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Monetary Policy Rules: the Market's View*

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Abstract

We study the market-perceived monetary policy rule of the Bank of England (BoE) using financial market data and macroeconomic surprises. Leveraging exogenous variations in inflation and industrial production (IP) surprises around Office for National Statistics releases, we estimate gilt yield responsiveness to inflation and real activity, revealing how markets expect the BoE to react to macroeconomic changes. Markets generally understand the UK flexible inflation-targeting regime, revising both inflation expectations and short-term rates upward after inflation surprises. We identify two key nonlinearities. First, perceived responsiveness changes over time, with short-term rates responding when away from their lower bound, and medium-term rates responding during periods of unconventional monetary policy. Second, financial markets expect a weaker response to inflation when it originates from supply shocks. This, however, does not translate into a risk of de-anchored expectations.

JEL Classification: C10, E50, E58, G10.
Keywords: Market Perceptions, Financial Markets' expectations, Inflation, Yields, Monetary Policy Rule.

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1 Introduction

The effectiveness of monetary policy transmission depends crucially on how financial markets interpret and respond to policy decisions (Woodford 2005). As monetary policy has become more systematic over time (Woodford 2005; Ramey 2016), understanding how markets anticipate policy responses to inflation and real activity has gained increasing importance.

In this paper, we assess the markets' perception of the systematic component of monetary policy and the extent to which this reflects developments in monetary policy design. Bandera, Barnes, Chavaz, Tenreyro, and vom dem Berge (2023) and Reichlin and Zettelmeyer (2024), among others, have recently reignited interest in whether central banks should respond differently to demand and supply shocks. The former argues that central banks should often "look through" supply shocks and not overly react to inflation fluctuations driven by temporary supply-side disturbances. Orphanides and Williams (2005), on the other hand, contend that monetary authorities must respond decisively to supply-driven inflation to prevent stagflation and deanchoring of inflation expectations. Exploiting surveys of market participants and asset prices, we investigate whether these perspectives are reflected by market participants' views of monetary policy.

To estimate the market-perceived policy rule of the Bank of England (BoE), we exploit exogenous variations in consumer price (CPI) inflation and industrial output/production (IP) generated by the Office for National Statistics (ONS) data releases. As a measure of the markets' expectations, we use data from Reuters Economic Poll, which provides predictions for inflation and industrial production ahead of their official releases. The surprises are then computed as the difference between the variables' realized and expected values. We then quantify the response of nominal interest rates at different maturities to inflation and IP surprises.

We make two main contributions. First, building on the recent macroeconomic literature (Hamilton, Pruitt, and Borger 2011; Bauer, Pflueger, and Sunderam 2024a; Bauer, Pflueger, and Sunderam 2024b; Cuciniello 2024), we assess whether UK financial markets expect the BoE to respond systematically to inflation and output variations; i.e., to follow a rule. We break this into three testable implications and confirm that: (i) markets anticipate nominal interest rates to respond systematically to inflation and IP surprises; (ii) their expectations align with theory, predicting a rate hike in response to positive inflation and output surprises; and (iii) they distinguish between conventional and unconventional monetary policy frameworks.[1] Overall, markets under-

[1] In the UK unconventional monetary policy primarily means Quantitative Easing (QE). Forward guidance has had a less prominent role, having been announced explicitly in August 2013, and negative rates were considered but never implemented. QE, on the other hand, has gone through several phases, starting in 2009.

stand how monetary policy operates and also how the BoE responds to price inflation and output fluctuations both in normal times and when short-term rates are at their Effective Lower Bound (ELB).

Our second contribution is to examine whether markets expect the BoE to respond differently to demand and supply disturbances and to explore if this affects the anchoring of inflation expectations. We propose a simple definition of demand and supply surprises, which follows the same logic as sign-restriction identification schemes in Vector Autoregressions (Uhlig 2005), but replaces the statistical, VAR-based, predictions with surveys of financial market operators.[2]

We find that UK financial market operators expect the BoE to respond less to inflation deviation from target when they are supply-driven; i.e., they anticipate BoE to partially look-through supply disturbances. Building on the theoretical insights of Orphanides and Williams (2005), we examine whether a more muted response to supply-driven inflation deviations from the target shifts medium-term inflation expectations, potentially signaling a risk to the de-anchoring of long-term expectations. Our findings reveal no evidence to support this conjecture.

In summary, UK financial markets demonstrate a strong understanding of the BoE's *flexible inflation-targeting mandate*. Market participants also appear to recognize that supply-side shocks create policy trade-offs, leading to expectations of a stronger BoE response to inflation deviations driven by demand shocks.

Literature review. The BoE has had a very clearly defined monetary policy objective for over 30 years, which we can consider the prototypical form of a flexible inflation-targeting regime. In theory, a central bank with a clear mandate could reap some of the benefits of commitment by sticking to a well-defined policy rule (Woodford 2005). In practice, even if a pre-defined rule could account for all possible contingencies, e.g., the COVID pandemic, following it mechanically would be advisable only in a world in which our understanding of the economy (our model) was unchanging (King 2005). In light of this, the monetary policy strategy of the BoE has been recently defined as "rule-based but not rule-bound" (Pill 2024).

This institutional setup makes it particularly interesting. The UK can be taken as a clear case-in-point for a systematic but evolving approach to policy (Woodford 2005; Ramey 2016). Moreover, we can leverage a liquid market for inflation swaps and timely Reuters Economic Poll surveys to capture financial-market participants' behavior. In this sense, our work relates to some recent papers that study inflation expectations and monetary policy in the UK. Bahaj, Czech, Ding, and Reis (2023) use

[2]Surveys of market participants are bound to contain more information than small VAR models and, most importantly, can more effectively adapt to the sudden changes in the economic landscape brought about by the pandemic.

transaction-level data on UK inflation swaps and find, among other things, that information diffuses quickly to inflation expectations. This is in line with our findings on the response of swap-based inflation expectations, and reassuring regarding the fact that the changes in interest rates we observe in the wake of inflation news indeed depend on the inflation news.

High-frequency monetary policy shocks have gained significant attention in recent years.[3] However, concerns have been raised about the relevance of these shocks (Ramey 2016; Bauer and Swanson 2023a). As monetary policy becomes increasingly systematic, genuine monetary policy shocks are likely to become smaller and potentially less frequent, making it more challenging to estimate their macroeconomic impact.

The macroeconomic responses estimated by Braun, Miranda-Agrippino, and Saha (2024) and Gerko and Rey (2017) for the UK are less precisely estimated compared to estimates using US data (Gertler and Karadi 2015; Miranda-Agrippino and Ricco 2021). One possible explanation is the clarity of the UK's monetary policy remit and the consistent implementation of its flexible inflation-targeting mandate. Notably, high-frequency monetary policy shocks stem from (i) monetary policy decisions, (ii) policy communication, and (iii) market perceptions of monetary policy conduct.

The transmission of monetary policy to financial markets depends critically on the markets' perceived monetary policy response function (Woodford 2005). To estimate it, we need variations in the arguments of a plausible monetary policy rule; i.e., inflation and some measure of real activity such as industrial production, that are exogenous to policy (Barnichon and Mesters 2020). Barnichon and Mesters (2020) use identified supply shocks as an exogenous driver of inflation and monetary policy rates. We follow a different empirical strategy which does not require taking a stand on a particular shock. Rather, it exploits the timing of the inflation and industrial production statistical releases by the ONS.

