policy transmission mechanism from financial conditions to activity and inflation, since the start of the recent monetary policy tightening cycle, the Eurosystem staff macroeconomic projections have systematically overestimated GDP growth, and these downward surprises do not seem to be fully explained by errors in the technical assumptions, including the changes in the fiscal and monetary policy stance. This evidence might be signalling a stronger transmission of monetary policy to macroeconomic variables than in the past. However, the labour market has demonstrated remarkable resilience over the past two years, as illustrated by lower than expected unemployment rates compared with staff projections.
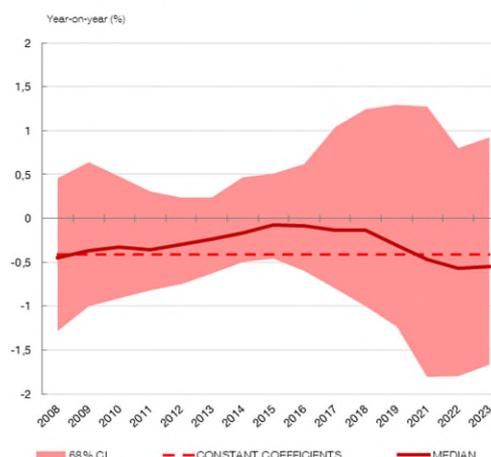
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[18] For further details, see Hernández de Cos (2024).

[19] For further details, see Lane (2023) and García-Posada and Paz (2024).

TIGTHER FINANCIAL CONDITIONS HAVE TRANSMITTED MORE FORCEFULLY TO ACTIVITY AND (ALTHOUGH NOT SIGNIFICANT TO) INFLATION THAN IN PREVIOUS CYCLES ON AVERAGE

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TIME-VARYING IMPACT OF A 25 BPS SHOCK ON GDP OVER THE <u>FIRST</u> YEAR

TIME-VARYING IMPACT OF A 25 BPS SHOCK ON HICP OVER THE <u>SECOND</u> YEAR

SOURCE: Banco de España.
NOTES: Impact of a 25 bps (non-systematic) monetary policy shock based on recursive estimates of a Structural VAR (SVAR) model extension from Brandt et al (2019). Structural shocks are identified through sign restrictions.

Complementary econometric evidence shows that, in the recent tightening cycle, the transmission of monetary policy to GDP growth and inflation may have been somewhat more intense than observed on average before this unprecedented tightening cycle [20] (slide 5). This is especially the case for growth, whereas the evidence for inflation is less conclusive. [21]

All in all, this analysis confirms that a stronger than expected monetary policy impact remains a downside risk to the euro area growth outlook, which, in turn, is an important factor behind our assessment that the risks to the inflation outlook are now balanced.

6 What have we learnt from our experience with Quantitative Tightening (QT)?

The macro-financial effects of Quantitative easing (QE) have been extensively analyzed.[22]

The theory shows that QE mainly impacts yields through anticipation effects: investors react to their expectations about how much debt the central bank will extract over time from the market, so that risk-averse market participants will not have to hold it. In part, this involves the extraction of duration risk – the risk related to changes in a bond's market price over its remaining life due to changes in short-term interest rates.[23]

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[20] The in-house evidence is based on recursive estimates on the impact of (non-systematic) monetary policy shocks by means of a Structural VAR (SVAR) model extension from Brandt et al (2021), identified through sign restrictions.

[21] An additional lesson that we can learn from the US experience is based on recent research by Canova and Perez-Forero (2024), who show evidence on how two types of monetary policy shocks impact the US economy under high versus low inflation regimes. They focus on conventional policy disturbances (which alter aggregate conditions by adjusting short-term nominal interest rates) and liquidity disturbances (which modify the money supply by affecting the long end of the term structure of interest rates) and conclude that in high inflation regimes, the peak response of output growth, unemployment, and inflation is smaller, but the effects persist longer.

[22] See, for instance, Aguilar et al (2020, 2022, 2024), and Altavilla, Carboni and Motta (2021), Eser et al (2023).

[23] Vayanos and Vila, (2021), Eser et al (2023), op. cit.

In the euro area, duration risk extraction is reinforced by the extraction of sovereign credit risk.[24] In this regard, QE has proved to be a useful tool for combatting unwarranted fragmentation of financial conditions across member states, which may be crucial for ensuring the smooth transmission of monetary policy throughout the euro area, especially at times of financial market distress.

But now that central banks are embarked in quantitative tightening (QT), we still need to understand the impact of central banks reducing their asset portfolios. In this regard, there are many reasons to expect that the observed effects of QT will not just be the mirror image of QE. Even if central bank purchases and sales of assets have a fundamentally symmetric impact on market conditions, nonetheless the manner and circumstances of QE expansions and QT contractions may cause their observed effects to differ.[25]

First, QE policies were often implemented at moments of high market stress, when their effects are larger,[26] whereas central banks have waited for times of market tranquility before embarking on QT.

