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Questioni di Economia e Finanza

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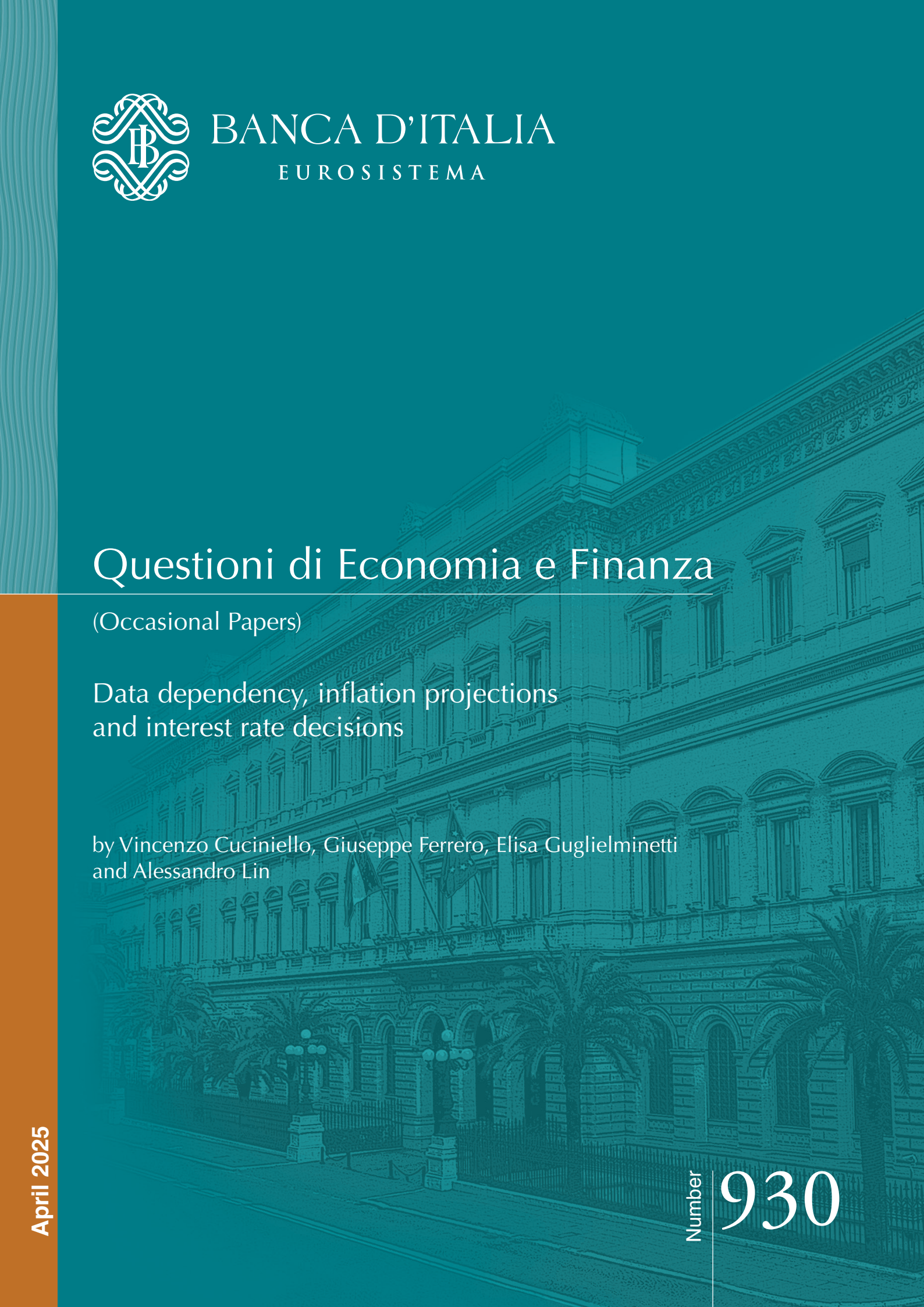
by Vincenzo Cuciniello, Giuseppe Ferrero, Elisa Guglielminetti and Alessandro Lin



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DATA DEPENDENCY, INFLATION PROJECTIONS AND INTEREST RATE DECISIONS

by Vincenzo Cuciniello*, Giuseppe Ferrero*, Elisa Guglielminetti* and Alessandro Lin*

Abstract

In 2023, the ECB introduced three criteria – inflation outlook, underlying inflation dynamics, and monetary policy transmission – to guide its data-dependent approach to policy rates. We argue that this shift does not imply a change in the ECB's reaction function to deviations of medium-term inflation from target but rather reflects the use of alternative signals to assess medium-term inflation, a variable that is not directly observable. By integrating multiple indicators, the ECB aimed to enhance its inflation assessment, improving policy decisions in an environment of increased uncertainty. During the 2021-22 inflation surge, forecasts incorporating underlying inflation and monetary policy transmission outperformed staff projections over a one-year horizon. However, in the subsequent disinflation phase, these forecasts overestimated inflation and underperformed relative to staff projections, raising concerns about an overly restrictive monetary policy stance. Our results underscore the importance of placing greater emphasis on medium-term projections when their accuracy is in line with historical regularities.

