Model-based recommendations for monetary policy decision-making

As a result of the COVID-19 pandemic and Russia's unjustified war of aggression against Ukraine, inflation rates in the euro area reached record levels. The Governing Council of the European Central Bank (ECB) responded to this with its strongest interest rate hiking cycle thus far since the introduction of the euro: since July 2022, it has raised monetary policy interest rates by a total of 4.5 percentage points. Furthermore, in March 2023, the holdings of assets acquired under the asset purchase programme (APP) started to be reduced.

These monetary policy decisions reflect challenging trade-offs, as the Governing Council aims to fulfil its price stability mandate without creating unnecessary costs to the economy or risks to financial stability. For this reason, the Governing Council gathers a very comprehensive view in its consultations before it makes its decisions.

This article explores one of the components of this complex monetary policy decision-making process: model-based optimal policy projections (OPPs). In approximated form, they reflect the outlined policy trade-offs and, on the basis of suitable models, produce a recommended course of action for the path of monetary policy.

Eurosystem staff macroeconomic projection exercises represent the starting point for the calculation of OPPs and a point of reference for the monetary policy decision-making process. These provide a comprehensive picture of current and prospective developments in aggregate economic activity and prices in the euro area. However, these projections are based on market expectations of the monetary policy interest rate. From a monetary policy decision-making standpoint, the projections thus do not inherently make any statements regarding an optimal interest rate path.

Therefore, in terms of monetary policy, the key question is which monetary policy measures based on these projections optimally fulfil the price stability mandate. OPPs may provide an answer to this question: the resulting time path for monetary policy instruments is the result of an optimisation procedure intended to best achieve the objective of price stability, taking into account other relevant economic aspects. Here, "optimality" is always defined within the context of the respective model analyses used to determine the corresponding paths of interest rates. These analyses factor in assumptions on the preferences of monetary policy decision-makers; however, these assumptions do not necessarily reflect the actual preferences of the individual ECB Governing Council members.

This article outlines the use of OPPs in the monetary policy decision-making process on the basis of selected analyses. It discusses the need for sensitivity analyses as well as the limitations of the approach presented here. Despite their constraints, OPPs support and complement other, sometimes less formal, components of monetary policy decision-making. They have the advantages of analytical consistency and transparency. In this way, they help to rigorously test the validity of considerations and arguments within the monetary policy decision-making process.

Introduction

Recent strong surges in inflation …

Over the past two years, the euro area has seen exceptionally strong surges in inflation. These arose from a combination of supply bottlenecks related to the COVID-19 pandemic, a sharp increase in demand as the economy reopened from widespread pandemic-related lockdowns, and spikes in energy prices resulting from Russia's unjustified war of aggression against Ukraine.[1] Unlike inflation fuelled purely by demand, supply shocks pose particular challenges for monetary policy, as they drive economic activity and inflation in different directions. This results in complex monetary policy trade-offs.

… caused decisive interest rate responses from ECB Governing Council

The ECB Governing Council, which makes monetary policy decisions for the euro area, responded to the far too high inflation rates with an unprecedented series of interest rate rises. Since July 2022, it has increased the interest rate on the deposit facility – currently the most relevant key interest rate for the monetary policy stance – by 4.5 percentage points, from -0.5% to 4%. The aim of these decisive interest rate hikes is to slow down aggregate demand as a way of counteracting the exceptionally strong inflation dynamics. In doing so, the Governing Council is trying to avoid increasing interest rates by "too much", as this could otherwise cause unnecessary costs to the economy and risks to financial stability.[2] Hence, monetary policy decision-making has been and is being carried out in a macroeconomic environment that requires the Governing Council to walk a fine line.

OPPs support monetary policy considerations using macroeconomic projections …

This article discusses how the ECB Governing Council is supported in these challenging monetary policy trade-offs and decision-making processes by model-based optimal policy projections (OPPs). In this context, OPPs are one component of a comprehensive analysis that draws on multiple economic, monetary and financial factors that are key to price developments in the euro area. Their role within this comprehensive analysis is mainly to provide a rigorous, formal perspective. Here, the starting point and point of reference for calculating OPPs is the Eurosystem staff macroeconomic projections, which offer a concise picture of current and prospective developments in aggregate economic activity and prices in the euro area.[3]

… based on market expectations regarding monetary policy instruments

Macroeconomic projections are based on the core assumption that the ECB Governing Council employs its instruments in the manner expected by markets at the time the projections are made.[4] The projections thus do not inherently contain any direct or immediate recommendations for monetary policy action, i.e. no assessment of an appropriate or even optimal interest rate path for monetary policy decision-makers. Instead, the Governing Council's assessment may differ from market expectations and, through its monetary policy decisions, the Governing Council may alter the projected path of key macroeconomic variables in order to fulfil its mandate.

OPPs: optimal deviation of monetary policy instruments from market expectations

This leads to the normative question of which monetary policy decisions contribute to optimally fulfilling the price stability mandate. Alongside a number of individual (sub-)analyses that feed into the monetary policy decision-making process, OPPs help to provide an answer to this question. Amongst other things, they include optimal time paths for the future development of monetary policy instruments (such as the relevant monetary policy interest rate or asset purchases and sales). These time paths, then, are the outcome of an optimisation procedure that aims to fulfil the mandate – which is primarily to maintain price stability over the me-

1 For more on this, see Nagel (2022), Lane (2022a, 2022b, 2023) and Arce et al. (2023).
2 See Panetta (2023).
3 Staff macroeconomic projections serve to estimate future price developments in the best possible way and thus identify potential risks to price stability at an early stage. For more information, see Deutsche Bundesbank (2023a).
4 The modern view of monetary policy emphasises that monetary policy measures achieve their impact on economic developments largely by steering private sector expectations about future developments in inflation, output and interest rates (see Woodford (2003) and Svensson (2005)).

dium term – in the best possible way. If necessary, OPPs will therefore also include the optimal deviation of monetary policy instruments from market expectations.[5] However, it is important to stress that "optimality" must be understood here only within the context of the employed model analyses and the monetary policy preferences formulated within them, and not as a statement on the actual preferences of the ECB Governing Council or its members.

OPPs are based on assumptions and must always be challenged

It is also important to emphasise that OPPs represent just one component, albeit a noteworthy one, of the monetary policy decision-making process. OPP calculations are based on a range of assumptions, particularly projections for both economic developments and the rate of inflation, which are subject to considerable uncertainty. Moreover, the calculation of OPPs draws on macroeconomic models that only approximate reality. For this reason, a number of sensitivity and scenario analyses help to verify the robustness of OPP outputs and are indispensable when preparing monetary policy meetings. Despite the constraints within which OPPs and the underlying models are calculated, OPPs support and complement other, sometimes less formal, components of the monetary policy decision-making process. This is because OPPs have the advantage of being analytically rigorous, comparable over time, and transparent, which means they can play a part in testing the soundness of considerations and arguments in monetary policy decision-making.

