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Under inflation forecast targeting, central banks such as the ECB adjust policy to keep expected inflation on target. We evaluate the ECB's inflation forecasts: they are unbiased and efficient but contain little information at forecast horizons beyond three quarters. In a New Keynesian model with transmission lags, inflation forecast targeting is indeed effective in stabilizing inflation—provided there is no forward-looking behavior—though the information content of forecasts is unrealistically high. In the presence of forward-looking behavior, the information content declines because monetary policy becomes more effective in meeting the target, but inflation is best stabilized by targeting current inflation.

JEL Classification: C53, E52

Keywords: Inflation targeting

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Inflation Forecast Targeting Revisited

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July 2025

Abstract

Under inflation forecast targeting, central banks such as the ECB adjust policy to keep expected inflation on target. We evaluate the ECB's inflation forecasts: they are unbiased and efficient but contain little information at forecast horizons beyond three quarters. In a New Keynesian model with transmission lags, inflation forecast targeting is indeed effective in stabilizing inflation—provided there is no forward-looking behavior—though the information content of forecasts is unrealistically high. In the presence of forward-looking behavior, the information content declines because monetary policy becomes more effective in meeting the target, but inflation is best stabilized by targeting current inflation.

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"The future's not ours to see."

Doris Day

1 Introduction

Monetary policy started to target inflation systematically in the early 1990s, with the central banks of New Zealand and Canada taking the lead (Borio, 2024). Around the same time, the New Keynesian framework emerged as the leading paradigm in monetary economics, providing intellectual underpinnings and a rationale for specific target values—typically set at two percent (Clarida et al., 1999; Woodford, 2003; Schmitt-Grohé and Uribe, 2010; Coibion et al., 2012). In the textbook version of the New Keynesian model, monetary policy can influence current inflation immediately by adjusting interest rates. In practice, however, it takes a sequence of reactions for changes in financing conditions to fully feed through to demand, and from demand to inflation (Lane, 2022). In the presence of such lags, inflation targeting effectively implies *inflation forecast targeting*, as established by Svensson (1997).[1] This means that the inflation forecast becomes an explicit intermediate target—the central bank adjusts policy when its projection for medium-term inflation deviates from the target (Schnabel, 2024).

How well does inflation forecast targeting work? It was widely regarded as successful, even during the challenging period following the global financial crisis. For instance, the 2021 strategy review of the European Central Bank reaffirmed its commitment to inflation forecast targeting (ECB, 2021). However, the high inflation experienced during 2021–2023 revealed a fundamental problem with inflation-forecast targeting. As inflation reached record levels in the euro area (EA) and levels not seen in the US for 40 years, policymakers were caught off guard. Monetary policy was initially unresponsive to the inflation surge, as central banks attempted to "look through" what was considered a transitory inflation spike *because medium-term inflation forecasts were on target*. For example, in December 2021, when inflation had reached nearly 5 percent, ECB President Lagarde acknowledged that the inflation outlook "had been revised up" but noted it was "still projected to settle below our two percent target over the projection horizon." Consequently, she considered it "very unlikely" that the ECB would raise interest rates in 2022 (Lagarde, 2021).[2]

[1] See also Svensson (1999) and related arguments by Hall (1985) and King (1994), among others.

[2] Similarly, Fed Chairman Powell explained in March 2021: "If we do see what we believe is likely a

Eventually, the ECB began raising interest rates in July 2022, when inflation had climbed to nearly 9 percent.[3] The US Federal Reserve started raising rates four months earlier, but at this point, US inflation had been running well above the 2 percent target for over a year and was still accelerating.

With hindsight, it appears that monetary policy responded (too) slowly to the inflation surge because the inflation forecasts were misguided: "forecast errors, in turn, arguably contributed to central banks' delayed reaction to the surge in inflation" (Schnabel, 2024).[4] But inflation forecasts, and hence potential forecast errors, are essential to inflation forecast targeting (Binder and Sekkel, 2024; Holm-Hadulla et al., 2021).[5] Hence, as we revisit inflation forecast targeting in this paper, we start with an assessment of the inflation forecasts. We focus on the projections produced by the ECB but emphasize upfront that their quality is comparable to that of other forecasters. In the second part of the paper, we offer a structural interpretation based on versions of the New Keynesian model.

In the first part of the paper, we revisit basic properties of optimal inflation forecasts, which then serve as a benchmark for a series of diagnostics that we run on the ECB's inflation projections. When forecasting inflation, central banks may operate under different assumptions regarding the future interest rate path. Inflation projections may be based on the assumption that interest rates remain unchanged, on market-based interest rate expectations, or the central bank's own interest rate path expectation (Galí, 2011). As we discuss in more detail below, the ECB's forecasts are based on market-based interest-rate expectations. In principle, such forecasts may therefore be neither fully aligned with the ECB's inflation target nor optimal in a statistical sense. It turns out, however, that in practice they are.

transitory increase in inflation, where longer-term inflation expectations are broadly stable, I expect that we will be patient." (Powell, 2021)

[3] Arguably, the ECB tightened its stance earlier, as it started to reduce its asset purchases in December 2021.

[4] Also in real time the policy stance was not unquestioned, see, for instance, Conrad et al. (2021). That monetary policy was plagued by deflationary pressures in the decade following the global financial crisis likely also contributed to the delay. For example, in August 2021, ECB chief economist Lane explained that a "transitory period in which inflation is moderately above target" (Lane, 2021) is in line with the ECB's forward guidance. Again, in hindsight, the 2021 strategy review of the ECB appears to have been overly focused on "forward guidance," which is mentioned 69 times, while "inflation forecasts" appear only twice and "inflation projections" seven times (ECB, 2021).

[5] In 2020, the Fed adopted average inflation targeting, which allows inflation to overshoot when the inflation target in periods when the lower bound does not constrain policy in order to offset the deflationary bias induced by the zero lower bound (Williams, 2021). And while the general public seems to have taken little notice of the policy change (Coibion et al., 2023), the approach still relies heavily on inflation forecasts.

Still, and unsurprisingly, forecast accuracy deteriorates as the horizon increases. However, their information content declines so rapidly that projections become *uninformative* once the forecast horizon exceeds three quarters. We define the information content of the forecast as one minus the ratio of the projection's mean squared forecast error (MSE) and the MSE of the unconditional mean, and find that it declines quickly with the forecast horizon. We say that a forecast is uninformative whenever the information content is less than or equal to zero.

We show that the information content of a forecast depends on three terms. The first term depends on the bias of the forecast. The second term captures the potential inefficiency of the forecast. Following Mincer and Zarnowitz (1969), we consider a forecast as efficient if the slope coefficient in a regression of the realization on a constant and the forecast equals one. The third term equals the squared correlation between the forecast and the realization and, hence, measures the explanatory power of the forecast. This decomposition allows us to determine whether the low information content of a forecast is due to bias or inefficiency. However, even for optimal forecasts, the explanatory power often declines quickly with the forecast horizon. Indeed, we find that the ECB's projections adhere to standard properties of optimal forecasts: they are unbiased and efficient.

In the next step, we show, based on a test proposed by Breitung and Knüppel (2021), that the ECB predictions are uninformative beyond a forecast horizons of three quarters. This is relevant in the context of inflation forecast targeting. The "target horizon" at which monetary policy aims to achieve its objective is not formally specified but is typically referred to as the "medium run," reflecting uncertainty about the length of the monetary policy transmission lag. It is generally understood to be around two years, also at the ECB.[6] Our results show that forecasts are uninformative at that horizon. Moreover, at a forecast horizon of two years, projections show little variability and are tightly clustered at the ECB's pre-2021 target of close to but below 2%. The evidence we provide for the ECB's projections are in line with earlier results on the predictive content of survey-based economic forecasts (see, for instance, Isiklar and Lahiri, 2007; Galbraith and Tkacz, 2007). For the Consensus Economics survey, Breitung and Knüppel (2021) report "that forecasts of macroeconomic key variables are hardly informative beyond two to four quarters ahead."

[6]According to Schnabel (2024), the policy-relevant horizon is typically two to three years.

In the second part of the paper, we assess inflation forecast targeting and the information content of forecasts within versions of the New Keynesian model. First, to set the stage, we derive a number of closed-form results for the baseline New Keynesian model. We show, in particular, that while extending the target horizon has no effect on the information content of the inflation forecast, it increases inflation volatility and the forecast's MSE. Moreover, a target horizon longer than one quarter entails equilibrium indeterminacy. In sum, there is no rationale for inflation forecast targeting.

We therefore turn to a richer, hybrid version of the New Keynesian model, which features backward-looking behavior as in Svensson (1997). This specification also introduces additional transmission lags, as changes in the interest rate affect aggregate demand only with a delay. In this environment, if we rule out forward-looking behavior in the private sector altogether, we recover the result that monetary policy performs best at stabilizing inflation when the target horizon is set equal to the number of transmission lags. However, due to these lags, the economy exhibits significant inertia, giving rise to persistent deviations from the steady state. A direct implication is that the information content of inflation forecasts is high—much higher, in fact, than what is observed in the data.

If, instead, we allow for forward-looking behavior in the private sector, we can calibrate the model to match the (low) information content of the ECB's inflation forecasts. In this case, the economy is more responsive to monetary policy, and inflation returns more quickly to target which, in turn, accounts for why the information content of the inflation forecast is lower. Intuitively, although transmission lags mean that interest rates affect expenditure only with a delay, current interest rates still influence current demand through their effect on expectations. However, in this setting, the optimal target horizon is actually zero—meaning that monetary policy should adjust rates in response to current, rather than forecasted, inflation.

The paper is structured as follows. In the remainder of the introduction, we place the paper in the context of the literature. Section 2 introduces a general framework for modeling the inflation process. Section 3 presents our results for the ECB projections. In Section 4 we revisit inflation forecast targeting within variants of the New Keynesian model. A final section concludes.

Related Literature. In addition to the work referenced above, our paper builds on and relates to a number of further contributions and policy discussions. First, the weak performance of central bank forecasts in recent years has triggered a broad-based discussion of the policy and forecasting processes at major central banks, see, e.g., King (2022) and Bernanke (2024). And while the ECB also initiated a strategy review in 2024, it explicitly excluded a discussion of the medium-term orientation for achieving the inflation target (Rehn, 2024; Reuters, 2024).

Second, there is a substantial body of work that systematically assesses inflation targeting. Clinton et al. (2015) discuss the history of inflation forecast targeting, its global implementation, and various practical challenges associated with it. Adrian et al. (2018) provide a comprehensive overview of both the theoretical and practical aspects of inflation forecast targeting. Batini and Haldane (1999) evaluate a variety of inflation forecast-based rules and identify several advantages over standard Taylor-type rules.

Third, there is a distinct strand of the literature concerned with evaluating central bank inflation forecasts, surveyed by Binder and Sekkel (2024). Kontogeorgos and Lambrias (2022) provide the most comprehensive analysis of the ECB's inflation projections, showing that the projections were unbiased and efficient over the period from 1999Q1 to 2018Q4.[7] At forecast horizons of four and eight quarters, there is no significant difference between the forecast performance of the ECB's inflation projections, the Survey of Professional Forecasters, or an AR(1) benchmark model. Following the large forecast errors in 2021 and 2022, the ECB investigated the sources of these errors. As discussed in Chahad et al. (2022, 2023), the errors can largely be attributed to inaccuracies in the technical assumptions, particularly concerning energy commodity prices. Argiri et al. (2024) evaluate the forecast performance of the ECB, the Federal Reserve, and the Bank of England. They examine forecast horizons of one and four quarters and find that, while ECB forecasts are efficient, forecast accuracy deteriorates substantially as the forecast horizon increases. Finally, by comparing the ECB's forecast accuracy with that of other institutions, Candelon and Roccazzella (2025) show that the relative accuracy of the ECB's projections varies over time and declined in 2022.

[7] Chahad et al. (2024) extend the analysis to a more recent sample. Granziera et al. (2024) confirm that the ECB's inflation projections are, on average, unbiased but show evidence of a state-dependent bias. When inflation is high, the ECB tends to underpredict future inflation—i.e., the projections converge more quickly to the target than actual inflation.