We contribute to the growing literature that estimates monetary policy rules using financial market data (Hamilton, Pruitt, and Borger 2011; Bauer, Pflueger, and Sunderam 2024b; Bauer, Pflueger, and Sunderam 2024a; Cuciniello 2024) and macroeconomic news or surprises derived from surveys of financial market participants (Gürkaynak, Sack, and Swanson 2005). Building on this research, we leverage the timing of ONS releases to identify exogenous variations in inflation and IP.

As discussed above, while monetary policy in the UK is guided by some regularities, these rules are bound to change over time, if anything because our understanding of economics change. This means that competent financial market operators can plau-

[3]With studies focusing on the US (Kuttner 2001; Gertler and Karadi 2015; Miranda-Agrippino and Ricco 2021), the Euro Area (Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa 2019; Jarociński and Karadi 2020, which also includes the US), and the UK (Gerko and Rey 2017; Cesa-Bianchi, Thwaites, and Vicondoa 2020; Braun, Miranda-Agrippino, and Saha 2024).

sibly infer the systematic responses of monetary policy to macroeconomic news, and yet their learning effort can be described as perpetual, in the sense of Orphanides and Williams (2005).[4]

This implies that nonlinearities and time variation are inherent features of the perceived policy rule. These characteristics are crucial because markets interpret monetary policy announcements as reflecting, in part, a systematic but imperfectly known monetary policy response function (Bauer and Swanson 2023b); in part, a macroeconomic outlook by policymakers that differs from that of the private sector (Nakamura and Steinsson 2018); and in part, a genuine monetary policy shock.

In our analysis, we examine two specific forms of nonlinearity. First, we explore whether the sensitivity of short-term interest rates to macroeconomic surprises has evolved over time. Our findings reveal a significant increase in responsiveness in the UK during 2022–2024 compared to the period when rates were at the Effective Lower Bound. This result aligns with those of Bauer, Pflueger, and Sunderam (2024a) for the United States and Cuciniello (2024) for the Euro Area. Similarly, Cieslak, Mcmahon, and Pang (2024) document heightened sensitivity of Treasury yields to core CPI news following the liftoff in March 2022.

Our findings also relate to but differ from, those of Swanson and Williams (2014), who show that 1-year yields in the U.S. similarly responded to news both at the Zero Lower Bound and when rates were above it. In contrast, our estimates suggest that in the UK, short-term yields were considerably less responsive at the ELB, highlighting a potentially distinct dynamic in the UK monetary policy environment. We further contribute to the literature by extending the analysis to medium- and long-term interest rates. Our results show that while short-term rates cease to respond to the news at the ELB, long-term rates become increasingly responsive, consistent with the expected effects of unconventional monetary policy interventions.

The second departure from a standard policy rule we consider assesses if the systematic response of monetary policy varies depending on the nature of the economic disturbance. More specifically, we test whether markets expect the BoE to respond on average differently to demand versus supply shocks. To address this, we introduce a novel classification of macroeconomic surprises, drawing inspiration from the sign-restriction identification approach commonly used in VAR analyses (Uhlig 2005). A demand surprise is identified when inflation and real activity data releases lead to unexpected market movements in the same direction. Conversely, a supply surprise is classified when inflation and industrial output surprises exhibit opposite signs within a given period.

The key distinction between supply and demand surprises is that the former pose

[4]For example, it would have been hard to infer how BoE could deploy unconventional monetary policy interventions prior to 2008.

a policy trade-off whilst the latter do not. An inflationary supply shock would call for an increase in rates to bring inflation back to target, but a cut in rates to stabilize output. Our estimates suggest that markets perceive BoE to respond to inflation more strongly when they result from a demand surprise. Therefore, markets expect the BoE to, at least partially, look through supply shocks. According to Orphanides and Williams (2005), the more modest response to supply-driven inflation increases the risk of stagflation and de-anchoring of medium-term inflation expectations. However, when we test for de-anchoring, we find no evidence of it.

The rest of the paper is organized as follows. In Section 2 we list the data used in our analysis. Section 3 describes the empirical specification and reports the main results. Section 4 concludes.

2 Data

In order to characterize the monetary policy rule perceived by financial market participants, we combine two sets of high-frequency (daily) data. First, we use data on government bond yields and swap-based inflation expectations. To that, we add official data releases by the ONS and financial-market participant surprises or news, which exploits the Reuters Economic Poll survey of financial operators to assess to which extent data releases represent a surprise to markets.

Our daily sample covers the period from April 2005 to September 2024. This period is characterized by significant uncertainty arising from both global and country-specific developments. The analysis covers major events such as the global financial crisis, the COVID-19 pandemic, and the Russian invasion of Ukraine. It includes an extended phase of low and stable inflation, as well as a dramatic shift to double digit price inflation. The latter part of the sample is also characterized by major changes in the trade relationship with the European Union, encapsulating developments that are more specific to the UK. The sample period captures significant fluctuations in bank rates, including a prolonged phase where the policy rate remained near or at its Effective Lower Bound (ELB) and monetary policy used unconventional tools such as QE (Busetto et al. 2022). It also covers the subsequent shift back to conventional policy and the move toward policy normalization later in the period.

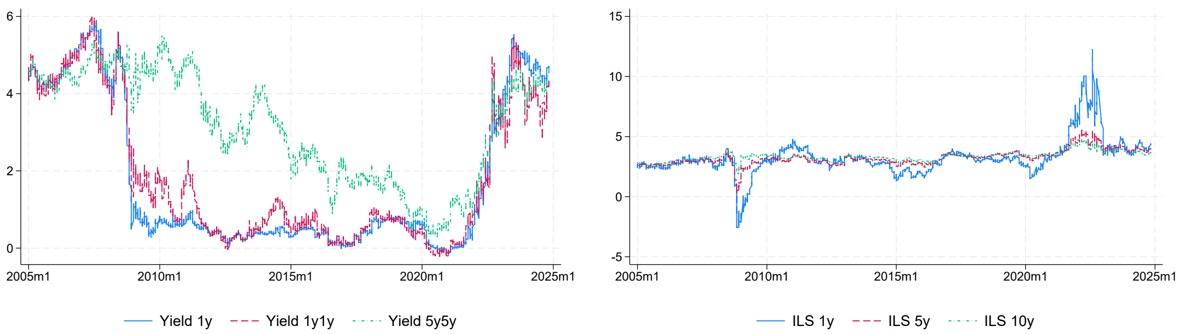
Prices and yields. We measure UK nominal interest rates with gilt yields at different horizons. Panel A of Figure 1 plots daily observations for the 1-year horizon, the 1-year 1-year-ahead horizon and the 5-year 5-year-ahead horizon gilt yields. It is worth noting that while rates have been low and constant for long spells in the aftermath of the Great Recession, they never quite hit the Zero Lower Bound. Rather, we could consider the policy rate to have been at an Effective Lower Bound; i.e., at a level which allowed limited but non-zero scope for further rate cuts (Masolo and Winant 2019). This is important because short-term rates retained a degree of variability even in the 2010s. Moreover, our empirical analysis will show that during the ELB period, financial markets expected the monetary policy to primarily influence medium-term rates, mainly through the implementation of QE.

