Market Perceived Monetary Policy and the Yield Curve*

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Abstract

This paper introduces a novel approach to measuring financial markets' perceived shifts in the systematic conduct of monetary policy using swap rates. By exploiting intraday variations in inflation expectation revisions, I document three key findings for the euro area. First, during the effective lower bound (ELB) period, market perceptions of the ECB's response to inflation news remained comparable in magnitude to those in the pre-ELB period. Second, the response was perceived as weakest during the COVID crisis and strongest in the post-COVID recovery, representing the most significant variation since 2008. Third, these perceived policy responses influence the transmission of monetary policy decisions by amplifying short-term yield reactions and reinforcing yield curve flattening.

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Keywords: European Central Bank, monetary policy rules, financial market expectations, term structure of interest rates.

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1 Introduction

The yield curve is a central element in the transmission of monetary policy. Economists have traditionally explained movements in long-term interest rates relative to short-term rates through changes in term premia or shifts in the financial markets perception of the central bank's long-run inflation target (Hanson and Stein, 2015; Kozicki and Tinsley, 2001). Smith and Taylor (2009) further show that the coefficients of affine equations for long-term interest rates depend on the *actual* monetary policy rule coefficient at each maturity. Yet, considerably less attention has been paid to how the financial markets *perceived* monetary policy response to inflation influences the transmission of monetary policy decisions to the yield curve.

A common approach to estimating the perceived monetary policy rule relies on event studies that analyze interest rate reactions within a short window around macroeconomic news releases. The rationale behind this approach is that the estimated policy response will be less biased if interest rate movements are primarily driven by the shock in the news. This method is widely used to identify forward-looking Taylor-rule-type reaction functions as perceived by financial market participants, as in Gürkaynak et al. (2005), Hamilton et al. (2010), and Kroner (2024).[1]

A key limitation of this methodology, as highlighted by Gürkaynak et al. (2020), is that macroeconomic news have low explanatory power around announcements for asset prices as those reflect not only responses to observed macroeconomic surprises in headline figures but also reactions to latent factors that encapsulate additional information in the releases. For instance, beyond headline figures–such as the euro area's annual inflation flash estimate–data releases provide valuable insights, including inflation's main components and cross-country details. Gürkaynak et al. (2020) shows that a combination of the headline surprise and a single latent news factor can explain the majority of yield curve movements around news announcements.

To account for the interest rate response to both headline and non-headline factors,

[1] Rigobon (2003) and Rigobon and Sack (2003, 2004) estimate a Taylor-rule-type equation through heteroskedasticity-based identification. This approach is complementary to the one employed in this paper.

one can use a comprehensive measure of inflation expectations, particularly short-term Inflation-Linked Swap (ILS) rates. Since inflation swaps reflect risk-neutral expectations, they capture the expected inflation rate adjusted for an inflation risk premium. In the subsequent analysis, I focus on short-term ILS and assume that inflation risk premia do not dominate changes in a narrow window around announcements.[2]

In this context, it is crucial to identify a shock that is strongly correlated with variations in ILS rates while remaining orthogonal to other structural shocks influencing interest rate revisions. To illustrate the approach pursued in this article, I begin with a reduced-form equation for estimating inflation expectation revisions, commonly employed in high-frequency event studies in macroeconomics (Gürkaynak and Wright, 2013):

$$\Delta \mathbb{E}_t \pi_k = \alpha_k s_t + \eta_t, \tag{1}$$

where $\Delta \mathbb{E}_t \pi_k \equiv \mathbb{E}_t \pi_k - \mathbb{E}_{t-1} \pi_k$ represents the ILS-based revision in k-period-ahead inflation expectations from $t-1$ to t. The inflation surprise, s_t, is defined as the difference between realized inflation and its forecast based on all publicly available information just before the inflation news announcement. To a first-order approximation, s_t can be interpreted as a linear combination of structural shocks (Boehm and Kroner, 2024). The error term η_t captures all structural shocks influencing the revision in inflation expectations that are not explained by s_t, such as monetary/fiscal policy shocks or latent news factors not captured by headline news.

Assume that in period t the central bank sets the interest rate i_t in response to inflation π_t according to the following simple rule:

$$i_t = i^* + \phi(\pi_t - \pi^*) + \mu_t, \tag{2}$$

where π^* is the central bank's inflation target, i^* is the natural nominal rate–both assumed constant for simplicity–and μ_t captures a monetary policy shock.

[2]As I will discuss later, 1-year and 2-year ILS rates are highly responsive to inflation news, as they are typically dominated by specialized inflation traders, particularly hedge funds. Moreover, they are less affected by risk premia, which tend to increase with maturity Cochrane and Piazzesi (2005).

The revision at time t in expected interest rates k-period ahead can be expressed as

$$\Delta\mathbb{E}_t i_k = \phi \Delta\mathbb{E}_t \pi_k + \Delta\mathbb{E}_t \mu_k, \tag{3}$$

where $\Delta\mathbb{E}_t\mu_k$ represents the forecast revisions of future monetary policy shocks which may reflect persistent monetary policy shocks or persistent deviations from the rule (Rudebusch, 2002). For example, if monetary policy shocks follow an AR(1) process with persistence ρ, $\Delta\mathbb{E}_t\mu_k = \rho^k\mu_t$, this implies that ordinary least squares (OLS) estimates of ϕ in equation (3) may be biased due to the correlation between $\Delta\mathbb{E}_t\pi_k$ and $\Delta\mathbb{E}_t\mu_k$. Formally, the bias in the OLS estimator for ϕ would be given by

$$\hat{\phi} = \frac{\mathbb{COV}_t(\Delta\mathbb{E}_t i_k, \Delta\mathbb{E}_t\pi_k)}{\mathbb{VAR}_t(\Delta\mathbb{E}_t\pi_k)} = \phi + \rho^k \frac{\mathbb{COV}_t(\eta_t, \mu_t)}{\mathbb{VAR}_t(\Delta\mathbb{E}_t\pi_k)} \tag{4}$$

and it is larger the shorter is the horizon k.

To estimate ϕ, I rely on the assumption that inflation surprises are linear combinations of structural shocks orthogonal to other structural shocks entering in η_t, which may also contain μ_t. Consequently, inflation surprises may serve as a valid instrument, provided that they are strongly correlated with inflation expectation revisions while remaining uncorrelated with other structural shocks that do not generate the surprise, namely $\mathbb{COV}_t(s_t, \mu_t) = 0$. Specifically, I first estimate equation (1) within a 30-minute window surrounding euro-area inflation news releases to obtain the predicted values of $\Delta\mathbb{E}_t\pi_k$, namely $\hat{\alpha}_k s_t$. I then use these predicted values as regressors in equation (3). In this case, the estimated ϕ coefficient in equation (9) is unbiased by the correlation with μ_t.[3]

I apply this methodology to the euro area, documenting three key facts over the period 2008–2024.