2 Forecasting Inflation

In this section, we first introduce a general framework for modeling the inflation process. Within this framework, Section 2.1 reviews some well-known properties of optimal forecasts under a squared error loss function. In Section 2.2, we suggest a measure for the *information content* of a forecast and show how that measure can be decomposed into components related to the R^2 and the slope of the Mincer and Zarnowitz (1969) regression as well as the bias of the forecast. We then introduce the concept of an *uninformative* forecast, and show how our measure of information content relates to the tests proposed by Breitung and Knüppel (2021).

We assume that the year-on-year inflation process, π_t, is stationary and ergodic with infinite-order moving average representation

$$\pi_t = \mu + \sum_{j=0}^{\infty} \theta_j \varepsilon_{t-j}, \tag{2.1}$$

where $\theta_0 = 1$, $\sum_{j=0}^{\infty} |\theta_j| < \infty$ and ε_t is an *i.i.d.* white noise process with variance σ_ε^2. It follows that the unconditional mean and variance of inflation are given by $\mathbf{E}[\pi_t] = \mu$ and $\mathbf{Var}[\pi_t] = \sigma_\varepsilon^2 \sum_{j=0}^{\infty} \theta_j^2$.

2.1 Properties of Optimal Inflation Forecasts

Now we consider a central bank forecasting inflation in $t+h$ given the information set $\mathcal{F}_t = \{\varepsilon_t, \varepsilon_{t-1}, \ldots\}$ that is available at time t. We assume the central bank derives the optimal forecast minimizing a squared error loss function. Under these assumptions, the *optimal* h-step ahead forecast is

$$\mu_{t+h|t} = \mathbf{E}[\pi_{t+h}|\mathcal{F}_t] = \mu + \sum_{j=h}^{\infty} \theta_j \varepsilon_{t+h-j}. \tag{2.2}$$

Thus, inflation in period $t+h$ can be decomposed as

$$\pi_{t+h} = \mu_{t+h|t} + u_{t+h|t}, \tag{2.3}$$

where $u_{t+h|t}$ is the h-step ahead prediction error of the optimal forecast. Due to the uncorrelatedness of the optimal forecast and the prediction error, the variance of the inflation process can be written as

$$\mathbf{Var}[\pi_{t+h}] = \mathbf{Var}[\mu_{t+h|t}] + \mathbf{Var}[u_{t+h|t}]. \tag{2.4}$$

The mean squared error of the h-step ahead forecast corresponds to the variance of the prediction error: $\mathrm{MSE}(\mu_{t+h|t}) = \mathbf{Var}[u_{t+h|t}]$. For simplicity, in the following, we write $\mathrm{MSE}(\mu_{t+h|t}) = \mathrm{MSE}(h)$. Note that $\mathrm{MSE}(1) = \sigma_\varepsilon^2$ and $\mathrm{MSE}(h+1) = \mathrm{MSE}(h) + \theta_h^2\sigma_\varepsilon^2$ for $h \geq 1$. We denote the change in the mean squared prediction error when the forecast horizon decreases from $h+1$ to h by $\Delta\mathrm{MSE}(h) = \mathrm{MSE}(h+1) - \mathrm{MSE}(h)$. Following Lahiri (2012, p.21), we think of $\Delta\mathrm{MSE}(h)$ as a measure of the "information content of the new information" about π_{t+h} that becomes available at time t when replacing the forecast $\mu_{t+h|t-1}$ by the revised forecast $\mu_{t+h|t}$. It follows that the optimal forecast possesses the following properties (see Diebold and Lopez, 1996; Isiklar and Lahiri, 2007; Lahiri, 2012):

P1 The optimal forecast, $\mu_{t+h|t}$, is unbiased, i.e. $\mathbf{E}[\mu_{t+h|t}] = \mu$.

P2 As $h \to \infty$, $\mu_{t+h|t}$ converges to the unconditional mean. In the special case that $\theta_j = 0$ for $j \geq h^\star$, $\mu_{t+h|t} = \mu$ from forecast horizon $h^\star$ onward.

P3a The variance of the optimal forecast is weakly decreasing in the forecast horizon and converges to zero as $h \to \infty$. If $\theta_j = 0$ for $j \geq h^\star$, then $\mathbf{Var}[\mu_{t+h|t}] = 0$ for $h \geq h^\star$.

P3b $\mathrm{MSE}(h)$ is weakly increasing in the forecast horizon and converges to the unconditional variance of π_t as the forecast horizon goes to infinity. If $\theta_j = 0$ for $j \geq h^\star$, then $\mathrm{MSE}(h) = \mathbf{Var}[\pi_t]$ for $h \geq h^\star$.

2.2 Predictive Ability and Limits to Predictability

Our primary interest is in studying the information content of the ECB's projections. We measure the information content of a forecast by one minus the ratio of the mean squared error of the forecast and the mean squared error of the unconditional mean. We show that this measure of information content can be decomposed into three components: The information content increases in the explanatory power of the forecast and decreases due to bias or inefficiency. For testing up to which forecast horizon the ECB's projections are informative, we rely on the tests proposed in Breitung and Knüppel (2021). Assuming that the forecast corresponds to the optimal forecast but is contaminated with noise, we derive an expression for the OLS estimator of the slope component of the Mincer and Zarnowitz (1969) regression from which we deduce a criterion that can be used the check whether a forecast is informative at a certain horizon.

We first review some details of the Mincer and Zarnowitz (1969) regression (henceforth MZ-regression). Let $\hat{\pi}_{t+h|t}$ denote a (not necessarily optimal) forecast of inflation in $t+h$ made at time t and

$$e_{t+h|t} = \pi_{t+h} - \hat{\pi}_{t+h|t} \tag{2.5}$$

the corresponding forecast error. The mean squared error of the forecast can be decomposed into the squared bias and variance of the forecast error:

$$\text{MSE}(\hat{\pi}_{t+h|t}) = \mathbf{E}[(\pi_{t+h} - \hat{\pi}_{t+h|t})^2] = (\mathbf{E}[e_{t+h|t}])^2 + \mathbf{Var}[e_{t+h|t}]. \tag{2.6}$$

The MZ-regression is given by

$$\pi_{t+h} = \alpha_h + \beta_h \hat{\pi}_{t+h|t} + \nu_{t+h}, \tag{2.7}$$

where ν_{t+h} is the error term. Following Theil (1966), Mincer and Zarnowitz (1969) refer to $\hat{\pi}^c_{t+h|t} = \alpha_h + \beta_h \hat{\pi}_{t+h|t}$ as the "optimal linear correction" of the forecast. In general, $\mathbf{Var}[e_{t+h|t}] \geq \mathbf{Var}[\nu_{t+h}]$. Mincer and Zarnowitz (1969) define a forecast to be efficient if $\beta_h = 1$, i.e. if $\mathbf{Var}[\nu_{t+h}] = \mathbf{Var}[e_{t+h|t}]$. If, in addition, the forecast is unbiased, i.e. $\alpha_h = 0$, then $\mathbf{Var}[\nu_{t+h}] = \text{MSE}(\hat{\pi}_{t+h|t})$. The MZ-regression is commonly used to jointly test the unbiasedness and efficiency of a forecast by testing the hypothesis $H_0 : \alpha_h = 0,\ \beta_h = 1$. If $\hat{\pi}_{t+h|t}$ corresponds to the optimal forecast, i.e. $\hat{\pi}_{t+h|t} = \mu_{t+h|t}$, and $\mathbf{Var}[\mu_{t+h|t}] > 0$, the null hypothesis is satisfied. This is because $\mathbf{Cov}(\pi_{t+h}, \mu_{t+h|t}) = \mathbf{Var}[\mu_{t+h|t}]$ and, hence, $\beta_h = \frac{\mathbf{Cov}(\pi_{t+h}, \mu_{t+h|t})}{\mathbf{Var}[\mu_{t+h|t}]} = 1$ and $\alpha_h = \mathbf{E}[\pi_{t+h}] - \beta_h \mathbf{E}[\hat{\pi}_{t+h|t}] = 0$. In this case, equation (2.7) corresponds to equation (2.4) with $\nu_{t+h} = u_{t+h|t}$.

Mincer and Zarnowitz (1969) suggest measuring relative forecast accuracy of a forecast by the ratio of the MSE of the forecast and the MSE of a "benchmark" forecast. Using the conditional mean, μ, as the benchmark forecast, we define the *information content* of a forecast, $\hat{\pi}_{t+h|t}$, at horizon h, as

$$IC(\hat{\pi}_{t+h|t}) = 1 - \frac{\text{MSE}(\hat{\pi}_{t+h|t})}{\text{MSE}(\mu)} = 1 - \frac{\text{MSE}(\hat{\pi}_{t+h|t})}{\mathbf{Var}[\pi_{t+h}]}. \tag{2.8}$$

The higher the information content of the forecast, the closer $IC(\hat{\pi}_{t+h|t})$ is to one. Our definition of the information content is related to the measures suggested in Theil (1966) and Galbraith (2003). The empirical analogue of $IC(\hat{\pi}_{t+h|t})$ corresponds to (one minus the square of) Theil's U statistic (when the naive benchmark is the average of π_t in the evaluation sample). Galbraith (2003) focuses on autoregressive processes and provides an asymptotic expression of forecast content that accounts for parameter estimation uncertainty.

If $\hat{\pi}_{t+h|t} = \mu_{t+h|t}$, the *information content* can be written as

$$IC(\mu_{t+h|t}) = 1 - \frac{\text{MSE}(\mu_{t+h|t})}{\mathbf{Var}[\pi_{t+h}]} = \frac{\mathbf{Var}[\mu_{t+h|t}]}{\mathbf{Var}[\pi_{t+h}]} = R^2(\mu_{t+h|t}). \tag{2.9}$$

That is, the information content of the *optimal* forecast equals the population R^2 of the h-step ahead MZ-regression of π_{t+h} on $\mu_{t+h|t}$ (see also Granger and Newbold, 1986). Depending on the properties of the inflation process, the information content of the *optimal* forecast can decrease quickly with increasing forecast horizon, i.e., $IC(\mu_{t+h|t})$ quickly approaches the value of zero. The information content can be smaller than zero for forecasts that are not optimal.

The following proposition decomposes the information content of a forecast $\hat{\pi}_{t+h|t}$.

Proposition 1. *The information content of a forecast $\hat{\pi}_{t+h|t}$ can be decomposed as*

$$IC(\hat{\pi}_{t+h|t}) = \underbrace{F_{t+h|t}}_{Fit} - \underbrace{B_{t+h|t}}_{Bias} - \underbrace{S_{t+h|t}}_{Slope}, \tag{2.10}$$

with

$$F_{t+h|t} = R^2(\hat{\pi}_{t+h|t}) \tag{2.11}$$

$$B_{t+h|t} = (\mathbf{E}[e_{t+h|t}])^2/\mathbf{Var}[\pi_{t+h}] \tag{2.12}$$

$$S_{t+h|t} = (1-\beta_h)^2 \frac{\mathbf{Var}[\hat{\pi}_{t+h|t}]}{\mathbf{Var}[\pi_{t+h}]} \tag{2.13}$$

and $R^2(\hat{\pi}_{t+h|t})$ being the population R^2 of the MZ-regression of π_{t+h} on $\hat{\pi}_{t+h|t}$.

Equation (2.10) in Proposition 1 shows that the information content of a forecast can be expressed as a function of the R^2 of the MZ-regression, the bias of the forecast, and the slope, β_h. Equation (2.10) directly follows from equation (5a) in Mincer and Zarnowitz (1969).[8] When the

[8] Mincer and Zarnowitz (1969) decompose the MSE of the forecast $\hat{\pi}_{t+h|t}$ into $\text{MSE}(\hat{\pi}_{t+h|t}) =$

forecast, $\hat{\pi}_{t+h|t}$, is unbiased, then $B_{t+h|t} = 0$. When the forecast is efficient, i.e., $\beta_h = 1$, then $S_{t+h|t} = 0$. For the first component, it holds that $F_{t+h|t} \leq IC(\mu_{t+h|t})$. Thus, we can express the cost of deviating from the optimal forecast, as measured by loss in information content, as

$$IC(\mu_{t+h|t}) - IC(\hat{\pi}_{t+h|t}) = [R^2(\mu_{t+h|t}) - R^2(\hat{\pi}_{t+h|t})] + B_{t+h|t} + S_{t+h|t}. \tag{2.14}$$

The first term represents the loss in fit (as measured by the decrease in the R^2 of the MZ-regression) when using $\hat{\pi}_{t+h|t}$ instead of $\mu_{t+h|t}$.