Panel B of Figure 1 reports our preferred measure of market-based inflation expectations: RPI zero-coupon inflation swaps. RPI is short for Retail Price Index, which has long been a popular measure of inflation in the UK - the Bank of England's inflation target was defined in terms of RPI excluding mortgage payments from 1997 to 2003. To this day, inflation swaps are based on RPI inflation (Bahaj, Czech, Ding, and Reis 2023). RPI inflation is generally higher than CPI inflation, by a factor of about .8 percent (Hurd and Relleen 2006). However, at high frequency, it comoves strongly, if not perfectly, with CPI inflation. The figure shows that the swap-based inflation expectations measure is generally higher than the 2-percent inflation target, which is defined in terms of CPI inflation. Break-even inflation expectations are more volatile at shorter horizons (ILS 1y), whereas they are much more stable at longer horizons (ILS 10y), suggesting that they are very well anchored.

Figure 1: Time series of the financial variables

Panel A: Gilt yields

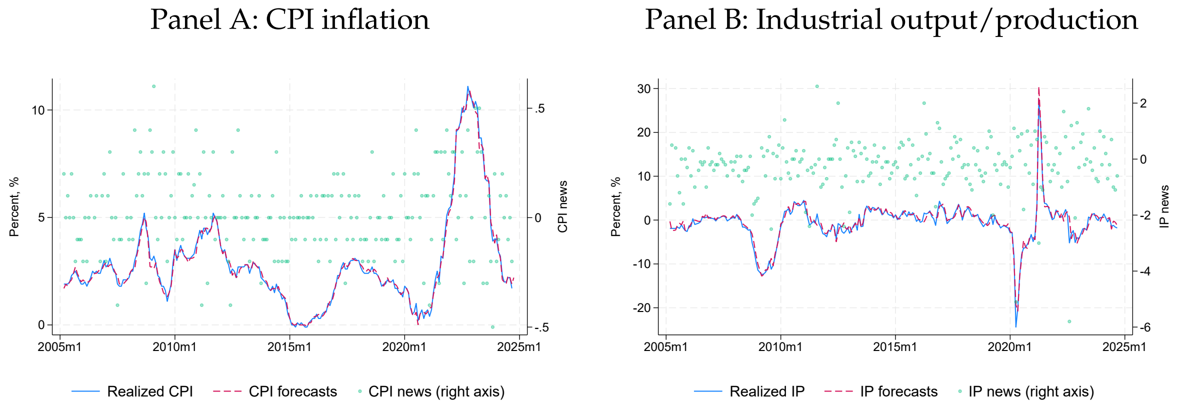
Panel B: Inflation-linked swaps



Notes: Panel A plots the gilt yields at different horizons over time. Panel B reports the inflation-linked swaps across different horizons. The vertical axis are in annual percentage points.

Survey-based news. Reuters Economic Polls constantly surveys financial market forecasters. The Reuters Poll consensus forecasts for the upcoming release of CPI inflation and Industrial Output/Production capture market-participant expectations in the run-up to the data release by statistical agencies. Up to around the outset of the COVID pandemic, actual CPI inflation hovered around the 2% inflation target. The UK economy then witnessed an inflation surge that started in the second half of 2021.

Figure 2: Time series of the Reuters Poll consensus forecasts for CPI inflation and IP, their realized values and the news surprises



Notes: Panel A plots the Reuters Poll consensus forecasts for CPI inflation (red dashed line) and the realized values (blue solid line). The green dots (right axis) are the news surprises defined as the difference between the realized and forecasted CPI inflation. Panel B reports the same variables for industrial production. The data are downloaded from Thomson Reuters.

Figure 2 reports the actual (year-on-year) CPI inflation in panel A and IP in panel B (blue lines) alongside the corresponding Reuters Poll consensus forecast (red dashed lines). As measures of exogenous changes in CPI inflation and IP, we define the news surprises. These are the forecast errors professional forecasters make; the difference between the blue and red line captures the extent to which the release of official inflation (and IP) figures surprised markets. The surprises (displayed by green dots) are reported on the right axis of Figure 2.[5] The forecasts are on average extremely accurate and timely. Moreover, the sample contains a mix of both negative and positive surprises, indicating that analysts do not consistently overestimate or underestimate forecasts. Therefore, the forecast errors can be considered as exogenous and unpredictable surprises about the state of the economy.

3 Empirical analysis

3.1 Policy rule specification

We now describe how we estimate the market-perceived monetary policy rules. The main identification strategy is as follows: each month, the ONS publishes the actual values for the CPI inflation and IP for the UK. As these release dates do not coincide with monetary policy announcements from the Bank of England, any adjustments in

[5]The effects of macroeconomic data releases on financial variables have been studies by, among others, Hamilton, Pruitt, and Borger (2011), Boehm and Kroner (2023) Bauer and Swanson (2023b) and Cuciniello (2024).

the gilt yields around these releases are unrelated to monetary policy decisions, but they reflect how the markets expect the monetary authority would respond to them.

Starting from the simple monetary policy rule:

$$i_t = r_t^* + \pi_t^* + \phi_t^x x_t + \phi_t^\pi (\pi_t - \pi_t^*) + \epsilon_t, \tag{1}$$

where i_t is the nominal interest rate set by the central bank, x_t is a measure of the real economy, i.e., the output gap, and π_t the inflation rate. The coefficients ϕ_t^x and ϕ_t^π capture the monetary policy response to the inflation gap and the output gap. r_t^* and π_t^* represent the expected long-run values for the real interest rate and inflation. ϵ_t is an exogenous monetary policy shock. This policy rule specification has been standard in the macroeconomic literature since Taylor (1993) and Taylor (1999).

Our focus is the estimation of the coefficients ϕ_t^x and ϕ_t^π which we allow to vary over time. Estimating these coefficients has been a challenge for researchers for decades.[6] Simple time series regressions of the variable would lead to bias estimates due to endogeneity. Indeed, i_t, x_t and π_t are simultaneously determined as the central banks set their policy rate in response to the state of the economy and, at the same time, the economy adjusts in response to the policy rate level.

To recover the market perceptions about the policy rule, we estimate the *perceived* coefficients $\hat{\phi}_t^x$ and $\hat{\phi}_t^\pi$ by regressing the gilt yields at different horizons on the CPI inflation and IP surprises in a few days' window around the data releases.[7] The surprises allow us to overcome the endogeneity problem as (i) they do not coincide with monetary policy announcements from the BoE, so any change in the yields around these releases is unrelated to monetary policy decisions; (ii) analysts' forecast errors are exogenous and unpredictable surprises regarding the state of the economy, to which financial markets respond. We explicitly test this second assumption in the next section.

The empirical counterpart of equation (1) is then:

$$i_{t+h,t+k|t} = \alpha + m_t + \gamma D_t^\pi + \omega D_t^{IP} + \hat{\phi}_t^\pi D_t^\pi Surprise_t^\pi + \hat{\phi}_t^x D_t^{IP} Surprise_t^{IP} + \epsilon_{t+h,t+k|t}, \tag{2}$$

where $i_{t+h,t+k|t}$ is the gilt yield at time t at horizon h to k. Our baseline estimation considers $h = 1$ and $k = 2$ years, so on the left-hand side we have the one-year, one-year forward (1y1y) gilt yield. D_t^π is a dummy variable that takes the value 1 in the days after the CPI inflation release and 0 otherwise, whereas D_t^{IP} takes value 1 after the IP release and 0 otherwise. We refer to these variables as $Dummy\ ONS$. We consider

[6]See, among others, Taylor (1993), Clarida, Gali, and Gertler (2000), Clarida, Gali, and Gertler (1998), Kim and Nelson (2006), Orphanides (2003), Orphanides (2001).