First, focusing on the 1-year, 1-year-ahead horizon, the perceived systematic response of the ECB to inflation during the Effective Lower Bound (ELB) period before the COVID crisis remained stable and comparable to the perceived systematic response in the pre-

[3]Note that $\hat{\phi} = \frac{\mathbb{COV}_t(\Delta\mathbb{E}_t i_k, \hat{\alpha}_k s_t)}{\mathbb{VAR}_t(\hat{\alpha}_k s_t)} = \phi + \rho^k \hat{\alpha}_k \frac{\mathbb{COV}_t(s_t, \mu_t)}{\mathbb{VAR}_t(\hat{\alpha}_k s_t)} = \phi$.

ELB period, measured at the 1-year-ahead horizon, when the ECB cut the deposit facility rate from 3.25 percent to 1 percent in response to the Global Financial Crisis and to 0 percent in 2012 following the deepening of the European sovereign debt crisis. This finding suggests that monetary policy during the ELB period was perceived as effective by financial markets, operating through expectations of future rate changes at longer maturities.

Second, the perceived monetary policy response to inflation was weakest during the COVID crisis and became the strongest in 2022–2024. These results align with the ECB's actual monetary policy response to the COVID crisis, which prioritized market stabilization, ensuring ample central bank liquidity to support credit provision, and maintaining a sufficiently accommodative stance (ECB, 2020). During the post-Covid recovery, as it became evident that inflation would be both higher and more persistent than initially forecasted, the ECB responded more aggressively, raising the deposit facility rate ten times, with an accumulate increase of 4 points.

Finally, I examine how the above-described perceived, time-varying monetary policy reaction to inflation influences the transmission of monetary policy decisions across the term structure. After identifying monetary policy shocks as the 30-minute change in OIS rates around scheduled monetary policy press releases on Governing Council meeting days, I show that, for a given ϕ, a monetary policy tightening shifts the yield curve upward while flattening it, as short-term yields increase more than long-term ones. Moreover, the higher ϕ, the more sensitive short-term rates are to a monetary policy shock relative to long-term rates.

These results suggest a state-dependent transmission of monetary policy decisions to the term structure through the perceived monetary policy reaction to inflation. Intuitively, a larger reaction coefficient ϕ implies that expected future short-term interest rates will rise more sharply in response to an increase in future inflation. However, a higher ϕ also suggests lower inflation persistence, meaning that for a given rise in inflation today, future inflation is expected to increase by a smaller amount, and thus interest rates will adjust to a lesser extent (Smith and Taylor, 2009).

Related literature. This paper contributes to the literature on estimating shifts in monetary policy rules. In the United States, such shifts have been documented in actual monetary policy rules since the seminal works of Taylor (1999) and Clarida et al. (2000), which identified a structural change in the early 1980s. More recently, Hamilton et al. (2010), Bocola et al. (2024), and Kroner (2024) have estimated forward-looking policy rules using financial data.

Hamilton et al. (2010) focus on the interest rate response to macroeconomic news and find that between 1994 and 2007, the market's perception of the Federal Reserve's policy rule evolved: the response to output disappeared, while the response to inflation became more gradual but larger in the long run. Bocola et al. (2024) document a sizable decline in the perceived responsiveness of the Fed to inflation expectations during 2020-2022. Kroner (2024) finds that surprises in CPI inflation had significantly larger effects on interest rates and inflation expectations–measured by inflation swap rates–during the 2021-2023 inflation surge compared to the preceding low-inflation period.

A similar conclusion is reached by Bauer et al. (2024), who show that the Fed's perceived monetary policy response to inflation shifted materially in the post-pandemic period using forward-looking policy rules estimated from macroeconomic forecaster surveys and event studies. My approach is complementary, as it employs a different methodology hinging on Cuciniello (2024) to estimate the perceived reaction function and focuses on a distinct objective and scope.

I further extend the macro-finance literature on the state-dependence of monetary policy (e.g. Tenreyro and Thwaites 2016, Jordà et al. 2020, Alpanda et al. 2021, Eichenbaum et al. 2022, and Santoro et al. 2014). My contribution lies in demonstrating that market-based expectations regarding the central bank's responsiveness to inflation can influence how monetary policy decisions impact on the entire term structure.

Finally, this paper also relates to the literature that seeks to explain movements in the term structure. Kozicki and Tinsley (2001) attribute long-term interest rate variations to changes in the Federal Reserve's long-run inflation expectations, Smith and Taylor (2009) to shifts in the coefficients of the actual monetary policy rule, and Hanson and Stein (2015)

to fluctuations in the term premium. I contribute to this literature by providing evidence that a stronger perceived monetary policy response to inflation amplifies short-term yield reactions while reinforcing the flattening of the yield curve.

A road map. Section 2 describes the data. Section 3 introduces a simple framework to outline the identification strategy of inflation news shocks. Section 4 provides evidence that inflation surprises are a strong instrument for inflation expectation revisions. Section 5 shows estimates of the responses of interest rates to the inflation news shock. Section 6 focuses on the perceived (time-varying) monetary policy reaction to inflation shocks affects the transmission of monetary policy decisions to the entire term structure. Section 7 concludes.

2 Data

In this section, I provide an overview of the data used for the main empirical analysis.

2.1 Survey-based expectations

The focus throughout the paper is on the inflation flash release in the euro area. For each release, I construct measures of inflation surprises in equation (1) by subtracting the Bloomberg professional forecasters' expectations as follows:

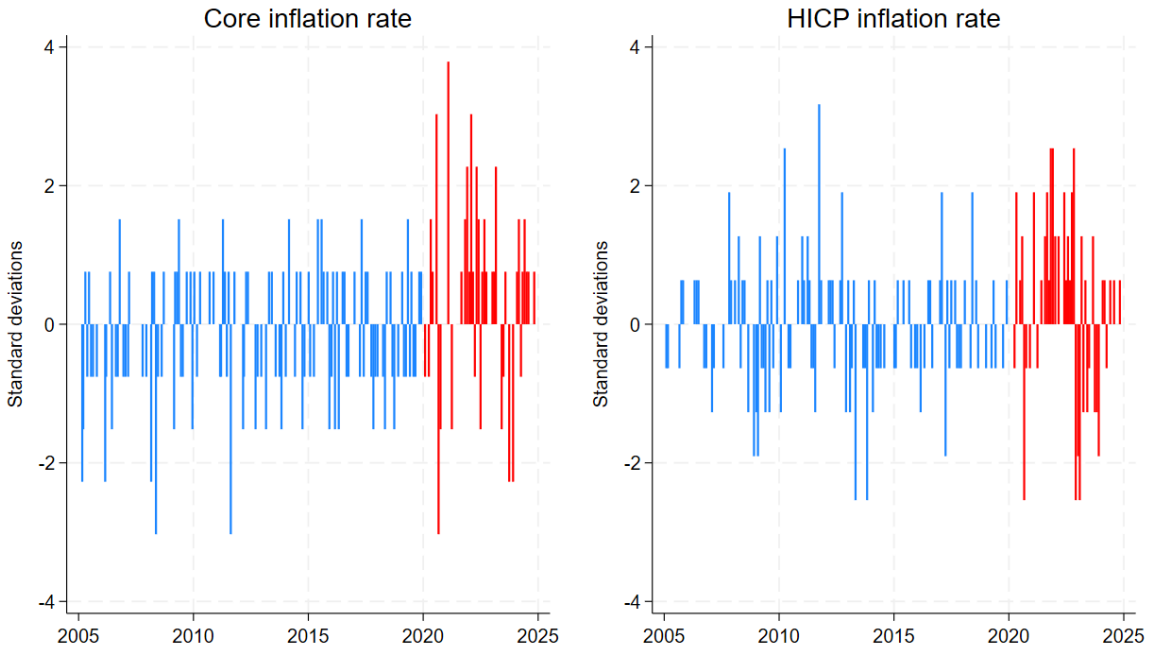
$$s_t = \frac{y_t - E[y_t|\mathcal{I}_{t-\Delta^-}]}{\hat{\sigma}^y}, \tag{5}$$