For illustration, we discuss three examples. First, assume that the forecast equals the optimal forecast plus a constant bias, i.e., $\hat{\pi}_{t+h|t} = c + \mu_{t+h|t}$ with $c \neq 0$. Then, $S_{t+h|t} = 0$ and $R^2(\mu_{t+h|t}) - R^2(\hat{\pi}_{t+h|t}) = 0$. That is, the forecast is still efficient and has the same explanatory power for the realization as the optimal forecast. However, due to the bias, $IC(\mu_{t+h|t}) - IC(\hat{\pi}_{t+h|t}) = B_{t+h|t} = c^2/\mathbf{Var}[\pi_{t+h}]$. Second, assume that true process follows an AR(1) with $\pi_t = \rho\pi_{t-1} + \varepsilon_t$ and $0 < \rho < 1$. Assume that a forecaster deviates from the optimal forecast by employing the one-step ahead forecast $\hat{\pi}_{t+1|t} = \tilde{\rho}\pi_t$ with $\tilde{\rho} \neq \rho$ and $0 < \tilde{\rho} < 1$. While this forecast is unbiased and has the same R^2 as the optimal forecast, the slope of the MZ-regression is $\beta_1 = \rho/\tilde{\rho} \neq 1$. Thus, the forecast systematically over- or underpredicts and

$$IC(\mu_{t+1|t}) - IC(\hat{\pi}_{t+1|t}) = S_{t+1|t} = \tilde{\rho}^2 - 2\rho\tilde{\rho} + \rho^2. \tag{2.15}$$

The forecast "efficiency" notion in Mincer and Zarnowitz (1969) implies that the forecast neither systematically over- nor underpredicts. However, this does not necessarily mean the forecaster uses all available information efficiently. For example, to forecast the AR(1) process, a forecaster might use $\hat{\pi}_{t+1|t} = \rho^2\pi_{t-1}$ as the forecast for π_{t+1} given information available at time t. While this forecaster uses the correct AR(1) parameter, she does not use π_t, which is observable in period t. Indeed, her forecast corresponds to the optimal two-step ahead forecast given information at time $t-1$. Nevertheless, the forecast $\hat{\pi}_{t+1|t} = \rho^2\pi_{t-1}$ is unbiased and efficient (according to the notion in Mincer and Zarnowitz (1969)) because $B_{t+1|t} = 0$ and $S_{t+1|t} = 0$. However, the

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$(\mathbf{E}[e_{t+h|t}])^2 + (1-\beta_h)^2\mathbf{Var}(\hat{\pi}_{t+h|t}) + (1 - R^2(\hat{\pi}_{t+h|t}))\mathbf{Var}[\pi_{t+h}]$. They refer to the three components as the mean component (MC), the slope component (SC), and the residual component (RS).

forecast is not optimal and, hence,

$$IC(\mu_{t+1|t}) - IC(\hat{\pi}_{t+1|t}) = [R^2(\mu_{t+1|t}) - R^2(\hat{\pi}_{t+1|t})] = \rho^2(1-\rho^2). \tag{2.16}$$

Breitung and Knüppel (2021) provide a framework for testing for the predictive content of a forecast based on the null hypothesis that

$$\mathbf{E}[(\pi_{t+h} - \hat{\pi}_{t+h|t})^2] \geq \mathbf{E}[(\pi_{t+h} - \mu)^2] \quad \text{for} \quad h \geq h^\star \text{ and } t \in \{1, \ldots, T\}, \tag{2.17}$$

where T denotes the number of observations in the evaluation sample. The forecast is said to be *uninformative* from forecast horizon $h^\star$ onward because the MSE of $\hat{\pi}_{t+h|t}$ is not lower than the MSE of the unconditional mean. Thus, the null hypothesis is equivalent to $IC(\hat{\pi}_{t+h|t}) \leq 0$ for $h \geq h^\star$.

Breitung and Knüppel (2021) propose test statistics for several settings. We focus on the setting where the forecast equals the optimal forecast with an additive noise term. Davies and Lahiri (1995), Lahiri and Sheng (2010), and Juodis and Kučinskas (2023) provide evidence for a noise component in the individual forecasts of professional forecasters as well as in the consensus forecast (due to the disagreement among forecasters). As discussed before, central bank forecasts are based on technical assumptions, combine the forecasts from various models, and incorporate expert judgement. Thus, we treat those forecasts as consensus forecasts with a noise component. Technically, we assume that the central bank's projections can be written as

$$\hat{\pi}_{t+h|t} = \mu_{t+h,t} + \eta_t. \tag{2.18}$$

For simplicity, we assume that the noise term is *i.i.d.* with a mean of zero and variance $\mathbf{Var}[\eta_t] = \sigma_\eta^2 > 0$.[9] In addition, we assume that η_t and ε_{t-j} are uncorrelated for all j. The noise term ensures that $\mathbf{Var}[\hat{\pi}_{t+h|t}] > 0$ at all forecast horizons. In this setting, the forecast errors are given by

$$e_{t+h|t} = \pi_{t+h} - \hat{\pi}_{t+h|t} = u_{t+h,t} - \eta_t, \tag{2.19}$$

[9] In general, the framework in Breitung and Knüppel (2021) allows for serial correlation in the noise term. Also, note that σ_η^2 is assumed to be constant. This is different from a setting where η_t represents estimation error. The variance of the estimation error would naturally decline with an increasing number of in-sample observations.

i.e., consist of the error of the optimal forecast and the noise-induced error. Note that the forecast errors have an expectation of zero, i.e. forecasts remain unbiased. However, the noise term increases the expected squared error loss of the forecast compared to the MSE of the optimal forecast.

The null hypothesis stated in equation (2.17) can be tested using the MZ-regression. Using that $\alpha_h = \mathbf{E}[\pi_{t+h}] - \beta_h \mathbf{E}[\hat{\pi}_{t+h|t}] = (1-\beta_h)\mu$, we can rewrite the MZ-regression as

$$\pi_{t+h} = (1-\beta_h)\mu + \beta_h \hat{\pi}_{t+h|t} + \nu_{t+h}. \tag{2.20}$$

We can think of the MZ-regression as determining the optimal forecast combination of μ and $\hat{\pi}_{t+h|t}$. In equation (A.11) in the appendix, we present an expression for the optimal weight β_h^{opt}, i.e., the weight that minimizes the squared error loss of the combined forecast. For $\beta_h^{opt} = 0.5$, a forecaster is indifferent between the forecasts $\hat{\pi}_{t+h|t}$ and μ. This is the case, if $\mathbf{E}[(\pi_{t+h} - \hat{\pi}_{t+h|t})^2] = \mathbf{E}[(\pi_{t+h} - \mu)^2]$ or $IC(\hat{\pi}_{t+h|t}) = 0$ (see equation (A.11)). In general, a forecast $\hat{\pi}_{t+h|t}$ is uninformative, if $IC(\hat{\pi}_{t+h|t}) \leq 0$. This corresponds to $\beta_h^{opt} \leq 0.5$. Due to the noise component, a forecast can be uninformative, although the conditional expectation is not yet constant. Thus, based on the MZ-regression, Breitung and Knüppel (2021) suggest testing the hypothesis that a forecast is uninformative beyond horizon $h^\star$ by testing the null hypothesis $H_0 : \beta_h \leq 0.5$ against the alternative $H_1 : \beta_h > 0.5$. The test is conducted sequentially for $h = 1, 2, \ldots$. Once the null is rejected, the uninformative horizon is reached.

In the following, we highlight an alternative interpretation of the OLS estimator of β_h in equation (2.7) when the forecast is given by equation (2.18). Due to the noise component, a classical situation of measurement error and attenuation bias arises for the OLS estimator.

Proposition 2. *Assume that the forecast, $\hat{\pi}_{t+h|t}$, is contaminated with noise as in equation (2.18). The OLS estimator of β_h in equation (2.7) is given by*

$$\beta_h^{OLS} = \frac{\mathbf{Var}(\mu_{t+h,t})}{\mathbf{Var}(\mu_{t+h,t}) + \sigma_\eta^2}. \tag{2.21}$$

A forecast is uninformative at horizon h if

$$\mathbf{Var}(\mu_{t+h,t}) = \mathbf{Var}(\pi_t) - MSE(h) \leq \sigma_\eta^2. \tag{2.22}$$

Table 1: Information content of AR(1) process.

	$IC(\mu_{t+h\|t})$	β_h^{OLS}	$IC(\hat{\pi}_{t+h\|t})$	$F_{t+h\|t}$	$S_{t+h\|t}$	$R^2(\mu_{t+h\|t}) - R^2(\hat{\pi}_{t+h\|t})$
$h = 1$	0.640	0.903	0.571	0.578	0.007	0.062
$h = 2$	0.410	0.856	0.341	0.351	0.010	0.059
$h = 3$	0.262	0.792	0.193	0.208	0.014	0.054
$h = 4$	0.168	0.709	0.099	0.119	0.020	0.049
$h = 5$	0.107	0.610	0.039	0.065	0.027	0.042
$h = 6$	0.069	0.500	0.000	0.034	0.034	0.034
$h = 7$	0.044	0.390	-0.025	0.017	0.042	0.027
$h = 8$	0.028	0.291	-0.041	0.008	0.049	0.020

Notes: The table reports the information content of the h-step ahead forecasts of an AR(1) process with persistence parameter $\rho = 0.8$. In the columns, the information content of the optimal forecast, $\mu_{t+h|t}$, and the information content of forecast $\hat{\pi}_{t+h|t}$ from equation (2.18) are reported.

Note that $\mathbf{Var}(\mu_{t+h^\star,t}) \leq \sigma_\eta^2$ implies that $\mathbf{Var}(\mu_{t+h,t}) \leq \sigma_\eta^2$ for all $h > h^\star$. Thus, if the data-generating process is known, equation (2.22) provides an easy-to-check condition to determine the forecast horizon $h^\star$ from which the forecasts $\hat{\pi}_{t+h|t}$ are uninformative. The condition in equation (2.22) can be rewritten in terms of the information content of the optimal forecast. The forecast $\hat{\pi}_{t+h|t}$ is uninformative at horizon h if

$$IC(\mu_{t+h|t}) \leq \frac{\sigma_\eta^2}{\mathbf{Var}(\pi_t)}. \tag{2.23}$$

It is reasonable to assume that the variance of the noise is a fraction α of the variance of inflation. Thus, when the variance of the noise corresponds to $100 \cdot \alpha\%$ of the variance of inflation, the forecast $\hat{\pi}_{t+h|t}$ is uninformative if the information content of the optimal forecast is less than or equal to α.