Furthermore, QE took the form of outright purchases, but QT can now take the form of a passive run-off of bond portfolios.[27]

Lastly, the announcement of large-scale QE programmes, such as the ECB's pandemic emergency purchase programme (PEPP), often came as a surprise to the market, while the current QT path has been carefully announced ahead of time to avoid any surprise tightening.[28] [29]

In view of the different contexts in which QE and QT have taken place, it is unsurprising that empirical studies of QT find much smaller effects than those attributed to QE[30].

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[24] Costain, Nuño, and Thomas (2024).

[25] For example, in models such as Vayanos and Vila (2021) and Costain, Nuño, and Thomas (2024) the response to a small surprise contraction of the central bank's balance sheet is the mirror image of the response to a small surprise expansion. Nonetheless, the impact depends on the market price of risk, so the response to a QE or QT announcement when financial conditions are tight (e.g., near the ELB or in a liquidity crisis) will larger than under looser financial conditions. Moreover, the impact of balance sheet policies in these models is very forward-looking, so it goes mostly through announcement effects. Therefore, the response of bond yields to a surprise announcement is much larger than to an announcement that largely confirms market expectations.
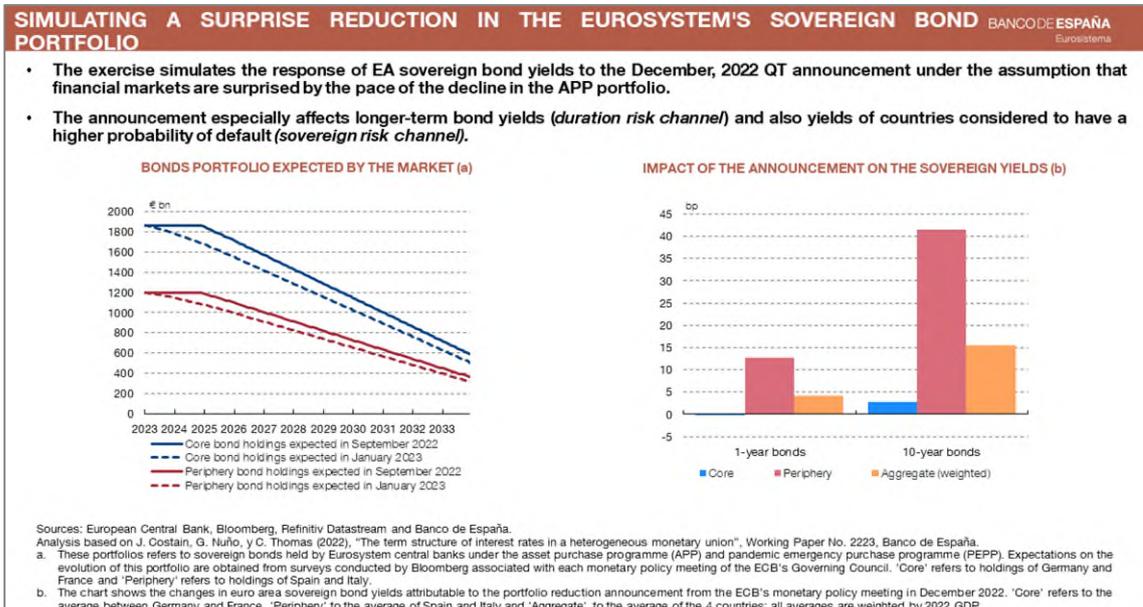
[26] See Krishnamurthy (2022).

[27] Indeed, among the four major central banks (the Federal Reserve, European Central Bank, Bank of England and Bank of Japan), only the Bank of England has implemented active QT by selling bond in the current QT episode.

[28] For instance, the European Central Bank (ECB) announced in December 2022 the pace at which it would begin to reduce the Asset Purchase Programme (APP) portfolio through partial reinvestment of maturing bonds, ensuring a gradual and predictable reduction. See the press release "Monetary Policy Decisions of 15 December 2022".

[29] Logan (2024) likewise discusses asymmetries in the observed effects of QE and QT attributable to differing financial conditions at the time of implementation, and to differences in the impacts of anticipated and unanticipated policy announcements. See Logan (2024), "Discussion of 'Quantitative tightening around the globe: What have we learned', by Du, Forbes, and Luzzetti", at the US Monetary Policy Forum of the Univ. of Chicago Booth School of Business.

[30] Du, Forbes, and Luzzetti (2024)) surveyed the effects of QT across countries. Their findings suggest that the cumulative impact of QT announcements from 2021 to 2023 was an increase of around 20-26 bps, on average across countries, government bond yields at horizons of 1 year and longer, with some heterogeneity across countries (for the euro area, they find an increase of 18 to 22 bp in yields of bonds with maturities of two to ten years. By way of comparison, Eser et al (2023), calculate a cumulative decline in yields of more than 90 bps in ten-year euro area yields in response to the ECB's asset purchase programme (APP) over the years of its maximum impact (roughly 2017-2019).

