Living Up to Expectations*

The Effectiveness of Forward Guidance and Inflation Dynamics Post–Global Financial Crisis

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Abstract

This paper studies the effectiveness of forward guidance when central banks face private agents with heterogeneous expectations allowing for a degree of bounded rationality. Exploiting unique survey-based measures of expected inflation, output growth, and interest rates, we estimate a small-scale New Keynesian model with forward guidance shocks for the United States and the other G7 countries plus Spain. We find that the share of fully-informed rational expectations (FIRE) agents in aggregate expectations is similar for the U.S., the U.K., Germany, and other major advanced economies (albeit far from one); however, Japan's share is much lower. For each country, the estimate of the share of FIRE agents has declined over time as VAR-based expectations—the heuristic approach assumed under bounded rationality—became more prominent in explaining the more recent data. Forward guidance has correspondingly grown less effective. In a counterfactual analysis, we document that, in the wake of the global financial crisis, inflation would have been significantly higher and the zero lower bound on short-term interest rates much less of a constraint had the public fully incorporated central banks' forward guidance statements as FIRE agents do. Moreover, inflation would have declined more, and somewhat faster, in the wake of the post-COVID-19 inflation surge.

Keywords: Forward Guidance, Monetary Policy, Heterogeneous Expectations, Expectations Formation, VAR-based Forecasting.

JEL classifications: D84, E30, E52, E58, E60, P52.

1 Introduction

Forward guidance has become a standard component of the modern central bank toolkit. Forward guidance involves providing communication (either explicit or implicit) on the future path of short-term interest rates. Although central banks have used some form of forward guidance for many years, it became particularly popular during the global financial crisis (GFC), when it was deployed in the U.S. and other developed countries as a substitute for conventional rate cuts at the zero lower bound (ZLB). Forward guidance again came to the fore with the onset of the COVID-19 pandemic and the resulting economic instability.

Because forward guidance works by shaping private-sector expectations of the future path of policy, to be effective central bank announcements must be incorporated into the expectations of economic actors. If the public does not believe or directly disregards those forward guidance statements, private-sector expectations of other macroeconomic variables (e.g., output and inflation) will be unaffected by central bank communication, leading to no contemporaneous or anticipated influence of forward guidance on the economy. However, if the public incorporates central bank commitments in their own forecasts, forward guidance ought to anchor private-sector expectations and stimulate the economy in advance of the promised future changes in the path of policy.

Our paper analyzes the effectiveness of forward guidance across both time and countries under a degree of bounded rationality and heterogeneity in the formation of expectations.[1] We also provide intriguing new evidence on how the recent paths of inflation and other aggregate macro variables might have been different over the last several years had central bank announcements been fully incorporated into private expectations by all agents.

We construct a small-scale New Keynesian model based on Curdia et al. (2015) and Cole and Martínez García (2023). In addition to staggered price-setting, the model allows for some explicitly backward-looking elements such as habit formation and price indexation, and features the usual combination of demand and supply shocks. Monetary policy is conducted using an inertial Taylor (1993)–type interest rate rule. The interest rate rule is augmented with a sequence of "news shocks" about future policy following Del Negro et al. (2012) and Cole and Martínez García (2023), which we interpret as forward guidance shocks.

[1] Boundedly rational agents are those whose decision-making process is constrained by cognitive limitations, information asymmetry, time constraints, or computational constraints. Unlike fully-informed rational expectations or FIRE agents who can process all available information instantaneously and costlessly, the bounded rationality assumption acknowledges that some agents forecast and make decisions in the real world with only incomplete information and simplified heuristics/econometrics.

To investigate the effectiveness of forward guidance, we allow for heterogeneous expectations to recognize that forecasting disagreements occur and can arise in part from differences in the way agents gather and process information to form their expectations. Furthermore, we depart from the full-information rational expectations (FIRE) paradigm introducing a fraction of boundedly rational agents because, as Sargent (1993) argued, an environment populated solely by rational agents attributes to the public much *more* knowledge than sophisticated econometricians are thought to have in reality. In our paper, a fraction of agents form expectations according to rational expectations and, being fully informed, incorporate forward guidance announcements into their decision-making too. The other fraction of agents form expectations as an econometrician, using a backward-looking vector autoregression (VAR) model that *excludes* all announcements about future policy changes. Our heterogeneous beliefs framework is grounded on the axiomatic approach laid out in Branch and McGough (2009). This has the attractive feature that aggregate expectations boil down to a convex combination of FIRE and VAR beliefs.

In our framework, the fraction of FIRE private agents is represented by the parameter $\tau \in [0, 1]$. When $\tau \to 1$, all agents exhibit homogeneous, full-information, and rational expectations, as typically assumed in the workhorse New Keynesian model (e.g., Del Negro et al. (2012) with forward guidance shocks). When $\tau \to 0$, aggregate expectations are also homogeneous, but reduced to a backward-looking VAR forecasting model. Consequently, when τ is larger, forward guidance announcements are quite effective at steering inflation and output from the moment of the announcement onward (and anticipation effects are stronger) as the share of FIRE agents dominates. When τ is instead close to zero, forward guidance becomes largely ineffective.

The parameter τ governs the convex combination of two different types of expectations (or forecasting models) between private agents, making its identification dependent on the heterogeneity of beliefs within the economy. Although τ determines the share of FIRE agents in the economy, it can also be understood as a (reduced-form) measure of the imperfect credibility of forward guidance, as described by Yellen (2006). To be precise, what that entails is simply that deviations from FIRE violate the Yellen (2006)'s notion of full credibility under which "market participants correctly anticipate the actions that the [central bank] will make in response to economic news and shocks [including forward guidance]. This alignment of the [central bank's] actions and the public's expectations strengthens the monetary policy transmission mechanism and shortens policy lags. In contrast, in the absence of [full] credibility, policymakers and the public [or part of the public] may work at cross-purposes, and monetary policy must act to overcome and dislodge expectations that hinder the achievement of [the central bank's] goals."[2]

The majority of our empirical analysis focuses on four countries: the U.S., the U.K., Germany, and Japan. However, we also present results that extend our analysis to other major advanced economies of the G7+ group (Canada, France, Italy, and Spain).[3] Our data sample extends from the third quarter 1990 (third quarter 1994 for Spain) through the third quarter 2022, including the most recent COVID-19 episode. For each country, we estimate the model parameters and recover smoothed shocks using Bayesian methods.

The data feature not only typical macro aggregates but also survey-based expectations from Consensus Economics, which collects responses on the values of future macroeconomic variables from the world's leading forecasters for all of the countries we consider. The expectations data series includes forecasts of one- and two-period-ahead real GDP growth and one-period-ahead headline CPI inflation. To identify forward guidance shocks, we exploit interest rate expectations up to 5 quarters ahead from the same source.[4]

The results of the full sample show that the estimates of the major countries of τ lie close to 0.5 over the full sample, except Japan's. The U.S. is estimated to be the highest, followed by the U.K. and Germany. Japan is estimated to be the lowest, with a notably lower estimate than the other countries. However, these estimates mask interesting time series heterogeneity. For all four countries, we find larger τ estimates for the earlier great moderation period (1990–2007) and substantially smaller estimates for the most recent period of (mostly) low interest rates (2005–2022).

We find similar results for Canada, France, Italy, and Spain that tend to be close in magnitude to what we find for the U.S., the U.K., and Germany, but not Japan. We also perform a rolling estimation exercise, reestimating the model over successive 69-quarter samples. For each country, we find approximately monotonic decreases in the mean estimate of τ. These estimated declines in τ coincide with smaller estimated effects of a hypothetical forward guidance shock in the model.

Taking the U.S. as an example, we estimate that a stimulative forward guidance shock

[2]Strictly speaking, τ measures the fraction of FIRE agents who react to forward guidance announcements, not the fraction of agents who believe central bank announcements about the future path of policy to be credible. However, because agents who use a backward-looking VAR for forecasting do not incorporate forward guidance announcements, we think it appropriate, with caveats, to refer to τ also as an implicit indicator of the misalignment between the forward guidance of the central bank and the public expectations of the policy path, as in Yellen (2006).

[3]See Martínez García (2018) for further details on the common business cycle patterns of the G7+ countries.

[4]As a robustness check, we also use longer-dated interest rate forecasts, extending them up to 8 quarters ahead, and find similar results. More details about the data can be found in Appendix A.

was approximately two-thirds as effective at raising output and inflation at the end of the sample period as at the beginning. Put differently, forward guidance effectiveness seems to have declined during the period in which forward guidance was used most prominently as nominal short-term rates became stuck at the ZLB for extended periods.

The economic significance of a declining τ is then investigated with a counterfactual exercise. Specifically, we explore the question: What would the path of aggregate macro variables have looked like had each central bank been interacting solely with FIRE agents (i.e., $\tau = 1$) under exactly the same forward guidance shocks recovered from our baseline estimation? In other words, what would the effect of forward guidance have been had it been deployed when it was most potent? For the U.S., the U.K., and Germany, inflation would have been higher and the ZLB on short-term nominal interest rates less of an issue in the wake of the GFC.