JEL Classification: E43, E47, E52, E58.

Keywords: data dependence, reaction function, underlying inflation, monetary policy transmission.

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Executive Summary

In 2021-22, the accuracy of inflation forecasts produced by the ECB and Eurosystem staff deteriorated markedly, even for very short horizons.

After announcing a data-dependent approach to policy rates setting in June 2022, in March 2023 the ECB clarified that this approach would have relied on three criteria: (i) the assessment of the inflation outlook, (ii) the dynamics of underlying inflation, and (iii) the strength of monetary policy transmission.

The introduction of the criteria reflects an effort to enhance the ECB's assessment of inflation in the medium term. As such, they can be interpreted as signals regarding the future path of inflation, whose predictability has changed over time.

The ECB's systematic response to deviations of medium-term inflation forecast from the target has, instead, not changed with the adoption of the data-dependent approach.

During the 2021-22 inflation surge, forecasts incorporating information on underlying inflation and the strength of the monetary policy transmission outperformed the Eurosystem staff projections over a one-year horizon.

Conversely, during the disinflation phase, the forecasts based on the three criteria over-predicted inflation and underperformed staff projections, suggesting the possibility of an excessively restrictive monetary policy stance.

1. Introduction

In the first half of 2022, amid heightened uncertainty and large and systematic errors in Eurosystem/ECB staff inflation projections, the ECB announced that the normalization of policy rates would follow a data-dependent approach. In April 2022, the ECB stated that future policy decisions "*will depend on the incoming data*".[1] The term "*data dependence*" was explicitly introduced in the June 2022 Monetary Policy Statement.[2] As Governing Council member P. Lane later clarified, incoming data became critical for extracting more accurate signals on unobservable variables such as future inflation and output, which are essential for calibrating the monetary policy stance.[3]

In March 2023, the ECB clarified the specific data relevant for decisions on key interest rates, emphasizing three criteria: (*i*) the assessment of the inflation outlook based on incoming economic and financial data, (*ii*) the dynamics of underlying inflation, and (*iii*) the strength of monetary policy transmission.[4]

In this paper, we analyze the ECB's shift in communication and the adoption of these three criteria within the framework of a standard reaction function, consistent with the mandate of price stability. In this framework, the policy rate responds only to anticipated deviations of inflation from its target over the medium term. We argue that the introduction of the three criteria reflects an effort to enhance the ECB's assessment of inflation dynamics during a period of heightened uncertainty. These criteria can be interpreted as signals regarding the inflation path, with their predictive accuracy evolving over time.

By emphasizing the role of the three criteria in informing the ECB's policy decisions through improved inflation forecasting, we contribute to the ongoing debate in two ways. From a positive perspective, we elucidate the rationale behind the use of these criteria in calibrating the monetary policy stance over time. From a normative perspective, our analysis provides insights into the appropriate weighting of these criteria in determining the key interest rates. Specifically, the weight assigned to a given criterion should be proportional to its predictive accuracy for medium-term inflation. By disentangling the distinct roles of the three criteria in forecasting inflation and shaping the ECB's policy response, our approach offers a clear advantage over reduced-form specifications that directly link the policy rate to these criteria.

The first criterion relies on newly available economic and financial data to update the expected future inflation path. It is "*the key input into decision-making in normal times*" (Lane, 2024a). A suitable proxy for this criterion is the quarterly Eurosystem/ECB staff macroeconomic projections for inflation, i.e., the (Broad) Macroeconomic Projection

[1] ECB (2022a): "*Looking ahead, the ECB's monetary policy will depend on the incoming data and the Governing Council's evolving assessment of the outlook. In the current conditions of high uncertainty, the Governing Council will maintain optionality, gradualism and flexibility in the conduct of monetary policy*".

[2] ECB (2022b): "*On the basis of our updated assessment, we decided to take further steps in normalising our monetary policy. Throughout this process, the Governing Council will maintain optionality, data-dependence, gradualism and flexibility in the conduct of monetary policy.*"

[3] Lane (2024a): "*The June monetary policy statement added "data dependence" to this list [optionality, gradualism and flexibility], since the high level of uncertainty implied that the application of the principles of optionality, gradualism and flexibility should take into account the information contained in the incoming data flow.*"

[4] ECB (2023).

Exercise, (B)MPE.[5] During periods of relatively low uncertainty, these projections over a one-year horizon serve as a reliable indicator of medium-term inflation dynamics.