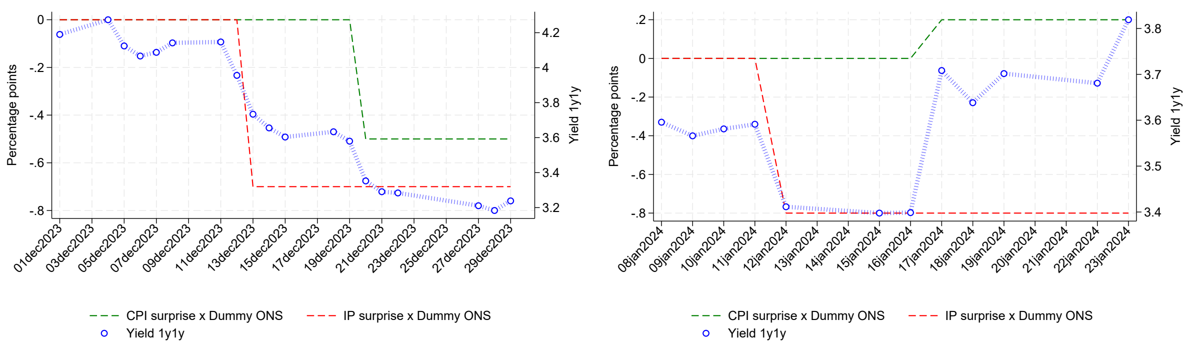
[7]Nunes, Ozdagli, and Tang (2023) adopts a similar approach to disentangle pure monetary policy shocks and information shocks for the US.

a symmetric window of 5 days but, as we show in Section 3.3, our results are robust to window selection. $Surprise_t^{\pi}$ and $Surprise_t^{IP}$ are the CPI inflation and IP surprises from Reuters Economic Poll. m_t are the time-fixed effects, which absorb any variable constant within each time window, like the long-run real interest rate or the inflation target. The coefficients of interest are $\hat{\phi}_t^{x}$ and $\hat{\phi}_t^{\pi}$, which capture how the gilt yields are adjusted in response to exogenous changes in CPI inflation and IP, thus reflecting how financial markets perceive the Bank of England's policy rule.

This specification is close to that in Cuciniello (2024) who estimates the market-perceived European Central Bank's policy rule. Empirical policy rule specifications typically include the lag of the policy rate as a measure of policy gradualism and as a way to capture the high persistence of nominal rates. In our specification, i_{t-1} is absorbed by the time fixed effect. As our left-hand side variable is an expected rate at a horizon of one year or more, though, it is possible that that the gradual adjustment of rates is not fully captured by past interest rates. Rather, it could depend on expected nominal rates at horizon below one year. This rate could very well respond to our surprises, which cannot be fully captured by our month fixed effect. For the sake of robustness, then, we follow Cuciniello (2024) and also estimate a specification which includes the 1-year horizon gilt yield as a control.

Figure 3: Daily time series of the surprises and 1-year 1-year-ahead horizon gilt yields

Panel A: December 2023 Panel B: January 2024



Notes: Panel A plots the day-by-day series of the CPI inflation and IP surprises alongside (left axis) the 1-year 1-year-ahead horizon gilt yields for December 2023 (right axis). Panel B reports the same series for January 2024.

Figure 3 illustrates our empirical strategy through a graphical representation. The plots depict the daily time series of CPI inflation and IP surprises alongside the 1-year, 1-year-ahead horizon gilt yields for December 2023 (Panel A) and January 2024 (Panel B). In December, the 1y1y yield remained stable throughout the early part of the month until the release of the IP data on December 13th. Analysts had underestimated IP growth, resulting in a substantial negative forecast error of 0.7 percentage points. Financial markets reacted swiftly to this information, with the yield dropping immediately and stabilizing at the new level until the release of CPI inflation data on December 20th. The CPI surprise also presented a negative forecast error of 0.5 percentage points, triggering a further decline in the yield.

We observe a similar pattern in January 2024, which features a negative IP surprise followed by a positive CPI inflation surprise. Markets exhibited the expected responses: a decline in the yield following the negative IP forecast error, and a notable increase after the positive CPI inflation surprise.

In our empirical strategy, we leverage yield variations around the timing of macroeconomic data releases. By comparing yield levels a few days before the releases to those observed a few days afterward, we estimate the responsiveness of yields to exogenous changes in inflation and economic growth. This approach allows us to isolate the impact of surprises in these variables on financial market expectations.

3.2 Surprises and financial variables

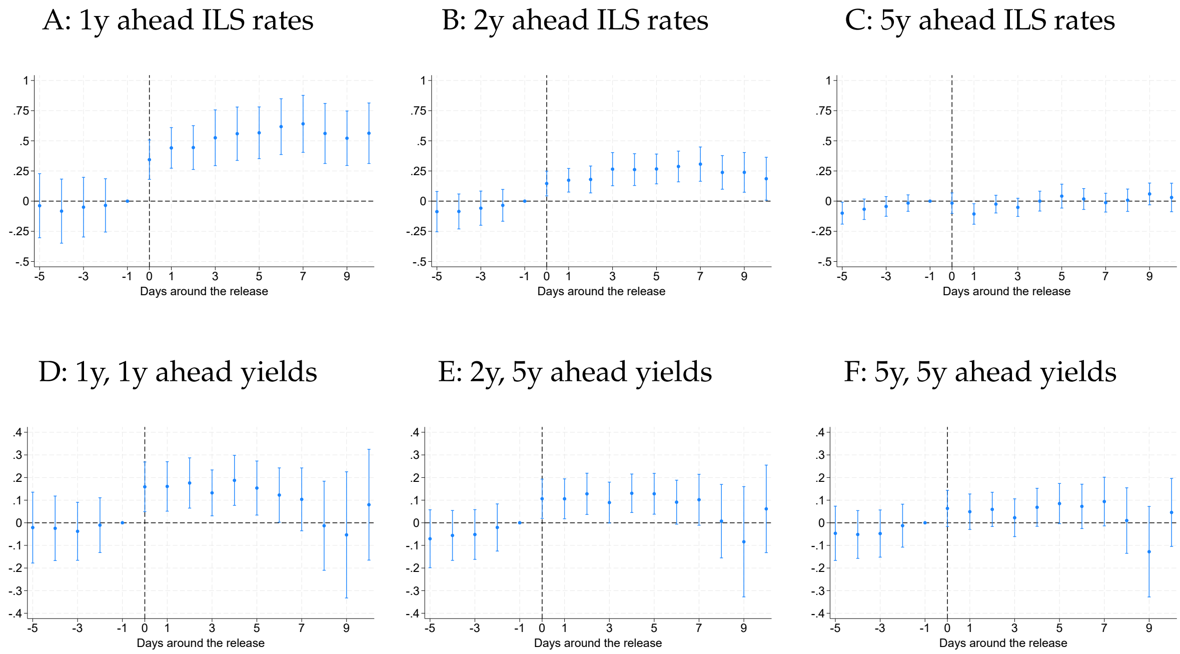
Before estimating the market-perceived policy rule, we evaluate whether financial markets respond to the surprises. We do so by slightly modifying the baseline equation (2). Instead of the dummy D_t, which is equal to 1 in the days after the release and 0 otherwise, we interact the surprises with a series of dummies equal 1 for each day before/after the release from 5 days before to 10 days after and 0 otherwise. The day before the release is used as baseline. Moreover, we estimate the effects for the CPI inflation and the IP releases separately as the ONS publishes these two statistics usually not on the same day – we observe 0 to 9 day difference in the data releases in our sample with an average of 3.8 days. As dependent variables we use the inflation-linked swaps (ILS) at different horizons as measure of the market's inflation expectations and the gilt yields at different maturities.[8]

The top rows of Figure 4 report the responses of the inflation-linked swaps to the CPI surprises on a day-to-day basis around the CPI releases. The effect on the 1-year ahead ILS (Panel A) is strong and immediate: Following a 1 percentage point CPI surprises, the swap increases by 0.5 percentage points. The effect is persistent throughout the window considered. The fact that markets adjust immediately in response to the ONS publication is not surprising as the release happens at 7 am. Therefore, the day of the release the markets are able to fully incorporate this information. Given the timing of the announcement, the use of intraday data would not improve our identifications.