Concretely, our analysis suggests that at least some of the "missing inflation" post-GFC that has puzzled the earlier literature could be due to issues related to the potency of the anticipatory effects of forward guidance predicted under FIRE. Japan is somewhat of an outlier in the counterfactual analysis in part because Japan reached the ZLB in the early 1990s: While we estimate that the ZLB would have been less of a constraint, the differences in Japan's path of inflation post-GFC would not have been as stark as they were for the other three major countries. The evidence for Canada, France, Italy, and Spain is largely consistent with that for the U.S., the U.K., and Germany.

We next employ our counterfactual exercise to study the inflation surge that occurred in the aftermath of the short-lived COVID-19 recession. For the U.S., the U.K., and Germany, our analysis reveals that inflation would have started to decline faster, and somewhat sooner, in 2022 had central banks been interacting solely with FIRE agents. This suggests that forward guidance was likely appropriate to bring down inflation but may have been calibrated under the assumption of greater alignment with the FIRE paradigm. The evidence is largely consistent when we look at the experiences of Canada, France, Italy, and Spain. In turn, Japan is again an outlier.

Our paper contributes to a large literature that studies forward guidance and the so-called forward guidance puzzle. The paper shows that heterogeneous expectations—and the bounded rationality of some agents—dampen the implausibly strong anticipation effects of forward guidance found in dynamic stochastic general equilibrium (DSGE) models with only FIRE agents (see, e.g., Del Negro et al. (2012) and the more recent work of Cole and Martínez García (2023)). The finding of Kohlhas and Walther (2021) that survey-based measures of expectations are incompatible with standard ways of modeling rational expectations also underscores the need to incorporate heterogeneous expectations into macroeconomic models, as we do here.[5]

Tetlow (2022) examines expectations formation, credibility, and policy communication relative to determinants of the sacrifice ratio. Our work considers aggregate outcomes in a related manner, exploring through counterfactuals the role of heterogeneous expectations and bounded rationality on the post-GFC missing inflation puzzle and on the post-COVID-19 inflation surge. Our paper also builds on a growing literature that relies on survey-based forecasts to discipline the identification of news shocks (Martínez García (2021); Angeletos and Huo (2021); Milani (2023)). The novel contribution of our paper is studying empirically how expectations formation and its implications for the effectiveness of forward guidance vary across both time and space. Our counterfactual analyses also offer some potential insights into the role of central bank announcements in the recent behavior of inflation.

The remainder of the paper is organized as follows: Section 2 introduces the baseline model with forward guidance, heterogeneous forecasts, and bounded rationality, exploring its properties and the role of the key parameter τ. Section 3 outlines the dataset and Bayesian estimation strategy. Section 4 presents the main findings on the effectiveness of forward guidance across time and space, including counterfactual analyses and robustness checks, extending the analysis to all G7+ countries. Section 5 concludes. Appendix A details the data sources, and Appendix B provides additional tables and figures.

2 Model

We employ a standard New Keynesian model rooted in the workhorse framework of Woodford (2003), Giannoni and Woodford (2004), Milani (2007), Curdia et al. (2015), Cole and Milani (2017), and Cole and Martínez García (2023). The log-linear system taken to the data is derived from optimizing household and firm behavior, as in Cole and Martínez García (2023), and features habit formation in consumption, price stickiness, and price indexation.

Monetary policy is described by an inertial Taylor (1993) interest-rate rule. We extend this rule by distinguishing between unanticipated (surprise) and anticipated (forward-

[5] Caballero and Simsek (2022) view forecasting heterogeneity as "mistakes" when central bank interest-rate decisions diverge from private expectations. Their focus is on differences between markets and the central bank, not among private agents as in our framework. Moreover, Park (2018) notes that central banks typically rely on FIRE-based forecasting models, which may lead them to misjudge the effects of forward guidance when expectations are heterogeneous.

guidance) monetary policy shocks, which introduces a reduced-form representation of forward-guidance announcements. The policy rule is described in Subsection 2.2.

We depart from the homogeneous-FIRE benchmark common in the DSGE literature. Private agents are heterogeneous-beliefs household-firm pairs that differ in expectation formation, so not all agents incorporate forward guidance into their forecasts and decisions.

While FIRE agents fully internalize policy announcements, a subset of agents is information-constrained and forms expectations using simple forecasting rules fitted to observed data. This is in the spirit of the "natural expectations" approach of Fuster et al. (2012), and consistent with Angeletos et al. (2021), whose evidence of initial underreaction and subsequent overshooting motivates direct, horizon-specific forecasting rules.

This interpretation is also consistent with survey evidence that expectations need not adjust in a fully model-consistent manner. Coibion and Gorodnichenko (2015) document underreaction in consensus forecasts, while Adam et al. (2025) and Born et al. (2025) show excessive anchoring and underreaction to public or macro news. Our framework captures these features parsimoniously by showing how aggregate expectations need not move one-for-one with announced future policy.

In our setting, VAR-based forecasts do not directly incorporate forward guidance because they depend only on realized macroeconomic outcomes. When FIRE agents respond to policy announcements and influence aggregate dynamics, VAR-based forecasts adjust indirectly by tracking the resulting macro effects, and thus information-constrained agents respond accordingly.[6]

Although this attenuation of forward-guidance effects can also arise in representative-agent models with homogeneous cognitive discounting, such as Gabaix (2020) and Benchimol et al. (2025), the heterogeneous-expectations structure adopted here has additional implications.[7] In particular, it generates forecast disagreement—a feature of the survey evidence—and introduces an expectations externality: even fully informed agents internalize that a share of the population does not respond to forward guidance. Hence, forward-guidance effectiveness depends not only on individual expectations, but also on how

[6] A VAR provides a tractable approximation to the reduced-form solution of forward-looking log-linear DSGE models using only observed macroeconomic data (Martínez García (2020)). This approximation is broadly valid without forward-guidance shocks and learnable in the spirit of Evans and Honkapohja (2001), but it breaks down in the presence of forward-guidance or other news shocks.

[7] Benchimol et al. (2025) estimate cross-country differences in attention in a homogeneous bounded-rationality framework. Our approach instead allows for heterogeneous expectations within countries and can capture time variation in the share of FIRE agents.

those FIRE agents expect others to form expectations, generating a nonlinear relationship between their share and policy effectiveness. In this sense, our framework complements rather than substitutes for homogeneous bounded-rationality approaches.

2.1 Main Structural Relationships

As in Curdia et al. (2015) and Cole and Martínez García (2023), the workhorse New Keynesian model can be described with the following pair of log-linearized equations, the dynamic investment–savings (IS) equation and the New Keynesian Phillips curve (NKPC):

$$\tilde{x}_t = \mathbb{E}_t(\tilde{x}_{t+1}) - (1-\beta\eta)(1-\eta)(i_t - \mathbb{E}_t(\pi_{t+1}) - r_t^n), \tag{1}$$

$$\tilde{\pi}_t = \beta\mathbb{E}_t(\tilde{\pi}_{t+1}) + \xi_p\left(\omega x_t + ((1-\beta\eta)(1-\eta))^{-1}\tilde{x}_t\right) + \mu_t, \tag{2}$$

where

$$\tilde{y}_t \equiv y_t - \eta y_{t-1} - \beta\eta\mathbb{E}_t(y_{t+1} - \eta y_t), \tag{3}$$

$$\tilde{y}_t^n \equiv y_t^n - \eta y_{t-1}^n - \beta\eta\mathbb{E}_t\left(y_{t+1}^n - \eta y_t^n\right), \tag{4}$$

$$\tilde{x}_t \equiv \tilde{y}_t - \tilde{y}_t^n = x_t - \eta x_{t-1} - \beta\eta\mathbb{E}_t(x_{t+1} - \eta x_t), \tag{5}$$

$$\tilde{\pi}_t \equiv \pi_t - \iota_p\pi_{t-1}. \tag{6}$$

The one-period nominal interest rate (i_t) denotes the short-term policy rate, inflation ($\pi_t \equiv \Delta p_t$) is the first difference of the consumption price level in logs p_t, and the output gap is $x_t \equiv y_t - y_t^n$, i.e., the log deviation of actual output (y_t) from potential output (y_t^n). Aggregate expectations are denoted by $\mathbb{E}_t(\cdot)$ and incorporate heterogeneous beliefs (see Subsection 2.3).

The intertemporal rate of substitution is set to unity, $\omega > 0$ is the inverse Frisch elasticity, $\eta \in [0,1]$ governs habit formation, and $\beta \in (0,1)$ is the discount factor. Following Calvo (1983), a fraction $\theta \in [0,1]$ of firms cannot reset prices each period, implying an NKPC slope scaled by $\xi_p \equiv \frac{(1-\theta\beta)(1-\theta)}{\theta}$. As in Yun (1996), non-reoptimizing firms index prices to past inflation with degree $\iota_p \in [0,1]$.

Using equation (5) together with (3)–(4) and (6), the system (1)–(2) can be rewritten in terms of three observable variables: output (or output growth Δy_t), inflation π_t, and the nominal short-term interest rate i_t.

Frictionless Allocation Potential output (y_t^n) and the natural real rate (r_t^n) are the levels of output and the real interest rate that prevail absent nominal and informational frictions, i.e., under flexible prices and homogeneous FIRE. They define the frictionless allocation consistent with stable prices.