We illustrate how the noise term affects the information content of the forecast with a numerical example. As before, we assume that π_t follows an AR(1), i.e., $\pi_t = \rho\pi_{t-1} + \varepsilon_t$ with ε_t being white noise. We set $\rho = 0.8$ and choose σ_ε^2 such that $\mathbf{Var}(\pi_t) = 1$. Finally, we set σ_η^2 such that $h^\star = 6$. This choice corresponds to $\alpha = 0.069$. Table 1 shows how the information content of the forecast changes with the forecast horizon h. The $IC(\mu_{t+h|t})$ column displays the information content of the optimal forecast. Because the optimal forecast is unbiased and efficient, the information content of the AR(1)-forecast can be written as

$$IC(\mu_{t+h|t}) = R^2(\mu_{t+h|t}) = 1 - \frac{\sum_{j=0}^{h-1} \theta_j^2}{\sum_{j=0}^{\infty} \theta_j^2} = 1 - \frac{\sum_{j=0}^{h-1} \rho^{2j}}{1/(1-\rho^2)}. \tag{2.24}$$

Even for the optimal forecast, the information content for $h = 1$ is only 0.64, i.e., considerably below one. This is due to unavoidable forecast errors. Further, the information content quickly approaches zero because the correlation between the optimal forecast and π_{t+h} converges to zero. The second column shows the OLS estimate of the slope coefficient β_h when the optimal forecast is contaminated with noise. By construction, $\beta_6^{OLS} = 0.5$ and $IC(\mu_{t+6|t}) = \alpha$. The information content of $\hat{\pi}_{t+h|t}$ is reported in the third column. Because the forecast is not efficient, $IC(\hat{\pi}_{t+h|t}) < IC(\mu_{t+h|t})$ for all h and, by construction, $IC(\hat{\pi}_{t+6|t}) = 0$. The fourth and fifth columns decompose $IC(\hat{\pi}_{t+h|t})$ into the fit component $F_{t+h|t}$ and the slope component $S_{t+h|t}$. The slope component explains only a small fraction of the information content when the forecast horizon is low. Finally, the last column focuses on the loss in explanatory power, as measured by the change in the R^2 of the MZ-regression, when replacing the optimal forecast by $\hat{\pi}_{t+h|t}$. While at short forecast horizons the discrepancy between $IC(\hat{\pi}_{t+h|t})$ and $IC(\mu_{t+h|t})$ is mainly due to a loss in fit, the slope component is more important for forecast horizons $h > h^{\star}$. Overall, the table shows that the information content of the optimal forecast can decrease quickly with the forecast horizon. When the forecast is contaminated with noise, this has two effects. First, the forecast is no longer efficient, and $S_{t+h|t} > 0$. Additionally, due to the inefficiency, the explanatory power of the forecast $\hat{\pi}_{t+h|t}$ is lower than the explanatory power of the optimal forecast.

Finally, we can use the MZ-regression to test the null hypothesis that $\mu_{t+h|t} = \mu$. Because $\hat{\pi}_{t+h|t}$ and π_{t+h} are uncorrelated when $\mu_{t+h,t} = \mu$, this null hypothesis is equivalent to testing $H_0 : \beta_h = 0$.[10] It also follows that $\alpha_h = \mathbf{E}[\pi_{t+h}] = \mu$ and the population R^2 of the MZ-regression is equal to zero.

3 The inflation projections of the ECB

We are now in a position to evaluate the inflation projections of the ECB. We proceed in two steps. First, we show that the projections satisfy the properties of optimal forecasts. Second, we assess their information content and find it declines quickly in the forecast horizon. We cannot reject the hypothesis that the projections are uninformative for a horizon of 4 quarters or beyond.

Each year, the ECB's projections are produced in four forecasting rounds; those in June

[10] If the forecast is characterized by a constant bias (i.e., $\hat{\pi}_{t+h|t} = \mu + c + \eta_t$ with $c \neq 0$), then $H_0 : \beta_h = 0$ will not be rejected. It is, therefore, advisable to first check whether the forecast is unbiased.

and December involve the entire Eurosystem (Broad Macroeconomic Projection Exercise or BMPE), while those in March and September are updates of the BMPE by ECB staff (ECB, 2016; Kontogeorgos and Lambrias, 2022). The BMPE relies on a set of technical assumptions, provided by ECB staff and follows an iterative procedure.[11] First, based on the technical assumptions, the national central banks forecast a range of macroeconomic variables for their countries. These projections are aggregated and re-distributed by the ECB to make them consistent with the euro area aggregate. After a round of revisions, the projections are finalized.

3.1 Data and basic properties

We use quarterly year-on-year inflation data for the euro area. The rate of inflation is defined as $\pi_t = 100 \cdot (P_t - P_{t-4}) / P_{t-4}$, where P_t is the overall HICP index at a quarterly frequency.[12] As before, we denote the h-step ahead projections of the ECB by $\hat{\pi}_{t+h|t}$. We focus on projections for horizons of one to eight quarters. In addition, we denote the nowcasts for the current quarter by $\hat{\pi}_{t|t}$. The inflation projections are available from the ECB's Macroeconomic Projection Database. Forecast errors are denoted by $e_{t+h|t} = \pi_{t+h} - \hat{\pi}_{t+h|t}$. In the empirical analysis, we focus on the 2001Q2 to 2024Q3 period.

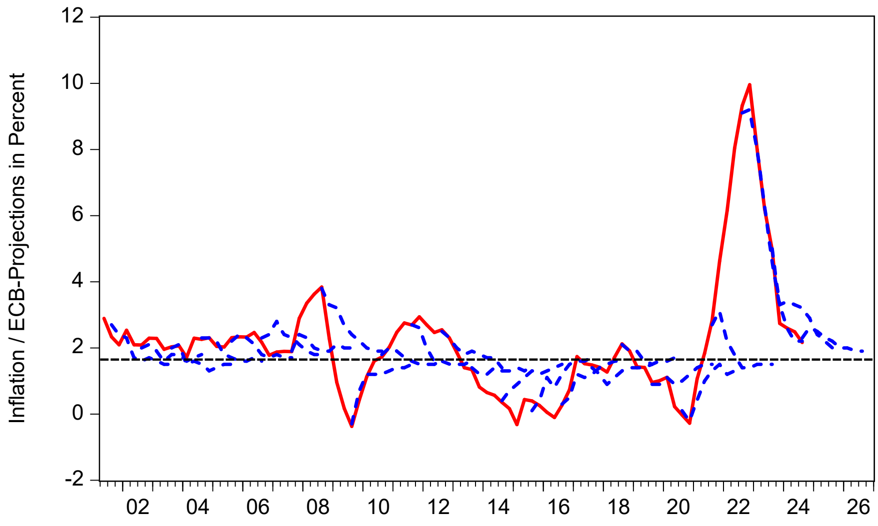
Figure 1 shows the time series of inflation in the euro area (red line) and the ECB's projections (dashed blue line). To increase readability, we only plot the projections the ECB made in September of each year. The horizontal dashed black line corresponds to the average of the eight quarters ahead projections. As expected, the variability of the projections decreases with the forecast horizon. For $h = 8$, the projections have only little variation around their average.

This impression is confirmed by Table 2, which provides summary statistics for actual and projected inflation. In Panel A, we focus on a subsample that ends in 2021Q3. At that time, the ECB published its strategy review of 2021, and inflation was 2.8%. Panel B covers the full sample period from 2001Q2 to 2024Q3, including the surge in inflation in 2022. In Panel A, the mean

[11] The assumptions concern interest rates, exchange rates, energy commodity prices, and fiscal policies (ECB, 2006; Chahad et al., 2022). The paths of interest rates and oil prices are assumed to follow market expectations, the exchange rate is assumed to remain constant, and fiscal policies are assumed to follow national budget plans. Additionally, ECB staff provides forecasts for the development of the global economy.

[12] We compute P_t as the average of the monthly HICP index within each quarter. The monthly values of the HICP index are based on the November 20, 2024 data vintage (downloaded from the ECB Data Portal; series key: ICP.M.U2.N.000000.4.INX). Since revisions of HICP data are usually small, the choice of the data vintage does not affect our results.

Figure 1: Euro area inflation and ECB projections



Notes: We show projections for forecast horizons of $h = 1, \ldots, 8$ quarters. We only plot the projections made in September of each year. The dashed horizontal line corresponds to the average of the 8-quarters ahead projections. The sample period is 2001Q2 to 2024Q3.

and standard deviation of realized inflation are 1.639% and 0.961%, respectively.[13] The mean and standard deviation of the nowcasts are essentially the same as for actual inflation. At all forecast horizons $h \geq 1$, the mean of the projections is close to the mean of actual inflation. We formally check for unbiasedness by regressing the forecast errors (FE) of the ECB's projections on a constant, i.e., by testing the null hypothesis $H_0 : \delta_0 = 0$ in the regression

$$e_{t+h|t} = \delta_0 + \zeta_{t+h} \tag{3.25}$$

using heteroskedasticity and autocorrelation consistent (HAC) standard errors. As indicated by the reported p-values, at all forecast horizons, we cannot reject the null hypothesis that the ECB projections are unbiased. That is, we confirm property **P1** of forecast optimality. Our finding of unconditional unbiasedness is consistent with Kontogeorgos and Lambrias (2022) and Granziera et al. (2024).

The standard deviation of the nowcasts is essentially the same as the standard deviation of actual inflation. In line with property **P3a** of forecast optimality, the standard deviation of the

[13] The first-order autocorrelation equals 0.86.

Table 2: Summary statistics for realized inflation and ECB projections.

	mean	FE	p-value	sd	RMSE($\hat{\pi}_{t+h\|t}$)	ΔMSE(h)
	Panel A: Sample period 2001Q2 to 2021Q3					
π_t	1.639			0.961		
$\hat{\pi}_{t\|t}$	1.649	-0.010	[0.390]	0.961	0.097	0.124
$\hat{\pi}_{t+1\|t}$	1.606	0.033	[0.493]	0.855	0.365	0.211
$\hat{\pi}_{t+2\|t}$	1.589	0.050	[0.593]	0.712	0.587	0.235
$\hat{\pi}_{t+3\|t}$	1.566	0.073	[0.580]	0.525	0.761	**0.245**
$\hat{\pi}_{t+4\|t}$	1.554	0.085	[0.607]	0.346	0.908	0.046
$\hat{\pi}_{t+5\|t}$	1.551	0.087	[0.617]	0.282	0.933	-0.002
$\hat{\pi}_{t+6\|t}$	1.577	0.062	[0.730]	0.247	0.932	0.028
$\hat{\pi}_{t+7\|t}$	1.610	0.029	[0.875]	0.216	0.947	0.013
$\hat{\pi}_{t+8\|t}$	1.636	-0.008	[0.965]	0.202	0.954	
	Panel B: Sample period 2001Q2 to 2024Q3					
π_t	2.145			1.868		
$\hat{\pi}_{t\|t}$	2.140	0.004	[0.812]	1.823	0.126	0.301
$\hat{\pi}_{t+1\|t}$	2.039	0.105	[0.224]	1.629	0.563	0.731
$\hat{\pi}_{t+2\|t}$	1.931	0.214	[0.217]	1.318	1.024	1.089
$\hat{\pi}_{t+3\|t}$	1.799	0.346	[0.183]	0.935	1.462	**1.219**
$\hat{\pi}_{t+4\|t}$	1.680	0.465	[0.163]	0.600	1.832	0.376
$\hat{\pi}_{t+5\|t}$	1.633	0.512	[0.150]	0.461	1.932	0.174
$\hat{\pi}_{t+6\|t}$	1.621	0.523	[0.154]	0.388	1.976	0.084
$\hat{\pi}_{t+7\|t}$	1.627	0.518	[0.165]	0.312	1.997	0.050
$\hat{\pi}_{t+8\|t}$	1.626	0.515	[0.175]	0.225	2.010	

Notes: The table reports summary statistics for actual inflation (π_t) and the ECB's projections ($\hat{\pi}_{t+h|t}$), where h denotes the forecast horizon. sd and FE denote the standard deviation and forecast error. The p-values are for the test of unbiasedness in equation (3.25). RMSE($\hat{\pi}_{t+h|t}$) is the root mean squared prediction error of the projection. The last column shows the reduction in forecast uncertainty when the forecast horizon decreases from $h+1$ to h.

projections decreases with the forecast horizon. The second last column shows that the root mean squared error (RMSE) is substantially lower than the standard deviation of actual inflation at short forecast horizons but rises quickly with increasing forecast horizons. This behavior of the RMSE is in line with property **P3b**.

The summary statistics in Panel B show that the basic patterns of the projections are unchanged once we include the high inflation period in the sample. The mean and standard deviation of actual inflation increase due to the high inflation rates now included in the sample period. Nevertheless, the unbiasedness of the projections is still confirmed (although the p-values decline). The increased variability in actual inflation is now reflected in a considerably higher standard deviation of the projections, particularly at short forecast horizons. Due to larger forecast errors, at each forecast horizon, the RMSE is higher than in the sample period in Panel A but still increases with increasing forecast horizon. Interestingly, for $h \geq 5$, the RMSE is now larger than the standard deviation of actual inflation.