It is reasonable to assume that the reduced response to QT reflects its gradual and predictable implementation[31]. It is also likely to reflect the more benign financial market conditions now, compared to conditions when QE began (slide 6).

SIMULATING A SURPRISE REDUCTION IN THE EUROSYSTEM'S SOVEREIGN BOND PORTFOLIO — BANCO DE ESPAÑA Eurosistema

- The exercise simulates the response of EA sovereign bond yields to the December, 2022 QT announcement under the assumption that financial markets are surprised by the pace of the decline in the APP portfolio.
- The announcement especially affects longer-term bond yields (*duration risk channel*) and also yields of countries considered to have a higher probability of default (*sovereign risk channel*).

BONDS PORTFOLIO EXPECTED BY THE MARKET (a)

IMPACT OF THE ANNOUNCEMENT ON THE SOVEREIGN YIELDS (b)

Sources: European Central Bank, Bloomberg, Refinitiv Datastream and Banco de España.
Analysis based on J. Costain, G. Nuño, y C. Thomas (2022), "The term structure of interest rates in a heterogeneous monetary union", Working Paper No. 2223, Banco de España.
a. These portfolios refers to sovereign bonds held by Eurosystem central banks under the asset purchase programme (APP) and pandemic emergency purchase programme (PEPP). Expectations on the evolution of this portfolio are obtained from surveys conducted by Bloomberg associated with each monetary policy meeting of the ECB's Governing Council. 'Core' refers to holdings of Germany and France and 'Periphery' refers to holdings of Spain and Italy.
b. The chart shows the changes in euro area sovereign bond yields attributable to the portfolio reduction announcement from the ECB's monetary policy meeting in December 2022. 'Core' refers to the average between Germany and France, 'Periphery' to the average of Spain and Italy and 'Aggregate' to the average of the 4 countries; all averages are weighted by 2022 GDP.

The recent experience therefore seems to validate the gradual and predictable approach to QT adopted by central banks. Since balance sheet policies act mostly through anticipation effects, they have a larger impact if they come as a surprise. Had QT not been carefully signaled beforehand, its effects would likely have been larger.[32]

At the same time, the experience of central banks that faced some bumps on the road to balance sheet normalisation shows that temporary flexibility in its implementation can be useful in managing liquidity events without reversing the medium-term path of QT.[33]

Moreover, as excess liquidity in the system decreases alongside central banks' balance-sheet run off, it will also be important to monitor market developments and analyze which investor types are absorbing the increased supply of bonds.[34] Likewise, it will be essential to ensure that reserves remain ample at the endpoint of the QT process, as otherwise the impact of QT may be larger and the risk of liquidity events may increase.[35]

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[31] Indeed, Du et al found it challenging to identify any "surprises" in QT actions, when using indicators of surprises and disagreement in market forecasts.

[32] See, for instance, Box 3.1: "The impact of a faster than expected reduction in Eurosystem asset holdings on euro area sovereign bond yields", in the Banco de España Annual Report 2022, Chapter 3.

[33] For example, the Bank of England faced a liquidity crisis affecting UK pension funds at the outset of its QT policy, briefly expanding its longer bond purchases but maintaining its medium term path of balance sheet normalisation. See Pinter (2023).

[34] See, for instance, "Who buys bonds now? How markets deal with a smaller Eurosystem balance sheet", The ECB Blog, 22 March 2024.

[35] See Copeland, Duffie and Yang (2021) and Altavilla, Rostagno and Schumacher (2023).

7 Monetary policy and financial stability

One of the lessons of the global financial crisis, as underscored in the ECB's 2021 monetary policy strategy review, was that financial stability is a pre-condition for price stability (and vice versa).

In practice, on many occasions, the pursuit of price stability through monetary policy is complementary to that of financial stability.

This would be the case, for instance, if financial stability and inflationary risks were to emerge in parallel, so that a tightening of monetary policy could, via its negative effect on aggregate demand, reinforce the incentives of economic agents to deleverage and reduce risk-taking, complementing the activation of macroprudential tools.

There are cases, however, in which a trade-off between the two objectives arises, as in cases in which bank solvency issues emerge in a high inflation environment. These solvency issues should be mitigated by a proper supervision and resolution framework and by the action of fiscal authorities. Nonetheless, monetary policy may have to react taking into account that a financial crisis is likely to lead to the emergence of prolonged disinflationary forces that should ease this trade-off between monetary and financial stability over time, albeit at a potentially high cost in terms of output loss.

Recent events, including both the pandemic crisis and the current inflationary episode, have witnessed monetary policy responses that have successfully been able to pursue the price stability mandate without undermining financial stability.