where y_t denotes the released value and $E[\cdot|\mathcal{I}_{t-\Delta^-}]$ represents the expectation conditional on information available immediately prior to the release. To ensure comparability of surprise magnitudes across HICP and Core inflation releases, the surprises are standardized by dividing by the sample standard deviation of $y_t - E[y_t|\mathcal{I}_{t-\Delta^-}]$, denoted as $\hat{\sigma}^y$.

The Bloomberg forecasts are updated up until the release time, thereby incorporating all publicly available information. Core and HICP inflation surprises, calculated since 2005, are presented in Figure 1. Observations exceeding four standard deviations are

excluded to mitigate the influence of extreme outliers, such as those observed at the onset of the COVID-19 pandemic. Both series exhibit robust statistical properties, even amidst the recent surge in inflation. However, the volatility of the two series appears modestly elevated during the post-COVID period (red bars).

Figure 1: Time series of standardized surprises



Notes: This figure shows the standardized surprises for Core and HICP inflation releases. Observations which are larger than 4 standard deviations are excluded.

2.2 Intraday data

To estimate equation (1), I use tick-by-tick data on Inflation-Linked Swap (ILS) rates from LSEG Tick History. These swap contracts are tied to a non-seasonally adjusted consumer price index (CPI), with the relevant benchmark in the euro area being the Harmonized Index of Consumer Prices excluding tobacco (HICPxT). The euro-area ILS market is widely regarded as the most liquid globally, offering key advantages over alternative indicators of inflation expectations. In particular, the high-frequency trading of ILS makes it better suited for analyzing market reactions to macroeconomic news than survey-based data.

These data facilitate the estimation of changes in inflation expectations at various horizons following the release of Core and HICP inflation estimates in the euro area. Specifically, I analyze changes in 1-year and 2-year ILS rates within 30-minute windows surrounding the euro area HICP and Core inflation releases (from five minutes before to 25 minutes after the release). The dates and times of the inflation releases are sourced from Bloomberg. The tick-by-tick ILS data spans the period from 2008 to 2024.

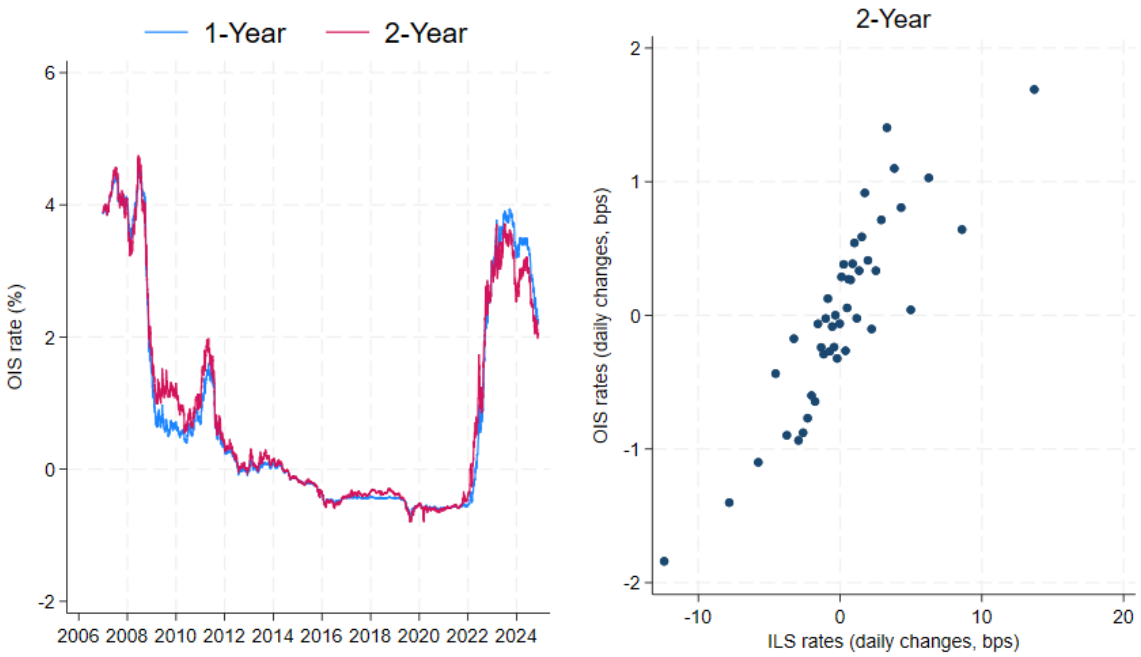
2.3 Daily data

To estimate equation (3), I analyze daily short-term OIS rates using Bloomberg data.

As illustrated in the left panel of Figure 2, short-term OIS rates declined sharply after the Global Financial Crisis (GFC), turning negative between 2014 and 2022. Since July 2022, the ECB has implemented ten rate hikes, raising all three key policy rates by a total of 4 percentage points.

The right panel of Figure 2 shows the binned scatter plot of the relationship between daily changes in 2-year OIS and 2-year ILS rates over the period 2008–2024. There is a strong positive correlation between these swap rates, suggesting that a rule such as equation (3) provides a useful framework for interpreting these data.

Figure 2: Short-term OIS rates



Notes: This figure shows the path of 1-year and 2-year OIS rates (left panel) and the binned scatter plot of the relationship between daily changes in 2-year OIS and 2-year ILS rates (right panel).

3 Identification strategy

In this section, first I introduce a simple framework to outline the identification strategy of inflation news shocks.

I assume that financial market participants believe that the central bank follows a simple policy rule:

$$i_t = i_t^* + \phi(\pi_t - \pi^*) + \mu_t, \tag{6}$$

where i_t represents the money market interest rate at time t, i_t^* denotes its "natural" nominal level, π_t is the inflation rate, π^* is the central bank's inflation target (assumed constant for simplicity), and μ_t captures a monetary shock.

By taking forecast revisions at time t of the k-period-ahead interest rate in equation

(6),

$$\Delta\mathbb{E}_t i_k = \underbrace{\Delta\mathbb{E}_t i_k^*}_{\approx 0} + \phi\Delta\mathbb{E}_t \pi_k + \Delta\mathbb{E}_t \mu_k, \tag{7}$$

where $\Delta\mathbb{E}_t x_k \equiv \mathbb{E}_t x_k - \mathbb{E}_{t-1} x_k$ denotes forecast updates of x_k. Although I allow the natural rate to vary over time, given the focus on high-frequency updates (daily or intraday), I assume that its forecast revisions are negligible, i.e., $\Delta\mathbb{E}_t i_k^* = 0$. Most of the literature considers the natural rate of interest to be a very slow-moving process driven by secular forces, such as demographics and capital flow patterns across countries (e.g., Laubach and Williams, 2003). The term $\Delta\mathbb{E}_t \mu_k$ may reflect persistent monetary policy shocks or persistent deviations from the rule (Rudebusch, 2002). For example, if monetary policy shocks follow an AR(1) process with persistence ρ, then $\Delta\mathbb{E}_t \mu_k = \rho^k \mu_t$.