The last column shows $\Delta\text{MSE}(h)$. For both subsamples, the reductions in forecast uncertainty are substantial when $h \leq 3$ but are comparably small for $h > 3$. The largest information gain materializes when the forecast horizon decreases from $h = 4$ to $h = 3$. This suggests that the information content of the forecasts will be low for $h > 3$.

Overall, the evidence from Table 2 suggests that the behavior of the ECB's projections broadly aligns with what would be expected for optimal forecasts.

3.2 Testing for the information content of the projections

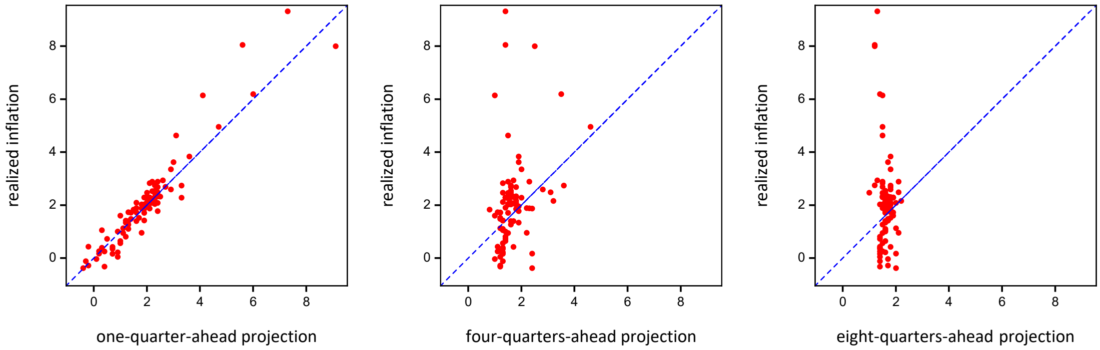
When inflation had just surpassed the two percent target in August 2021, ECB chief economist Lane explained the ECB's forward guidance as follows:

> "In support of its symmetric two per cent inflation target and in line with its monetary policy strategy, the Governing Council expects the key ECB interest rates to remain at their present or lower levels until it sees inflation reaching two percent well ahead of the end of its projection horizon and durably for the rest of the projection horizon, and it judges that realized progress in underlying inflation is sufficiently advanced to be consistent with inflation stabilizing at two per cent over the medium term. This may also imply a transitory period in which inflation is moderately above target." (Lane, 2021).

The forward guidance described in Lane (2021) highlights that the projections are crucial for the ECB's policy decisions. In the following, we investigate the information content of the ECB's inflation projections at different horizons and, in particular, at the target horizon.[14] Figure 2 shows scatter plots of actual inflation (y-axis) against the ECB's projections (x-axis) for the full sample period. The scatter plots are for the one-quarter ahead, the four-quarters ahead, and the eight-quarters ahead projections. In the hypothetical situation that the projections were perfect,

[14] Depending on the quarter in which projections are made, the "end of the projection horizon" is between 2 and 3 years into the future. The "well ahead" is commonly interpreted as referring to the midpoint of the projection horizon, i.e., 12 to 18 months.

Figure 2: Actual inflation vs. ECB projections.



Notes: The figure shows scatter plots of actual inflation against one-quarter-ahead (left panel), four-quarters-ahead (middle panel) and eight-quarters-ahead (right panel) projections. The sample period is 2001Q2 to 2024Q3.

i.e., if projections and subsequent realizations match exactly, all points should lie on the 45-degree line.

While the left panel shows that the one-quarter ahead projections and the corresponding realizations are close to the 45-degree line, the four-quarters ahead forecasts have only weak and the eight-quarters ahead forecasts essentially no explanatory power for future inflation. This is confirmed when estimating a MZ-regression as described in equation (2.7). Table 3 shows the corresponding parameter estimates for all eight forecast horizons. Again, Panel A presents results for the 2001Q2 to 2021Q3 subsample and Panel B for the full sample period. In both panels of Table 3, the estimates of α_h and β_h are close to zero and one when $h = 1$. For forecast horizons of up to $h = 4$, the estimates of β_h remain close to one but drop substantially for longer forecast horizons. The $IC(\hat{\pi}_{t+h|t})$ column of Table 3 reports the information content of the projections. For $h = 1$, the information content is high (0.854 in Panel A and 0.908 in Panel B). However, already for forecast horizons of $h \geq 4$, the information content declines below 0.1, confirming that for those horizons, the forecast performance of the ECB's projections is comparable to the one of the unconditional mean. In Panel B, the information content is negative for $h \geq 5$, i.e., the projections are less informative than the unconditional mean.

Next, we use the tests proposed in Breitung and Knüppel (2021) to test for the informative forecast horizon ($\beta_h \leq 0.5$) and for a constant unconditional mean ($\beta_h = 0$). We implement both tests as suggested in Theorem 2 of Breitung and Knüppel (2021). Following their recommendation,

Table 3: Testing for the information content of the ECB's projections.

	α_h	β_h	$IC(\hat{\pi}_{t+h\|t})$	$H_0 : \beta_h = 0.5$	$H_0 : \beta_h = 0$
	Panel A: Sample period 2001Q2 – 2021Q3				
$h=1$	-0.031 (0.086)	$1.040^{\star\star\star}$ (0.049)	0.854	0.000	0.000
$h=2$	-0.062 (0.204)	$1.070^{\star\star\star}$ (0.132)	0.622	0.000	0.000
$h=3$	-0.118 (0.397)	$1.122^{\star\star\star}$ (0.264)	0.365	0.003	0.000
$h=4$	0.237 (0.902)	0.902 (0.590)	0.096	0.231	0.042
$h=5$	0.368 (1.200)	0.819 (0.779)	0.046	0.335	0.129
$h=6$	0.224 (1.223)	0.897 (0.774)	0.048	0.300	0.120
$h=7$	0.545 (1.438)	0.679 (0.880)	0.017	0.418	0.209
$h=8$	0.733 (1.680)	0.547 (1.001)	0.003	0.481	0.281
	Panel B: Sample period 2001Q2 – 2024Q3				
$h=1$	-0.097 (0.117)	$1.099^{\star\star\star}$ (0.078)	0.908	0.027	0.027
$h=2$	-0.198 (0.234)	$1.213^{\star\star\star}$ (0.166)	0.696	0.032	0.027
$h=3$	-0.245 (0.391)	$1.329^{\star\star\star}$ (0.278)	0.381	0.036	0.025
$h=4$	0.568 (0.724)	$0.938^{\star\star}$ (0.382)	0.028	0.167	0.064
$h=5$	1.397 (1.061)	0.458 (0.520)	-0.081	0.533	0.214
$h=6$	2.313 (1.431)	-0.104 (0.720)	-0.131	0.800	0.558
$h=7$	3.605 (2.226)	-0.898 (1.205)	-0.156	0.883	0.784
$h=8$	$6.006^{\star}$ (3.613)	-2.378 (2.049)	-0.170	0.899	0.860

Notes: The table reports the estimates of α_h and β_h from the MR-regression in equation (2.7). The numbers in parentheses are robust standard errors. In the β_h column, $\star$, $\star\star$, and $\star\star\star$ indicate that the null hypotheses $H_0 : \beta_h = 0$ is rejected at the 10%, 5%, and 1% level. The $IC(\hat{\pi}_{t+h|t})$ column reports the information content as measured by one minus the ratio of MSE($\hat{\pi}_{t+h|t}$) and MSE($\bar{\pi}_t$), where $\bar{\pi}_t$ is based on the observations of the evaluation sample. The columns $H_0 : \beta_h = 0$ and $H_0 : \beta_h = 0.5$ present the p-values of the corresponding LM tests.

we estimate μ by the sample average of the inflation rates during the evaluation sample. We first test our preferred hypothesis, $H_0 : \beta_h \leq 0.5$. The corresponding p-values in Panels A and B suggest that projections up to horizon $h = 3$ are informative. For $h \geq 4$, we cannot reject the hypothesis that the projections are uninformative. Last, we test whether the conditional mean is constant at horizon h, i.e., $H_0 : \beta_h = 0$. According to the p-values of the corresponding LM statistic, the maximum horizon at which we can reject the null hypothesis of a constant conditional

Table 4: Decomposing the Information Content of the ECB's projections.

	$IC(\hat{\pi}_{t+h\|t})$	$F_{t+h\|t} = R^2(\hat{\pi}_{t+h\|t})$	$B_{t+h\|t}$	$S_{t+h\|t}$
	Panel A: Sample period 2001Q2 – 2021Q3			
$h=1$	0.854	0.856	0.001	0.001
$h=2$	0.622	0.628	0.003	0.003
$h=3$	0.365	0.375	0.006	0.004
$h=4$	0.096	0.106	0.008	0.001
$h=5$	0.046	0.058	0.008	0.003
$h=6$	0.048	0.053	0.004	0.001
$h=7$	0.017	0.023	0.001	0.005
$h=8$	0.004	0.013	0.000	0.009
	Panel B: Sample period 2001Q2 – 2024Q3			
$h=1$	0.908	0.919	0.003	0.007
$h=2$	0.696	0.732	0.013	0.023
$h=3$	0.381	0.443	0.035	0.027
$h=4$	0.028	0.091	0.063	0.000
$h=5$	-0.081	0.013	0.076	0.018
$h=6$	-0.131	0.000	0.079	0.053
$h=7$	-0.156	0.022	0.078	0.100
$h=8$	-0.158	0.081	0.076	0.163

Notes: The table reports the decomposition of the information content, $IC(\hat{\pi}_{t+h|t})$, of the ECB's projections into the fit component, $F_{t+h|t} = R^2(\hat{\pi}_{t+h|t})$, the bias component, $B_{t+h|t}$, and the slope component, $S_{t+h|t}$.

mean at the 5% level is four quarters ahead.

As discussed before, Property **P2** states that the optimal forecast converges to the unconditional mean of the process and, hence, the information content might quickly decline with the forecast horizon. Thus, the results from Table 2 and 3 do not necessarily suggest that the ECB's forecasts deviate from optimality. To investigate a potential deviation from optimality, Table 4 provides a decomposition of the information content of the ECB's projections. First, note that the difference between $IC(\hat{\pi}_{t+h|t})$ and $R^2(\hat{\pi}_{t+h|t})$ is small in Panel A but sizable at least for $h \geq 4$ in Panel B. Consistent with this observation, the bias component, $B_{t+h|t}$, and the slope component, $S_{t+h|t}$, are small at all forecast horizons in Panel A. In contrast, in Panel B there is some evidence for bias and, for $h \geq 6$, the slope component matters.[15] Second, the $R^2(\hat{\pi}_{t+h|t})$ quickly decreases with the forecast horizon. For example, for $h = 4$ the R^2s drop to 0.106 (Panel A) and 0.091 (Panel B), respectively. That is, the explanatory power of the projections for subsequent inflation quickly deteriorates. This aligns with the visual impression from the middle and right panels of Figure 2.

[15] For long forecast horizons, there is some evidence for underestimation when including the high inflation period in Panel B (see also Table 2).

For $h \geq 5$, the variation in the projections further decreases, and there is almost no correlation between the projections and realized inflation. In Panel B, the information content is negative at those horizons due to the non-zero bias and slope components.

In summary, although there is hardly any evidence of systematic bias or inefficiency, our results show that the ECB's projections are not informative at the forecast horizons that are most relevant for the ECB's forward guidance. Note that our results do not rule out the possibility that the projections can be further improved by increasing the informational efficiency.[16]

4 A structural interpretation

The statistical analysis in the previous section shows that the information content of the ECB's projections declines rapidly with the forecast horizon. In particular, the ECB's projections are uninformative at the target horizon. Does this compromise the effectiveness of inflation forecast targeting? We explore this question at two levels. First, to set the stage, we examine the issue within the baseline New Keynesian model. Based on this model, we derive a number of closed-form properties of the inflation process under inflation forecast targeting. We then turn to a richer model that incorporates features from Svensson (1997), which provide a rationale for inflation forecast targeting that is absent in the baseline model.