One such example was the pandemic emergency purchase programme (PEPP), which ensured financial market functioning and helped to restore investors' confidence in a context of sharp increases in financial stress and market volatility, which supported the expansionary monetary policy stance in the face of a deflationary shock.

More recently, the announcement of the transmission protection mechanism (TPI) occurred in an environment of mounting inflationary pressures and of a monetary policy tightening stance. The TPI allowed to stabilize markets and to support the smooth functioning of financial markets necessary to transmit its tighter monetary policy stance homogenously across countries. The TPI has thus been crucial in allowing for a forceful monetary policy reaction to tackle the inflation problem.

In this regard, the conclusions reached in our monetary policy strategy to explicitly take financial stability considerations into account in monetary policy deliberations seems valid. Under this framework, any monetary policy response to financial stability concerns will depend on prevailing circumstances and will be guided by the implications for price stability. In practical terms, this means that an integrated framework of economic analysis and monetary and financial analysis is used to measure developments in financial vulnerabilities and macroprudential measures, and their impact on output and inflation, including in the long- run.

Moreover, there are also lessons for macroprudential policy from recent experience. In particular, an important lesson is that a more active stance to foster the accumulation of sufficient releasable macroprudential buffers during non-crisis periods to release them in

crisis periods could make macroprudential policy complementary to monetary and fiscal policies with regard to their macroeconomic stability objective.

8 Monetary and fiscal policy interactions

Just as macroprudential policy has important implications for the conduct of monetary policy, the same is true of fiscal policy.

The COVID-19 pandemic clearly demonstrated that fiscal and monetary policy can be complementary.

However, as we emerged from the pandemic and the inflationary shocks took hold, monetary and fiscal policies increasingly risked pulling in opposite directions, losing effectiveness in the process.

Fiscal policy responded to the start of the war in Ukraine with measures to mitigate the impact of the energy and food price shock on households and businesses. However, many of these measures were not sufficiently selective or targeted at the most vulnerable groups, resulting in an expansionary impulse that was broader than necessary, thus adding to inflationary pressures.

An important lesson in this respect is that monetary and fiscal policies are more effective when their stances are mutually supportive.

In the current context, this means that fiscal policy should help avoid additional inflationary pressures and the associated monetary policy response. Accordingly, it is vital that governments continue to withdraw the measures applied during the energy crisis in step with falling energy and food prices. This would alleviate demand-driven inflationary pressures and avoid a more forceful monetary policy response.

From a more medium-term standpoint, fiscal policies should adopt a medium-run perspective to reinforce euro area governments' commitment to public debt sustainability and increase the fiscal space available to deal with future crises. Effective and transparent implementation of the new Stability and Growth Pact is therefore of the essence.

Finally, it is worth mentioning that some elements are still missing in order to ensure the proper functioning of the policy mix in the euro area. To achieve this objective, a central fiscal capacity is required, one of adequate size and with sufficient and reliable funding to allow for effective macroeconomic stabilisation at the monetary union level. A common, permanent, European financing instrument would also allow the financing of large-scale projects that provide public goods at a European level (such as those linked to defense expenditure or the fight against climate change), while avoiding any excessive or uneven impact on national public finances and disruptions of the single market.

These efforts will also require a significant contribution from private investment. For this to happen, it is crucial to first reduce the fragmentation of capital markets and improve the limited degree of risk-sharing that still characterises the monetary union. Thus, it is crucial to complete the banking union and to press ahead with the capital markets union. A key element of this framework would be the issuance of benchmark pan-European safe assets. This would allow the prices of equity and fixed-income instruments across the euro area to
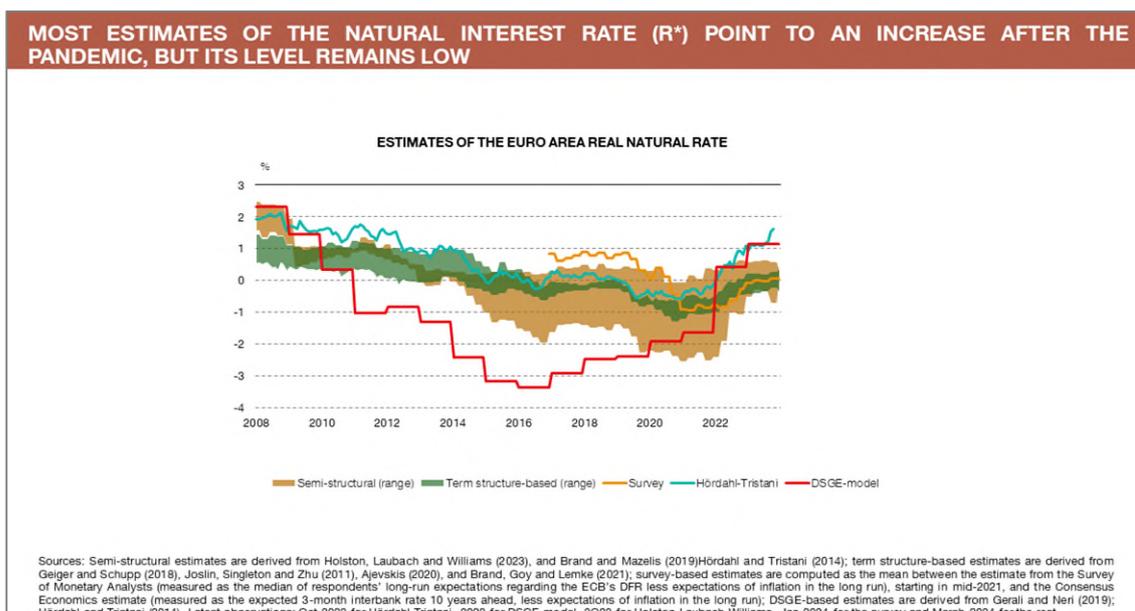
reflect their fundamental risk more clearly and thus limit flight-to-quality capital flows towards core countries.