The second criterion, the evolution of underlying inflation, "*provides valuable information on inflation developments over the medium term"* and *"gain in importance in uncertain times"* (Kamps, 2024). It aims to isolate the persistent component of current inflation, which signals "*where headline inflation will settle in the medium term after temporary factors have vanished*" (Lane, 2023). Since underlying inflation is inherently unobservable, it must be proxied or estimated, typically using current or past data. As a result, it is backward-looking and responds to shocks with a lag.

The third criterion, the strength of monetary policy transmission, accounts for factors that may not be fully captured by standard forecasting models, such as market dysfunctions, financial tensions, or broader non-linearities and state-dependent effects. These factors can alter both the strength and timing of monetary policy transmission, providing additional information on price dynamics over the medium term, especially during periods of heightened uncertainty.[6]

Our empirical analysis follows a two-step approach. First, we investigate the evolving information content of the three criteria in predicting medium-term inflation. To this end, we estimate a linear regression model with time-varying parameters, where one-year ahead inflation is modelled as a function of the three criteria. The estimated time-varying parameters can be interpreted as the weights assigned to these different signals in forecasting medium-term inflation. Secondly, we assess how these changes have influenced the responsiveness of the policy rate to expected medium-term inflation. Specifically, we estimate a standard reaction function, where the policy rate primarily responds to inflation projections. These projections may be those derived solely from the (B)MPE or those obtained by complementing the (B)MPE with the other two criteria.

The analysis reveals that between 2011 and mid-2021, the Eurosystem/ECB staff inflation projections alone outperformed models incorporating the other two criteria in predicting both short- and medium-term price dynamics. Arguably, the ECB primarily based its assessment of future inflation on medium-term forecasts derived from (B)MPE projections.

During the inflation surge phase, however, incorporating the other two criteria improved the accuracy of both short- and medium-term inflation predictions. Consistent with this evidence, the ECB likely extracted additional information from these criteria and emphasized their role in its 2023 communication on key interest rate decisions.

More recently, the predictive power of these additional criteria—particularly underlying inflation—has declined, while the accuracy of (B)MPE projections has improved. Relying on all three criteria for inflation assessment would systematically lead to higher inflation

[5] In numerous ECB publications and speeches by members of the Executive Board, reference has been made to the Eurosystem/ECB staff projections with regard to the first criterion. See, for example, Lane (2024a), Lane (2024b), Kamps (2024).

[6] Kamps (2024): "*The truth is that the transmission of monetary policy itself is surrounded by uncertainty. This uncertainty is explicitly recognised in the ECB's monetary policy strategy statement. The reason is that evolving economic and financial structures, the stage of the monetary policy cycle and the shocks hitting the economy may all affect policy transmission, either amplifying or attenuating policy impulses*."

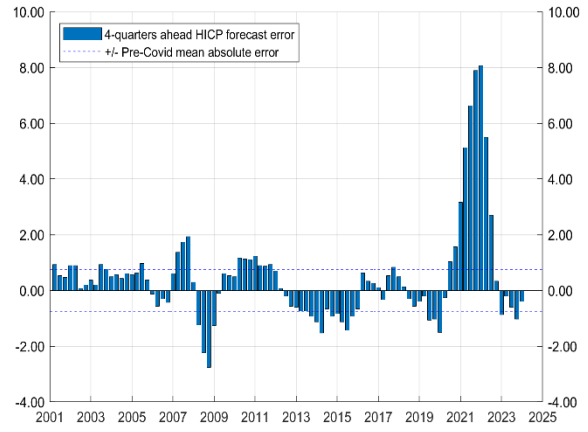
forecasts compared to (B)MPE projections alone, potentially resulting in an overly restrictive monetary policy stance.

2. (B)MPE forecast errors in a highly uncertain environment

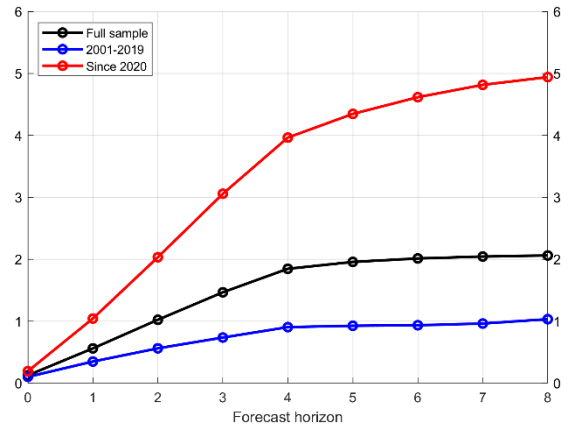
(B)MPE inflation forecasts exhibited a notable decline in accuracy between 2020 and 2023, with forecast errors frequently exceeding historical norms. Figure 1a shows that between 2001 and 2019, (B)MPE inflation forecast errors remained relatively small, with a mean absolute error of 0.75 percentage points when considering a four-quarters projection horizon, but rose to unprecedented levels starting in 2021. This deterioration is evident across all forecast horizons. Figure 1b shows the root mean square error (RMSE) by forecast horizon (x-axis) for different periods. Up to 2019 (blue line), RMSE were low for short-term horizon, gradually increasing with the forecast horizon, as expected, and stabilizing beyond four quarters. However, since 2020 (red line), RMSEs have surged dramatically, surpassing historical levels across all forecast horizons.