Importantly, the plot also illustrates that prior to the release there is no detectable

[8]The timing of the surprises requires adjustments due to reporting lags. CPI inflation is reported with a one-month lag, IP with a two-month lag.

Figure 4: Event study of the effects of CPI surprises on financial variables



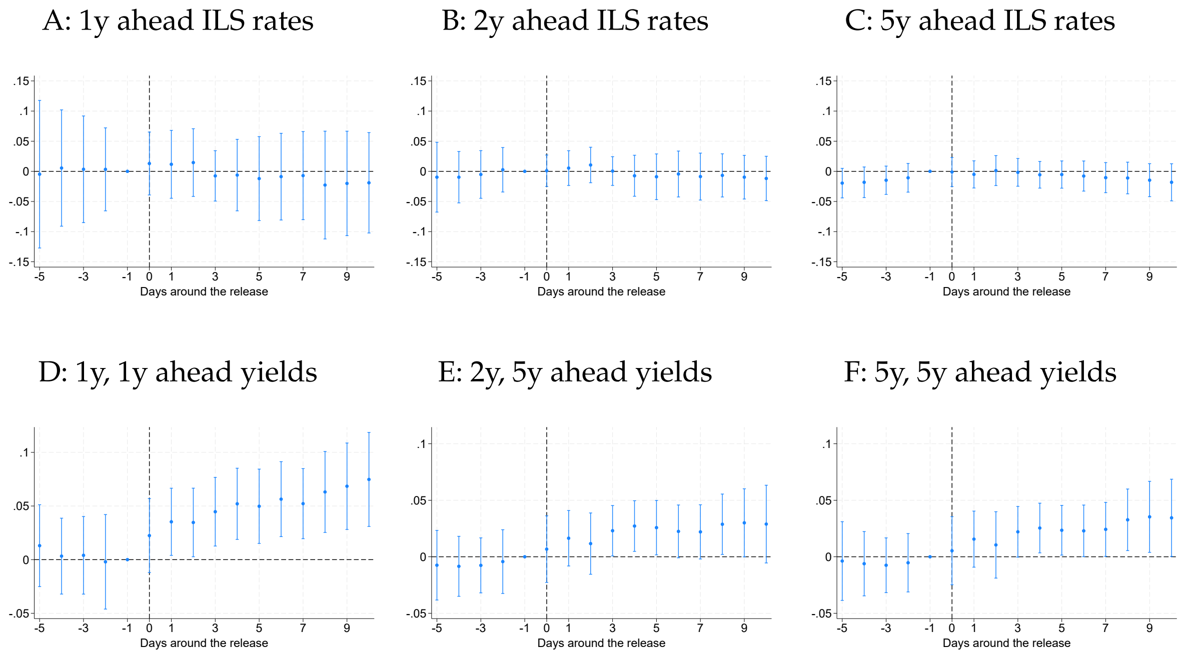
Notes: The figure reports the estimated effects of a CPI surprise on financial variables. The coefficients are obtained by interacting the surprises with a series of dummies equal 1 for each day before/after the CPI inflation release from 5 days before to 10 days after and 0 otherwise. The day before the release is used as baseline. The dependent variables are the inflation-linked swap (top rows) and the gilt yields (bottom rows) at different maturities.

pre-trend; i.e., the Reuters Poll surprises are not predicted by markets. Panel B of Figure 4 shows that the response of the two-year ahead inflation expectations is significant but about half the size of the response of the one-year expectation. Finally, Panel C shows that inflation expectations at the five-to-ten year horizon do not respond. Taken together, this set of regressions tells us that: (i) Reuters Poll surprises are indeed a good proxy for market-participant surprises as they are not predictable; (ii) they cause a revision in short- and medium-term inflation expectations; (iii) they reveal that markets expect any inflation variations to be reined in, which is consistent with the idea that long-term expectations are well anchored.

The bottom rows of Figure 4 report the results using the gilt yields at different horizons as dependent variables. The short-term rates respond significantly to inflation surprises. That is not the case for medium to long-term rates – We will show below how the focus shifts when we examine the lower-bound period, during which monetary policy relied primarily on unconventional tools, such as Quantitative Easing. These findings confirm that financial markets strongly respond to CPI releases. Moreover, the positive response of the short-term yields, despite the fact that no monetary policy decision is taken on the days of the releases, suggests that the markets expect the central bank to respond to a positive shock to inflation by raising rates.

The day-by-day estimation illustrates an important difference between the response of inflation expectations and yields. The latter remains significant for about a week, that is to say, for a shorter period than inflation expectations. We read this as suggesting that inflation expectations are primarily impacted by inflation news, while gilt yields respond to other sources of news, like real-economy news and monetary policy announcements.

Figure 5: Event study of the effects of IP surprises on financial variables



Notes: The figure reports the estimated effects of a IP surprise on financial variables. The coefficients are obtained by interacting the surprises with a series of dummies equal 1 for each day before/after the IP inflation release from 5 days before to 10 days after and 0 otherwise. The day before the release is used as baseline. The dependent variables are the inflation-linked swap (top rows) and the gilt yields (bottom rows) at different maturities.

In Figure 5 we replicate the same analysis focusing on the effects of the IP surprises on financial variables. Inflation expectations are found to not respond to IP surprises. However, short-term rates do, confirming that markets expect an increase in the policy rate by the central bank in response to a positive economic shock. The magnitude of the response is smaller compared to that following a CPI response.

Overall, the empirical findings so far provided corroborate the validity of the surprises as exogeneous measures of a change in inflation and industrial production. The financial markets do not anticipate the surprises and strongly respond to them. Moreover, the gilt yields' size and relative magnitude of the responses are in line with the predictions from the theoretical literature.

Table 1: Market-perceived Taylor rules in the UK

	(1) ILS 1y	(2) Yield 1y1y	(3) Yield 1y1y	(4) Yield 1y1y	(5) Yield 1y1y	(6) Yield 1y1y	(7) Yield 1y1y
CPI surprise x Dummy ONS	0.520***	0.182***		0.187***	0.109***	0.226***	0.149***
	(0.0486)	(0.0257)		(0.0262)	(0.0197)	(0.0375)	(0.0272)
IP surprise x Dummy ONS			0.0349***	0.0343***	0.0238***	0.0538***	0.0266***
			(0.00614)	(0.00951)	(0.00740)	(0.00799)	(0.00473)
Yield 1y					0.837***		0.912***
					(0.0554)		(0.0441)
Constant	3.218***	1.749***	1.729***	1.722***	0.358***	1.722***	0.242***
	(0.00509)	(0.00304)	(0.00323)	(0.00750)	(0.0911)	(0.00411)	(0.0714)
Observations	2506	2506	2377	2451	2451	2571	2571
Month FE	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The Table reports regression results for the 1-year inflation linked swap and the 1-year, 1-year-ahead horizon yields on the CPI inflation and IP news surprises within a 5-day window around the CPI inflation release. The CPI inflation surprises and IP surprises, obtained from Thomsom Reuters, are measured as the difference the professional forecasters' expectations and the actual release. Further controls included (discussed in the main text, not shown). The analysis is performed using data for the period 2005M4:2024M9. Robust standard errors are displayed in parentheses.