Note that equation (7) cannot be estimated by OLS, as revisions in inflation expectations are likely correlated with revisions in monetary policy shocks. For example, in a simple New Keynesian model, a monetary policy tightening is expected to reduce future inflation, leading to a negative correlation between $\Delta\mathbb{E}_t \pi_k$ and $\Delta\mathbb{E}_t \mu_k$.

A common approach to estimating forward-looking Taylor-rule-type reaction functions (7) is to use headline inflation surprises s_t instead of forecast revisions of inflation (Gürkaynak et al., 2005; Hamilton et al., 2010; Kroner, 2024). In this case, one can estimate the coefficient ϕ in equation (7) through OLS, provided that the inflation surprise s_t is uncorrelated with the error term $\Delta\mathbb{E}_t \mu_k$.

Yet, as underlined by Gürkaynak et al. (2020), *non-headline* inflation news factors are also important for explaining the observed asset price reactions. For instance, the March inflation report from Eurostat indicated that measures of inflation excluding energy and unprocessed food had climbed above 3 percent for the first time since the euro's inception. This piece of non-headline news can be significant even though it is not reflected in the headline number.

To account for the interest rate response to both headline and non-headline factors, one can use ILS rates as a "summary statistics" of inflation expectation $\mathbb{E}_t \pi_k$. A reduced-

form equation for ILS rates can be written as:

$$\Delta \mathbb{E}_t \pi_k = \alpha_k s_t + \eta_t, \tag{8}$$

where the error η_t captures all other structural shocks affecting inflation expectation that are not explained by the inflation surprise, s_t. However, this suggest that OLS estimates of ϕ in equation (7) may be biased due the endogeneity of inflation, which is influenced by all structural shocks in the economy, including the monetary policy shock. Formally, the errors η_t and $\Delta \mathbb{E}_t \mu_k$ can be correlated:

$$\hat{\phi} = \frac{\mathbb{COV}_t(\Delta \mathbb{E}_t i_k, \Delta \mathbb{E}_t \pi_k)}{\mathbb{VAR}_t(\Delta \mathbb{E}_t \pi_k)} = \phi + \frac{\mathbb{COV}_t(\eta_t, \Delta \mathbb{E}_t \mu_k)}{\mathbb{VAR}_t(\Delta \mathbb{E}_t \pi_k)}. \tag{9}$$

To tackle this endogeneity bias, equation (7) may be instrumented with an instrument that is uncorrelated with the error term but highly correlated with $\Delta \mathbb{E}_t \pi_k$. Specifically, to estimate ϕ, I apply an instrumental-variable approach, using s_t as the instrument for $\Delta \mathbb{E}_t \pi_k$. Then, ϕ can be estimate by OLS or more efficiently by Seemingly Unrelated Regression (SUR):

$$\begin{cases} \Delta \mathbb{E}_t \pi_k = \alpha_k s_t + \eta_t \\ \Delta \mathbb{E}_t i_k = \phi \Delta \mathbb{E}_t \widehat{\pi}_k + \epsilon_t \end{cases} \tag{10}$$

where $\Delta \mathbb{E}_t \widehat{\pi}_k$ is the predicted value from equation (8), and I will refer to it as an "inflation news shock," and ϵ_t denotes the error term.

4 Inflation news shock

In this section, I provide evidence using intraday data that inflation surprises are a strong instrument for inflation expectation revisions.

First, I show that inflation surprises significantly affect ILS rates. To this end, I

estimate regressions of the form:

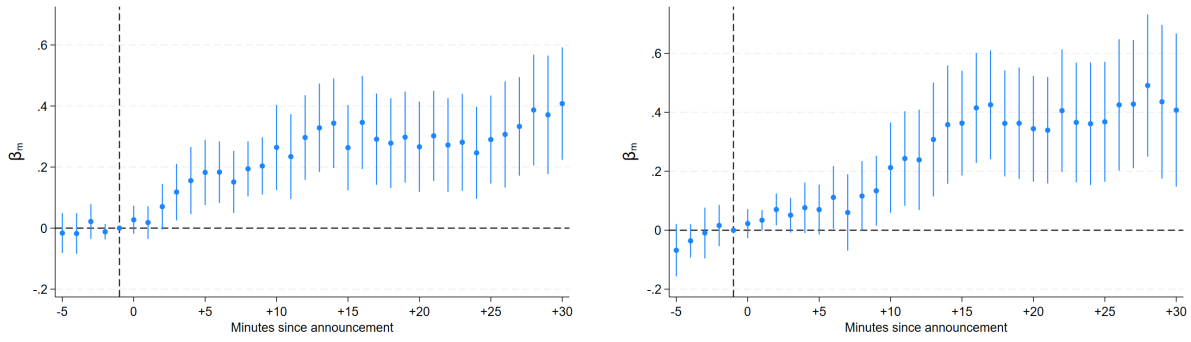
$$\Delta \mathbb{E}_t \pi_{1y}^m = ILS_{t,1y}^m - ILS_{t,1y}^{-1} = \beta_{-1} s_t + \sum_{m \neq -1} \chi_m \mathbb{1}^m + \sum_{m \neq -1} \beta_m s_t \mathbb{1}^m + \eta_t, \tag{11}$$

where $ILS_{t,1y}^m$ and $ILS_{t,1y}^{-1}$ represent the 1-year ILS rates in the m-th minute and the minute just before the inflation release ($m = -1$), respectively. The coefficient β_m, which captures the effect of the inflation surprise s_t on the ILS rate at the m-th minute, is allowed to vary across minutes in the sample period (2008-2024). The value of the coefficient at minute -1 is normalized to one. $\mathbb{1}^m$ is a dummy variable equal to one for the m-th minute and zero otherwise. Observations with changes above the 95th percentile or below the 5th percentile are excluded from the sample.

Figure 3 presents the event study showing the time profile of the β coefficients for Core inflation (panel a) and HICP inflation surprises (panel b), covering 5 minutes before to 30 minutes after the respective inflation release. The parallel trend hypothesis appears to hold reasonably well in the 5 minutes preceding the release. ILS rates respond quickly to surprises: for instance, a one standard deviation positive surprise leads to an increase in ILS rates within 2-3 minutes, peaking at around 15 minutes, after which the response stabilizes.

Figure 3: Response of 1-year ILS rates to inflation surprises

a: Core inflation s_t b: HICP inflation s_t



Notes: This figure shows the estimated β coefficients in equation (11) around the Core and HICP inflation releases. 95% confidence interval are reported using Huber-White robust standard errors.