Figure 1: (B)MPE inflation forecast errors and RMSE

a) Forecast error at four-quarter horizon



b) RMSE at different forecast horizons



Sources: authors' calculations, based on ECB Statistical Data Warehouse data. An error is defined as the outturn for a given quarter minus the projection made for that quarter. The last observation refers to 2024q4.

The accuracy of inflation projections at various horizons has exhibited significant deviations in recent years, reflecting the heightened uncertainty and volatility characterizing the post-pandemic economic environment. Notably, inflation projection errors at a four-quarter horizon in 2022 were nearly an order of magnitude larger than the historical pre-pandemic average, with even greater discrepancies observed at the eight-quarter horizon. As highlighted by P. Lane, this phenomenon bears particular relevance for policymakers, given that the medium-term inflation outlook remains central to monetary policy decisions due to the inherent transmission lags of policy rate adjustments to inflation outcomes.[7]

These findings highlight the inherent limitations of inflation forecasts based on empirical estimates of model relationships derived from historical regularities. In periods of pronounced macroeconomic uncertainty, such forecasts become less reliable. Consequently, it is necessary to identify supplementary indicators to refine the calibration of the monetary

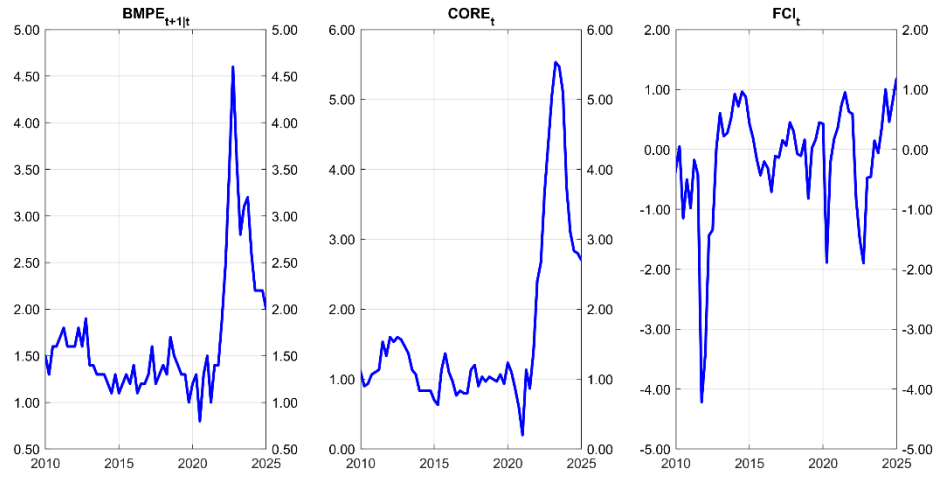
[7] See Lane (2024b).

policy stance. The traditional reliance on (B)MPE inflation projections was likely complemented by signals from underlying inflation measures and evolving evidence on the strength of monetary policy transmission. Overall, these additional criteria might have provided a more comprehensive view of inflation dynamics, enabling the ECB to adjust its policy response in a more nuanced and data-dependent manner.

3. The predictive content of the three criteria in the ECB's reaction function

In this section, we analyse how the information content of the three criteria in predicting medium-term inflation has evolved over time. To this end, we use three proxies (Figure 2): (i) the quarterly (B)MPE projections for headline HICP inflation four quarters ahead as a measure of the inflation outlook; (ii) realized core inflation as an indicator of underlying inflation; and (iii) the Bloomberg's financial condition index (FCI) to capture the strength of monetary policy transmission.[8]

Figure 2: The three criteria



Notes: the left panel represents the (B)MPE projections for headline HICP inflation four quarters ahead; the middle panel represents the quarterly average of y-o-y core inflation rate (HICP inflation excluding food and energy components); the right panel represents the Bloomberg's financial condition index measured at the end of the quarter.

To assess the contribution of three criteria in predicting medium-term inflation over time, we estimate the following linear regression model:

$$\pi_{t+h} = \theta^{(3F)}_{BMPE,t}\hat{\pi}^{(BMPE)}_{t+h|t} + \theta^{(3F)}_{CORE,t}\,\pi^{(CORE)}_{t} + \theta^{(3F)}_{FCI,t}FCI_t + \varepsilon^{(3F)}_{t} \qquad (1)$$