In that environment, potential output evolves according to

$$\begin{aligned}\omega y_t^n + \tfrac{1}{(1-\beta\eta)(1-\eta)}\left(y_t^n - \eta y_{t-1}^n\right) - \tfrac{\beta\eta}{(1-\beta\eta)(1-\eta)}\left(\mathbb{E}_t^{FIRE}\left(y_{t+1}^n\right) - \eta y_t^n\right) \\ = \tfrac{\eta}{(1-\beta\eta)(1-\eta)}\left(\beta\mathbb{E}_t^{FIRE}\left(\gamma_{t+1}\right) - \gamma_t\right),\end{aligned} \tag{7}$$

and the corresponding natural rate satisfies

$$r_t^n = \mathbb{E}_t^{FIRE}\left(\gamma_{t+1}\right) - \omega\mathbb{E}_t^{FIRE}\left(\Delta y_{t+1}^n\right). \tag{8}$$

Here $\mathbb{E}_t^{FIRE}(\cdot)$ denotes FIRE expectations. Both y_t^n and r_t^n are driven by the productivity-growth shock $\gamma_t \equiv \Delta\ln(A_t)$, where A_t denotes total factor productivity (TFP).

Exogenous (Nonmonetary) Shock Processes. The exogenous productivity-growth shock (γ_t) and cost-push shock (μ_t) follow standard AR(1) processes:

$$\gamma_t = \rho_\gamma\gamma_{t-1} + \varepsilon_t^\gamma, \tag{9}$$

$$\mu_t = \rho_\mu\mu_{t-1} + \varepsilon_t^\mu, \tag{10}$$

where $\varepsilon_t^\gamma \overset{iid}{\sim} N\left(0,\sigma_\gamma^2\right)$ and $\varepsilon_t^\mu \overset{iid}{\sim} N\left(0,\sigma_\mu^2\right)$. The persistence parameters satisfy $0 < \rho_\gamma < 1$ and $0 < \rho_\mu < 1$, while the variances satisfy $\sigma_\gamma^2 > 0$ and $\sigma_\mu^2 > 0$. The two shocks are assumed independent of each other and uncorrelated at all leads and lags.

2.2 Monetary Policy

Monetary policy is described by an inertial Taylor (1993) rule in which the nominal interest rate (i_t) tracks the neutral rate (i_t^n) and responds to inflation (π_t) and, possibly, the output gap $x_t \equiv y_t - y_t^n$:

$$i_t - i_t^n = \rho(i_{t-1} - i_{t-1}^n) + (1-\rho)\left[\chi_\pi\pi_t + \chi_x(y_t - y_t^n)\right] + \varepsilon_t^{MP} + \sum_{l=1}^{L}\varepsilon_{l,t-l}^{FG}, \tag{11}$$

where the Fisher equation implies that

$$i_t^n = r_t^n + \mathbb{E}_t(\pi_{t+1}). \tag{12}$$

The inertia parameter $0 \leq \rho < 1$ governs policy smoothing, while $\chi_\pi > 0$ (subject to determinacy) and $\chi_x \geq 0$ determine the response to inflation and the output gap.

Equation (11) also incorporates forward guidance via anticipated monetary policy shocks (news), following Del Negro et al. (2012), Cole (2020a), Cole (2020b), and Cole and Martínez García (2023). The surprise policy shock ε_t^{MP} is combined with forward-guidance shocks $\varepsilon_{l,t-l}^{FG}$ for $l = 1, \dots, L$.[8] The forward-guidance horizon is finite, $1 \leq L < \infty$.[9]

Monetary policy surprises and forward-guidance shocks are transitory:

$$\varepsilon_t^{MP} \overset{iid}{\sim} N(0, \sigma_{MP}^2), \tag{13}$$

$$\varepsilon_{l,t-l}^{FG} \overset{iid}{\sim} N(0, \sigma_l^{2,FG}), \qquad l = 1, \dots, L. \tag{14}$$

Each $\varepsilon_{l,t-l}^{FG}$ is known in period $t-l$ but affects the policy rate only in period t. The variances of each shock are $\sigma_{MP}^2 > 0$ and $\sigma_l^{2,FG} > 0$. All anticipated and unanticipated policy innovations are mutually uncorrelated and independent of the non-monetary shocks at all leads and lags.

2.3 Aggregate Expectations

A fraction of private agents is information-constrained and forms expectations using a parsimonious forecasting rule based only on observed macroeconomic dynamics, abstracting from forward-guidance announcements unless they affect realized outcomes. These agents forecast $Y_t = [\Delta y_t, \pi_t, i_t]'$, where Δy_t denotes output growth, π_t inflation, and i_t the short-term nominal interest rate.

Expectations are constructed using direct multi-horizon projections. For each forecast horizon $h \geq 1$,

$$Y_{t+h} = A_h + B_h Y_t + u_{t+h}, \qquad h \geq 1, \tag{15}$$

which implies

$$\mathbb{E}_t^{VAR}(Y_{t+h}) = B_h Y_t, \qquad h = 1, \dots, L, \tag{16}$$

since $A_h = \mathbf{0}$ and mean components are handled through the measurement equations in Subsection 3.2. In the baseline, B_h is diagonal,

$$B_h = \mathrm{diag}(b_{\Delta y,h}, b_{\pi,h}, b_{i,h}),$$

[8] Schmitt-Grohe and Uribe (2012) describe anticipated shocks as "news."

[9] We consider horizons up to 5 quarters to focus on roughly one year while limiting parameter proliferation. Extending to 8 quarters to match available survey forecasts yields similar results available upon request.

with

$$b_{\Delta y,1} = var_{1x1}, \quad b_{\Delta y,2} = var_{1x2}, \quad b_{\pi,1} = var_{2\pi},$$

$$b_{i,h} = (var_{3i}, var_{3i2}, var_{3i3}, var_{3i4}, var_{3i5}), \quad h = 1, \ldots, L,$$

where $L = 5$. This diagonal structure rules out spillovers while allowing flexible horizon-specific dynamics.[10]

This specification aligns with the model's equilibrium conditions, which require multi-horizon expectations: one-quarter-ahead inflation, two-quarter-ahead output growth, and L-quarters-ahead policy-rate expectations for forward guidance.[11]

The remaining agents form expectations under FIRE. They observe all relevant information, understand the share of VAR-based agents, and internalize the rule in (16), accounting for the equilibrium implications of heterogeneous beliefs. Following the aggregation approach of Branch and McGough (2009) and Haberis et al. (2019), aggregate expectations are[12]

$$\mathbb{E}_t\left(Y_{t+1}\right) = \tau \mathbb{E}_t^{FIRE}\left(Y_{t+1}\right) + (1-\tau)\mathbb{E}_t^{VAR}\left(Y_{t+1}\right), \tag{17}$$

where $\tau \in (0,1)$ is the share of FIRE agents.

Model expectations are aligned with survey timing: forecasts dated t correspond to the survey consensus released at time t (see Appendix A).[13]

Finally, potential output and the natural rate in (7) and (8) are defined under the frictionless allocation with homogeneous-FIRE expectations ($\tau \to 1$) and are used to construct the output gap and natural rate of interest.

2.4 Understanding the Mechanism

Before turning to estimation, we use a stylized version of the model to illustrate how the expectations-aggregation parameter τ shapes the effects of forward-guidance news shocks and the role of perceived persistence in expectations formation.

[10]Iterating a VAR(1) for indirect forecasting imposes a more restrictive geometric decay, $b_{\Delta y,h} = (\phi_{\Delta y})^h$, $b_{\pi,h} = (\phi_\pi)^h$, and $b_{i,h} = (\phi_i)^h$. However, requiring indirect forecasting or relaxing B_h with spillovers yields similar estimates, with little evidence favoring alternative specifications. Results are available upon request.

[11]The coefficients in B_h are jointly estimated with the structural model. Learning dynamics and stability (e.g., Evans and Honkapohja (2001), Orphanides and Williams (2004), Orphanides and Williams (2007)) are beyond the scope of this paper.

[12]The result follows Branch and McGough (2009), which imposes linearity and the law of iterated expectations, thereby disciplining higher-order beliefs.

[13]Cole and Martínez García (2023) consider alternative timing conventions to account for publication lags and find only minor quantitative differences.

To fix ideas, we set no consumption habit ($\eta = 0$), no price indexation ($\iota_p = 0$), and no interest-rate smoothing ($\rho = 0$). When $\tau = 1$ (all agents are FIRE), the model collapses to the textbook three-equation New Keynesian framework with no endogenous state variables. The remaining parameters are fixed at their prior means; see Appendix B, Table B1. Using Δy_t, the model can equivalently be written in terms of y_t to derive output level effects.