3.3 Perceived monetary policy rule

Having established the validity of the surprises, we now turn to estimating the market-perceived monetary policy rule. We compute the financial markets' responses to the CPI inflation and IP surprises around the CPI releases by estimating equation (2).

The first column of Table 1 reports the effect of a one percentage point inflation surprise on the 1-year ahead inflation-linked swap. The surprise causes an increase in the one-year inflation expectations of about half a percent, with month fixed-effects capturing any underlying changes in the macroeconomic landscape. This is in line with the findings from Figure 4. The result is consistent with the evidence provided by Bauer and Swanson (2023b), who find that forecasters revise their expectations upon the release of headline macroeconomic series.

Columns (2) to (7) of Table 1 report the results using the 1y1y yield as dependent variable. Column (2) is the baseline specification considering only the CPI surprises. The coefficient of the interaction between the CPI surprise and the $Dummy\ ONS$ provides an estimate of the market-perceived responsiveness of the Bank of England to an inflationary shock; i.e., $\hat{\phi}^{\pi}$. The financial markets expect the monetary authority to strongly respond to an increase in inflation by rising the policy rate. Column (3) considers a 5-day window around the IP releases proving an estimate of the market-perceived responsiveness to an economic shock; i.e., $\hat{\phi}^{x}$.

In Column (4) we jointly control for the CPI inflation and IP surprises. This specification provides an estimate of both $\hat{\phi}^{\pi}$ and $\hat{\phi}^{x}$. In line with economic theory, both

Table 2: Market-perceived Taylor rules, different window sizes

	(1) Window: 9 days	(2) Window: 7 days	(3) Window: 5 days	(4) Window: 3 days	(5) Window: 1 day
CPI surprise x Dummy ONS	0.164***	0.185***	0.187***	0.182***	0.163***
	(0.0289)	(0.0269)	(0.0262)	(0.0262)	(0.0361)
IP surprise x Dummy ONS	0.0557***	0.0554***	0.0343***	0.0334***	-0.411*
	(0.00856)	(0.0126)	(0.00951)	(0.0112)	(0.236)
Constant	1.742***	1.738***	1.722***	1.727***	1.285***
	(0.00499)	(0.00618)	(0.00750)	(0.00970)	(0.214)
Observations	4013	3315	2451	1566	678
Month FE	YES	YES	YES	YES	YES

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The Table reports regression results for the 1-year, 1-year-ahead horizon yields on the CPI inflation and IP news surprises. The size of the window considered around the CPI inflation release ranges from 9 to 1 day. The CPI inflation surprises and IP surprises, obtained from Thomsom Reuters, are measured as the difference the professional forecasters' expectations and the actual release. Further controls included (discussed in the main text, not shown). The analysis is performed using data for the period 2005M4:2024M9. Robust standard errors are displayed in parentheses.

coefficients are positive and significant. At the same time, the first coefficient is much larger than the second suggesting that markets correctly understand that the mandate of the Bank of England aims, first of all, at achieving price stability and, secondly, at supporting economic growth and employment.

Column (5) presents the estimates of equation (2), controlling for daily fluctuations in the one-year yield, which accounts for potential inertia in the policy rule. While the coefficients are slightly smaller in magnitude, their signs and estimation precision remain unaffected.

As previously noted, the CPI inflation and IP releases are not published on the same day, with a lag ranging from 0 to 9 days. This raises a potential concern in the baseline specification: more days may be "treated" by the release that occurs first compared to the second. To address this, Columns (6) and (7) of Table 1 presents coefficients estimated after excluding the days between the two releases, both with and without the 1-year yield as a control. In this specification, the $Dummy\ ONS$ variable is set to 0 for the 5 days preceding the first release and to 1 for the 5 days following the second release. This specification confirms that our main results are robust to this.

A potentially important driver of our findings is the "estimation window", i.e., how many days we consider before and after the surprises. A shorter window limits the possibility that other concurring news may muddle our results. At the same time, it reduces the number of observations. Figures 4 and 5 suggest that our findings are robust to varying the window size. Table 2 shows this more formally. We consider window sizes ranging from 1 to 9 days. The estimated coefficients are remarkably similar confirming that the size of the window considered has very little effect on the results. For CPI we hardly observe any change. For IP, the primary effect is on the precision of the estimate: the standard deviation of our coefficient of interest when we consider a one-day window is some 25 times larger than in our five-day baseline.

The results thus far, showing greater sensitivity of the 1y1y forward yield to CPI surprises, suggest that markets likely perceive the BoE as primarily focused on its inflation mandate. Following an exogenous CPI surprise, short-term yields respond immediately with effects lasting for several days after the release. The strong reaction to CPI surprises indicates that short-term inflation deviations have a significant impact on expectations about the BoE's policy trajectory, consistent with its mandate. The reaction to IP surprises is smaller, but its statistical significance highlights that markets recognize the BoE's dual mandate.

We strive to isolate exogenous surprises to estimate our coefficients of interest. Yet, there are three possible sources of bias. First, Clarida, Galí, and Gertler (2000) discuss how estimating a policy rule over periods of limited inflation variability can be problematic. Our approach, which relies on daily market responses, as opposed to pure time-series surprises, should be less prone to this. The first part of our sample may be less informative than recent years. Second, almost half of our sample spans a period in which short-term rate variability was curtailed by the lower bound. Third, our baseline estimates do not accommodate different responses to different disturbances.

We address the first two concerns by splitting our sample in three parts, which we discuss in the next paragraph. We then explicitly allow for the possibility that markets price different responses of the BoE to demand and supply surprises.

3.4 Conventional and unconventional policy

Monetary policy rates have been at what we can consider their Effective Lower Bound (ELB) between 2009 and 2019. This implies that our full-sample estimate of the short-term rate response to inflation surprises is probably biased downward. Moreover, our estimation fails to capture the unconventional monetary policy measures adopted by the Bank of England in the aftermath of the Great Recession.

Table 3 reports our estimation results when we split the sample in a pre-2009 period, the 2009-2019 period (when the policy rate was close to the ELB), and 2022 onwards. We omit the COVID period, as a way to show that our results are not driven by that most unusual set of observations. We estimate our baseline specification with the 1y1y yield (columns (1) through (3)) and the 5y5y yield (columns (4) through (6)) as dependent variables.