Conceptual framework for deriving optimal policy projections

Overview: construction of optimal policy projections

Three components for calculating OPPs

Three components are needed to calculate OPPs:

(i) the operationalisation of monetary policy target variables and their relative weighting;

(ii) the prospective paths of the target variables – for given market expectations regarding monetary policy instruments (i.e. macroeconomic projections);

(iii) the estimated transmission of monetary policy to these target variables.

The calculation of OPPs now centres around the question of how the ECB Governing Council should employ its monetary policy instruments to optimally influence the path of the target variables within the scope of its mandate (see the upper chart on p. 40).

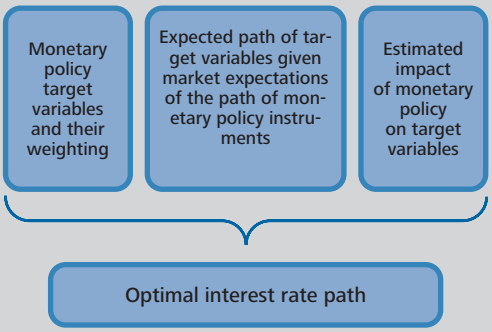
Construction of OPPs

Put simply, OPPs are calculated by adding the estimated impact of monetary policy instruments on the target variables to the projected paths of these variables. Here, the use of instruments is selected via an optimisation procedure in such a way that the target variables follow an optimal path within the scope of the mandate.[6] The lower chart on p. 40 provides a schematic illustration of this approach in the case of a monetary policy-induced rise in interest rates. It depicts the fundamental trade-off that Eurosystem monetary policy would face given an unfavourable supply shock. On the one hand, an increase in interest rates would lower the rate of inflation and thus bring it back closer to its target value. On the other hand, an increase in interest rates would amplify the economic downturn. When OPPs are calculated, these countervailing effects are traded off within the scope of the mandate. The outcome of these calculations – the optimal compromise – is an optimal interest rate

5 In some of the more recent literature on monetary policy, OPPs are therefore also referred to as "optimal policy perturbations" (Barnichon and Mesters (2023)).

6 The method for calculating optimal policy projections was developed in recent macroeconomic literature. See Svensson (2005), Svensson and Tetlow (2005), Svensson (2010), de Groot et al. (2021), Harrison and Waldron (2021), Hebden and Winkler (2021), Barnichon and Mesters (2023) and McKay and Wolf (2023). The method is immune to the Lucas critique (Lucas (1976)), as it takes account of the fact that households and firms have individually optimal responses to current and future monetary policy impulses. In this context, "optimality" means profit or utility maximising.

Components for calculating optimal policy projections (OPPs)



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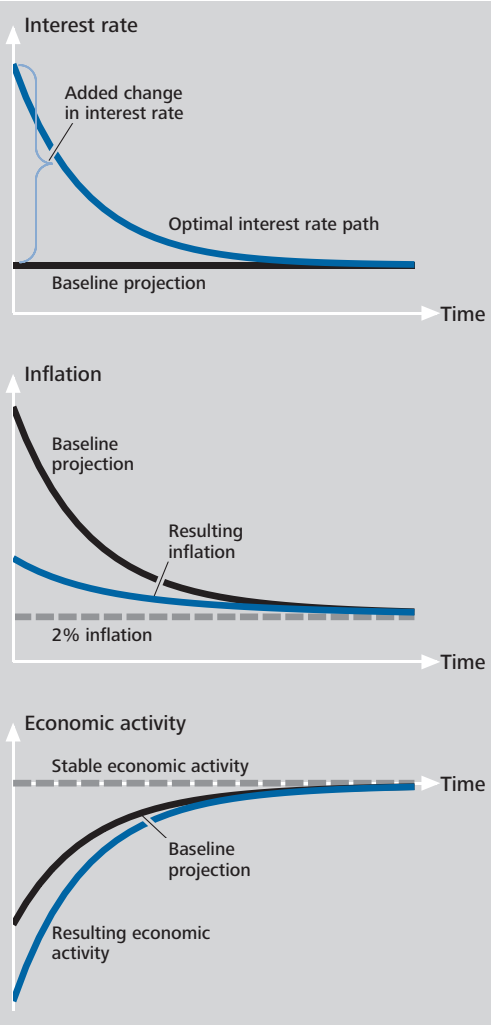
Stylised representation of the construction of an optimal interest rate path



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path as well as the associated paths of inflation and economic activity (blue lines).

Operationalisation of monetary policy target variables and their weighting

Component 1: target variables and their weighting

To determine the optimal time path for monetary policy instruments, the calculation of OPPs first requires the price stability mandate to be operationalised (component 1 in the list presented above). This is done by selecting individual target variables and then weighting them to set their relative priorities in monetary policy.

Price stability in the Eurosystem operationalised with a medium-term inflation target of 2%

The Eurosystem's monetary policy strategy considers that price stability is best maintained by aiming for an inflation rate of 2% over the medium term.[7] When calculating OPPs, the main target variable for monetary policy is therefore the deviation of inflation from its 2% target.

Monetary policy decision-making can take account of economic fluctuations …

The focus on the medium term takes account of the fact that monetary policy is transmitted with a time lag and is thus only able to influence current economic developments to a very limited extent. In addition, a medium-term horizon for monetary policy allows for flexible responses when inflation rates and economic activity move in opposite directions. This means that, in principle, when the ECB Governing Council stabilises the rate of inflation, it does so not entirely without regard to economic developments. If the stabilisation of inflation is too narrowly interpreted, accompanied by overly large fluctuations in economic activity, this may jeopardise the inflation target over the medium term. From the Eurosystem's perspective, it is therefore appropriate to avoid excessive fluctuations in economic activity. Minimising eco-

7 For an in-depth description of the Eurosystem's monetary policy strategy, see European Central Bank (2021) and Deutsche Bundesbank (2021). The Governing Council's inflation target of 2% is symmetric. In this context, "symmetric" means that both negative and positive deviations of inflation from the target are considered equally undesirable by the Governing Council.

nomic fluctuations is thus a second target variable underpinning the calculation of OPPs.

… and financial stability risks in order to achieve the inflation target over the medium term

Lastly, the orientation towards the medium term also permits the consideration of financial stability aspects that could arise from excessive fluctuations in monetary policy interest rates. In this context, financial stability is not a monetary policy objective in its own right, but is instead a prerequisite for achieving the inflation target over the medium term.[8] Small fluctuations in interest rates ceteris paribus increase the certainty of planning for households, firms and financial markets, and also reduce the likelihood of sharp corrections in asset values. For this reason, the third target variable that the Bundesbank takes into account when calculating OPPs is the volatility of the monetary policy interest rate.