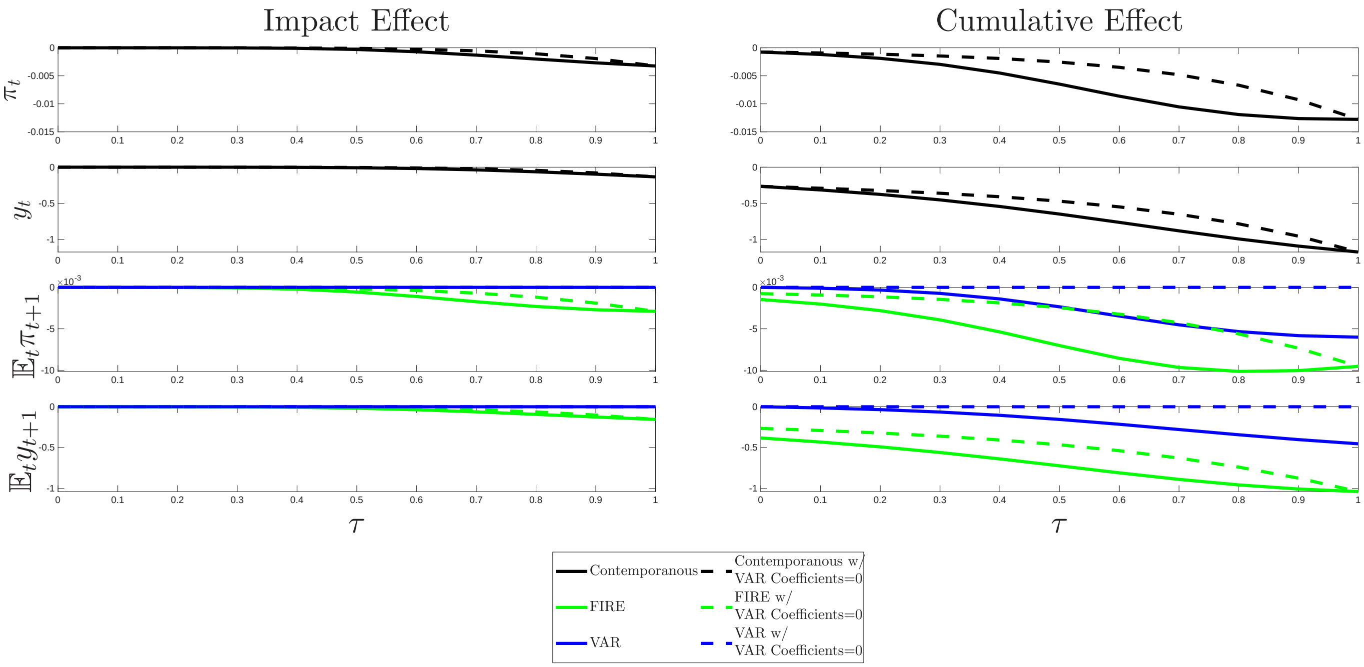

Figure 1: Impulse Responses of Macroeconomic Variables to a 5-Period-Ahead Forward Guidance Shock

Note: Benchmark model of Section 2, but with no habit in consumption ($\eta = 0$), no price indexation ($\iota_p = 0$), and no interest rate smoothing ($\rho = 0$). 30 basis point (bp) increase.

Figure 1 reports both impact and cumulative responses over the five-quarter anticipation horizon for output, inflation, and their one-quarter-ahead expectations. Solid lines correspond to the baseline specification in which VAR-based agents perceive persistence in their outlook, while dashed lines shut down persistence in their forecasting rule. The figure also distinguishes expectations by agent type, allowing us to visualize disagreement between FIRE (green lines) and VAR-based agents (blue lines).

Two results stand out. First, the strength of anticipatory effects is governed by τ. When τ is low, forward guidance has little impact on both realized variables and expectations—along with only minor forecasting disagreement—as most agents rely on backward-looking rules.

As τ rises, both impact and cumulative responses increase, and disagreement across agent types becomes more pronounced. Second, perceived persistence operates primarily through expectations. When VAR-based agents over- or under-estimate persistence, cumulative effects change noticeably, while impact responses remain muted unless τ is sufficiently large. Thus, the extent to which disagreement translates into realized outcomes depends on the share of each type of agent.

These effects are nonlinear. Differences across specifications are small when the share of FIRE agents is low, since even fully rational agents internalize that most agents respond weakly to policy announcements. As τ increases, both anticipatory effects and cross-agent disagreement strengthen, reflecting an expectations externality: FIRE agents forecast aggregates and therefore incorporate the muted response of others when forming expectations, even when they fully internalize policy announcements.

Perceived persistence further shapes these dynamics. Without persistence, VAR-based forecasts replicate FIRE dynamics once the forward-guidance shock materializes, so cumulative effects are smaller and variables return more quickly to steady state. With perceived persistence, VAR-based agents interpret realized movements as persistent, generating additional propagation after implementation even though the underlying shock is i.i.d. This propagation affects not only VAR-based agents but also FIRE agents through equilibrium interactions, reinforcing the role of expectation heterogeneity in shaping forward-guidance transmission. Accordingly, in the empirical analysis below, we focus particularly on the anticipation channel—our primary measure of forward-guidance effectiveness.

Greater information availability may increase attentiveness and forecast accuracy (e.g., Bracha and Tang (2025); Weber et al. (2025); Pfäuti (2026)). However, lower values of τ should not be interpreted as reduced attention to forward guidance in our model. Rather, they reflect less weight on anticipated policy announcements, consistent with selective attention arising from rising informational complexity or heightened credibility concerns. Either way, this is consistent with selective attention: agents rely more heavily on reduced-form forecasting rules even as central bank communication becomes more prominent.

A related question is whether cross-τ differences could reflect other features of the economy or policy rule. In Appendix B, Figure B1 shows that varying the Calvo (1983) parameter θ has only minor quantitative effects. Although θ changes the NKPC slope and policy trade-offs, it does not materially alter forward-guidance propagation or its dependence on τ.

Similarly, Appendix B, Figures B2–B3 vary the policy responses to inflation (χ_π) and the output gap (χ_x). These parameters affect magnitudes but not the propagation mechanism or its dependence on τ.

Taken together, these exercises suggest that the empirical effectiveness of forward guidance under heterogeneous expectations is unlikely to be confounded by simultaneous identification of key transmission or policy-rule parameters.

3 Bayesian Estimation

We use Bayesian techniques to estimate the parameters of the model described in Section 2—including, but not limited to, the parameters governing the strength of forward guidance—for the four main countries of interest in our analysis, that is, the U.S., the U.K., Germany, and Japan, over different subsamples.

3.1 Data

We use quarterly data on real GDP growth, headline CPI inflation, and the nominal short-term (3-month) interest rate as the counterparts of output growth, inflation, and the nominal interest rate in the vector $Y_t = [\Delta y_t, \pi_t, i_t]'$. In addition to these realized observables, we use survey forecasts of real GDP growth, inflation, and the future path of the nominal short-term interest rate.[14] These expectations are obtained from quarterly Consensus Economics forecasts for the U.S., the U.K., Germany, and Japan from 1990:Q3 to 2022:Q3 (129 observations).[15] The data sources and additional details on the matching of the observed data and forecasts to the model counterparts can be found in Appendix A.

With only the three realized macro aggregates in Y_t, the model is not fundamental in the sense of Hansen and Sargent (1980) and Martínez García (2020). In other words, these observables alone do not contain enough information to identify the vector of structural shocks $\varepsilon_t = \left[\gamma_t, \mu_t, \varepsilon_t^{MP}, \{\varepsilon_{l,t-l}^{FG}\}_{l=1}^{L}\right]'$. It is to restore identification that we augment the observable system with survey-based expectations following the empirical strategy explored by Doehr and Martínez García (2015) in a VAR setting and employed by Cole and Milani (2017) and Cole and Martínez García (2023) within a DSGE framework.

To be precise, we augment Y_t with a sufficient number of survey expectations to discipline

[14] Survey respondents forecast the nominal policy rate rather than a shadow rate. Using a shadow-rate series would therefore mix distinct objects. Modeling the expected policy-rate path directly preserves consistency between the model and the survey data and allows forward guidance shocks to be identified from movements in expected future policy rates.

[15] We collect the same data for Canada, France, and Italy from 1990:Q3 to 2022:Q3 (129 observations) as well as for Spain from 1994:Q3 to 2022:Q3 (113 observations).

the aggregate expectations in the model. The model-implied augmented vector is

$$\bar{Y}_t = \left[\Delta y_t, \pi_t, i_t, \mathbb{E}_t(\Delta^4 y_{t+1}), \mathbb{E}_t(\Delta^4 y_{t+2}), \mathbb{E}_t(\Delta^4 p_{t+1}), \mathbb{E}_t(i_{t+1}), \ldots, \mathbb{E}_t(i_{t+L})\right]'. \tag{18}$$

Its observable counterpart is

$$\bar{Y}_t^{obs} = \left[\Delta y_t^{obs}, \pi_t^{obs}, i_t^{obs}, \mathbb{E}_t^{obs}(\Delta^4 y_{t+1}), \mathbb{E}_t^{obs}(\Delta^4 y_{t+2}), \mathbb{E}_t^{obs}(\Delta^4 p_{t+1}), \mathbb{E}_t^{obs}(i_{t+1}), \ldots, \mathbb{E}_t^{obs}(i_{t+L})\right]'. \tag{19}$$

Here, the superscript *obs* indicates the survey-based or realized counterpart in the data. In the baseline specification, $L = 5$.