Estimates for inflation are precisely estimated, despite a drop in the number of observations in each subsample. Away from ELB, markets expect the BoE to strongly respond to an unexpected increase in inflation by raising short-term rates. The magnitude of the coefficient during the ELB period is around one tenth of the magnitude in

Table 3: Time-varying market-perceived Taylor rules

	(1) Yield 1y1y 2005m4-2008m12	(2) Yield 1y1y 2009m1-2019m12	(3) Yield 1y1y 2022m1-2024m9	(4) Yield 5y5y 2005m4-2008m12	(5) Yield 5y5y 2009m1-2019m12	(6) Yield 5y5y 2022m1-2024m9
CPI surprise x Dummy ONS	0.323***	0.0451*	0.433***	0.0607	0.123***	0.103**
	(0.0839)	(0.0243)	(0.0721)	(0.0445)	(0.0335)	(0.0491)
IP surprise x Dummy ONS	0.0501	0.0226***	0.0894***	0.0161	0.0311**	0.0283
	(0.0647)	(0.00806)	(0.0271)	(0.0419)	(0.0157)	(0.0212)
Constant	4.575***	0.745***	3.251***	4.576***	2.923***	3.449***
	(0.0260)	(0.00566)	(0.0235)	(0.0201)	(0.00412)	(0.0190)
Observations	434	1421	356	434	1421	356
Month FE	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The Table reports regression results for the 1-year, 1-year-ahead horizon and the 5-year, 5-year-ahead horizon yields on the CPI inflation and IP surprises within a 5-day window around the CPI inflation release considering different time periods. The CPI inflation surprises and IP surprises, obtained from Thomsom Reuters, are measured as the difference the professional forecasters' expectations and the actual release. Further controls included (discussed in the main text, not shown). The analysis is performed using data for the period 2005M4:2024M9. Robust standard errors are displayed in parentheses.

the recent period. The significant increase in responsiveness in the most recent years is in line with the findings from Cuciniello (2024) for the Euro Area and Bauer, Pflueger, and Sunderam (2024a) for the U.S.

Medium-to-long term rates are basically unresponsive pre-2009 and after 2022. However, during the ELB period, markets anticipated the yields at the five-to-ten year horizon to be steered by the BoE in response to inflation developments. This is in line with the way QE was expected to work. An intended goal of QE was to lower medium-term rates by boosting prices as the Bank of England bought medium-term bonds in exchange for short-term government debt.

The increased sensitivity to CPI surprises during 2022–2024 suggests that markets believe the Bank of England adopts a more aggressive stance on inflation control during periods of elevated inflation. This is consistent with theoretical Taylor rules, where central banks prioritize inflation over output when inflation is significantly above target. Markets perceive the BoE as highly responsive to inflation risks in high-inflation regimes, reinforcing the view that maintaining credibility around the inflation target is critical.

The coefficient estimates in the pre-2009 sample is somewhat smaller but still almost twice as large that estimated over the entire sample, despite the more modest variation in inflation. This suggests that our estimation approach is less prone to the effects discussed by Clarida, Galí, and Gertler (2000).

The findings point to a nonlinear perceived reaction function, where the weight on inflation deviations increases in high-inflation periods. Markets expect a more aggressive response to inflationary pressures when inflation is above a certain threshold. Moreover, a more pronounced market reaction to inflation news during high-inflation periods suggests that financial markets act as a stronger conduit for monetary policy expectations. Changes in market rates are likely to be passed through more directly to broader financial conditions, such as lending rates or corporate bond yields. The results highlight the importance of central bank communication during high-inflation periods. Clear and consistent communication can help stabilize market expectations and reduce excessive volatility in forward rates driven by inflation news.

3.5 Demand vs supply news surprises

Demand shocks are comparatively easy to deal with for monetary policy. A positive demand shock will cause both inflation and output to rise. Monetary policy, by raising interest rates, can effectively return both towards their target/natural level. Supply shocks, on the other hand, pose a trade-off to the policymaker: they drive inflation and real activity in opposite directions.

The timing of the CPI inflation and IP releases allows us to distinguish demand and supply surprises, in a way that parallels demand and supply shock identification by sign restrictions in VARs (Uhlig 2005). Each month, market participants observe the CPI and the IP releases a few days apart. The two surprises can differ in magnitude but most importantly in sign.

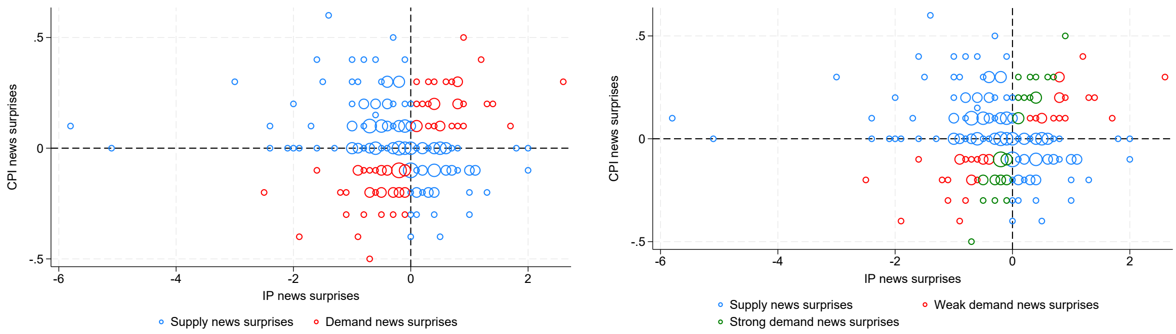
In Panel A of Figure 6 we show the scatter plot of all the combinations of CPI inflation and IP surprises for each month in our sample: there is significant heterogeneity in the combined sign and size of the releases. We classify a month as having a demand-news surprise if the CPI and IP surprises have the same sign, i.e., either both positive or both negative. In Figure 3 we provide an example of a month characterized by a demand surprises (Panel A) and a month characterized by a supply surprise (Panel B).

Panel A of Figure 6 reports demand surprises in red and supply surprises in blue – the size of the circle captures the frequency of the surprise as, due to rounding, some values recur. In keeping with the VAR literature, we can think of demand and supply surprises as "set identified" shocks. We cannot trace the source of the surprise back to a single structural shock. However, for the purposes of studying the perceived monetary policy response, the exact source of the disturbance is second order, relative to the challenge it poses to policymakers.

To evaluate whether financial markets understand and internalize the trade-off faced by the BoE in responding to these two different types of shocks, we modify our baseline specification. We define a dummy equal to 1 for a month in which the CPI inflation and IP surprises have the same sign, corresponding to red dots in Panel A of Figure 6, and 0 otherwise. We call this dummy $Demand\ NS$ as short for Demand News Surprises. We then extend the baseline equation (2) by introducing a triple interaction between the CPI surprises, the dummy identifying the days after the ONS

Figure 6: Scatter plots of the CPI inflation and IP surprises

A: Supply and demand surprises　　　B: Weak and strong demand surprises



Notes: Panel A reports the scatter plot of IP (on the horizontal axis) and CPI inflation (on the vertical axis) surprises, with the circle size representing the frequency of the observations; supply news surprises are represented by blue circles, demand news surprises by red circles. Panel B reports the same scatter plot as Panel A but demand surprises are further classified into strong (in red) and weak (in green), depending on the relative magnitude of the CPI inflation and IP surprises.

release and the dummy identifying demand surprises.

Column (1) of Table 4 reports our estimation results when we allow for markets to hold different expectations regarding the response of the central bank to demand and supply shocks. As robustness check, Column (3) repeats the same analysis but excluding the days between the CPI inflation and IP releases and considering as time window 5 days before the first release and 5 days after the second release.

The positive and significant coefficients of the triple interaction suggests that markets expect the Bank of England to respond more forcefully to demand disturbances. This is consistent with standard economic theory, which emphasizes the centrality of demand shocks in monetary policy decision-making due to their simultaneous impact on both inflation and output. In contrast, supply shocks often create trade-offs that complicate policy responses. Markets appear to take into account that, when responding to a supply shock, a central bank is more cautious due to the adverse effects on the real economy.