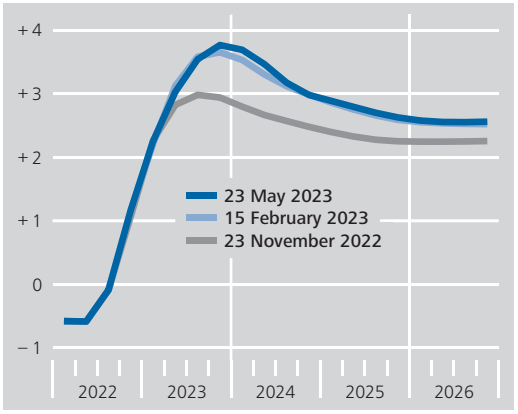
Target variables are weighted …

Depending on the economic situation, these target variables may be at odds with one another. One prototypical example of this is the impact of a supply shock that causes both higher inflation and an economic downturn (e.g. an unexpected rise in energy prices). In this case, the goal of combating the excessively high inflation following such a shock is – all else being equal – at odds with the goal of preventing the economic downturn from becoming longer or more severe. The target variables therefore need to be traded off within the context of monetary policy decision-making, which means that the target variables each have to be assigned suitable relative weightings.

… using a loss function

This is done by means of a (formal) loss function, which represents the relative priority of each target variable within the context of the monetary policy mandate.[9] Here, "loss" refers to the margin by which the monetary policy targets are missed. The further the target variables deviate from their target values, the greater the loss. The weighting assigned to the target variables within the loss function determines the degree to which the (squared) deviations of the individual target variables from their respective target values affects the overall loss. Not only the target variables' current values, but their future values as well, are factored into the loss function. This intertemporal approach takes account of the fact that monetary policy does not act statically but rather in a dynamic environment, weighing current and future developments against each other. Through its decisions, monetary policy only has a limited impact on the current (prevailing) economic situation. Instead, it exerts its main influence on future economic activity and the inflation rate over the medium term. This implies that a complex trade-off needs to be achieved: for example, a (sharp) rise in interest rates may be conducive to the aim of lowering inflation in the near future. At the same time, though, that (sharp) rise in interest rates should also not result in the rate of inflation falling significantly short of its target further down the line. The

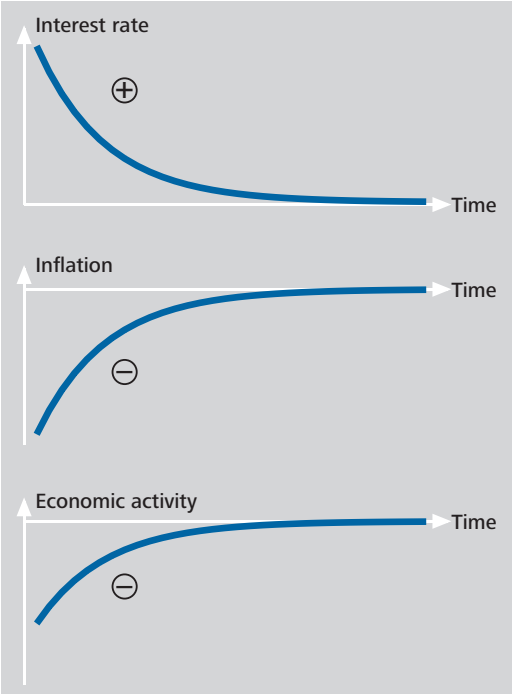
Expected path of the euro short-term rate (€STR) at different points in time



Source: ECB.
Deutsche Bundesbank

8 Financial stability ensures reliable and predictable transmission of monetary policy to all economic agents. For more information on the role of financial stability in monetary policy, see Deutsche Bundesbank (2021).
9 In stylised (structural) macroeconomic models, it is possible to derive a loss function that, when minimised, maximises welfare for the economic agents in the model (see Woodford (2003) and Galí (2015)). However, since the model used should be consistent with the stylised facts on monetary policy and thus comprises many model blocks (see Gerke et al. (2022)), it is not possible to derive such a micro-founded loss function for this model. Instead, a loss function that can be supported directly by the monetary policy mandate of the Eurosystem – as shown – is used. The formal representation of a loss function is documented in Dengler et al. (2024).

Stylised representation of the impact of a rise in interest rates in the form of impulse responses



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aim of this trade-off, then, is to stabilise the target variables optimally overall.

Expected development of target variables and monetary policy interest rate

Component 2: projections for target variables

The second component in the calculation of OPPs is an assessment of how the target variables are likely to develop for given market expectations about the path of the monetary policy interest rate. This assessment is based on time series from the Eurosystem's macroeconomic projections – the (broad) macroeconomic projection exercises ((B)MPEs) produced by Eurosystem staff on a quarterly basis.[10] The current (B)MPE at each point in time contains the projected path of the inflation rate and of economic activity in the euro area, operationalised as the annual rates of change in the Harmonised Index of Consumer Prices (HICP) and real gross domestic product (GDP), respectively. The (B)MPE is based on, inter alia, financial market expectations regarding the development of the monetary policy interest rate over the projection horizon at each point in time (see the chart on p. 41). Projections and market expectations derived from (B)MPEs are a key point of reference for the OPPs. As mentioned above, the OPPs answer the question of how the ECB Governing Council should deviate from these baseline time paths in order to optimally fulfil the monetary policy mandate (i.e. to minimise the loss function).

Estimated impact of monetary policy on target variables

Component 3: quantifying the impact of monetary policy

The third component in the calculation of optimal interest rate paths is the quantitative estimation of the impact of monetary policy. In particular, the impact of a change in the monetary policy interest rate path on the target variables of the loss function must be calculated. Here, the focus is on the causal effect of an interest rate path change for monetary policy purposes: how are target variables affected when monetary policy alters the interest rate path compared with a scenario in which it is left unchanged?

This question is answered in the form of impulse responses, i.e. specific time paths. These reflect the impact of an isolated, one-time impulse (in this case, a change in the interest rate) over a specific time horizon.[11] The adjacent chart schematically illustrates such an impulse response: a (temporary) interest rate hike that is implemented "today" and dissipates after a certain amount of time will typically cause a

10 The Eurosystem's macroeconomic projections are available to the public at https://www.ecb.europa.eu/pub/projections/html/index.en.html. A guide to the Eurosystem's macroeconomic projection exercises can be found at https://www.ecb.europa.eu/pub/pdf/other/staffprojectionsguide201607.en.pdf. MPEs are published by ECB staff in March and September, while BMPEs are published by staff of the wider Eurosystem in June and December.

11 A variety of impulse responses are necessary to calculate optimal paths; see Dengler et al. (2024).

(temporary) decline in the inflation rate and macroeconomic activity.[12]

Macroeconomic model captures impact of monetary policy

A macroeconomic model is needed to quantify the causal effect of a change in the interest rate using impulse responses. This model must capture the relationship between the interest rate and other macroeconomic variables (and thus also the target variables) in an empirically plausible fashion. In principle, both purely empirical, comparatively atheoretical, time series models (such as vector autoregressive models[13]) and more theory-based structural models (such as dynamic stochastic general equilibrium (DSGE) models) are suitable for this purpose. When calculating optimal interest rate paths, which is the primary focus of this article, DSGE models offer certain conceptual advantages over purely empirical models. In particular, the calculation incorporates not only the effect of an immediate change in interest rates (as illustrated in the chart on p. 42), but also the effect of anticipated interest rate changes at future points in time (sometimes referred to as "news shocks").[14] Whilst in monetary policy practice these effects can only be determined to a limited extent and approximately at best using empirical models, they can be quantified relatively easily and model-consistently using DSGE models.[15] DSGE models thus yield an analytically consistent input derived from "first principles" for the calculation of OPPs that provide analytically rigorous and transparent support for monetary policy decision-making that is consistent over time.[16]