Define the k-period log differences as $\Delta^k y_{t+h} \equiv y_{t+h} - y_{t+h-k}$ and $\Delta^k p_{t+h} \equiv p_{t+h} - p_{t+h-k}$. Hence, $\Delta^4 y_{t+h}$ and $\Delta^4 p_{t+h}$ denote four-quarter log differences, while $\Delta y_{t+h} \equiv y_{t+h} - y_{t+h-1}$ and $\Delta p_{t+h} \equiv \pi_{t+h}$ denote quarter-over-quarter log differences. Because the survey forecasts for real GDP growth and headline CPI inflation are reported in year-over-year form, while the model is written in quarter-over-quarter rates, we use the following measurement identities

$$\mathbb{E}_t\left(\Delta^4 y_{t+j}\right) = \sum_{h=0}^{3} \mathbb{E}_t\left(\Delta y_{t+j-h}\right), \text{ for } j = 1, 2, \quad \mathbb{E}_t\left(\Delta^4 p_{t+1}\right) = \sum_{h=0}^{3} \mathbb{E}_t\left(\Delta \pi_{t+1-h}\right). \tag{20}$$

to map the model objects into the set of variables included in (19).

3.2 Observation Equations

We specify observation equations that map each data series to its corresponding model counterpart. The observation equations are given in the following matrix form

$$\bar{Y}_t^{obs} = \bar{Y}_t + \Gamma_t + M o_t, \tag{21}$$

where Γ_t collects intercepts and trend adjustments, o_t collects measurement errors, and M selects those observables measured with error.

The components of Γ_t are given by

$$\Gamma_t = \left[\bar{\gamma}^{\Delta y} + \gamma_t,\ \bar{\gamma}^{\pi},\ \bar{\gamma}^{i},\ \bar{\gamma}^{\Delta y,1} + \Theta_t^{\Delta y,1},\ \bar{\gamma}^{\Delta y,2} + \Theta_t^{\Delta y,2},\ \bar{\gamma}^{\pi,1},\ \bar{\gamma}^{i,1},\ \bar{\gamma}^{i,2},\ \ldots,\ \bar{\gamma}^{i,L}\right]', \tag{22}$$

where the trend adjustments for the year-over-year GDP-growth forecasts satisfy

$$\Theta_t^{\Delta y,1} \equiv (1 + \rho_\gamma)\gamma_t + \gamma_{t-1} + \gamma_{t-2}, \qquad \Theta_t^{\Delta y,2} \equiv (1 + \rho_\gamma + \rho_\gamma^2)\gamma_t + \gamma_{t-1}. \tag{23}$$

Thus, the quarter-over-quarter productivity-growth component is accumulated consistently with the four-quarter transformation used to construct year-over-year GDP-growth forecasts. Measurement errors are introduced only for the survey-expectation series. Define

$$o_t = \left[o_t^{\Delta y_{t+1}}, o_t^{\Delta y_{t+2}}, o_t^{\pi_{t+1}}, o_t^{i_{t+1}}, o_t^{i_{t+2}}, \dots, o_t^{i_{t+L}} \right]', \tag{24}$$

and let

$$M = \begin{bmatrix} \mathbf{0}_{3\times(L+3)} \\ \mathbf{I}_{L+3} \end{bmatrix}. \tag{25}$$

Hence, only the survey-based expectations are measured with *i.i.d.* measurement error, while realized output growth, inflation, and the nominal interest rate are matched directly to their model counterparts. We allow measurement errors on the expectation variables because survey forecasts are noisy proxies for model-consistent expectations, reflecting reporting noise, rounding, and cross-sectional heterogeneity not explicitly modeled.

3.3 Priors

The choice of priors for the U.S., the U.K., Germany, and Japan are presented in Appendix B, Tables B1–B4. The priors for the structural parameters largely follow the extant literature (e.g., Smets and Wouters (2007), Cole and Milani (2017), and Cole and Martínez García (2023)).[16] For each country, we estimate the model over three different periods. The full sample runs from 1990:Q3 to 2022:Q3. We end the sample in 2022:Q3 to avoid contamination from the Ukraine war. We also consider a "great moderation" sample running from 1990:Q3 to 2007:Q3, and a more recent "low-interest-rate" sample spanning 2005:Q3 to 2022:Q3, which includes the run-up to and fallout from the GFC as well as the COVID-19 recession.

All parameters are estimated separately for each country, except the subjective discount factor (β), the inverse of the Frisch elasticity of labor supply (ω), and the degree of price indexation (ι_p), which are fixed at the conventional values of 0.99, 0.8975, and 0.5, respectively. Full posterior estimates for the U.S., the U.K., Germany, and Japan are available in Appendix B, Tables B1–B4.

[16] For the parameters in the observation system (21), we adopt agnostic priors. The intercept terms in (22) have normal priors centered on the sample means of their corresponding data series. The standard deviations of the measurement errors in (24) are assigned inverse-gamma priors with mean 0.1 and two degrees of freedom.

4 Main Estimation Results

In this section on our findings, we discuss our main estimation results and their implications for the efficacy of forward guidance across both time and space.

4.1 Posterior Estimates of τ Across Countries and Time

Table 1 shows posterior estimates for the key parameter τ for the U.S., the U.K., Germany, and Japan across the aforementioned three sample periods. For the full posterior estimation results, refer to Appendix B, Tables B1–B4.

Table 1: **Posterior Estimates of τ Across Countries and Time**

	Posterior Distribution								
	Full Sample (1990:Q3–2022:Q3)			Great Moderation (1990:Q3–2007:Q3)			Low-Interest-Rate Period (2005:Q3–2022:Q3)		
	Mean	5%	95%	Mean	5%	95%	Mean	5%	95%
U.S.	0.47	0.44	0.50	0.55	0.49	0.60	0.39	0.35	0.43
U.K.	0.42	0.39	0.45	0.57	0.52	0.62	0.32	0.28	0.36
Germany	0.43	0.40	0.47	0.45	0.40	0.49	0.33	0.29	0.37
Japan	0.23	0.21	0.25	0.33	0.29	0.37	0.12	0.10	0.14

Note: The prior distribution of τ is assumed to be $U(0,1)$ across all countries and periods.

For the full sample, we find that the U.S. has the highest estimate of our key parameter with a posterior mean estimate of $\tau = 0.47$. The estimates for the central banks of the U.K. and Germany come in close behind at 0.42 and 0.43, respectively. Japan is an outlier on the downside, with a full-sample posterior mean estimate of 0.23 for τ.[17]

The full-sample estimation obscures notable subsample instability that is nevertheless concordant across countries. During the Great Moderation sample, the posterior means of τ are higher for all countries. The U.K. exhibits the highest value, with a posterior

[17] As robustness checks, we extend the forward-guidance horizon from 5 to 8 quarters and consider alternative forecasting rules, including cross-variable spillovers and a parsimonious AR(1)-type indirect forecasting rule. The estimated FIRE share and forward-guidance effects remain largely unchanged. Results are available upon request.

mean estimate of τ at 0.57, followed by the U.S. at 0.55, and Germany at 0.45. Japan stands out again as an outlier with a lower posterior mean of 0.33. Unlike the other three countries, Japan has experienced a prolonged period of low interest rates since the early 1990s, encompassing much of the Great Moderation period analyzed here.

In the low-interest-rate sample, the aggregate expectations in all four countries are estimated to significantly favor non-FIRE forecasts relative to the great moderation sample. The U.S. has the highest estimate of τ, with a value of $\tau = 0.39$, However, this figure is only 71 percent of the great moderation posterior mean. In the U.K., the posterior mean ($\tau = 0.32$) is only approximately half its value for the great moderation period. For Germany, similarly to the U.S., the posterior mean ($\tau = 0.33$) is approximately 73 percent of its great moderation value. Japan continues to be an outlier on the downside, with its estimated posterior mean for the low-interest-rate period (0.12) being only one-third its value for the great moderation period (0.33).

A natural interpretation of the decline in τ is that survey expectations became less aligned with the model-consistent benchmark after the GFC. One possibility is reduced trust in central bank communication and forward guidance, leading forecasters to place less weight on announced policy paths (see, e.g., Ehrmann (2025)). Another is a shift in forecasting practices toward greater reliance on judgment and reduced-form time-series models. Evidence from the ECB Survey of Professional Forecasters special survey points in this direction, documenting post-2008 changes in forecasting models, increased use of time-series methods, and a larger role for judgment (European Central Bank (2014)). Our estimates do not separately identify these channels, so we interpret them as complementary rather than distinct mechanisms.

Cross-country differences in τ may similarly reflect variation in monetary policy frameworks, communication strategies, the credibility and salience of forward guidance, and the broader macroeconomic environment faced by forecasters.

4.2 Forward Guidance Shocks Across Time and Countries

We next use our estimated model to measure the contribution of forward guidance shocks to actual policy.