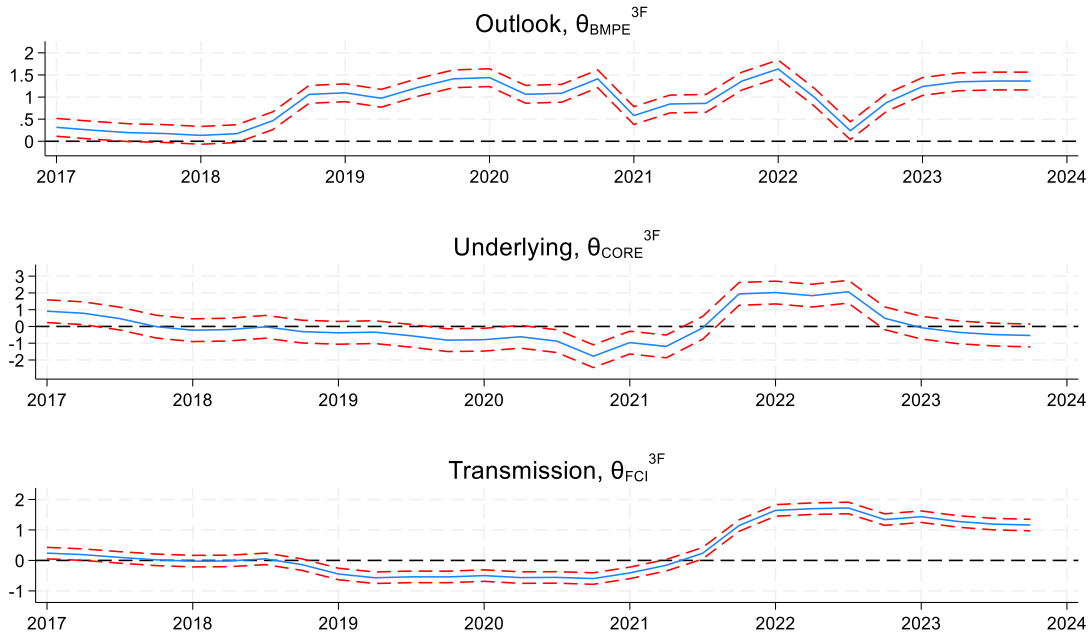
where π_{t+h} is the realized inflation at time $t+h$, $\hat{\pi}^{(BMPE)}_{t+h|t}$ represents the Eurosystem/ECB staff projection at time t for inflation at time $t+h$, $\pi^{(CORE)}_{t}$ is realized core inflation, and FCI_t is Bloomberg's financial condition index, all at a quarterly frequency. The parameters $\theta^{(3F)}_{i,t}$ are estimated using 10-year rolling-window OLS regressions in the period 1999Q1-2024Q4.[9]

Figure 3 reports the series of estimated coefficients. All coefficients are normalized by the standard deviation of the corresponding explanatory variable. After a marked drop in the

[8] This index tracks the overall level of financial stress in euro area money, bond, and equity markets to help assess the availability and cost of credit. A positive value indicates accommodative financial conditions, while a negative value indicates tighter financial conditions relative to pre-crisis norms.
[9] The main results remain qualitatively unchanged when using a shorter window, such as five years.

first half of 2022, the coefficient on (B)MPE projections has returned to levels close to unity in the most recent period. The coefficient on underlying inflation, which became significantly different from zero in 2021, has returned insignificant since late 2023. Meanwhile, the coefficient on monetary policy transmission strength turned positive and significant in 2022 and has remained stable thereafter.

Figure 3: Time-varying coefficients in the 3-factor model - four-quarter ahead inflation forecast



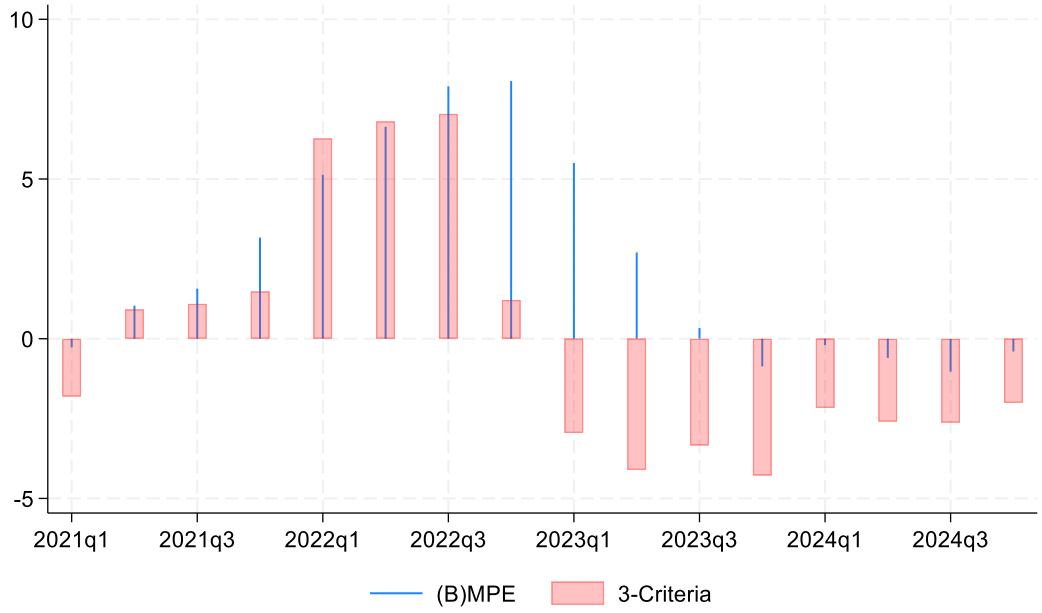
Notes: time-varying coefficients obtained by estimating equation (1) on rolling windows of 40 quarters. Each coefficient refers to a one-standard deviation rise in their corresponding variable.