All the components needed for the calculation of OPPs are at hand, then: optimal interest rate paths can be calculated using the weighted target variables within the loss function, projections of the future path of the target variables, and the estimated impact of monetary policy.[17]

Market expectations of the interest rate path, projected inflation and output gap according to the June 2023 BMPE

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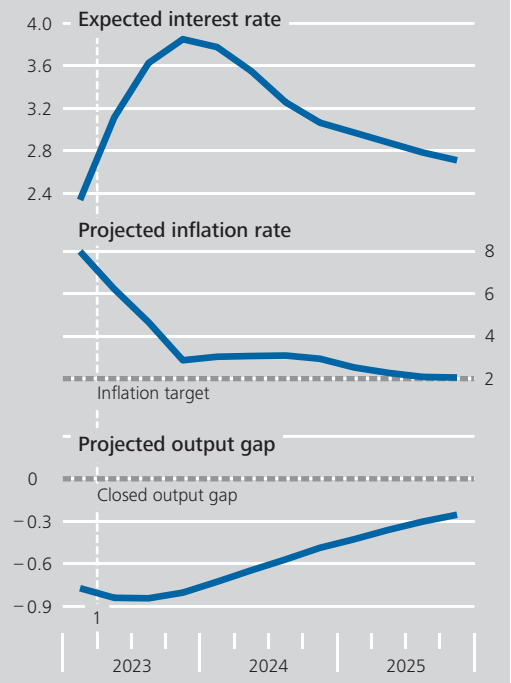


Source: ECB. **1** Beginning of projection horizon: Q2 2023.
Deutsche Bundesbank

12 Given empirically estimated impulse responses, the strongest effects of a change in the interest rate usually only occur with a time lag of around one to two years. See, inter alia, Christiano et al. (1999, 2005) and the literature that builds on this. See also Monetary Policy Committee, Taskforce on Rate Forward Guidance and Reinvestment (2022). The DSGE model described below reproduces such a time lag.
13 VAR models are presented and applied in, inter alia, Deutsche Bundesbank (2023b, 2023c). For an introduction to this concept, see Kilian and Lütkepohl (2017).
14 The reason for this is, to put it simply, that a (scaled) impulse response, as shown in the chart on p. 42, is not always sufficient to "hit" the best possible time path of the target variables. Rather, linear combinations of impulse responses to immediate and future monetary policy shocks are needed. See Dengler et al. (2024) for details.
15 For approaches to calculating approximate OPPs using empirical models, see Barnichon and Mesters (2023) and McKay and Wolf (2023).
16 In this context, "first principles" means the use of a general equilibrium model that is microfounded and is built on maximising utility for households and profits for firms.
17 A clear distinction should be made between OPPs and time paths based on Taylor rules (the latter derive their name from the original Taylor rule (Taylor (1993)). Taylor rules are simple rules that describe how the interest rate is set as a function of different variables (current inflation and GDP are often used). They are usually estimated on the basis of historical data, and their aim is to capture monetary policy decisions as well as possible (mostly ex post). However, the Taylor rules differ fundamentally from OPPs in that they are not subject to any optimisation procedures. In other words, Taylor rules do not answer the question of how monetary policymakers should set the interest rate. This, in turn, is a distinguishing feature of OPPs.

Illustration of optimal interest rate paths for preparing monetary policy decisions based on the June 2023 BMPE projections

Illustration of methodology based on June 2023 macroeconomic projections

The following section presents, as an example, a calculation of OPPs based on the June 2023 BMPE projections. For didactic purposes, we begin with the assumption that the monetary policy interest rate was the sole monetary policy instrument in active use by the Eurosystem at that time.

Macroeconomic projections, model and weighting of target variables

Monetary policy debate in June 2023 influenced by the then current BMPE; according to BMPE, inflation rate still too high and economic activity simultaneously sluggish

The macroeconomic projections for the euro area (hereinafter referred to as the June 2023 BMPE) were a key component of the June 2023 monetary policy deliberations. These provided the time series required for the loss function target variables of the OPPs. The June 2023 BMPE projected HICP inflation rates well above the 2% target for multiple successive quarters. At the same time, the expected path of economic activity was assessed to be relatively weak. This was reflected in a negative projected output gap, which operationalises economic activity as a target variable in the context of the OPP calculations.[18] With regard to the monetary policy interest rate, operationalised by the interest rate on the deposit facility, market participants expected in June that this rate would rise from its level of 3.25% at that time to around 3.75% within the next few quarters.[19,20] The chart on p. 43 illustrates the path of the three target variables over time, first as realised values up to the first quarter of 2023 and thereafter as projected values according to the June 2023 BMPE.

To calculate OPPs from the June projections, a representative macroeconomic DSGE model was used to quantify the necessary impulse responses.[21] The model is based on the currently prevailing paradigm in monetary policy analysis, a New Keynesian model framework, which has become a standard in the academic literature and the international monetary policy debate.[22] The impulse responses describe how an interest rate increase leads – with a time lag – to a decline in the output gap and the inflation rate.[23] Although analysis in the context of the New Keynesian model produces an aggregated and thus simplifying representation of monetary policy transmission, it does allow for a consistent derivation of monetary policy recommendations based on a coherent theoretical framework, as stated above.

New Keynesian DSGE model allows for quantification of monetary policy measures

The last step is to select the weights assigned to the target variables in the loss function. The weighting assigned to deviations in the infla-

18 The output gap is defined as the percentage deviation of real GDP from potential output. Potential output is calculated using a production function approach as part of the Eurosystem's projections. A negative output gap suggests a tendency towards underutilisation of resources, whilst a positive output gap signals a tendency towards an overheating economy.
19 Here, market expectations relate to the money market rate (euro short-term rate (€STR)), which closely tracks the Eurosystem interest rate on the deposit facility (see Deutsche Bundesbank (2020)).
20 As the Eurosystem usually changes monetary policy interest rates only by (multiples of) 0.25 percentage point, concrete figures for interest rate time series are, in accordance with this practice, rounded to the nearest possible monetary policy value (3.5%, 3.75%, 4%, etc.) in the following.
21 The parameters of this model were estimated using macroeconomic data from the euro area. As mentioned above, broadly atheoretical time series models could also be used, in principle. Dengler et al. (2024) document that the Bundesbank also calculates OPPs for other models.
22 The model contains the model blocks common in the literature. It is a DSGE model containing two types of households (those with and those without access to credit markets), firms experiencing pricing frictions and trade unions that are subject to wage-setting frictions, as well as a banking sector with financing frictions and a government. Households behave with bounded rationality. For details, see Gerke et al. (2022) and Dobrew et al. (2023), and for additional applications of DSGE models in monetary policy analysis, see Deutsche Bundesbank (2021).
23 Put simply, households reduce their consumption expenditure in the model when the interest rate rises, as saving is more worthwhile when interest rates are higher. At the same time, firms invest less, as higher lending rates make borrowing more expensive. The reduced economic capacity utilisation (output gap) ultimately causes firms to lower their goods prices, resulting in lower inflation rates. Analogously, an interest rate reduction leads to higher inflation and increased economic activity.

tion rate from target is normalised to one, while the output gap is weighted at 0.25 and interest rate changes at 3.[24]

Monetary policy discussion in June 2023 and OPPs

Public debate on further interest rate hikes in June 2023 and beyond

The June 2023 BMPE illustrates a prototypical monetary policy trade-off: taken in isolation, the inflation projection in June indicated the need for an even tighter monetary policy. Economic developments, by contrast – once again taken in isolation – indicated that a significant further tightening of monetary policy was not warranted.