Our benchmark estimates are based on five forward guidance shocks, with anticipation horizons ranging from one quarter to 5 quarters ahead. Measuring the contributions of forward guidance to policy is potentially challenging because a combination of forward guidance shocks can influence not only the level of the policy path—shifting it upward or downward—

but also its shape and slope, potentially steepening, flattening, or even inverting the expected policy rate path. For instance, a negative (expansionary) one-quarter-ahead forward guidance shock combined with a positive (contractionary) 5-quarter-ahead shock could steepen the real interest rate path. Conditional on these news shocks about future monetary policy not being offset by their effects on inflation expectations, this steepening would also appear in the policy path itself, complicating its interpretation and our ability to disentangle the effects of forward guidance.

To overcome the difficulty of assessing how different shifts affect the policy path, we set the parameters at the posterior mean over the full sample and solve an auxiliary version of our model with no forward guidance shocks at all. We use this auxiliary model to measure, at each point in time and for each country, the model-consistent expectation of the nominal short-term interest rate five quarters into the future. We then subtract this expectation from the aggregate expectations of the nominal short-term interest rate five quarters into the future, taking the estimated sequence of smoothed forward guidance shocks into account. The difference between the actual and auxiliary expectation gives us a sense of the contributions of forward guidance to the actual expectations of the nominal short-term interest rate at each point in time and for each country under consideration.

Figure 2 plots the resulting series for each of the four main countries in our sample across time. Positive values of the series indicate that forward guidance was on net hawkish (i.e., the actual expected path of the nominal short-term rate was higher than that in the auxiliary model with forward guidance shocks muted), whereas negative values indicate that forward guidance was on net dovish. The plots generally conform with the conventional narrative of the historical record.

To assess robustness to the assumed shock structure, we augment the benchmark specification with a demand-side disturbance in the IS equation and re-estimate the model.[18] This extension allows us to evaluate whether forward guidance shocks are capturing omitted demand-driven fluctuations. As shown in Figure 2, the estimated contribution of forward guidance remains largely unchanged. The stability of the decomposition across specifications indicates that the identified news shocks are not absorbing standard demand disturbances but instead reflect anticipated changes in the policy stance.

[18] Demand shock is assumed to evolve as an AR(1) process: $dem_t = \rho_{dem} dem_{t-1} + \varepsilon_t^{dem}$, where $\varepsilon_t^{dem} \sim N(0, \sigma^{dem})$. We assume the following prior distributions: $\rho_{dem} \sim B(0.25, 0.01)$ and $\sigma^{dem} \sim IG(0.01, 0.002)$. In addition, we hold fixed the non-shock-related parameters of the model at their posterior estimates from the baseline specification to keep the comparison as close as possible.

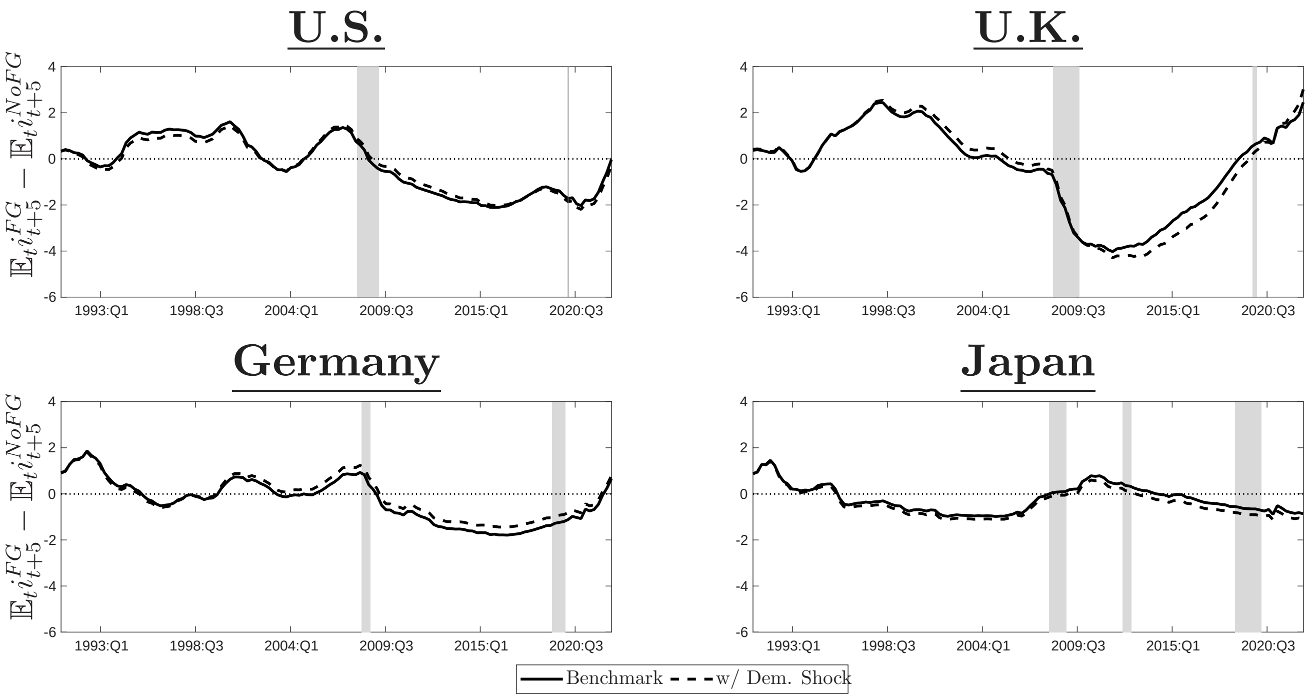

Figure 2: Estimated Forward Guidance Impact on the Expected Nominal Short-Term Interest Rate Five Quarters Ahead Across Time and Countries

Note: $\mathbb{E}_t\left(i_{t+5}^{FG}\right)$ defines the 5-quarter-ahead expectation of the nominal interest rate using equation (17). $\mathbb{E}_t\left(i_{t+5}^{NoFG}\right)$ is defined in the same way as $\mathbb{E}_t\left(i_{t+5}^{FG}\right)$ except in a counterfactual with no forward guidance (that is, where we remove $\sum_{l=1}^{L}\varepsilon_{l,t-l}^{FG}$ from equation (11) by setting it to zero). Shaded bars denote recession dates for each country according to the National Bureau of Economic Research (NBER), Cabinet Office of Japan, and Economic Cycle Research Institute (ECRI).

Consider first the U.S. In the run-up to the GFC, forward guidance switched from dovish to hawkish, putting upward pressure on interest rate forecasts. This coincided with the timing of the Federal Reserve's raising of policy rates. However, as soon as the GFC hits, the series quickly turns negative and remains negative through the end of the sample period. This dovish switch coincides with the Federal Reserve's actively using forward guidance in an attempt to lower long-term vis-à-vis short-term rates to circumvent the constraint of the ZLB, which became binding in December of 2008. At the nadir, the 5-period-ahead forecast of the short-term nominal interest rate is two percentage points lower than the auxiliary forecast without forward guidance shocks, suggesting that forward guidance in fact had a significant impact on the expected path of short-term nominal rates in the U.S.

The picture for the U.K. and Germany is qualitatively similar, while that for Japan is somewhat different and more muted. Overall, we view the results presented in Figure 2 as reassuring. Our estimated model picks up estimated forward guidance shocks that generally align well with the historical record. Next, we turn to analyzing the effectiveness of these shocks across time and space.

4.3 Effectiveness of Forward Guidance Across Time and Space

In this subsection, we analyze the effectiveness of forward guidance across time and space. Starting from the beginning of the sample period, for each country, we perform a rolling estimation exercise to assess the potential contribution of forward guidance shocks to macro variables such as output and inflation over time.[19]

In particular, for each country, we estimate the parameters over a rolling window of 69 observations (17 years and 1 quarter), beginning with the first observation in our sample. Hence, the first subsample period in this rolling window corresponds to the great moderation period and the last to the low-interest-rate period discussed earlier. Given the estimated posterior means of all parameters, we calculate the impulse responses of output and inflation to a 25 bp expansionary forward guidance shock in each window for each country. For the purposes of the presentation in the text, we focus on the response to a 5-quarter-ahead expansionary forward guidance shock (of 25 bp). We also simultaneously track the evolution of our key parameter τ over time.

This exercise also provides a natural bridge to the survey-based evidence on underreaction. In our framework, a lower τ implies that a larger share of agents relies on forecasting rules that do not fully internalize anticipated policy changes, so aggregate expectations respond more sluggishly to forward guidance than under homogeneous FIRE, consistent with the broader evidence in Coibion and Gorodnichenko (2015), Adam et al. (2025), and Born et al. (2025).

[19] Defining output growth Δy_t allows the model to evaluate shock effects on the output level y_t.