Comparing the four-quarter ahead inflation projections of the (B)MPE alone ($\hat{\pi}_{t+4|t}^{(BMPE)}$) with those of the 3-factor model ($\hat{\pi}_{t+4|t}^{(3F)}$), we find that between 2021Q2 and 2023Q1, while both models experienced a decline in forecasting accuracy, the 3-criteria model was relatively more accurate (Figure 4).[10] However, in the subsequent phase of declining inflation, the 3-criteria model systematically overpredicted inflation, leading to larger absolute forecast errors than those under the (B)MPE.[11]

[10] The four-quarter ahead inflation projection is obtained by taking expectation of equation (1).

[11] Additionally, Figure A1 in the Appendix shows that between 2013 and 2021, the (B)MPE inflation projection alone outperformed a model incorporating the other two criteria in predicting price dynamics, both in the short and medium term. Figure A2 in the Appendix further reports 1-quarter ahead and 8-quarter ahead inflation forecast errors.

Figure 4: Forecast errors for four-quarter ahead inflation



Notes: forecast errors for four-quarter ahead inflation of the (B)MPE (blue lines) and of the 3-factor model (red bars). An error is defined as the outturn for a given quarter minus the projection made for that quarter one year before.

4. Implications for monetary policy

This section analyzes how changes in medium-term inflation expectations have influenced the ECB's monetary policy stance, given that price stability is defined over the medium term. The monetary policy stance primarily depends on the gap between expected medium-term inflation and the target, with other economic objectives considered when this gap is zero.

To assess the impact of different inflation forecasts on monetary policy decisions, we estimate a simple interest rate reaction function:

$$i_t = \gamma_1 + \gamma_2 i_{t-1} + \gamma_3 \hat{\pi}^{(m)}_{t+4|t} + \gamma_4 r^*_t + \mu_t, \qquad m \in \{BMPE, 3F\} \tag{2}$$

where i_t is the policy rate at time t,[12] i_{t-1} is its one-quarter lagged value, $\hat{\pi}^{(i)}_{t+4|t}$ is the inflation forecast four-quarters ahead (either from the (B)MPE or the 3-factor model), γ_1 is a constant, and r^*_t denotes the median of the natural rate estimates obtained by the ECB's term structure, semi-structural models, and survey-based estimates at quarterly frequencies (ECB Economic Bulletin, Issue 1/2024).[13] The ECB is assumed to use four-quarter-ahead inflation forecasts as a proxy for medium-term inflation (Lane, 2024b).

[12] The policy rate is defined as the MRO rate prior to the ELB period, the shadow rate as estimated by Krippner (2020) during the ELB period, and the deposit facility rate (DFR) starting from mid-2022.

[13] It is worth noting that the 3-criteria model employs time-varying coefficients, as described and computed in the previous section. For forecasting $\hat{\pi}_{t+h|t}$, the model assumes that the estimated coefficients from the last h quarters in the sample - where realized inflation is not yet observed - remain fixed at their most recent observed values. For instance, for h=4, these coefficients are set equal to those available for the period ending in 2023Q3, when realized four-quarter ahead inflation data was last observed.

We estimate equation (2) under three specifications:

(i) $\hat{\pi}_{t+4}^{(BMPE)}$ over the full sample,

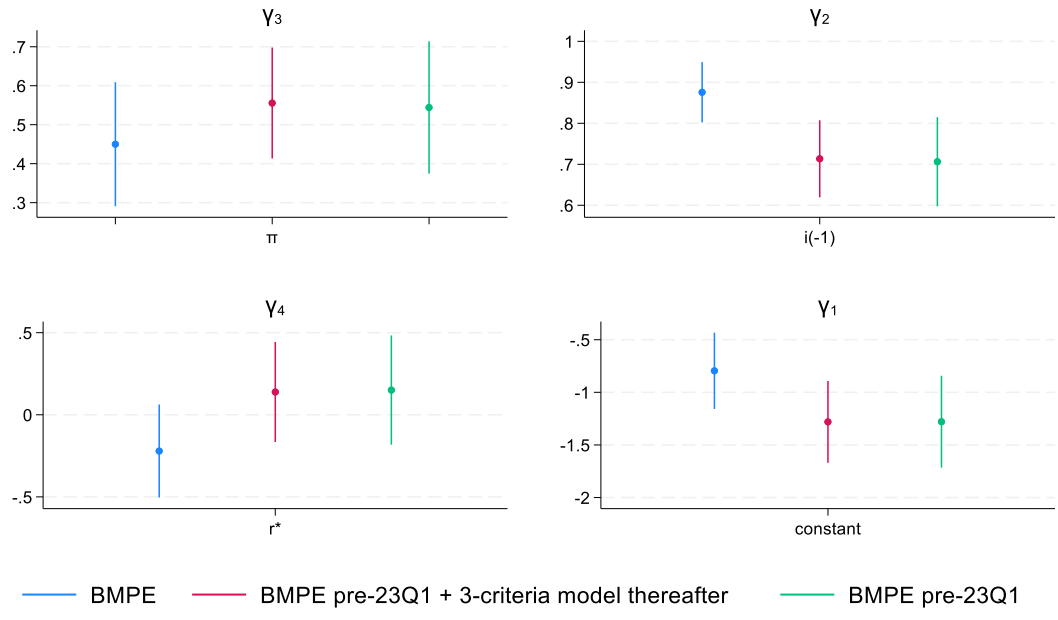
(ii) $\hat{\pi}_{t+4}^{(BMPE)}$ until 2022Q4 and $\hat{\pi}_{t+4}^{(3F)}$ since 2023Q1,

(iii) $\hat{\pi}_{t+4}^{(BMPE)}$ until 2022Q4.

Figure 5 presents the estimated policy response coefficients $(\gamma_1, \gamma_2, \gamma_3, \gamma_4)$ under these different specifications. The blue confidence interval corresponds to estimates using $\hat{\pi}_{t+4}^{(BMPE)}$ throughout the sample, while the red interval represents estimates using $\hat{\pi}_{t+4}^{(BMPE)}$ until 2022Q4 and $\hat{\pi}_{t+4}^{(3F)}$ thereafter.

Over the entire period (2001Q1-2024Q4), the coefficients in the (B)MPE-only model (blue) do not fully align with those from the model transitioning to the 3-factor framework in 2023Q1 (red), suggesting a potential structural change in the monetary policy reaction function. However, the absence of a significant difference between the coefficients estimated using $\hat{\pi}_{t+4}^{(BMPE)}$ until 2022Q4 (green) and those transitioning to $\hat{\pi}_{t+4}^{(3F)}$ thereafter (red) indicates no fundamental regime shift. Instead, the results suggest stability in the reaction function, with adjustments reflecting the evolving inflation forecasting framework rather than a structural policy change.

Figure 5: Estimated coefficients



Notes: the figure reports the estimated coefficients in equation (2) under three different assumptions on how $\hat{\pi}_{t+4|t}$ is obtained: (i) $\hat{\pi}_{t+4}^{(BMPE)}$ over the full sample (blue line); (ii) $\hat{\pi}_{t+4}^{(BMPE)}$ until 2022Q4 and $\hat{\pi}_{t+4}^{(3F)}$ since 2023Q1 (red line); (iii) $\hat{\pi}_{t+4}^{(BMPE)}$ until 2022Q4 (green line).

In previous sections, we documented that the predictive role of the 3-factor model weakened in the second half of 2023. Figure 4 and Figure A1 (Appendix) show that inflation forecasts based on the 3-criteria framework have systematically overpredicted inflation during

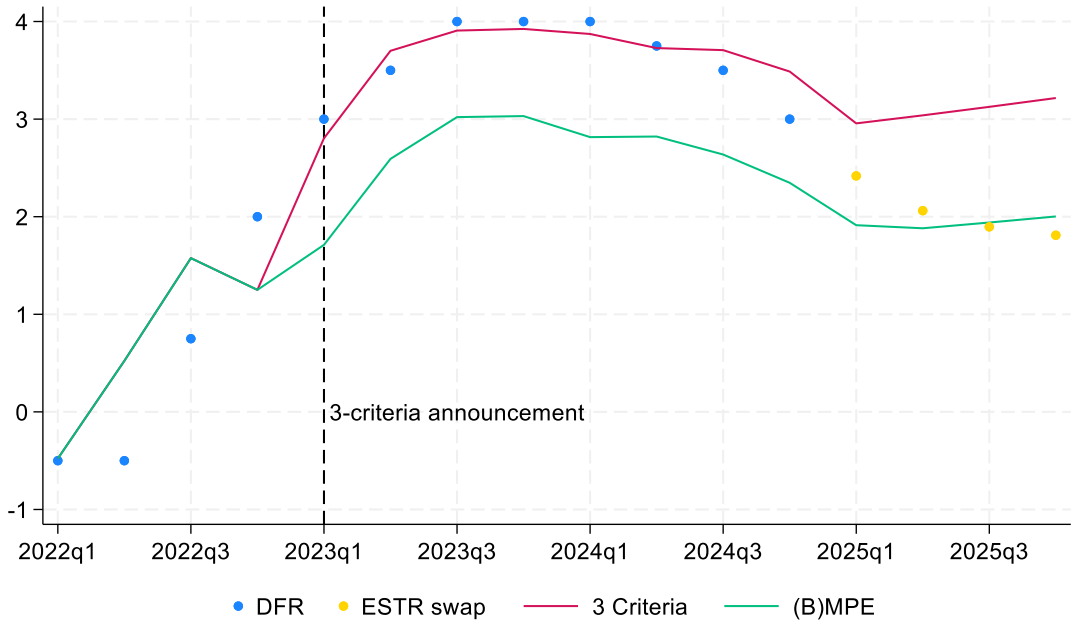
the disinflation phase and have underperformed compared to ECB staff projections over the last seven quarters.