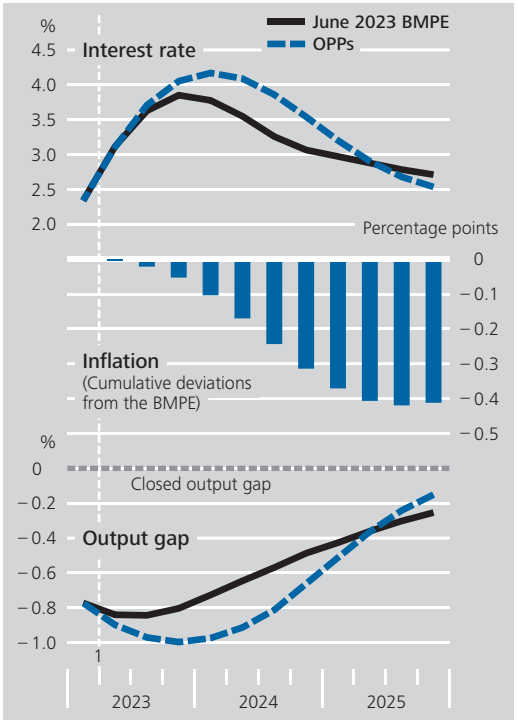
Optimal interest rate path in June 2023 initially in line with market expectations: further interest rate step optimal

The public debate ahead of the ECB Governing Council's June 2023 monetary policy meeting reflected this trade-off. Markets considered it very likely that the monetary policy interest rate would be raised by a further 0.25 percentage point to 3.5% at the meeting. But there was intense debate surrounding the interest rate's path beyond that, particularly its peak (also known as the terminal rate). Back then, the Bundesbank's OPP calculations indicated that further interest rate increases were warranted, including beyond the level expected by markets at that time. This is illustrated by the blue lines in the adjacent chart, which plot the optimal path of the monetary policy interest rate and the resulting OPP paths of the inflation rate and the output gap.[25] The OPP calculations suggest that the optimal interest rate path initially tracks the path expected by markets fairly closely. Taken in isolation, this indicated that the additional interest rate step of 0.25 percentage point expected by the majority of the market should be decided at the June meeting.

Subsequent divergence: optimal interest rate path higher than path expected by markets

Over time, however, the optimal and market-expected interest rates diverged. At a peak of around 4.25%, the optimal interest rate path at that time overshot the path expected by markets. This more restrictive time path would have contributed to lowering the high inflation rates more quickly (middle panel of the chart above), but at the expense of a more pronounced fall in the output gap (lower panel of said chart). Based on this rationale, the model-theoretical optimisation procedure of the OPPs assessed the monetary policy trade-off as being somewhat more strongly aligned towards combating inflation than implicitly suggested by market expectations. At the same time, an even larger direct interest rate step of 0.5 percentage point in June would not have been optimal from the perspective of the OPP calculations. While this would have lowered the inflation path further still, it would have done the same with the output gap. For the chosen

Optimal policy projections (OPPs) based on the June 2023 BMPE

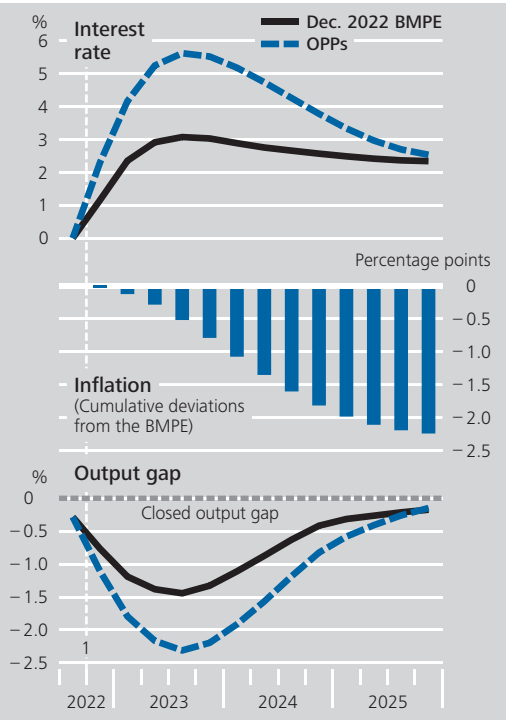


1 Beginning of optimal policy projections: Q2 2023.
Deutsche Bundesbank

24 These weights are derived from the macroeconomic literature (see, for example, Galí (2015), de Groot et al. (2021) and Harrison and Waldron (2021)). The (fairly high) weighting of 3 assigned to interest rate changes is necessary to avoid excessive volatility in market interest rates. A sensitivity analysis is carried out on pp. 48 ff. in which the relative weighting assigned to the output gap in the loss function varies.

25 For greater clarity, the path of inflation rates is shown in the following as a cumulative deviation from the BMPE and over time.

Optimal policy projections (OPPs) based on the December 2022 BMPE



1 Beginning of optimal policy projections: Q4 2022.
Deutsche Bundesbank

weighting of the target variables, this would have worsened the value of the loss function.[26,27] Lastly, not raising interest rates at all or announcing the end of interest rate hikes at the market-expected level of around 3.75% would have likewise worsened the value of the loss function.

Optimal interest rate path in June 2023 points to necessary interest rate step and additional tightening in future

The takeaway from the OPPs for the ECB Governing Council's June 2023 meeting, then, was that there was a case for monetary policy to further increase the interest rate from 3.25% to 3.5% and that further increases of the interest rate in future should not be ruled out.