The response of ILS rates to inflation surprises in Figure 3 does suggest that $\Delta \mathbb{E}_t \pi_{1y}$

and s_t are strongly correlated. However, to be a valid instrument, inflation surprises must be uncorrelated with ϵ_t in equation (10). To this end, it is worth noting that, as is commonly assumed in high-frequency identification strategies, equation (11) can be estimated using OLS since the inflation surprise s_t is likely to be uncorrelated with the error term η_t, i.e., $\mathbb{COV}_t(s_t, \eta_t) \approx 0$ within a sufficiently short time window.

I proceed under the assumption that this condition holds. This implies that inflation surprises are orthogonal to structural shocks that do not affect the inflation surprise itself, such as monetary policy shocks ϵ_t, making them a valid instrument for inflation expectations.

Next, to estimate the inflation news shock, $\Delta\mathbb{E}_t\widehat{\pi}_k$, I focus on the dates of inflation news releases as in Cuciniello (2024). Specifically, I estimate equation (11) using OLS within a 30-minute window around the Euro area Core inflation and HICP releases.

Table 1 presents the results for 1-year and 2-year ILS rates with heteroskedasticity-robust standard errors. The F-test for the joint significance of the regression coefficients exceeds ten, supporting the view that both Core and HICP inflation surprises are strong instruments. The estimated β coefficients are statistically significant at the 1 percent significance level.

Table 1: ILS rate responses to inflation surprises

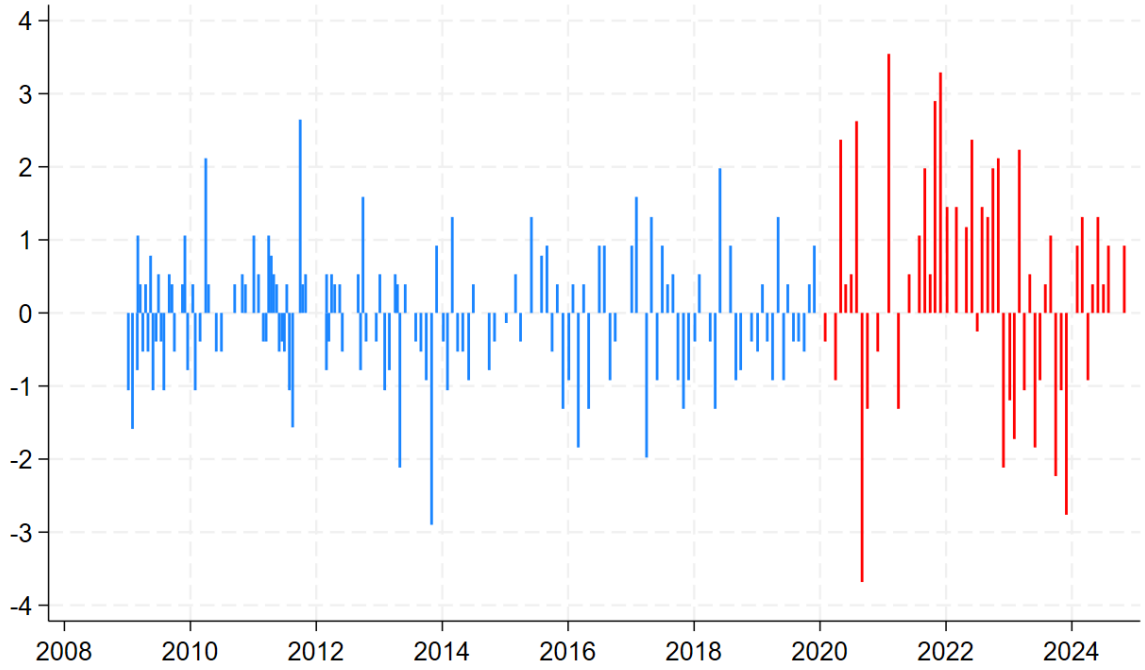
	(1) 1-Year	(2) 2-Year
s^{core}	0.155^{***}	0.134^{***}
	(0.0321)	(0.0298)
s^{hicp}	0.250^{***}	0.363^{***}
	(0.0391)	(0.0451)
F	84.51	101.5

Heteroskedasticity-robust standard errors are in parentheses

As a baseline for inflation news shocks, I use the predicted values of 1-year ILS rates, which are reported in Figure 4. ILS up to two years are dominated by specialized inflation traders, particularly hedge funds. Inflation news shocks are normalized such that a positive unit value corresponds to a one-standard deviation inflationary impulse. Over-

all, they are approximately evenly distributed between inflationary and disinflationary impulses, with relatively larger shocks observed in the last four years of the sample.

Figure 4: Inflation news shocks, $\Delta \mathbb{E}_t \widehat{\pi}_{1y}$



Notes: The time series of inflation news shocks identified using intraday time windows are shown over the actual time interval used in the estimations. The series are normalized such that a positive unit value corresponds to a one-standard deviation inflationary shock.

5 Perceived monetary policy response to inflation news shock

In this section, I estimate the daily responses of interest rates to the inflation news shock. I focus on the 1-year and the 1-year, 1-year-ahead horizons, as variations in ILS and OIS rates at these horizons primarily reflect changes in expectations rather than term or risk premia.

I regress daily changes in OIS forward rates on the inflation news shocks on the days of the Core and HICP inflation releases:

$$\Delta \mathbb{E}_t i_k = \phi \Delta \mathbb{E}_t \widehat{\pi}_k + \epsilon_t \qquad k \in \{1Y, 1Y1Y\}, \tag{12}$$

where ϵ_t is a residual.

Table 2 indicates that inflationary news shocks significantly affect near-term interest rates. Table A1 in the Appendix shows that the results remain robust when estimated using SUR. The first column of Table 2 shows that a 100-basis-point increase in inflation news shocks raises the spot one-year OIS rate (i.e., the one-year forward rate ending one year ahead) by 178 basis points. The second column of Table 2 reports the estimated ϕ when both OIS rates and inflation shocks are measured at the 1-year, 1-year-ahead horizon, which is 100 basis points larger than the estimated ϕ at the 1-year-ahead horizon.