4.1 The New Keynesian baseline model

Our analysis relies on the canonical representation of the New Keynesian model. It is based on a log-linear approximation of the equilibrium conditions around the deterministic steady state. We skip the microfoundation and refer the reader to the textbook treatment provided in Galí (2015). Two equations summarize the behavior of the private sector. A New Keynesian Phillips curve and a dynamic IS-equation, respectively:

$$\pi_t^q = \beta \mathbf{E}_t \pi_{t+1}^q + \kappa \tilde{y}_t, \tag{4.1}$$

$$\tilde{y}_t = \mathbf{E}_t \tilde{y}_{t+1} - \frac{1}{\sigma}(i_t - E_t \pi_{t+1}^q - r_t^n). \tag{4.2}$$

[16] As discussed in Section 2.2, this is because the notion of "efficieny" in Mincer and Zarnowitz (1969) differs from informational efficiency.

In what follows, we assume that time is measured in quarters. Expectations are formed rationally and $\mathbf{E}_t$ denotes the expectation operator. π_t^q is the quarter-on-quarter inflation rate defined as $\pi_t^q = \ln(P_t) - \ln(P_{t-1})$ with P_t being the price level; $\tilde{y}_t$ is the output gap, i_t the nominal interest rate, and r_t^n the natural rate of interest. The parameters β, κ, and σ determine the degree of discounting, the slope of the Phillips curve (governed by the frequency of price adjustments), and the inverse of the intertemporal elasticity of substitution and are all positive. We specify an AR(1) process for the natural rate: $r_t^n = \rho r_{t-1}^n + w_t$, with persistence parameter $\rho \in [0, 1)$ and *i.i.d.* innovations w_t with mean zero and variance σ_w^2. To close the model, we assume a forward-looking interest-rate rule:

$$i_t = \phi_\pi \mathbf{E}_t \pi_{t+k}^q, \tag{4.3}$$

where $\phi_\pi > 1$ determines how strongly the nominal interest rate is adjusted to inflation (expectations). As a distinct feature, the rule in equation (4.3) reflects the fact that a central bank, such as the ECB, adjusts policy rates in response to its inflation forecast for period $t + k$, $E_t \pi_{t+k}^q$ rather than to actual inflation as in the baseline version of the model (see also the classic study of Clarida et al., 2000). The parameter k in rule (4.3) is central to our analysis. It represents the *target horizon* of monetary policy—how forward-looking monetary policy is in adjusting interest rates, measured in quarters.

In what follows, we establish a number of properties of the inflation process. For this purpose we assume the equilibrium is uniquely determined, conditions for which we establish below. In this case, the solution for the inflation process is given by

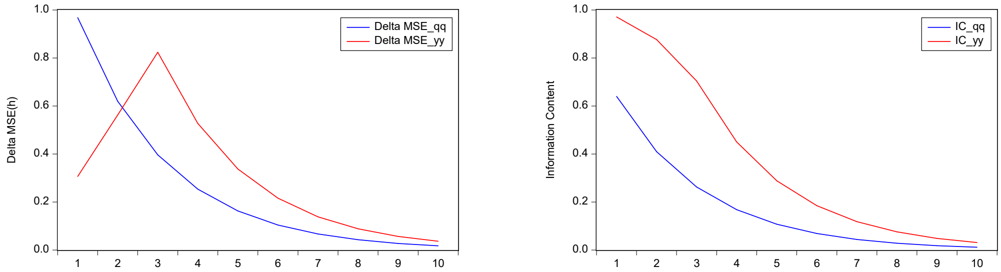
$$\pi_t^q = \rho \pi_{t-1}^q + \varepsilon_t, \tag{4.4}$$

where $\varepsilon_t = \Gamma_k w_t$ with $\Gamma_k \equiv \kappa / \left[\sigma(1-\rho)(1-\beta\rho) + \kappa(\phi_\pi \rho^k - \rho)\right]$. Because the solution for inflation follows an AR(1) process, the information content of the forecasts can be written as in equation (2.24) above and, hence, is solely governed by the persistence of the natural rate.

Importantly, the information content does not depend on the target horizon k set by monetary policy. To see why, note that the choice of the target horizon k affects both the volatility of inflation and the forecast accuracy, as reflected by the MSE. However, in the baseline model, where the inflation process follows an AR(1), changes in k affect both quantities proportionally, leaving the

Figure 3: The accuracy and information content of inflation forecasts

a) $\Delta\text{MSE}(h)$ b) $IC(h)$



forecast horizon h forecast horizon h

Notes: The left panel shows the gain in forecast accuracy when the forecast horizon decreases from $h+1$ to h. The right panel shows the information content. Blue lines represent quarter-on-quarter inflation, and red lines represent year-on-year inflation. The target horizon is $k = 1$.

information content unchanged. The following proposition establishes how k impacts the volatility of inflation and the MSE.

Proposition 3. *Assuming determinacy and a target horizon k in interest rate rule (4.3), quarter-on-quarter inflation, π_t^q, and the optimal forecasts, $\mu_{t,t-h}^q$, have the following property: For a given reaction coefficient ϕ_π, the variance of inflation increases in the target horizon k and so does the mean squared projection error,* $\text{MSE}(\mu_{t+h|t}^q)$.

In Section 3 above, we evaluate the ECB's year-on-year inflation forecasts. Given the forecasts of quarter-on-quarter inflation, it is straightforward to compute forecasts of year-on-year inflation. As we demonstrate in Appendix B, for these forecasts, the largest information gain, $\Delta\text{MSE}(h)$, occurs for $h = 3$. Again, the information content is exclusively governed by the persistence of the natural rate.

We illustrate the properties of quarter-on-quarter and year-on-year inflation with a numerical example. We assume that the central bank sets the target horizon to $k = 1$ and furthermore $\phi_\pi = 1.5$, $\rho = 0.8$, $\sigma = 1$, $\kappa = 0.08$, $\beta = 0.99$, and $\sigma_w^2 = 0.08$. For these parameter values, the unconditional standard deviation of year-on-year inflation is 1.8% (in line with actual EA inflation during the sample period 2001Q2 to 2024Q3, see Panel B of Table 2).

Panel a) of Figure 3 shows the change in the mean squared prediction error, $\Delta\text{MSE}(h) = \text{MSE}(h+1) - \text{MSE}(h) = \theta_h^2 \sigma_\varepsilon^2$, for increasing values of the forecast horizon h. The blue line represents results for quarter-on-quarter inflation, while the red line shows results for year-on-year inflation. For quarter-on-quarter inflation, $\theta_j = \rho^j$, and hence most weight is given to the most recent information. Thus, ΔMSE(h) decreases in h. In contrast, θ_3 receives the largest weight in the Wold representation for year-on-year inflation (see Appendix B). Thus, the largest information gain materializes when the forecast horizon decreases from $h = 4$ to $h = 3$. Intuitively, when $h \geq 4$, the central bank forecast is given by $\pi_{t+h|t} = \pi^q_{t+h|t} + \pi^q_{t+h-1|t} + \pi^q_{t+h-2|t} + \pi^q_{t+h-3|t}$, i.e., the centrals bank needs to forecast *four* quarter-on-quarter inflation rates given information available at time t. When the forecast horizon decreases to $h = 3$, the forecast problem changes to $\pi_{t+3|t} = \pi^q_{t+3|t} + \pi^q_{t+2|t} + \pi^q_{t+1|t} + \pi^q_t$, where π^q_t is observable.[17] This leads to a significant drop in forecast uncertainty. When the forecast horizon decreases to $h = 2$ and $h = 1$, forecast uncertainty is further reduced, but to a lesser extent (because $\theta_1 < \theta_2 < \theta_3$, see Appendix B). This pattern is in accordance with the last column of Table 2, which reports ΔMSE(h) for the ECB's projections.

Panel b) of Figure 3 plots the information content for quarter-on-quarter (blue line) and year-on-year (red line) inflation forecasts. Because quarter-on-quarter inflation follows an AR(1) process with persistence parameter ρ, the information content declines accordingly. The pattern exhibited by the blue line is consistent with the $IC(\mu_{t+h|t})$ column in Table 1. In line with the discussion of Panel a), the information content of year-on-year inflation is considerably higher for small values of h. This is because forecasting year-on-year inflation is a much less difficult task as long as $h < 4$. The shape of the red line is similar to the behavior of the information content of the ECB's projections in the $IC(\hat{\pi}_{t+h|t})$ column of Table 3. However, as expected, at each forecast horizon, the optimal model-based forecasts (Panel b), red line) have a higher information content than what we observe empirically. Below we calibrate a richer version of the model to accurately capture the information content of the inflation forecasts of the ECB.

So far, we have simply assumed equilibrium determinacy. We now formally assess the implications of inflation forecast targeting for equilibrium determinacy. We show, in particular, that if the target horizon is too high, the equilibrium is no longer unique. To show this analytically, we focus on a special case of the model with flexible prices, $\kappa \to \infty$, and consider an alternative

[17] This is true in the model given by equation (2.1). In practice, the central bank has to nowcast π_t in real-time.

to rule (4.3) that ensures a high degree of tractability:

$$i_t = \lambda E_t i_{t+1} + (1-\lambda)\phi_\pi \pi_t^q, \text{ with } \lambda \in [0,1). \tag{4.5}$$

In this *"forward-smoothing"* rule, the degree of forward-lookingness is determined by the parameter λ. To see this, iterate (4.5) forward to obtain

$$i_t = \underbrace{\lim_{T\to\infty} \lambda^T E_t i_{t+T}}_{=0} + \phi_\pi (1-\lambda) \sum_{i=0}^{\infty} \lambda^i E_t \pi_{t+i}^q. \tag{4.6}$$

The parameter λ can also be linked to the target horizon k. Specifically, we may interpret λ and $1-\lambda$ as probabilities (rather than weights). Equation (4.6) can then be interpreted as follows: In each period, monetary policy adjusts interest rates to current inflation with probability $1-\lambda$ and with probability $(1-\lambda)\lambda^i$ to expected inflation in period $t+i$, $i = 1, 2, \ldots$ It follows from the properties of the geometric distribution that the effective (expected) target horizon $\bar{k}$ is given by

$$\bar{k} = \frac{\lambda}{1-\lambda}. \tag{4.7}$$

We may then establish the following:

Proposition 4. *[Determinacy.] Assuming that prices are fully flexible ($\kappa \to \infty$) and that monetary policy follows the forward-smoothing rule* (4.5)*, there is a unique and stable rational expectations equilibrium if and only if the following condition is met:*

$$\lambda \quad < \quad \frac{\phi_\pi}{1+\phi_\pi}. \tag{4.8}$$

We delegate the proof to Appendix C and instead make several observations. First, condition (4.8) constrains λ to be smaller than 1, meaning there cannot be too much forward smoothing for determinacy to obtain. Second, assuming a conventional value of $\phi_\pi = 1.5$, condition (4.8) constrains λ to be smaller than 0.6, which, given (4.7), implies that $\bar{k}$ may not exceed 1. This suggests that forward targeting may quickly run into indeterminacy issues, at least according to the baseline model that underlies Proposition (4.8). We will revisit numerically the determinacy conditions for the richer model below. Loisel (2024) offers a characterization of the conditions for local-equilibrium determinacy in the New Keynesian model, assuming that monetary policy follows rule (4.3) rather than the forward-smoothing rule (4.5). He establishes a broad set of general conditions, rather than focusing on the role of the target horizon as we do.[18]

In concluding our analysis of the New Keynesian baseline model, we make two observations. First, in the numerical example, we set k to one quarter. Such a target horizon is well below the range typically considered by the ECB in practice but a higher target horizon makes the equilibrium indeterminate in the baseline model. Still, as panel b) of Figure 3 shows, at a forecast horizon of $h = k = 1$, the information content is still fairly high. Nevertheless, and this is our second observation for the baseline model, the optimal k is zero in the sense that it minimizes inflation volatility (see again Proposition 3). We revisit both findings in the next section, as we turn to a richer model.