Alignment of market expectations and optimal interest rate paths

The optimal interest rate path and the one expected by financial markets were closely aligned at the beginning of the projection period, but that has not always been the case in the past two years. Rather, the very high inflation rates – particularly at their peak in autumn 2022 and based on the Bundesbank's OPP calculations – generally made a tightening of monetary policy that was stronger and faster than expected by markets appear to be warranted. The adjacent chart illustrates this and compares market expectations and projections from the December 2022 BMPE with the optimal interest rate paths calculated internally by the Bundesbank at the time. On the one hand, it becomes clear that the interest rate path expected by financial markets was still quite low at the time, with a peak of 3%. Given the very high inflation rates, the optimal interest rate path calculated then was significantly higher (peak of 5.5%). On the other hand, unlike the picture in June 2023, the optimal interest rate path was already inclining considerably more steeply towards its peak at an early stage. Taken together, these factors would have led to a faster decline in the inflation rate, albeit accompanied by a stronger decline in macroeconomic activity than projected at the time by the BMPE based on market expectations.[28]

Optimal interest rate path significantly steeper and higher in December 2022 than market expectations

Sensitivity analyses and scenarios in monetary policy decision-making

Calculating optimal interest rate paths hinges on numerous factors, particularly the underlying projections or the prioritisation of monetary policy objectives. We will therefore illustrate

26 The incorporation of financial stability risks, operationalised by the smallest possible changes in interest rates, also suggested that the interest rate path should be as "smooth" as possible and therefore that an even greater increase in interest rates was not warranted.
27 The choice of weights is discussed on pp. 45 f.
28 The maximum of the optimal monetary policy interest rate in the June 2023 calculation is significantly lower than in December 2022. This is mainly on account of the intention to smooth the interest rate. As the interest rate was not raised as quickly and significantly as was suggested in the December 2022 OPPs, it "only" stood at 3.25% in June 2023. The December 2022 OPPs had already set the interest rate higher than 5% at this point in time, allowing it to slowly fall again shortly thereafter.

below how sensitivity and scenario analyses can be used to test the robustness of the derived optimal interest rate paths. Here, "robustness" means that the optimal interest rate path does not change significantly if at least one of the underlying assumptions is changed.[29]

On the sensitivity of projections

Sensitivity analyses regarding the BMPE baseline

Euro area monetary policy operates in a constantly evolving and thus uncertain environment. In terms of the OPPs, uncertainty is primarily inherent in macroeconomic projections. By construction, these projections are based on a variety of assumptions – such as on the future path of oil and energy prices, expected exchange rates and assumptions regarding wage developments and corporate profits. There is a high probability that the assumptions will not materialise as expected, meaning that the paths of HICP inflation rates and the output gap will diverge from those projected by Eurosystem staff. Hence, future developments that deviate from the projections can lead to different monetary policy conclusions.

Alternative scenario of stronger increases in energy prices or wages

It is common for alternative scenarios to be analysed and discussed as a way of explicitly factoring projection uncertainty into monetary policy deliberations.[30] We assume below, for illustrative purposes, that energy prices or wages rise more strongly than assumed in the June 2023 BMPE, both of which would lead to even higher inflation rates than those projected in the BMPE. However, whether or not this directly results in a tighter monetary policy stance, expressed as a steeper interest rate path, depends in part on the assumptions made in these alternative scenarios regarding the other variables in the loss function, particularly economic developments. In the stylised alternative scenario described below, higher wage and energy costs lead to higher goods prices and even weaker economic growth, causing the output gap to decline further. The light blue lines in the upper two panels of the chart on p. 48 show how the alternative scenario contrasts with the baseline scenario.

The three lower panels of the chart on p. 48 show the optimal path of the monetary policy interest rate, as well as the resulting OPPs of the inflation rate and the output gap, and compare them with the baseline scenario.

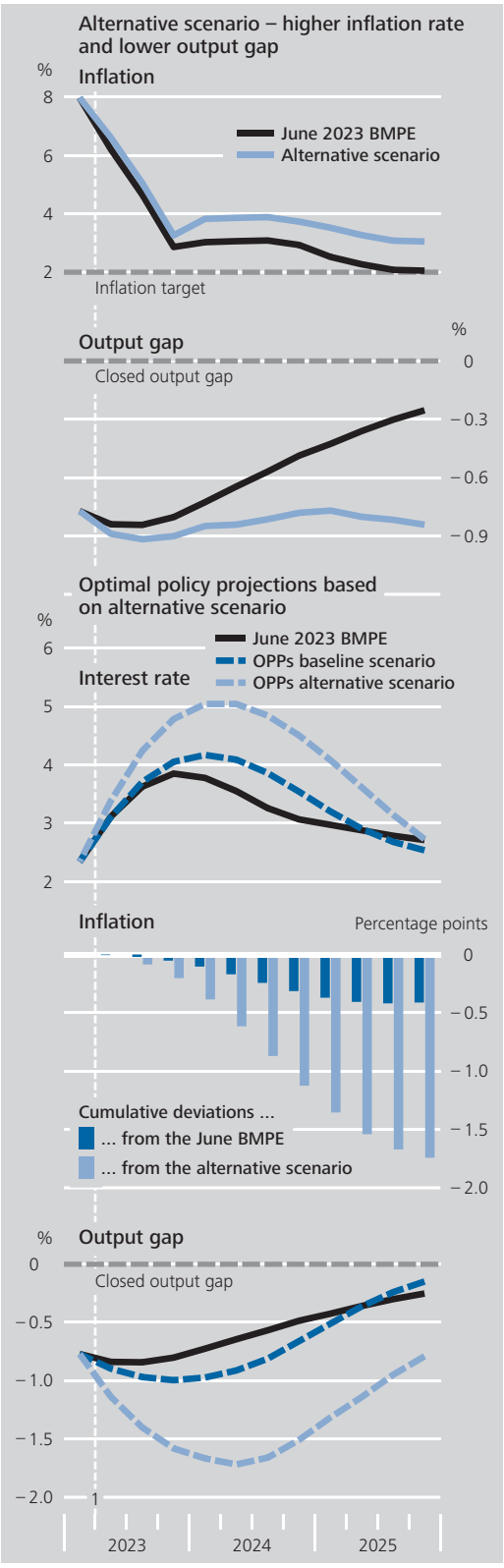
Scenario requires tighter monetary policy

The monetary policy trade-off in this alternative scenario is even more acute than in the baseline scenario. The higher inflation rates require, taken in isolation, an even higher interest rate path, while the more strongly negative output gap – taken in isolation – calls for a flatter interest rate path. Just how the trade-off can be optimally resolved depends on the relative weights in the loss function (which are discussed in the next section) and the specific time paths for the output gap and inflation rate. In the alternative scenario presented here, optimal monetary policy implies a tighter trajectory: the optimal interest rate path in the alternative scenario (light blue dashed line in the third panel of the chart on p. 48) peaks at around 5%, leaving it roughly 0.75 percentage point above the peak of the optimal interest rate path in the baseline scenario described above (dark blue dashed line). The tighter monetary policy stance causes inflation to fall more sharply (light blue bar in the fourth panel) and a more strongly negative output gap (bottom panel) than in the baseline scenario.

29 In this context, the monetary policy literature sometimes also follows a "robust control" approach, i.e. an approach in which a given monetary policy decision is intended to minimise the maximum possible loss given uncertainty about assumptions or scenarios. This is done using a min-max criterion; see the seminal work of Hansen and Sargent (2005, 2008). Such calculations are performed regularly at the Bundesbank when preparing monetary policy meetings.

30 For instance, an alternative energy price scenario was discussed in Box 3 of the June 2023 BMPE. See European Central Bank (2023).