While the standard distinction between demand and supply surprises provides valuable insights, it overlooks the relative magnitudes of inflation and economic growth surprises. Demand shocks, which typically push inflation and economic output in the same direction, do not inherently pose the same trade-off for central banks as supply shocks. However, monetary authorities pursuing price stability may plausibly react differently based on the relative size of inflation and IP news.

To assess the markets' ability to differentiate between scenarios of varying demand intensity, we extend our analysis by further decomposing demand surprises into strong

Table 4: Market-perceived responsiveness to demand and supply surprises

	(1) Yield 1y1y	(2) Yield 1y1y	(3) Yield 1y1y	(4) Yield 1y1y
Demand NS	0.00257		0.0223**	
	(0.00886)		(0.0112)	
CPI surprise x Dummy ONS	0.0954***	0.0954***	0.0526	0.0526
	(0.0338)	(0.0338)	(0.0499)	(0.0499)
Demand NS × CPI surprise x Dummy ONS	0.193***		0.396***	
	(0.0518)		(0.0753)	
Weak demand NS		0.0129		0.0582***
		(0.0115)		(0.0143)
Strong demand NS		-0.00702		-0.0147
		(0.0113)		(0.0142)
Weak demand NS × CPI surprise x Dummy ONS		0.0708		0.133
		(0.0668)		(0.0878)
Strong demand NS × CPI surprise x Dummy ONS		0.306***		0.621***
		(0.0597)		(0.0893)
Constant	1.749***	1.749***	1.722***	1.722***
	(0.00303)	(0.00302)	(0.00369)	(0.00365)
Observations	2506	2506	2571	2571
Month FE	YES	YES	YES	YES

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents regression results for the 1-year, 1-year-ahead horizon gilt yields regressed on CPI inflation surprises within a 5-day window surrounding the CPI inflation release. The surprises are categorized using two approaches: a dummy variable that differentiates between demand and supply surprises based on whether, within a given month, their sign aligns with that of the IP surprises (Columns (1) and (3)); and a categorical variable that further classifies them into supply, weak demand, or strong demand surprises, based on their sign and magnitude relative to the IP surprises (Columns (2) and (4)). The CPI inflation surprises, sourced from Thomson Reuters, are defined as the difference between professional forecasters' expectations and the actual release. Additional control variables are included in the regression (discussed in the main text but not shown in the table). The analysis uses data spanning the period from April 2005 to September 2024. Robust standard errors are reported in parentheses.

Table 5: Long-term inflation expectations responsiveness to demand and supply surprises

	(1) ILS 5-5y	(2) ILS 5-5y	(3) ILS 5-5y	(4) ILS 5-5y
Demand NS	0.00903		-0.00215	
	(0.00665)		(0.00711)	
CPI surprise x Dummy ONS	0.0183	0.0183	0.0503*	0.0503*
	(0.0321)	(0.0321)	(0.0302)	(0.0302)
Demand NS × CPI surprise x Dummy ONS	0.00484		-0.0295	
	(0.0399)		(0.0407)	
Weak demand NS		-0.00217		-0.00163
		(0.00836)		(0.00935)
Strong demand NS		0.0208**		-0.00263
		(0.00810)		(0.00872)
Weak demand NS × CPI surprise x Dummy ONS		0.0366		-0.0467
		(0.0486)		(0.0530)
Strong demand NS × CPI surprise x Dummy ONS		-0.0220		-0.0144
		(0.0438)		(0.0456)
Constant	3.479***	3.479***	3.467***	3.467***
	(0.00237)	(0.00237)	(0.00244)	(0.00244)
Observations	2506	2506	2571	2571
Month FE	YES	YES	YES	YES

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table presents regression results for the 5-year, 5-year-ahead horizon inflation-linked swaps regressed on CPI inflation surprises within a 5-day window surrounding the CPI inflation release. The surprises are categorized using two approaches: a dummy variable that differentiates between demand and supply surprises based on whether, within a given month, their sign aligns with that of the IP surprises (Columns (1) and (3)); and a categorical variable that further classifies them into supply, weak demand, or strong demand surprises, based on their sign and magnitude relative to the IP surprises (Columns (2) and (4)). The CPI inflation surprises, sourced from Thomson Reuters, are defined as the difference between professional forecasters' expectations and the actual release. Additional control variables are included in the regression (discussed in the main text but not shown in the table). The analysis uses data spanning the period from April 2005 to September 2024. Robust standard errors are reported in parentheses.

and weak demand surprises. Demand surprises are labeled strong when the inflation surprise is large, relative to the IP surprise. In contrast, weak demand surprises occur when CPI and IP surprises have the same sign, but the inflation surprise is small relative to the IP surprise. We introduce a new categorical variable that classifies shocks into three types: supply, weak demand, and strong demand surprises. This variable is interacted with both the CPI inflation surprise and the dummy variable indicating the days following the CPI inflation release. The results of this alternative classification are illustrated in Panel B of Figure 6.

The results, presented in Columns (2) and (4) of Table 4, highlight the role of demand intensity in shaping market expectations. The triple interaction terms indicate that financial markets anticipate a robust response from the Bank of England to CPI inflation surprises, particularly in the case of strong demand surprises: situations in which inflationary pressures are significant, but the IP surprise is relatively muted. This finding suggests that markets distinguish between different types of demand shocks, reacting more strongly to scenarios in which the demand news surprise has a prevailing inflation component.

Our decomposition of surprises offers a more nuanced perspective on how markets interpret monetary policy. It suggests that markets expect BoE to at least partially look through trade-off-inducing (supply) surprises.

A relatively muted response to supply shocks can, under some conditions discussed by Orphanides and Williams (2005), increase the risk stagflation or de-anchoring of inflation expectations. To address this concern, we replicate the previous analysis using the 5y5y inflation-linked swaps as the dependent variable to measure medium- to long-term inflation expectations.

The results, presented in Table 5, show that none of the interaction coefficients are statistically significant and, more generally, inflation expectations at the five-to-ten-year horizon are largely insensitive to inflation news. Although markets expect the BoE to respond heterogeneously to different types of shocks, the weaker responsiveness to supply-driven surprises does not result in an increase in long-term inflation expectations. Markets remain confident in the Bank's ability to anchor inflation expectations, even when supply shocks are met with a more measured policy response.

4 Conclusion

In this paper, we estimate the market's perception of the Bank of England's policy rule by analyzing changes in yields around ONS data releases. Exogenous changes in CPI inflation and industrial production are captured using CPI inflation and IP surprises, defined as the forecast errors of market analysts. We further investigate two forms of nonlinearity: how the Bank's responsiveness to these surprises evolves over time and whether the response differs between demand-driven and supply-driven disturbances.

Our analysis demonstrates that markets grasp the Bank of England's flexible inflation-targeting framework and expect it to respond systematically to inflation and output surprises. This understanding is evident in the stronger anticipated BoE reaction to demand-driven inflation deviations, which lack the policy trade-offs typically associated with supply shocks. Furthermore, we show that the perceived responsiveness of the BoE varies over time, with markets expecting more decisive actions during periods of heightened inflationary pressures, such as 2022–2024, compared to times when policy rates were constrained by the effective lower bound.

We cannot say if looking through some supply disturbances has been beneficial or detrimental from a welfare perspective. We can conclude, though, that markets act on the belief that the BoE will respond differently to different shocks. At the same time, markets discount the possibility that this might translate in a de-anchoring of inflation expectations.

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