Figure 6 illustrates how the choice of the inflation forecasting model influences policy rate decisions. It reports interest rates obtained using the same reaction function coefficients but different four-quarter-ahead inflation forecasts: (i) the (B)MPE (green line) and (ii) the 3-factor model post-2023Q1 (red line). As the 3-factor model has systematically projected higher inflation than the (B)MPE, the implied policy rate is consistently higher. Notably, the actual deposit facility rate (DFR) closely tracks the rate implied by the 3-criteria model during the period when the ECB explicitly based its policy decisions on this framework.

Given that the 3-factor model has systematically underperformed the (B)MPE model since 2023Q3, we conclude that reliance on the 3-criteria approach has resulted in an excessively restrictive monetary policy stance. This conclusion is reinforced by Figure 6, which shows that market expectations, as reflected in the €-str swaps market, point to a steeper decline in interest rates than implied by the 3-factor model. The alignment of market expectations with the (B)MPE projections further indicates that investors may view the ECB's policy as tighter than warranted given the inflation outlook.

In the current context, it appears essential to focus more on staff projections in assessing inflation in the medium term and, therefore, in monetary policy decisions, as it has demonstrated superior forecasting accuracy.

Figure 6: Actual and predicted policy rates



Notes: the figure reports the predicted interest rate in equation (6) under two different assumptions on how $\hat{\pi}_{t+4|t}$ is obtained: (i) $\hat{\pi}_{t+4}^{(BMPE)}$ over the full sample (green line) and (ii) $\hat{\pi}_{t+4}^{(BMPE)}$ until 2022Q4 and $\hat{\pi}_{t+4}^{(3F)}$ since 2023Q1 (red line).

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Appendix

Figure A1: Actual inflation and 4-quarter ahead inflation projections

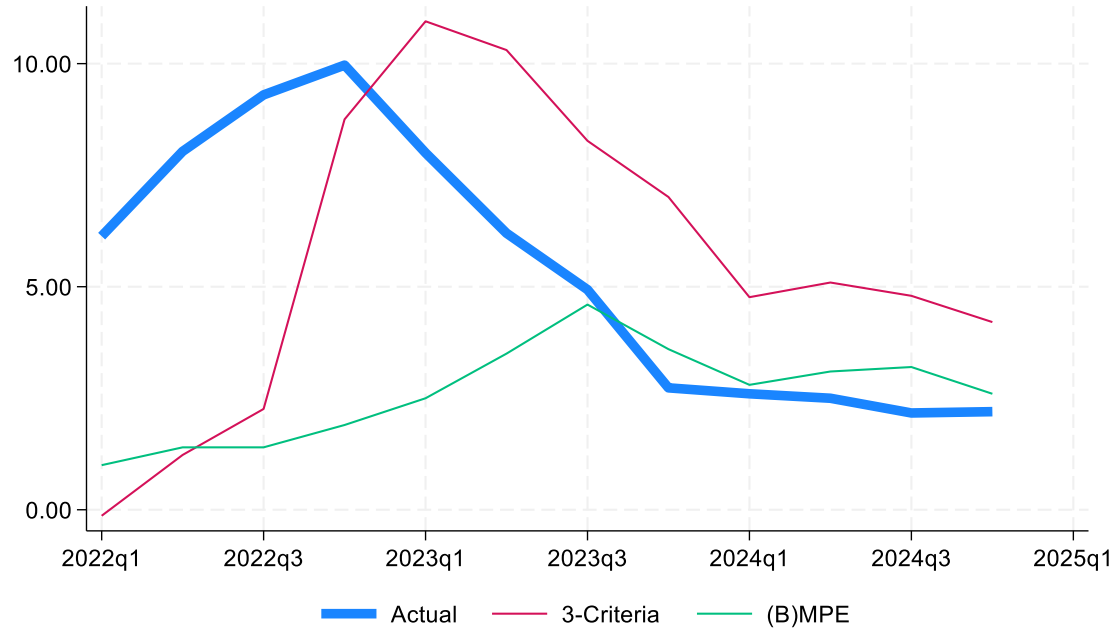

Figure A2: Forecast errors