9 On the usefulness of r* as a guide for monetary policy

A significant takeaway from the monetary tightening cycle pertains to the usefulness of estimates of the so-called *natural rate of interest*[36] in guiding regular monetary policy decisions.[37]

Throughout the tightening cycle, policy institutions and researchers have worked to identify movements in the natural rate of interest, seeking to determine how contractionary monetary policy was each step of the way. This approach will become more and more prevalent as we reach the final stages of the disinflation process, where, in principle, real policy rates (i.e. nominal rates minus expected inflation) should be converging to the natural real rate, wherever that may lie.

In my view, one of the most significant lessons to be learned from these analyses often comes in the preface, which consistently highlight the high level of uncertainty associated with estimating the natural rate.

MOST ESTIMATES OF THE NATURAL INTEREST RATE (R*) POINT TO AN INCREASE AFTER THE PANDEMIC, BUT ITS LEVEL REMAINS LOW

ESTIMATES OF THE EURO AREA REAL NATURAL RATE

Sources: Semi-structural estimates are derived from Holston, Laubach and Williams (2023), and Brand and Mazelis (2019)Hördahl and Tristani (2014); term structure-based estimates are derived from Geiger and Schupp (2018), Joslin, Singleton and Zhu (2011), Ajevskis (2020), and Brand, Goy and Lemke (2021); survey-based estimates are computed as the mean between the estimate from the Survey of Monetary Analysts (measured as the median of respondents' long-run expectations regarding the ECB's DFR less expectations of inflation in the long run), starting in mid-2021, and the Consensus Economics estimate (measured as the expected 3-month interbank rate 10 years ahead, less expectations of inflation in the long run); DSGE-based estimates are derived from Gerali and Neri (2019); Hördahl and Tristani (2014). Latest observations: Oct-2023 for Hördahl-Tristani, 2023 for DSGE-model, 3Q23 for Holston-Laubach-Williams, Jan-2024 for the survey and March 2024 for the rest.

Let us consider the current situation to illustrate the challenge at hand. The range of estimates for the real natural rate in the euro area implies *nominal* natural rates (i.e. real natural rate plus 2% inflation) ranging from 1.5% to 3%[38]. Furthermore, each of these point

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[36] The natural rate of interest, r* (or "r-star"), can be defined as the real rate of interest that is neither expansionary nor contractionary.

[37] Beyond regular monetary policy-making, the natural rate of interest plays an important role in central banks' monetary policy frameworks. As an example, the estimated secular decline in the euro area natural interest rates, and the resulting challenge posed by the lower bound on nominal interest rates for the ECB's ability to fulfil its price stability mandate, was the main motivation behind the ECB's 2021 strategy review.

[38] For further details, see Brand, Lisack and Mazelis (2024).

estimates across different methodologies comes with a significant margin of error[39] (slide 7).

And the high level of uncertainty surrounding the natural rate stems from more than methodological alone. If we look at the fundamentals that determine the natural rate in the theory, such as productivity growth, demographics, fiscal positions and climate change, it is easy to see how the long-term evolution of these determinants is extremely hard to predict, even directionally in some cases.

So, how do we conduct monetary policy when estimates of the natural rate of interest are subject to such high uncertainty?

Past research has sought to address this question.[40] The conclusion is that in the face of such uncertainty, the policy rate should be inertial, in the sense that the previous rate should serve as the primary reference point, largely replacing the natural rate, with adjustments made based on inflation and estimated output gaps. This approach not only mitigates the impact of estimation errors but also advocates for gradual adjustments in the policy rate, driven solely by estimated gaps, thereby promoting a data-dependent approach.

In addition to this, I would like to emphasise another dimension of information available to central banks, one that is often overlooked in studies focusing on Taylor rules for interest rates. When central banks announce their decisions, they gain valuable insight into whether they have surprised financial markets and, if so, the extent to which these surprises impact expectations of inflation and economic activity.[41] In a context of high structural uncertainty, a careful interpretation of these signals often proves to be the most effective tool for assessing the stance of monetary policy.[42]

10 Monetary policy and supply- side policies

The concept of r* is also useful to illustrate some of the interactions between monetary policy and structural reforms.