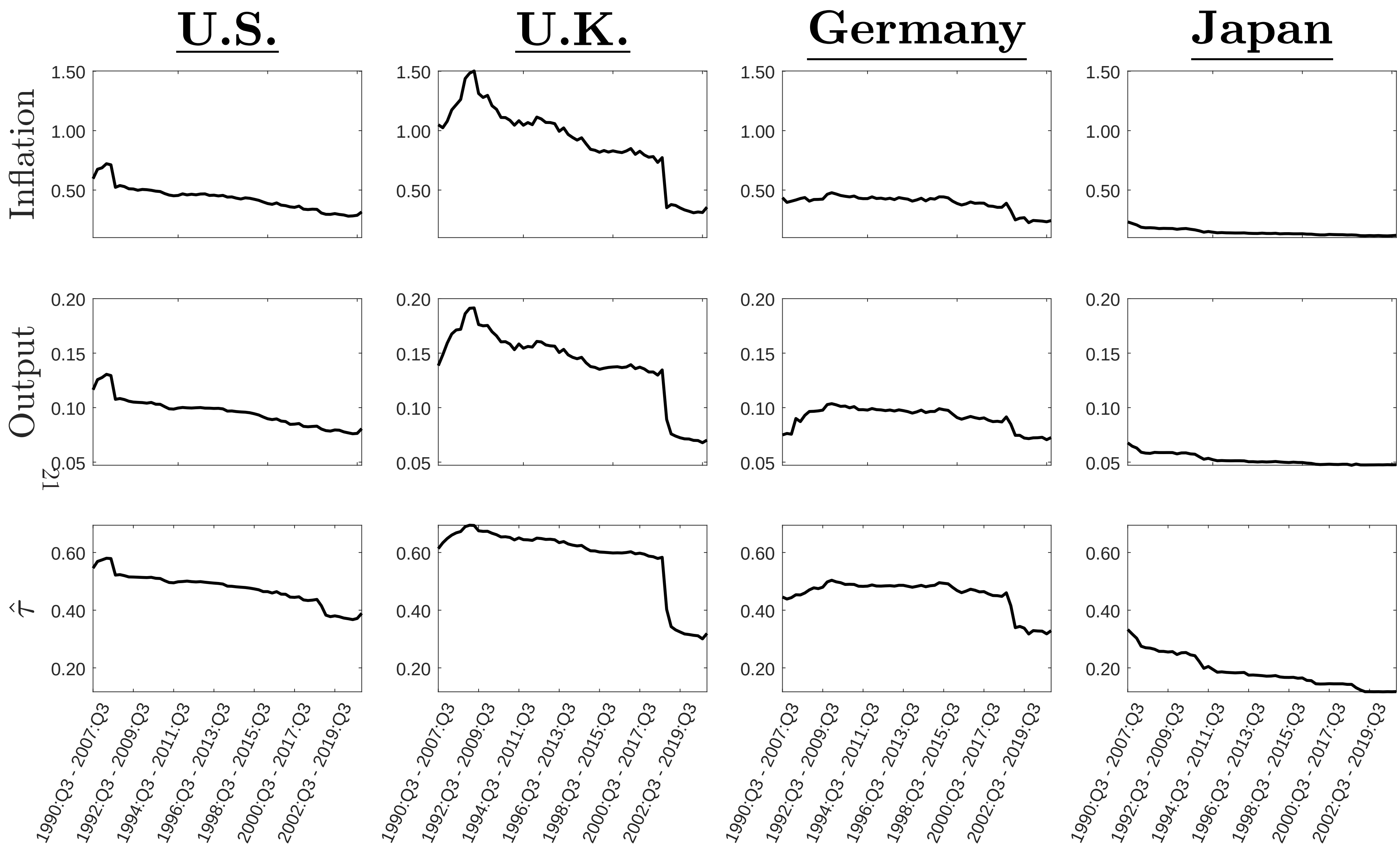

Figure 3: Estimated Impact of a 25 Bps Decrease in $\varepsilon_{5,t}^{FG}$ on Contemporaneous Output and Inflation and Variation in τ over Time and Across Countries

Note: The response of the variables to the forward guidance shock is calculated as the sum under the impulse response function from periods 0 to 5 (aligning with $\varepsilon_{5,t}^{FG}$). We recalculate the responses for each subsample setting the parameter values of the model at their estimated posterior mean for the given subsample. Note that inflation is expressed in annualized percentage points and the impact on output in percentage points.

Our summary measure focuses on periods 0–5 because this window isolates the anticipation effects of forward guidance, which are the aspect most directly tied to policy communication. At the same time, as the mechanism in Subsection 2.4 makes clear, a lower τ can also shift part of the adjustment toward the realization phase and increase persistence after implementation. Hence, the rolling responses in Figure 3 should be interpreted as a summary of the anticipatory effectiveness of forward guidance rather than as an exhaustive measure of its full dynamic effects, which are instead reflected in the counterfactual simulations reported below.

The response up to quarter five is most pertinent for policymakers as it captures the reaction to future central bank promises (the anticipation effects of forward guidance).[20] To summarize the effectiveness of these shocks, we sum the output and inflation impulse responses over this announcement period (i.e., the current quarter through quarter five) and display them in Figure 3. In the bottom row, we show rolling estimates of τ for each country.

We focus first on the column for the U.S. The cumulative output effect of a 5-quarter-ahead forward guidance shock is approximately 0.1 percent on average over all rolling sample periods. After a mild initial uptick, the output effectiveness of forward guidance steadily declines over time, from an initial value of approximately 0.12 percent to approximately 0.08 percent by the end of the sample period. The cumulative inflation response displays a similar pattern. Both of these declines coincide with estimated declines in the parameter τ over time, from an initial value of approximately 0.55 to a final value of approximately 0.40.

The patterns of forward guidance effectiveness for both the U.K. and Germany are qualitatively similar to those for the U.S. After brief initial upticks in the cumulative output and inflation responses, they both steadily decline for these two countries. However, unlike the U.S., both the U.K. and Germany experienced abrupt downward shifts in estimated effectiveness coinciding with the onset of the COVID-19 pandemic. Nevertheless, similar to the U.S., these patterns also mirror the estimated values of τ across time.

Japan is an outlier on the downside as noted above. In addition to having the lowest estimated value of τ, Japan's forward guidance is overall least effective at stimulating output and inflation. However, as in the other countries, the effectiveness of forward guidance in Japan is estimated to have declined over time. The declines in the effectiveness of forward guidance at stimulating output and inflation also coincide with estimated declines in the

[20]From quarter six onward, the impulse response reflects the realization of the promised policy change and the subsequent propagation of the shock. We focus here on periods 0–5 because they isolate the anticipation effects of forward guidance, although expectation heterogeneity can also affect the post-implementation dynamics, as discussed in Subsection 2.4.

country's already-low levels of τ.

4.4 Missing Inflation Episodes

In the wake of the GFC, central banks around the world struggled with troubling episodes of persistently low inflation. This period coincided with the time when major central banks in developed countries faced a binding ZLB on nominal short-term interest rates and explicitly adopted forward guidance as one more arrow in their policy quiver. Thus, a natural question that arises is what would the effect of forward guidance have been during this period had it been deployed when it was most potent (i.e., when $\tau = 1$)?

To answer the previous question, we engage in a counterfactual exercise. In particular, for each of the four major countries considered to this point, we take the model estimations for the low-interest-rate period (2005:Q3–2022:Q3) and extract the smoothed shocks that drive the model's endogenous variables. The smoothed shocks encompass all shocks within the model, including the forward guidance shocks. Taking the smoothed shocks, we set the other estimated parameters at their posterior mean but fix the parameter τ at 1 (all FIRE agents). We then simulate the counterfactual path for key macro variables in each country.

By comparing the observed macro paths with their counterfactuals under $\tau = 1$, we can assess how outcomes might have differed if the public had FIRE expectations fully incorporating forward guidance. In the U.S. case, Figure 4 shows the observed (solid lines) and counterfactual (dashed lines) paths for inflation (percent annualized), output growth (percent annualized), and the nominal interest rate (percent annualized). Our model suggests that, under the most potent forward guidance scenario ($\tau = 1$), inflation would have been slightly higher throughout the GFC and its aftermath, though it would still have dipped into deflation during the 2008 crisis peak. Notably, inflation would have stayed closer to the Fed's 2% target in the years following the GFC, only falling below the observed path after 2015, when forward guidance became more hawkish and the ZLB lifted.

Our counterfactual simulation suggests that a higher inflation path could have been achieved with minimal impact on output growth. While growth would have been more volatile during the GFC—on average higher than in reality but slower in the immediate aftermath—and interest rates would have still briefly reached the ZLB at the peak of the crisis. However, in this scenario, nominal interest rates would have risen above zero before the recession officially ended and remained above zero throughout most of the ZLB period in the U.S. Notably, our counterfactual indicates that the ZLB would not have significantly constrained policy if the public had formed expectations solely with FIRE and the Federal

Reserve had followed the same forward guidance path recovered with the estimated model.

The patterns for the U.K. (Figure 5) and Germany (Figure 6) closely resemble those of the U.S. In both countries, inflation would have been higher during and immediately after the GFC, with the difference between the counterfactual and actual inflation paths particularly pronounced in Germany. As in the U.S., output growth would have been more volatile in the counterfactual with $\tau = 1$ during the GFC. Moreover, in both the U.K. and Germany, the ZLB would not have been a significant constraint, as the short-term nominal interest rate in the counterfactual would never have reached zero.

The case of Japan shares some similarities with the U.S., U.K., and Germany, but also exhibits notable differences. In Japan's counterfactual simulation with $\tau = 1$ (Figure 7), inflation would have been higher during the GFC, though lower than the actual inflation for a few quarters thereafter. In the mid-2010s, inflation would have remained consistently higher in the counterfactual scenario compared to actual levels. The counterfactual path for output growth mirrors that of the other countries: higher and more volatile during the GFC, but lower in the immediate aftermath.