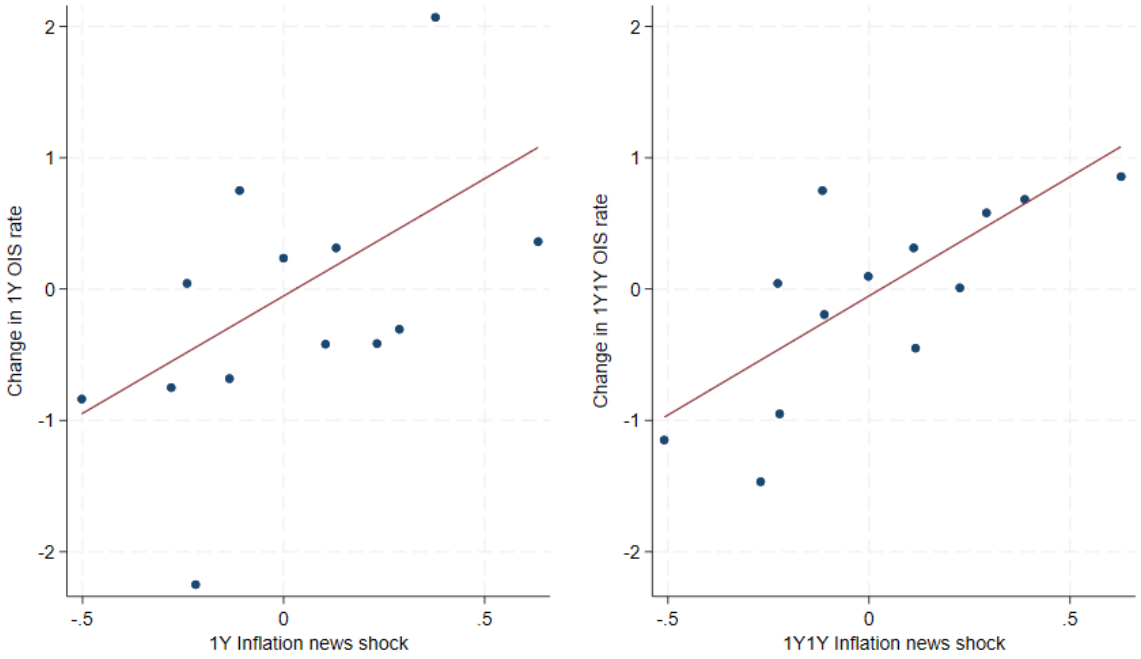
Table 2: Response of interest rates to the inflation news shocks

	(1)	(2)
	1Y	1Y1Y
$\hat{\phi}$	1.781^{***}	2.785^{**}
	(0.486)	(1.150)
N	240	242

Heteroskedasticity-robust standard errors are in parentheses

Figure 5 presents a binned scatter plot of the relationship between the inflation news shock and short-term OIS rates (the average expected response of short-term interest rates). The relationship between changes in OIS rates and the inflation news shock does not appear to be driven by a few outliers.

Figure 5: Binned scatter plot for OIS-rate regression



5.1 Conventional and unconventional monetary policy measures

A concern regarding the estimation approach I describe above is that in my sample period both standard and non-standard monetary policy instruments affect the whole of the term structure.

The Global Financial Crisis (GFC) and the sovereign debt crisis from 2008 to 2013 led, inter alia, to a credit crunch and substantial deflationary risks in the euro area. In response, the ECB implemented conventional monetary policy measures, cutting the deposit facility rate–the interest banks receive for overnight deposits at the central bank–by a cumulative 325 basis points from October 2008, reaching zero in July 2012.

Constrained by the zero lower bound, the ECB adopted accommodative policies from 2014 to 2021, commonly referred to as unconventional monetary policy, aimed at stimulating the economy through forward guidance, asset purchases, and longer-term refinancing operations. Euro area interest rates began rising at the end of 2021 as the ECB gradually responded to shifts in the inflation and economic outlook. From July 2022 to September 2023, the ECB raised its key interest rates ten consecutive times to combat high inflation,

marking the end of a decade-long period of declining and exceptionally low interest rates.

Table 3 presents the estimated values of the coefficient ϕ in equation (12) across three sub-periods: 2009-2013, 2014-2021, and 2022-2024. Three main findings emerge from this analysis.

Table 3: Sub-period response of interest rates to the inflation news shock

	1-Year			1-Year, 1-Year ahead		
	(1)	(2)	(3)	(4)	(5)	(6)
	08-13	14-21	22-24	08-13	14-21	22-24
$\hat{\phi}$	2.661**	0.130	4.324***	1.249	1.707**	6.265**
	(1.114)	(0.254)	(1.160)	(3.043)	(0.825)	(2.906)
N	116	92	32	118	92	32

Heteroskedasticity-robust standard errors are in parentheses

First, during the period of rate cuts (2009-2013), only the 1-year OIS rate appears to respond to inflation shocks. The first and third columns of Table 3 indicate that the 1-year OIS rate reacts significantly to inflation news shocks when monetary policy is conducted through standard rate cuts (2009-2013) or rate hikes (2022-2024). In contrast, column (2) shows that during the effective lower bound (ELB) period (2014-2021), $\hat{\phi}$ for 1-year OIS rates is not significantly different from zero.

Second, forward 1-year OIS rates at the 1-year and 1-year ahead horizons respond to inflation shocks during the ELB period. The coefficients are reported in columns (4) and (6). Moreover, $\hat{\phi}$ for 1-year OIS rates in 2009-2013 is very similar in magnitude to $\hat{\phi}$ for 1-year and 1-year ahead OIS rates in 2014-2021. This finding suggests that monetary policy during the ELB period was perceived as effective, operating through expectations of future rate changes. This result aligns with Altavilla et al. (2019), who find that forward guidance has its strongest impact on the middle of the yield curve, peaking at about two years.

Third, the perceived monetary policy response to inflation shocks in 2022-2024 is the largest, regardless of the forward horizon considered. This result is consistent with Cuciniello (2024), who show that the responsiveness of interest rate expectations to inflation expectations, as estimated using a Taylor rule, remarkably increased during the initial phase of monetary normalization compared to the pre-pandemic period.

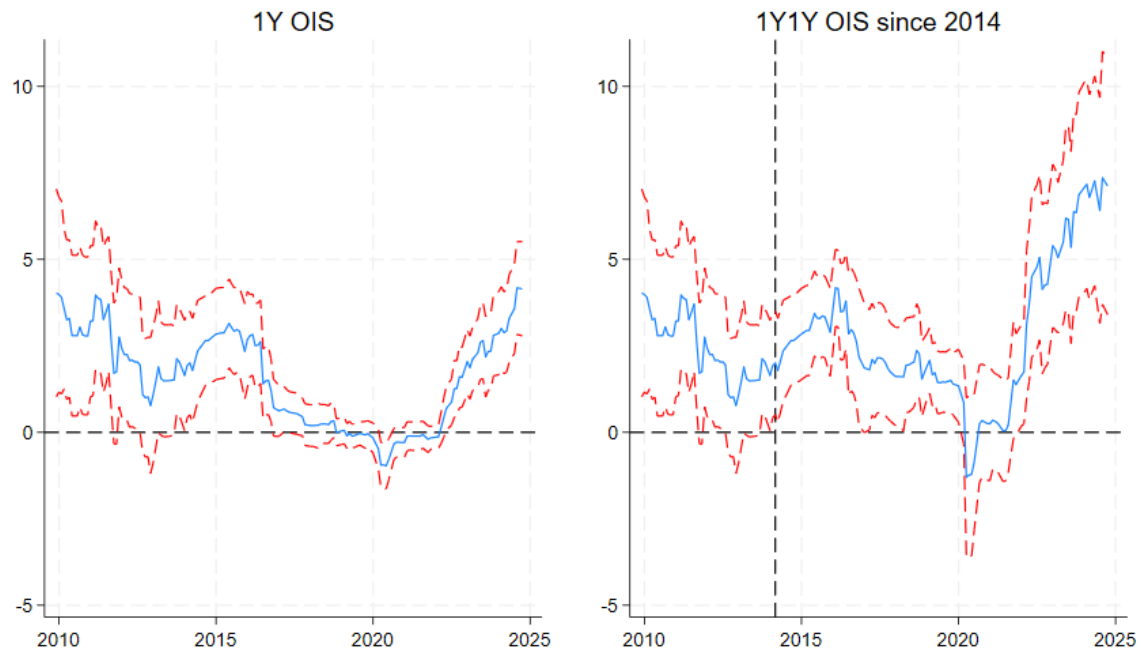
5.2 Time-varying monetary policy response to inflation shocks

The sub-period analysis in Table 3 may be sensitive to the definition of conventional and unconventional monetary policy periods. To address this concern, I estimate ϕ in equation (12) using 2-year rolling windows.