As shown previously, according to the available estimates, the natural interest rate has been in progressive decline over recent decades in advanced economies. The recent worldwide surge in inflation has eased these limitations somewhat, as monetary policy has raised nominal interest rates sharply and inflation expectations have increased. But the resulting uptick in real interest rates remains modest compared with the late 1970s.

Empirical studies attribute this secular drop in r* mainly to the decline in trend productivity growth and demographic developments, but also find a role for other factors which affect the balance between the supply of savings and the demand for investment, such as fiscal policy or capital flows.[43]

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[39] See, Laubach and Williams (2003).

[40] See Orphanides and Williams (2002).

[41] See, for example, Gürkaynak, Sack, and Swanson (2005), or Swanson (2021).

[42] See Schnabel (2024).

[43] See, for instance, IMF (2023) and Benigno et al (2024)

Going forward, new factors (e.g. the green transition or a slowdown in the globalisation process) are likely to also play a role, since they have the potential to reduce the long-run level of output and income and hence the supply of savings, but also to mobilise a larger amount of investment.

In this context, structural reform policies that can raise potential output growth and the equilibrium real interest rates may play a crucial role in providing monetary policy with more room for manoeuvre, meaning that monetary policy is less likely to be constrained by the effective lower bound for interest rates and, by extension, less likely to resort to unconventional policies.

In addition, structural reforms that foster potential output would also entail the output gap (i.e. the gap between actual and potential output) closing at a higher level of output, at which point monetary policy would have to return to a neutral stance. This would make debt levels (both public and private) more sustainable at any given level of interest rates, ensuring that governments, households and firms have less need to make adjustments.

And, more generally, structural reforms have the capacity to make the economy more resilient to shocks, which could be particularly key for the smooth functioning of monetary policy. A flexible and more resilient economy is more likely to adjust to shocks through changes in prices, which are also expected to fade quickly, keeping inflation expectations anchored and thus facilitating the work of monetary policy.

In a context of flexible markets and a high degree of competition, monetary policy actions will also be more effective, feeding through the economy more quickly. And these benefits are particularly relevant in a monetary union, since structural reforms can reduce cross-country economic divergence, making a single monetary policy more appropriate for all countries.

By making national economies more flexible, structural reforms can also reduce the likelihood of macroeconomic imbalances, such as financial or current account imbalances, which is also key to the correct functioning of the euro area.

All in all, these factors justify the need to place more emphasis on structural policies in the coming years to increase the resilience and the growth potential of our economies.

Conclusions

In the last three years we have had to deal with extraordinary inflationary shocks and conduct our policy response to them against a background of enormous uncertainty. It would be preposterous to pretend that we central bankers have always gotten things absolutely right, but as a whole I think it is fair to say that we have tried to do our best with the tools –and the knowledge– at our disposal. As the British mathematician and philosopher Bertrand Russell wrote, *"not to be absolutely certain [is] one of the essential things in rationality"*. All in all, we are increasingly confident that we are on the right track to achieve our 2% inflation target relatively soon.

Let me conclude by saying that I feel truly honoured to have had the chance to share my reflections with you today on this inflationary-disinflationary episode. I wish you all a fascinating and fruitful career as economists. As the famous French writer Antoine de Saint-

Exupery wrote in The Little Prince, "*As for the future, your task is not to foresee it, but to enable it.*"

Thank you.

References

Aguilar, P., O. Arce, S. Hurtado, J. Martínez-Martín, G. Nuño and C. Thomas (2020), "The ECB monetary policy response to the COVID-19 crisis", Documentos Ocasionales, 2026, Banco de España.

Aguilar, P., A. Arencibia, J. Costain, S. Hurtado, J. Martínez-Martín, G. Nuño and C. Thomas (2022), "La política monetaria del Banco Central Europeo frente a la crisis pandémica", Papeles de Economía Española, N.º 173.

Aguilar, P., M. Alloza, J. Costain, S. Hurtado and J. Martínez-Martín (2024), "The effect of the European Central bank's asset purchase Programmes on Spain's public finances", Documentos Ocasionales, 2409, Banco de España.

Aguilar, P., R. Domínguez-Díaz, JE. Gallegos and J. Quintana. (2024). "A Production Network Perspective on Inflation Developments". Banco de España Working Paper, forthcoming.

Altavilla, C., G. Carboni and R. Motto (2021), "Asset Purchase Programs and Financial Markets: Lessons from the Euro Area", *International Journal of Central Banking* 17 (4), pp. 1-48.

Arce O., Ciccarelli, M., Kornprobst, A., and C. Montes-Galdón (2024). "What caused the euro area post-pandemic inflation? An application of Bernanke and Blanchard (2023)", ECB Working Paper N. 343.