4.2 A more general model with transmission lags

The notion that monetary policy should target an inflation forecast rather than actual inflation is grounded in the insight that, due to transmission lags, the full effects of monetary policy take time to materialize. In what follows, we therefore consider a richer variant of the New Keynesian model that features transmission lags, drawing on the seminal analysis of Svensson (1997). Specifically, we replace (4.1) and (4.2) with the following equations:

$$\pi_t^q = (1-\xi)\bar{\beta}\pi_{t-1}^q + \xi(\mathbf{E}_t\pi_{t+1}^q) + \kappa\tilde{y}_t, \tag{4.9}$$

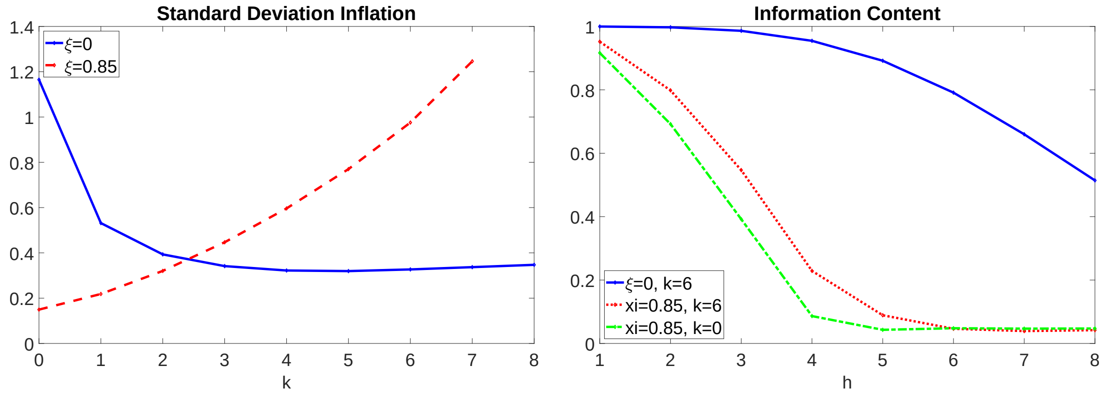
$$\tilde{y}_t = (1-\xi)\bar{\beta}\tilde{y}_{t-1} + \xi\mathbf{E}_t\tilde{y}_{t+1} - \frac{1}{\sigma}(i_{t-l} - (1-\xi)\pi_{t-1}^q - \xi\mathbf{E}_t\pi_{t+1}^q - r_t^n). \tag{4.10}$$

This variant differs from the baseline model considered in the previous subsection in two ways. First, it includes lagged terms in both equations, weighted by $(1-\xi)$, while expectations enter with weight ξ. While the original model of Svensson (1997) features *only* lagged terms, we adopt a hybrid specification in the spirit of Gali and Gertler (1999).[19] Second, we allow for the possibility of transmission lags in monetary policy. In Svensson (1997), monetary policy affects the economy only after two periods due to its purely backward-looking nature. In our analysis, we allow for longer transmission lags by assuming that the interest rate in (4.10) influences expenditure with a

[18] See also McCallum (2003) for the practical relevance of multiple solutions and Huang et al. (2009) for the role of endogenous investment for determinacy under inflation forecast targeting.

[19] Additionally, we weight the lagged terms with $\bar{\beta}$, following Svensson (1997). This helps ensure equilibrium determinacy under certain parameterizations of the model, without qualitatively affecting our results.

Figure 4: Model with transmission lags of monetary policy



Notes: left panel shows standard deviation of yoy inflation; right panel shows information content of inflation forecast. Solid blue lines represent results for backward-looking model ($\xi = 0$); Red lines the case $\xi = 0.85$: red dashed line (left) for alternative values of k, red dotted line and green dash-dotted line (right) for $k = 6$ and $k = 0$, respectively. Horizontal axis measures target horizon k (left) and forecast horizon h. Transmission lag $l = 6$.

delay of l periods. When $l = 0$, there is no transmission lag—except in the "Svensson case" with $\xi = 0$, in which the transmission lag is two periods.

We solve the model numerically to establish a number of results. For this purpose, we assume a value of 0.75 for weight $\bar{\beta}$ and set the Taylor rule coefficient $\phi_\pi = 1.31$, in line with estimates of Enders et al. (2013). For the other parameters, we maintain the values specified above. Further, we fix the standard deviation of natural-rate shocks at 0.0643 in order to match the volatility of inflation, given a value of $\xi = 0.85$, which we justify below. We simulate the model for 83 periods, corresponding to the length of our empirical sample, and use 100 periods as burn-in. We report average results over 1000 repetitions.

In a first step, we simulate a purely backward-looking version of the model ($\xi = 0$) and assume $l = 6$, meaning it takes six quarters for monetary policy to impact the economy. We then compute the standard deviation of inflation for various values of the target horizon k. The solid (blue) line in the left panel of Figure 4 shows the result. The standard deviation of inflation is smallest for $k = 5$, but differs only slightly for alternative values in the same range. Hence, in this backward-looking environment à la Svensson, the optimal policy targets the inflation forecast at a horizon that corresponds to the number of transmission lags, as, in fact, originally argued by Svensson (1997) and echoed by many observers and policymakers ever since.

In the right panel of Figure 4, the solid (blue) line shows for the same model version ($\xi = 0$)

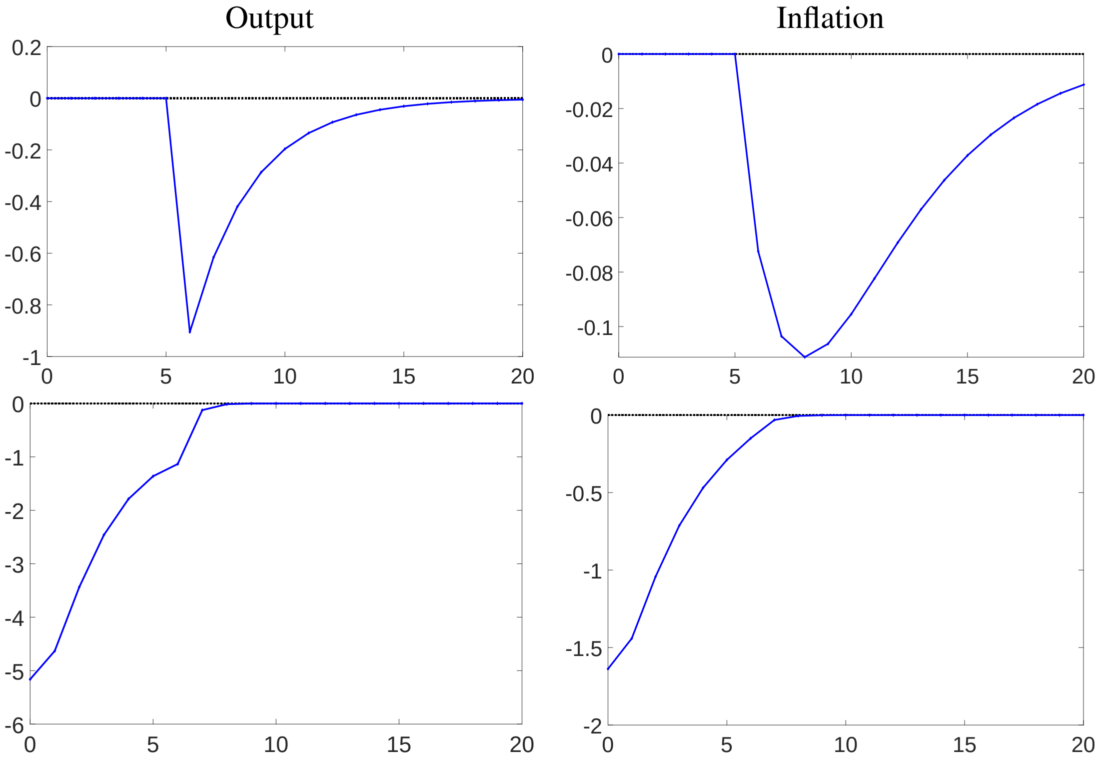
the information content of the inflation forecasts at various forecast horizons h, measured along the horizontal axis—while assuming a target horizon of $k = l = 6$. We find the information content to be high—indeed, much higher than in the data. Intuitively, the backward-looking version of the model generates substantial internal (and delayed) propagation. Because the effects of monetary policy take considerable time to materialize, the impact of shocks tends to persist for a long time and, importantly, in a way that can be well predicted. We illustrate this in the top panels of Figure 5, which show the impulse responses to a monetary policy shock, for output (left), measured in percentage deviation of output from its steady state, and inflation (right). In this case, the horizontal axis measures time in quarters after the shock. The maximum effect of the shock on output occurs only in period 6, reflecting the transmission lags; for inflation, it occurs only in period 8. In such an environment where—due to a high number of transmission lags or, more technically, state variables—there is a lot of persistence, forecasts have high information content.[20]

However, as established above, actual inflation forecasts exhibit much lower information content. It turns out that in the model given by equations (4.9) and (4.10), the information content depends on the degree of forward-lookingness in the economy but also on the target horizon k. We therefore devise a benchmark scenario within the model that captures current ECB policy while simultaneously generating a quantitatively accurate value for the information content of the inflation forecasts. Specifically, we keep $k = 6$, as before—and in line with ECB policy—while calibrating $\xi = 0.85$ to target a value of the information content of the inflation forecast at horizon $h = 6$ equal to 0.048 (see Panel A of Table 4 above).

The dotted (red) line in the right panel of Figure 4 shows the information content of the inflation forecast for the benchmark case. It declines much more rapidly in the forward-looking economy (with $\xi = 0.85$) than in the purely backward-looking economy ($\xi = 0$). In the left panel of Figure 4, we show how inflation volatility in the forward-looking case ($\xi = 0.85$, red dashed line) changes with alternative values of k, measured along the horizontal axis. We find that volatility is lowest when monetary policy targets current rather than expected inflation ($k = 0$).

[20] This is distinct from the original model of Svensson (1997). In his model, there is a two-period lag in monetary policy transmission because output and inflation are governed by past—rather than forward-looking—behavior. There are no additional transmission lags ($l = 0$). In this case, the optimal policy adjusts interest rates to ensure that $\mathbf{E}_t[\pi_{t+2}] = \pi^*$, where π^* is the inflation target. A direct implication is that the information content of the inflation forecast is zero at $h = 2$ under the optimal policy.

Figure 5: Impulse response to monetary policy shock

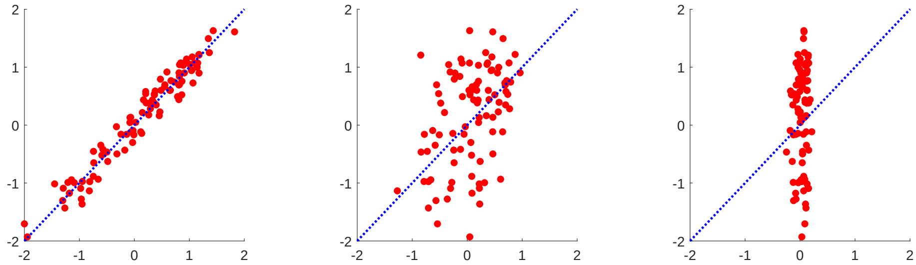


Notes: Top row represent results for backward-looking model ($\xi = 0$); bottom row for $\xi = 0.85$. Monetary policy shock is increase in policy rate by 1 percentage point. Transmission lags set to $l = 6$ and target horizon to $k = 6$. Vertical axis shows deviation from steady state, horizontal axis shows time in quarters.

Hence, while our benchmark scenario can account for the sharply declining information content of inflation forecasts under a policy rule that targets the inflation forecast ($k = 6$), inflation would be much more stable in the underlying economy if policy instead targeted current inflation ($k = 0$). For completeness, we also show how the information content changes with h when we assume $k = 0$. The dash-dotted (green) line in the right panel of Figure 4 displays the result. In this case, the information content is even lower than in the case $k = 6$.