Optimal policy projections (OPPs) for the alternative scenario based on the June 2023 BMPE



1 Beginning of projection horizon and optimal policy projections: Q2 2023.

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Sensitivity with respect to the weights in the loss function

Sensitivity analysis with regard to the weight of the output gap

The weights in the loss function express, in a highly condensed form, the prioritisation of monetary policy target variables – especially if a trade-off needs to be made between objectives. However, in monetary policy practice, using a loss function entails challenges. One is that a specific weighting of target variables cannot be unambiguously derived from the Eurosystem's mandate. Another is that a single concrete weighting of target variables in the loss function, when done in isolation, can only approximate and hence incompletely describe how the ECB Governing Council achieves an optimal trade-off within the meaning of its monetary policy mandate. One way of better capturing these complex trade-offs in model theory is therefore to vary the weights of the loss function. This way, alternative OPPs can be generated. Constructing alternative OPPs offers the advantage of allowing the monetary policy trade-offs to be made from complementary perspectives. Above and beyond that, Eurosystem decision-makers are also able to discuss alternative policy projections that were not constructed as OPPs.[31] In this sense, then, there is a certain degree of discretion when choosing the weights of the target variables. Therefore, to give greater regard to the ECB Governing Council's considerations and trade-offs, it is standard practice to calculate alternative OPP paths when generating OPPs, based on different weightings being assigned to the target variables in the loss function.

As already explained, an initial benchmark calculation (baseline analysis) generally applies weights that are commonplace in the academic literature. From these are derived the already-shown OPPs, which are depicted once again in

31 See Svensson (2010), p. 1260. Moreover, prioritisation need not always nor necessarily be consistent across various decision-makers. Indeed, the Treaty on the Functioning of the European Union does not precisely define the exact numerical targets that can be derived from the mandate for the individual target variables of the loss function.

the adjacent chart by the solid dark blue lines and bars. If the weight of the output gap is now varied based on the June 2023 BMPE, we can see how this affects the OPPs for the monetary policy interest rate, output gap and inflation rate.[32]

Output gap given a low weight: central bank is "hawkish" and optimal interest rate path is steeper

If monetary policy gives the output gap a lower weight ("hawkish"), it would be willing to tolerate a stronger economic downturn in order to achieve price stability. Thus, the optimal interest rate path in the adjacent chart in the "hawkish" scenario (blue thick dashed line) peaks at around 5%. That is 0.75 percentage point more than in the baseline analysis and around 1.25 percentage points more than expected by markets in June 2023 (black line). A tighter monetary policy stance of that kind brings about, with a time lag, stronger disinflation and thus a faster return to the inflation target. It also leads, however, to a more strongly negative output gap than had been projected in the June BMPE.

Output gap given a high weight: central bank is "dovish" and optimal interest rate path is flatter

Similarly, OPPs can be calculated based on a high relative weight being assigned to the stabilisation of the output gap (light blue fine dashed line; "dovish"). That kind of weighting would specifically avoid a stronger decline in the output gap, but at the same time, the inflation rate would return to target more slowly than in the baseline analysis (light blue bars in the middle panel of the adjacent chart). In this case, the optimal interest path does not surpass the 3.5% mark.

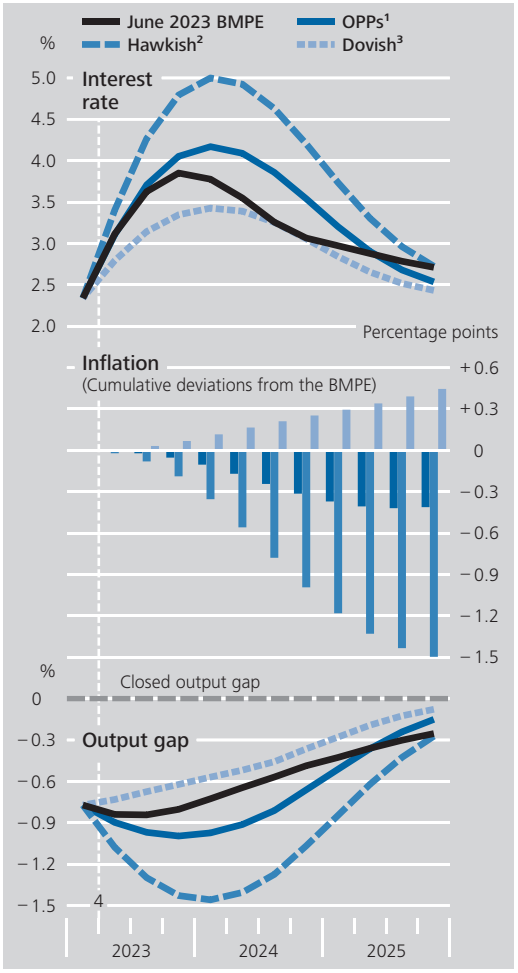
Incorporation of additional monetary policy instruments

Monetary policy has multiple instruments

Thus far, we have assumed, for the sake of simplicity, that the ECB Governing Council has only a single instrument, the interest rate. This assumption is not strictly necessary, as the methodology for calculating OPPs is flexible enough to accommodate multiple instruments – provided, however, that it is possible to measure the impact of each instrument on the economy, i.e. the corresponding impulse responses, using a macroeconomic model.[33]

In the past era of low inflation rates, broadly based asset purchase programmes were implemented as additional monetary policy instruments in an attempt to shore up aggregate de-

Sensitivity analysis looking at weighting of output gap



1 Optimal policy projections. **2** In the "hawkish" scenario, the weight given to the output gap is halved. **3** In the "dovish" scenario, the weight given to the output gap is doubled. **4** Beginning of optimal policy projections: Q2 2023.
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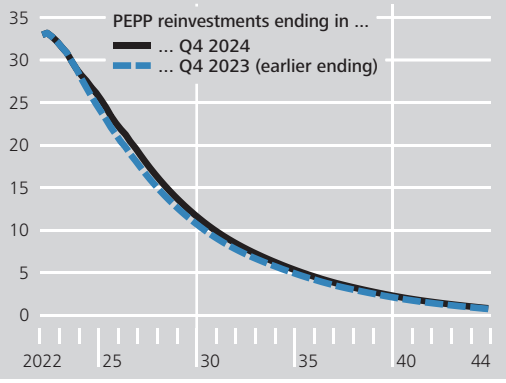
32 Comparable sensitivity analyses can be conducted in the same way for the weighting of interest rate changes in the loss function.
33 The DSGE model explained above can model not only the impact of conventional interest rate policy measures but also the impact of central bank asset purchases or sales on economic activity and inflation. It is therefore suitable for deriving optimal paths for multiple monetary policy instruments.

Impact of ending PEPP* reinvestments earlier

Securities holdings as a percentage of the total envelope[1]



* Pandemic emergency purchase programme. **1** In terms of ten-year equivalents.

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Effects of the accumulation and reduction of asset holdings on the central bank's balance sheet

mand and bring the inflation rate closer to the 2% target. Two of the most important purchase programmes in the euro area are the asset purchase programme (APP), which was officially launched in March 2015, and the pandemic emergency purchase programme (PEPP), which was announced and implemented in March 2020 in response to the COVID-19 pandemic.[34] In a high-inflation environment, these programmes are gradually being phased out. Thus, as of June 2023, the principal payments from maturing securities purchased under the APP are no longer being reinvested, while reinvestments under the PEPP are scheduled to be discontinued at the end of 2024.