The left panel of Figure 6 reports the time-varying response to inflation shocks, $\hat{\phi}_t$, focusing on 1-year OIS rates as the dependent variable. The sensitivity of 1-year interest rates fluctuated around 2.5 in the pre-ELB period before declining to nearly zero during the ELB period. Only when the ECB began raising rates in 2022 did the perceived response to inflation shocks increase sharply.

The right panel of Figure 6 presents the evolution of $\hat{\phi}$ when substituting the 1-year, 1-year ahead OIS rates as the dependent variable in equation (12) from 2014 onward. Except during the COVID-19 period, the sensitivity of interest rates to inflation shocks aligns with the pre-ELB period when using the 1-year OIS rate as the dependent variable. This finding confirms the effectiveness of unconventional monetary policy during the ELB period while also highlighting the exceptional nature of central bank interventions during the COVID-19 crisis, which temporarily lowered $\hat{\phi}$. Furthermore, the post-COVID period exhibits a sharp increase in the perceived monetary policy response to inflation shocks.

Figure 6: Time-varying response to inflation news shocks, $\hat{\phi}_t$



Notes: The red dashed lines depict 95 percent confidence intervals using 2-year rolling windows and heteroskedasticity-robust standard errors.

The findings indicate that the responsiveness of monetary policy to inflation, denoted by $\hat{\phi}_t$, varies over time, potentially reflecting changes in the ECB's focus on price stability. Notably, the rise in $\hat{\phi}_t$ post-2022 aligns with speeches by ECB officials emphasizing efforts to address inflationary pressures:[4]

- In August 2022, at the annual Jackson Hole central banking symposium, Isabel Schnabel emphasized the ECB's need for "determination" in curbing price rises, "even at the risk of lower growth and higher unemployment."

- In August 2022, Philip R. Lane, at the Annual Meeting of the Central Bank Research Association, highlighted that "when inflation is both high and expected to remain above target for an extended period, the central bank must provide reassurance that it has the capability and determination to deliver its price stability mandate."

[4]The recent normalization of monetary policy, starting in December 2021 with the cessation of net asset purchases within the PEPP and continuing with the discontinuation of net asset purchases under the APP in June 2022, followed by policy rate hikes in July 2022, has been unprecedented in both speed and magnitude.

- In September 2022, Christine Lagarde pointed out that "[the] imperative to anchor inflation expectations helps explain why, over the last two policy meetings of the ECB's Governing Council, we raised our key interest rates by 125 basis points in total. This is the fastest change in rates in our history and it has sent a strong signal of our determination to return inflation to our medium-term target in a timely manner."

6 State-dependent Transmission of Monetary Policy

In this section, I focus on how the transmission of monetary policy shocks to the entire term structure depends on the (time-varying) $\hat{\phi}_t$.

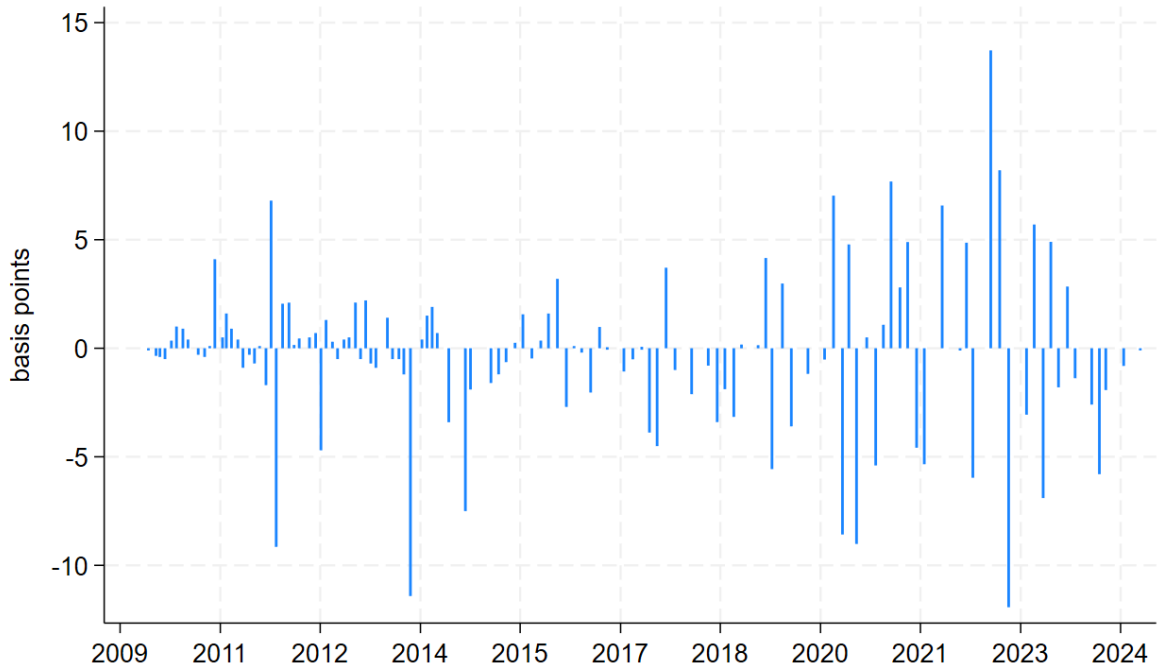
6.1 Monetary Policy Shocks

To construct my measure of monetary shocks, I use tick-by-tick data on Overnight Index Swap (OIS) rates–the closest available proxy for a euro area-wide risk-free rate–obtained from LSEG Tick History. In the euro market, OIS contracts historically referenced the euro overnight index average (EONIA), a weighted average of interest rates on unsecured overnight interbank loans. Since October 2, 2019, EONIA has been replaced by the euro short-term rate (€STR), which reflects the wholesale unsecured overnight borrowing costs of euro-area banks. I analyze changes in OIS rates over the same 30-minute windows surrounding European Central Bank (ECB) monetary policy announcements, spanning from five minutes before to 25 minutes after the release. The dates and times of these announcements are sourced from Bloomberg. The tick-by-tick OIS data covers the sample period from 2002 to 2024. The idea is that changes in OIS rates during these 30-minute windows are primarily driven by information about future monetary policy contained in the press release.

Figure 7 presents changes in the 1-year OIS rate before the ELB period (2009-2013) and in the 1-year and 1-year ahead OIS rates since 2014. As shown in the previous section, the advantage of this measure is that it captures the effects of forward guidance

and other unconventional monetary policy measures implemented over the past decade.