To understand these results, consider again the impulse responses to a monetary policy shock, this time for the forward-looking economy ($\xi = 0.85$) and $k = 6$, shown in the bottom panels of Figure 5. Observe that, even though there are *prima facie* lags in the transmission of monetary policy ($l = 6$), output and inflation respond immediately to the shock—in line with recent evidence on monetary policy transmission in the euro area (Badinger and Schiman, 2023; Ider et al., 2024). This reflects the fact that households and firms are, at least partially, forward looking (see, for instance Gali and Gertler, 1999; Coibion and Gorodnichenko, 2015). There is also evidence that

Figure 6: Realized inflation and inflation forecasts (model simulation)



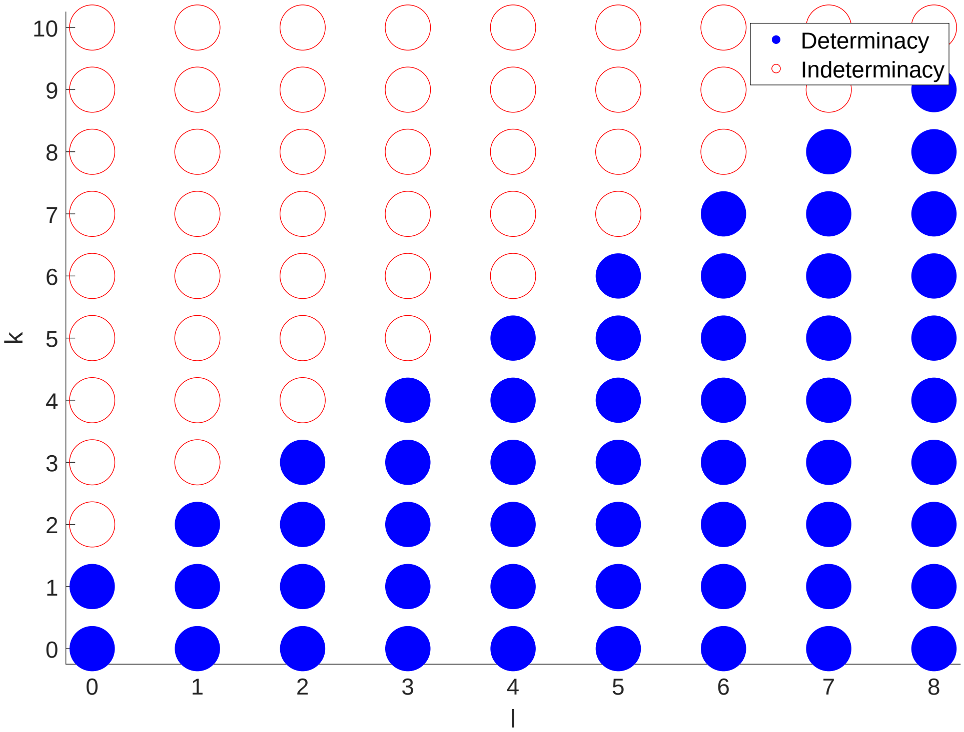
Notes: Vertical axis shows realized inflation, horizontal axis forecasts for horizons of $h = 1$ (left), $h = 4$ (middle), and $h = 8$ (right). Transmission lag of $l = 6$ periods, target horizons $k = 6$, and $\xi = 0.85$. Sample consists of $T = 100$ observations.

firm expectations respond to monetary policy announcements and that firms adjust their behavior in response to these expectations (Enders et al., 2019, 2022). Moreover, the notion that current economic activity is driven by expectations about future developments—particularly regarding monetary policy—is central to the New Keynesian literature and underpins, for example, the idea that monetary policy influences economic activity through forward guidance.

There are two implications. First, with $\xi = 0.85$, monetary policy is much more powerful in steering the economy compared to the purely backward-looking case (shown in the top panels of Figure 5). Second, because—as a result–output and inflation return more quickly to their steady-state values after a shock, the information content of the inflation forecasts declines much more rapidly over the forecast horizon. In this case, forecasts provide little information because monetary policy will—absent new shocks—be successful in keeping inflation on target. There is, however, an important twist: in such an environment, it is optimal to target current rather than forecasted inflation given that the objective is to stabilize inflation—see again the left panel of Figure 4.

We conclude our analysis with two additional exercises. First, we simulate the model with $k = l = 6$ and $\xi = 0.85$, and examine the relationship between realized inflation and the inflation forecast at various horizons. Figure 6 presents the results and is organized in the same way as its empirical counterpart in Figure 2 above. The pattern is also very similar: realized inflation, measured along the vertical axis, aligns closely with the forecast, measured along the horizontal axis, for a short forecast horizon (left panel, $h = 1$), but not at all for a long forecast horizon (right

Figure 7: Indetermincy in model with transmission lags.



Notes: Blue filled circles represent determinacy, red empty ones indeterminacy. X-Axis: transmission lag; y-axis: target horizon. $\xi = 0.85$. For the remaining calibration of the model, see main text.

panel, $h = 8$), where the forecasts instead cluster around zero.

Second, we assess the range of parameters for which the equilibrium of the model is (locally) unique and stable. Figure 7 presents the results for different values of the transmission lag l (horizontal axis) and the target horizon k (vertical axis), while all other parameters are held constant at the values used above. Solid circles indicate a unique and stable equilibrium, while empty circles indicate indeterminacy. As in the baseline New Keynesian model, we find that increasing the target horizon—holding all else constant—raises the risk of equilibrium indeterminacy. However, the pattern in Figure 7 shows that richer transmission lags reduce that risk. Specifically, we obtain a unique equilibrium as long as $k \leq l + 1$.

5 Conclusion

The recent surge in inflation caught policymakers off guard in both the euro area and the United States. Relying on inflation forecast targeting, they were slow to respond, believing the inflationary pressures to be temporary, as projections indicated that inflation would return to target over the medium term. Against this backdrop, we revisit the practice of inflation forecast targeting.

Empirically, we show that the inflation forecasts of the ECB are unbiased and efficient, but lack information content at the relevant forecast horizon. Our model-based analysis suggests this may stem from forward-looking behavior in the private sector. Even in a world with sizable transmission lags—where changes in policy rates take time to influence borrowing and lending conditions—monetary policy remains highly effective in shaping demand and controlling inflation through its impact on private sector expectations. As a result, the information content of inflation forecasts is low: inflation can be expected to remain on target. Nevertheless, in such an environment, the optimal target horizon is effectively zero—implying that monetary policy should respond to current inflation rather than forecasted inflation.

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Appendix

A Optimal weight in MZ-regression

In general, the optimal weight β_h^{opt} is given by

$$\beta_h^{opt} = \frac{\mathbf{E}[(\pi_{t+h} - \mu)^2] - \mathbf{Cov}(e_{t+h|t}, e_{t+h|t}^{\mu})}{\mathbf{E}[(\pi_{t+h} - \mu)^2] + \mathbf{E}[(\pi_{t+h} - \hat{\pi}_{t+h|t})^2] - 2\mathbf{Cov}(e_{t+h|t}, e_{t+h|t}^{\mu})}, \tag{A.11}$$

where $e_{t+h|t}^{\mu} = \pi_{t+h} - \mu$ is the forecast error of the unconditional mean.

B ARMA process for year-on-year inflation

Central bank inflation projections, such as those evaluated in Section 3 pertain to the year-on-year inflation rate $\pi_t = \ln(P_t) - \ln(P_{t-4})$. The year-on-year inflation rate can be written as $\pi_t = \pi_t^q + \pi_{t-1}^q + \pi_{t-2}^q + \pi_{t-3}^q$ and, hence,

$$(1 - \rho L)\pi_t = (1 - \rho L)(\pi_t^q + \pi_{t-1}^q + \pi_{t-2}^q + \pi_{t-3}^q) = \varepsilon_t + \varepsilon_{t-1} + \varepsilon_{t-2} + \varepsilon_{t-3}. \tag{B.12}$$

Recall that $0 < \rho < 1$ by assumption. Thus, π_t follows a stationary ARMA(1,3) process

$$\pi_t = \rho\pi_{t-1} + \varepsilon_t + \varepsilon_{t-1} + \varepsilon_{t-2} + \varepsilon_{t-3}. \tag{B.13}$$

The coefficients in the Wold representation–see equation (2.1)–of the year-on-year inflation process are given by $\theta_1 = 1 + \rho$, $\theta_2 = 1 + \rho + \rho^2$, and $\theta_j = \rho^{j-3} + \rho^{j-2} + \rho^{j-1} + \rho^j$ for $j \geq 3$. By construction, θ_3 is the largest coefficient in the Wold representation. It follows that the largest information gain materializes when the forecast horizon changes from $h = 4$ to $h = 3$.

The unconditional variance of year-on-year inflation is given by

$$\mathbf{Var}[\pi_t] = \Gamma_k^2 \sigma_w^2 \sum_{j=0}^{\infty} \theta_j^2. \tag{B.14}$$

and the optimal forecasts are given by

$$\begin{aligned}
\mu_{t+1|t} &= \rho\pi_t + \varepsilon_t + \varepsilon_{t-1} + \varepsilon_{t-2} && \text{(B.15)}\\
\mu_{t+2|t} &= \rho^2\pi_t + (1+\rho)\varepsilon_t + (1+\rho)\varepsilon_{t-1} + \rho\varepsilon_{t-2} && \text{(B.16)}\\
\mu_{t+3|t} &= \rho^3\pi_t + (1+\rho+\rho^2)\varepsilon_t + (\rho+\rho^2)\varepsilon_{t-1} + \rho^2\varepsilon_{t-2} && \text{(B.17)}\\
\mu_{t+h|t} &= \rho^{(h-3)}\mu_{t+3|t} \quad \text{for} \quad h \geq 4. && \text{(B.18)}
\end{aligned}$$

C Proof of Proposition 4

Now assume, to simplify, that prices are flexible. In this case the output gap is zero at all times and the real interest rate coincides with the natural rate. In this case, the Euler equation boils down to the Fisher equation, see also Ch. 2 of Galí (2015), and inflation and the interest rate are jointly determined by the following set of equations:

$$\begin{aligned}
i_t &= E_t\pi^q_{t+1} + r_t, && \text{(C.19)}\\
i_t &= \lambda E_t i_{t+1} + \phi_\pi(1-\lambda)\pi^q_t, && \text{(C.20)}
\end{aligned}$$

which we can write compactly as:

$$\begin{bmatrix} 0 & 1 \\ -\phi_\pi(1-\lambda) & 1 \end{bmatrix} \begin{bmatrix} \pi^q_t \\ i_t \end{bmatrix} = \underbrace{\begin{bmatrix} 1 & 0 \\ 0 & \lambda \end{bmatrix}}_{\equiv B} E_t \begin{bmatrix} \pi^q_{t+1} \\ i_{t+1} \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} r_t \qquad \text{(C.21)}$$

with

$$B^{-1} = \begin{bmatrix} 1 & 0 \\ 0 & 1/\lambda \end{bmatrix} \qquad \text{(C.22)}$$

and thus

$$\underbrace{\begin{bmatrix} 0 & 1 \\ -\frac{\phi_\pi(1-\lambda)}{\lambda} & 1/\lambda \end{bmatrix}}_{\equiv A} \begin{bmatrix} \pi^q_t \\ i_t \end{bmatrix} = E_t \begin{bmatrix} \pi^q_{t+1} \\ i_{t+1} \end{bmatrix} + B^{-1} \begin{bmatrix} 1 \\ 0 \end{bmatrix} r_t. \qquad \text{(C.23)}$$

A rational expectations equilibrium is determinate if and only if the matrix A has both eigenvalues outside the unit circle. This requires (Woodford, 2003, p. 670):

$$\det A > 1, \tag{C.24}$$

$$\det A - trA > -1, \tag{C.25}$$

$$\det A + trA > -1. \tag{C.26}$$

Note that tr $A = 1/\lambda$ and $detA = \frac{\phi_\pi(1-\lambda)}{\lambda}$. Given that $1/\lambda > 0$, the last condition is subsumed in the second one. The first then requires $\phi_\pi > \lambda/(1-\lambda)$, while the second is fulfilled for $\phi_\pi > 1$. That is, determinacy is given for

$$\phi_\pi > \max\{1; \lambda/(1-\lambda)\}.$$