A reduction of the assets held on the central bank's balance sheet contributes to a tight monetary policy stance and has a correspondingly dampening impact on inflation and economic activity.[35] In principle, then, a (stronger) reduction in asset holdings could substitute potential interest rate hikes. When calculating OPPs, we can therefore also investigate the extent to which an accelerated reduction of asset holdings adds to the impact of potential interest rate hikes or even renders them unnecessary.

To illustrate this point, let us assume that PEPP reinvestments are discontinued in Q4 2023 – that is, earlier than the Q4 2024 expiry date expected by most market participants in June. The adjacent chart shows the alternative path of the asset holdings compared with the path expected by markets at the time. In the present example, ending reinvestments earlier has a comparatively small impact on the expected reduction path for asset holdings.[36] As households and firms, bearing this in mind, expect only a marginally tighter monetary policy stance with regard to the reduction path, they would reduce their consumer expenditure and investment, respectively, only marginally in the context of the macroeconomic model. Accordingly, this would entail a comparatively minor impact on the inflation rate, economic activity and the optimal interest rate path.[37] This would be less than 0.1 percentage point below the optimal interest rate path shown in the previous section, for the calculation of which only the interest rate was permitted as a monetary policy instrument. It could therefore be concluded from this alternative calculation that ending PEPP reinvestments earlier, taken in isolation, could have contributed to a tighter monetary policy stance. However, the macroeconomic effects would have been comparatively minor, meaning that a further interest rate hike would still have been appropriate from a monetary policy perspective.

Scenario: ending PEPP reinvestments earlier

34 The APP was launched at the effective lower bound on interest rates as an additional expansionary instrument in an era of a subdued inflation outlook and falling inflationary expectations. The PEPP was introduced in response to the COVID-19 pandemic and its economic fallout in order to prop up financing conditions and ensure economic stability during the crisis.

35 This takes place through a variety of channels. For a discussion of the channels, see, for example, Deutsche Bundesbank (2016). One key channel, the announcement effect (also known as the stock effect) is discussed in Gerke et al. (2022).

36 The primary reason for the small impact on the expected reduction path is that only a small volume of assets are affected by the premature end of reinvestments relative to the stock of assets still held by the Eurosystem.

37 To isolate the effect of the presented alternative reduction path on the optimum interest rate in the model, the deviation of this alternative reduction path from market expectations is fed into the model. So, although in formal terms two monetary policy instruments – the interest rate and asset holdings – are available in this analysis, only the time path for the interest rate is optimally chosen.

Conclusion

OPPs represent the optimal compromise within the monetary policy trade-off process

Building on the Eurosystem's quarterly projections, macroeconomic models can be used to derive OPPs that aim to optimally fulfil the Eurosystem's monetary policy mandate. Here, OPPs serve as a basis for discussion and support decision-making in the context of the complex process of preparing monetary policy decisions. Their key advantage lies in allowing the monetary policy trade-off process to be modelled consistently by describing the optimal compromise between monetary policy trade-offs from the standpoint of model theory.

OPPs widely used as an input in monetary policy discussion but should not be construed as sole recommended course of action, as they …

The calculation of OPPs as an input in monetary policy decision-making feeds not only into the monetary policy discussions within the Bundesbank or the Eurosystem. Other central banks, too, such as the US Federal Reserve, the Bank of England, Norges Bank and Sveriges Riksbank, calculate and publish OPPs for their respective currency areas.[38] Common to all of them is that they emphasise the utility of OPPs in monetary policy decision-making, yet are also cognisant of the risks associated with overreliance on the monetary policy implications they involve.[39] OPPs do not serve as a direct recommendation for a specific course of action in monetary policy decision-making, as they are naturally based on assumptions whose realisation is uncertain. Accordingly, there is an inherent uncertainty about OPPs that monetary policy decision-makers must bear in mind.

… are conditional on certain macroeconomic projections and decision-makers' priorities and …

For example, it is effectively assumed when calculating OPPs that the macroeconomic projection will actually materialise. Uncertainty surrounding the macroeconomic projections is therefore disregarded initially, though it can, as explained above, generally be taken into account using sensitivity analyses. There is also some discretionary scope as to how precisely the ECB Governing Council achieves the optimal trade-off between the monetary policy target variables. In other words: there is a degree of uncertainty surrounding monetary policy decision-makers' priorities (i.e. ultimately the weights assigned within the loss function). For that reason, it is generally a good idea to test the robustness of the results in this regard.

… changes and non-linearities in monetary policy transmission process are only approximately captured

Moreover, there is, in principle, a degree of uncertainty about the functioning and strength of monetary policy at a given point in time, something the ECB Governing Council particularly highlighted in the context of its most recent decisions.[40] The impulse responses used to calculate OPPs initially reflect the cause-and-effect relationships observed in the past. Any change in the cause-and-effect relationships when calculating OPPs can therefore only be considered to an approximate degree.[41] The same applies for non-linear transmission channels of monetary policy decisions.[42]

OPPs to be understood as a notable element of the basis for discussion

Given that a raft of assumptions are used to underpin OPPs, they should therefore only be regarded as a contribution, albeit a notable one, to the monetary policy decision-making process. The comparative advantage of OPPs over other analyses carried out in the decision-making process lies in their analytical rigour and transparency with regard to the assump-

38 The Federal Reserve's Tealbooks, which contain an analysis of the US economy and descriptions of monetary policy alternatives, likewise derive optimal interest rate paths. For examples, see Board of Governors of the Federal Reserve System (2017). Calculations of optimal interest rate paths likewise feed into the monetary policy decision-making discussions of the Bank of England's MPC; see Broadbent (2022).
39 As Broadbent (2022) puts it: "One should always take the OPPs with a healthy dose of salt."
40 See, for example, the press release following the ECB Governing Council meeting of 26 October 2023: "The Governing Council's past interest rate increases continue to be transmitted forcefully into financing conditions."
41 For example, in a first step, a steeper Phillips curve, as documented by Benigno and Eggertsson (2023), can be diagnosed using a (separate) time-varying VAR estimate. In the second step, the parameters of the DSGE model can be adapted such that the resulting impulse responses reflect the potentially altered monetary policy impact.
42 Thus, for one thing, unusually strong (or a particularly rapid succession of) interest rate increases can contribute to firmly anchoring economic agents' inflation expectations and to preventing them from being a cause of high actual inflation rates themselves. For another, unusually strong interest rate increases could trigger strong adjustments in financial markets and themselves represent a risk to financial intermediaries. The latter risk of a non-linear transmission channel (not explicitly incorporated into the model) is, as already explained, approximated via the preference for small interest rate fluctuations.

tions made and the prioritisation of objectives. That said, OPPs are not direct recommendations for monetary policy actions but serve as a basis for discussion and a point of reference for monetary policy decision-makers. OPPs help monetary policy decision-makers estimate, in a coherent and consistent fashion, the impact of monetary policy alternatives on the expected development of the economy and the achievement of the monetary policy objective. Through this, OPPs can also contribute to an improved assessment of the proportionality of monetary policy decisions.

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