Altavilla, C., M. Rostagno and J. Schumacher (2023), "Anchoring QT: Liquidity, credit and monetary policy implementation", CEPR Discussion Paper 18581.

Banbura, M., Bobeica, E., and C. Martínez-Hernández. (2024) "What drives core inflation? The role of supply shocks" ECB Working Paper N. 2875.

Banco de España (2023), "Box 3.1: The impact of a faster than expected reduction in Eurosystem asset holdings on euro area sovereign bond yields", Annual Report 2022, Chapter 3.

Benigno, G., Hoffmann, B., Nuño, G., and D. Sandri (2024) "Quo vadis, r*? The natural rate of interest after the pandemic", BIS Quarterly Review.

Bernanke, B. (2024), "Forecasting for monetary policy making and communication at the Bank of England: a review", Bank of England, 12 April 2024.

Brainard, W. C. 1967. "Uncertainty and the Effectiveness of Monetary Policy." *American Economic Review* 57 (2): 411–425.

BIS (2022) "Annual report 2021/2022",

Borrallo, F., L. Cuadro-Sáez, A. Gras-Miralles and J. J. Pérez (2024), "The transmission of shocks to food and energy commodity prices to food inflation in the euro area", mimeo.

Brand, C., N. Lisack, and F. Mazelis (2024), "Estimates of the natural interest rate for the euro area: an update", ECB Economic Bulletin, Issue 1/2024.

Brandt, L., A. Saint-Guillhem, M. Schröder, and I. Van Robays (2021) "What drives euro area financial market developments? The role of US spillovers and global risk", ECB Working Paper No. 2560.

Burriel, P., Kataryniuk, I., Moreno C, and F. Viani (2024). "A new Supply Bottlenecks Index based on newspaper data" *International Journal of Central Banking*, 20 (2), April/2024 pp 17-68.

Burriel, P. and F. Odhendal (2024) "Asymmetries in the transmission of energy price increases and decreases to underlying inflation in the euro area and Spain", Economic Bulletin Banco de España, 2024/Q1 article 06.

Canova, F., and F. Perez-Forero (2024) "Does the Transmission of Monetary Policy Shocks Change when Inflation is High?", CEPR Discussion Paper No. 18993.

Cavallo, A., Lippi F., and K. Miyahara (2023) "Large Shocks travel Fast", CEPR Discussion Paper No. 18413.

Copeland, A., Duffie, D., and Y. Yang (2021), "Reserves were not so ample after all", NBER Working Paper 29090.

Costain, J., G. Nuño and C. Thomas (2024), "The term structure of interest rates in a heterogeneous monetary union", Working Paper 1165, Bank for International Settlements.

Costain, J., A. Nakov and B. Petit (2022) "Flattening of the Phillips curve with state-dependent prices and wages", Economic Journal 132(642), pp. 546-581.

Chahad, M., A. Hofmann-Drahonsky, C. Martínez Hernández and A Page (2022), "What explains recent errors in the inflation projections of Eurosystem and ECB staff?", *Economic Bulletin*, Issue 3, ECB.

Chahad, M., A. Hofmann-Drahonsky, C. Martínez Hernández and A Page (2023), "An updated assessment of short-term inflation projections by Eurosystem and ECB staff", *Economic Bulletin*, Issue 1, ECB.

Chahad, M., A. Hofmann-Drahonsky, C. Martínez Hernández and A Page (2024) "An update on the accuracy of recent Eurosystem/ECB staff projections for short-term inflation", *Economic Bulletin*, Issue 2, ECB.

Dedola, L., L. Henkel, C. Höynck, C. Osbat and S. Santoro (2024). "What does new micro price evidence tell us about inflation dynamics and monetary policy transmission?", ECB Economic Bulletin, Issue 3/2024.

Du, W., K. Forbes, and M. Luzzetti (2024), "Quantitative Tightening Around the Globe: What Have We Learned?", NBER Working Paper 32321.

Dupraz, S., Guilloux-Nefussi,S., and A. Penalver (2023), "A Pitfall of Cautiousness in Monetary Policy", *International Journal of Credit Banking.*

Eser, F., W. Lemke, K. Nyholm, S. Radde, A. L. Vladu (2023), "Tracing the Impact of the ECB's Asset Purchase Program on the Yield Curve", International Journal of Central Banking 19 (3), pp. 359-422.

European Central Bank (2024), "Who buys bonds now? How markets deal with a smaller Eurosystem balance sheet", The ECB Blog, 22 March 2024.

Ferrero, G, M Pietrunti, and A Tiseno (2019), "Benefits of gradualism or costs of inaction? Monetary policy in times of uncertainty", Bank of Italy, Economic Research and International Relations Area, no. 1205.

García-Posada and Paz (2024), "The transmission of monetary policy to credit supply in the euro area", mimeo.