Figure 7: Monetary policy shock, μ_t



6.2 Baseline estimates

The perceived monetary policy rule should influence how future interest rates respond to monetary policy surprises around ECB monetary policy announcements. Intuitively, a larger reaction coefficient ϕ implies that expected future short-term interest rates will increase more in response to a rise in future inflation. However, a higher ϕ also suggests that inflation is expected to increase by a smaller amount in the future for a given rise in inflation today, as inflation persistence declines. These two effects are documented in Smith and Taylor (2009), which derives a formula linking the coefficients of the monetary policy rule for the short-term interest rate to the coefficients of the implied affine equations for long-term interest rates.

Accordingly, I estimate a state-dependent response of the yield curve to monetary shocks, which depends on the estimated time-varying coefficient $\hat{\phi}_t$:[5]

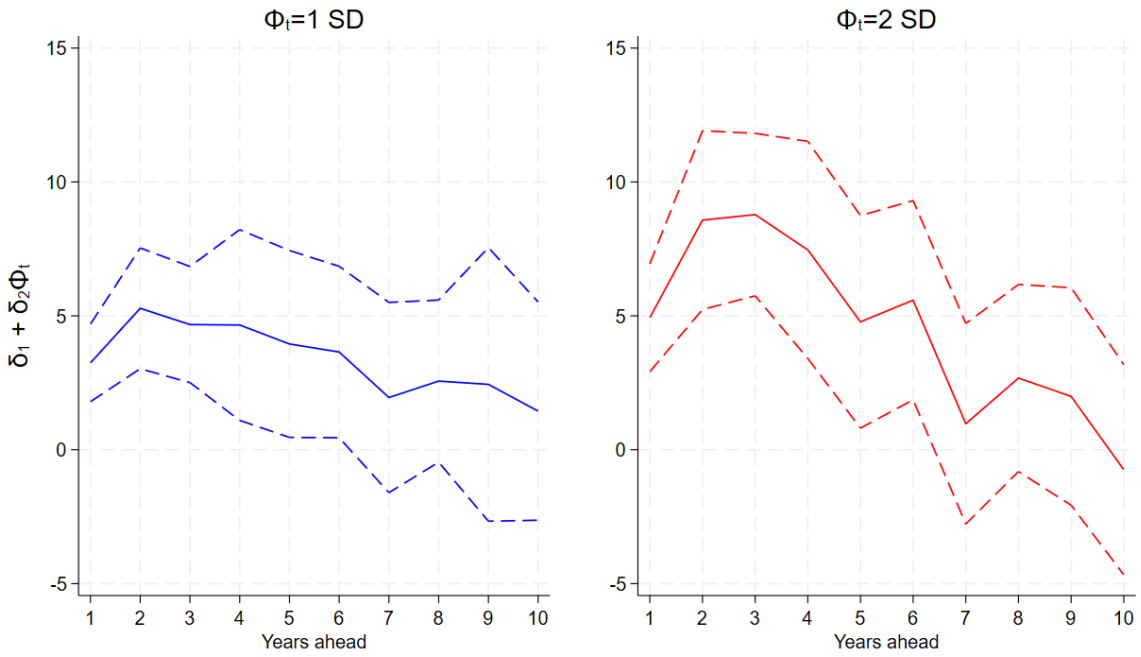
[5]Specifically, I estimate $\hat{\phi}_t$ using 1-year OIS rates before the ELB period and 1-year, 1-year ahead OIS rates thereafter. Results remain qualitatively robust when $\hat{\phi}_t$ is estimated using 1-year OIS rates for the entire sample period.

$$\Delta \mathbb{E}_t i_k = \delta_1 \mu_t + \delta_2 \hat{\phi}_t \times \mu_t + \delta_3 \hat{\phi}_t + \zeta_t, \tag{13}$$

where the coefficient δ_1 captures the impact of the monetary shock μ_t on the interest rate k-years ahead when $\hat{\phi}_t = 0$, while the coefficient δ_2 accounts for the different impact of the monetary shock when the perceived monetary policy rule is greater than zero. The total impact of a monetary shock is then given by $\delta_1 + \delta_2 \hat{\phi}_t$. Since I use 2-year rolling window estimates for ϕ, the sample starts in 2010 and ends in 2024.

The left panel of Figure 8 presents my baseline estimates of the total impact of a 10-basis point monetary shock on the term structure when $\hat{\phi}$ is equal to one standard deviation. Each estimate point in the figure comes from a separate OLS regression of the form discussed above–equation (13) The effect of a 10-basis point increase in interest rates is somewhat smaller for the 1-year, 1-year ahead rate, peaks at 5 basis points for the 1-year, 2-year ahead yield, and then gradually declines, becoming statistically insignificant for the 1-year, 7-year ahead yield. The right panel of Figure 8 reports the total impact of a 10-basis point monetary shock when the perceived coefficient is equal to two standard deviations. The effect of the shock is amplified, with an almost one-to-one increase in 1-year rates between 2- and 4-year ahead. The effect of the shock then falls sharply and monotonically at longer horizons, becoming statistically insignificant for maturities longer than 6 years ahead.

Figure 8: Term-structure response to 10-bp monetary policy shock



Notes: The dashed lines depict 95 percent confidence intervals using heteroskedasticity-robust standard errors.

Overall, a policy rate hike tends to raise the yield curve while flattening it, as short-term yields increase more than long-term ones. Additionally, Figure 8 indicates that a stronger perceived monetary policy response to inflation expectations reinforces the decoupling of short-term and long-term rates.

It is worth noticing that the transmission of monetary policy from short to long maturities operates not only through expectations of future rates but also via term premia. Nevertheless, the estimated effects are mostly concentrated at short horizons and weaken as maturities extend. This pattern runs counter to what one would anticipate if risk premia were the primary driver, as bond risk premia generally exhibit strong cross-maturity correlation and tend to rise with maturity (Cochrane and Piazzesi, 2005).

7 Conclusions

This paper provides a novel method to measure financial markets' perceived shifts in the systematic conduct of monetary policy using swap rates. Exploiting intraday variations

in inflation expectation revisions, I document three key findings in the euro area.

First, during the effective lower bound (ELB) period, market perceptions of the ECB's response to inflation news were comparable in magnitude to those in the pre-ELB period. Second, the response was perceived as weakest during the COVID crisis and strongest in the post-COVID recovery, marking the most significant variation since 2008. Third, these perceived responses influence the transmission of monetary policy shocks by amplifying short-term yield reactions and reinforcing yield curve flattening.

These findings highlight the role of market expectations in shaping interest rate dynamics and suggest that shifts in perceived policy responses can have significant macroeconomic implications. Future research could extend this framework to analyze how expectations evolve across different economic environments and how they interact with central bank communication strategies.

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Appendix

A.1 SUR Estimations

To account for potential correlation between the error terms η_t and ϵ_t in the system of equations (10), I estimate ϕ through SUR.

Table A1: Response of interest rates to the inflation news shock

	(1)	(2)
	1Y	1Y1Y
$\hat{\phi}$	1.872***	3.715***
	(0.517)	(1.173)
N	224	175

Heteroskedasticity-robust standard errors are in parentheses