Gautier, E. et al (2023) " Price adjustment in the euro area in the low-inflation period: evidence from consumer and producer micro price data", ECB Occasional Paper Series, no 319.

Gimeno R. and E. Ortega (2022) "Modelling inflation expectations: the value of mixing information and frequencies", Banco de España Working Paper, forthcoming.

Gürkaynak, R., Sack, B. and E. T. Swanson (2005) "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements", International Journal of Central Banking.

Gutierrez, E. and P. Roldán-Blanco (2024) "The inflationary spike in Spain between 2021 and 2023: evidence from micro data", Economic Bulletin Banco de España, 2024/Q1 Article 05.

Hernández de Cos (2024) "Monetary Policy Transmission and the Banking System", speech at "The ECB and Its Watchers" in Frankfurt.

Holton, S., and C. Rodriguez d'Acri. (2018). "Interest rate pass-through since the euro area crisis". *Journal of Banking & Finance*, vol. 96, pp. 277-291.

International Monetary Fund (2023) "The natural rate of interest: drivers and implications for policy", Chapter 2, World Economic Outlook.

Koch C., and D. Noureldin (2023), "How We Missed the Inflation Surge: An Anatomy of Post-2020 Inflation Forecast Errors", IMF Working Paper 23/103, International Monetary Fund.

Kataryniuk, I, Martinez-Martin, J., Pappa E., and S. Rast (2024) "The heterogeneous effect on inflation of supply shocks", Banco de España Working Paper, forthcoming.

Karadi P., A. Nakov, G. Nuno, E. Pasten, and D. Thaler (2024). "Strike the Iron while it's Hot: Optimal Monetary Policy with (S,s) Pricing" mimeo.

Krishnamurthy, A. (2022), "Lessons for Policy from Research," Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution, vol. 53(2 (Fall)), pages 233-242.

Kryvtsov, O., J. MacGee, and L. Uzeda (2023), "The 2021–22 Surge in Inflation", Staff Discussion Paper 2023-3, Bank of Canada.

Lagarde, C. (2023), "Policymaking in an age of shifts and breaks", speech at the annual Economic Policy Symposium "Structural Shifts in the Global Economy" organised by Federal Reserve Bank of Kansas City, Jackson Hole, 25 August.

Lane, P. R. (2023) "The banking channel of monetary policy tightening in the euro area". at the Panel Discussion on Banking Solvency and Monetary Policy, NBER Summer Institute Macro, Money and Financial Frictions Workshop, July.

Lane, P. R. (2024) "The 2021-2022 inflation surges and monetary policy in the euro area", ECB Blog, March 11.

Laubach, T. and J. Williams (2003b), "Estimating the natural rate of interest ", *The Review of Economics and Statistics,* Vol. 85, No. 4, pp. 1063-1070.

Logan, Lorie, K. (2024), "Discussion of 'Quantitative tightening around the globe: What have we learned', by Du, Forbes, and Luzzetti", at the US Monetary Policy Forum of the Univ. of Chicago Booth School of Business.

Milesi-Ferretti, G. M., L. Onorante and N. Vidalis (2023) "External evaluation of Banco de España macroeconomic projections", Banco de España, July 2023.

Ng, S. (2021) "Modeling Macroeconomic Variations after Covid-19", NBER Woking Paper No. 29060.

Orphanides, A. and J. Williams (2002), Orphanides and Williams (2002), "Robust Monetary Policy Rules with Unknown Natural Rates", Brookings Papers on Economic Activity, Vol 2002 (2), pp. 63-118.

Pill, H. (2022) "Monetary policy with a steady hand", speech given at the Society of Professional Economists, February 9, 2022.

Pinter, G., (2023), "An anatomy of the 2022 gilt market crisis", Bank of England Staff Working Paper 1019.

Reis R. (2022) "The Burst of High Inflation in 2021–22: How and Why Did We Get Here?", CEPR discussion paper, no. 17514.

Reserve Bank of Australia (2022), "Box C: What Explains Recent Inflation Forecast Errors?", Statement on Monetary Policy, November.

Schnabel, I. (2024) "R(ising) star", at The ECB and its Watchers XXIV Conference session on: Geopolitics and Structural Change: Implications for Real Activity, Inflation and Monetary Policy, Frankfurt, March 20.

Swanson, E. T. (2021) "Measuring the effects of federal reserve forward guidance and asset purchases on financial markets", Journal of Monetary Economics, Vol 118, pp. 32-53.

Tenreyro S., N. Bandera, L. Barnes, M. Chavaz and L. von dem Berge (2023), "Monetary policy in the face of supply shocks: the role of inflation expectations", ECB Sintra Forum on Central Banking.

Vayanos D. and J. Vila, (2021), "A Preferred-Habitat Model of the Term Structure of Interest Rates", *Econometrica* 89 (1), pp. 77-112.