The ZLB would have posed a greater constraint in Japan than in the other countries in our counterfactual analysis, which is not surprising given that Japan faced the ZLB even before the GFC, since the early 1990s. Under $\tau = 1$, the counterfactual path for the short-term nominal interest rate in Japan would have been more negative towards the end of the GFC and for several quarters afterward. However, in the mid-2010s, with higher counterfactual inflation, the ZLB would have been less binding. This suggests that the forward guidance policy, as recovered by our model, would have been less effective in steering Japan's economy away from the ZLB.

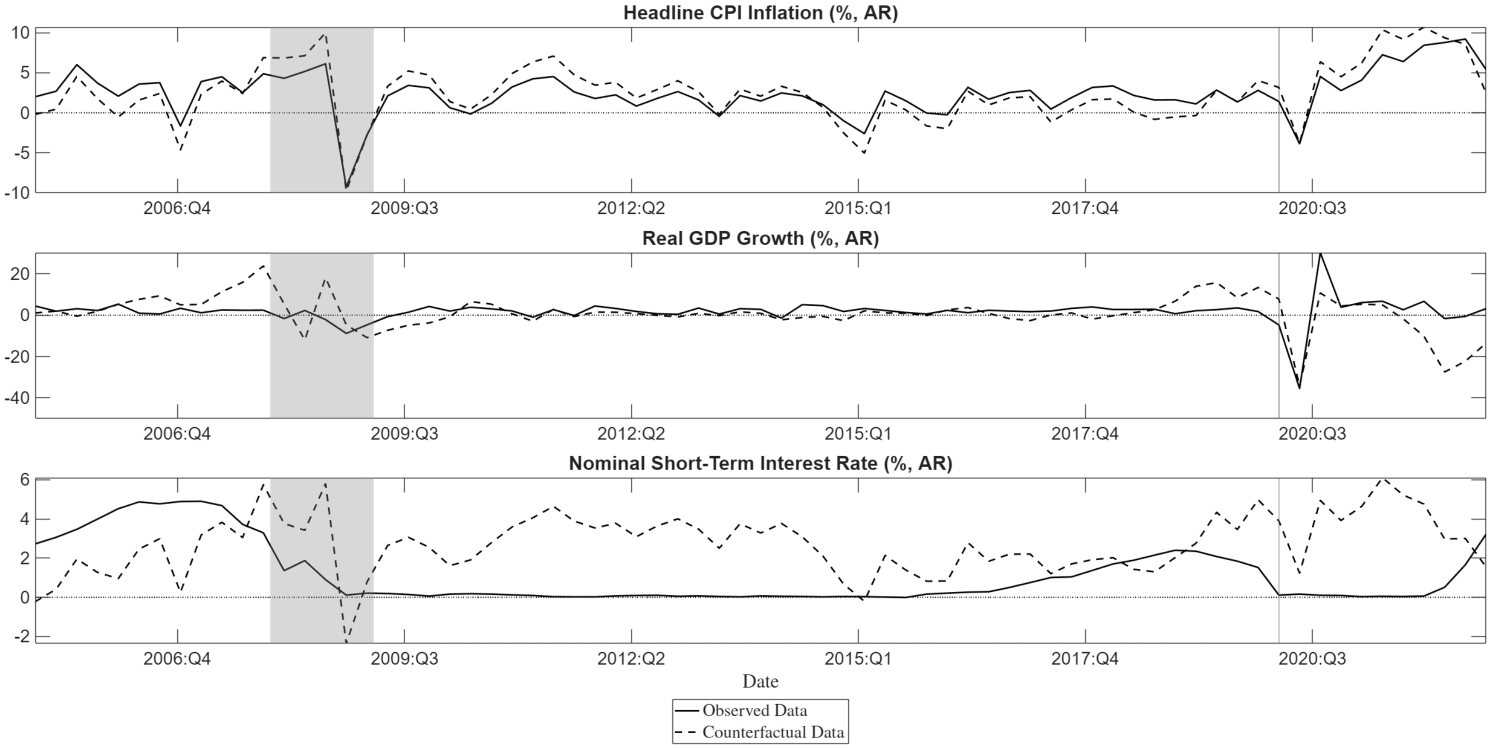

Figure 4: Counterfactual U.S. Inflation, Real GDP Growth, and Nominal Short-Term Interest Rate in the Low-Interest-Rate Period (2005:Q3–2022:Q3) Under $\tau = 1$

Note: The observed and counterfactual inflation, real GDP growth, and nominal short-term (3-month) interest rates series are quoted in percent annualized. We obtain the simulated data by setting the model parameter values to the posterior mean estimated in the low-interest-rate subsample (except for τ, which is fixed at 1) and feeding in the recovered shocks (including the forward guidance shocks). Shaded bars denote NBER recession dates for the U.S.

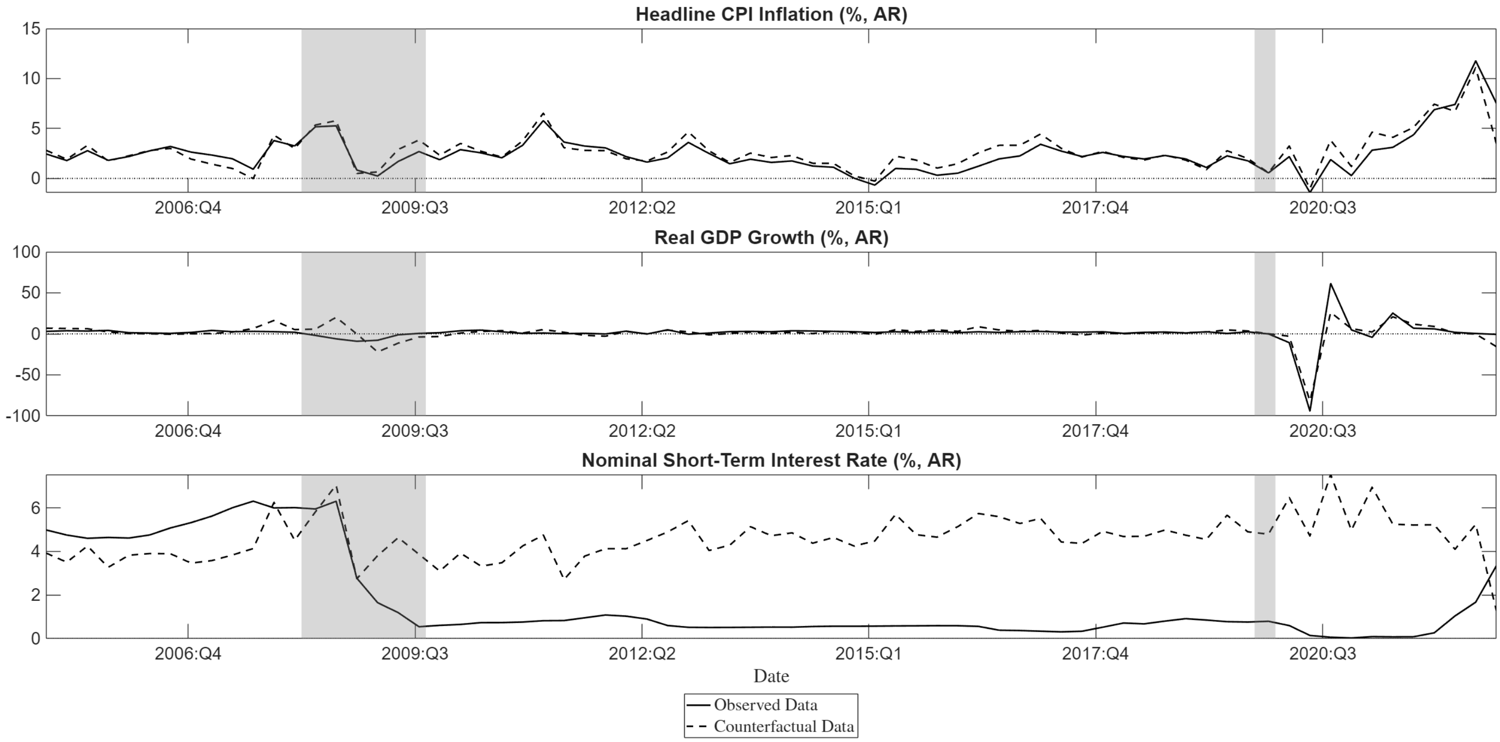

Figure 5: Counterfactual U.K. Inflation, Real GDP Growth, and Nominal Short-Term Interest Rate in the Low-Interest-Rate Period (2005:Q3–2022:Q3) Under $\tau = 1$

*Note:*The observed and counterfactual inflation, real GDP growth, and nominal short-term (3-month) interest rates series are quoted in percent annualized. We obtain the simulated data by setting the model parameter values to the posterior mean estimated in the low-interest-rate subsample (except for τ, which is fixed at 1) and feeding in the recovered shocks (including the forward guidance shocks). Shaded bars denote ECRI recession dates for the U.K.

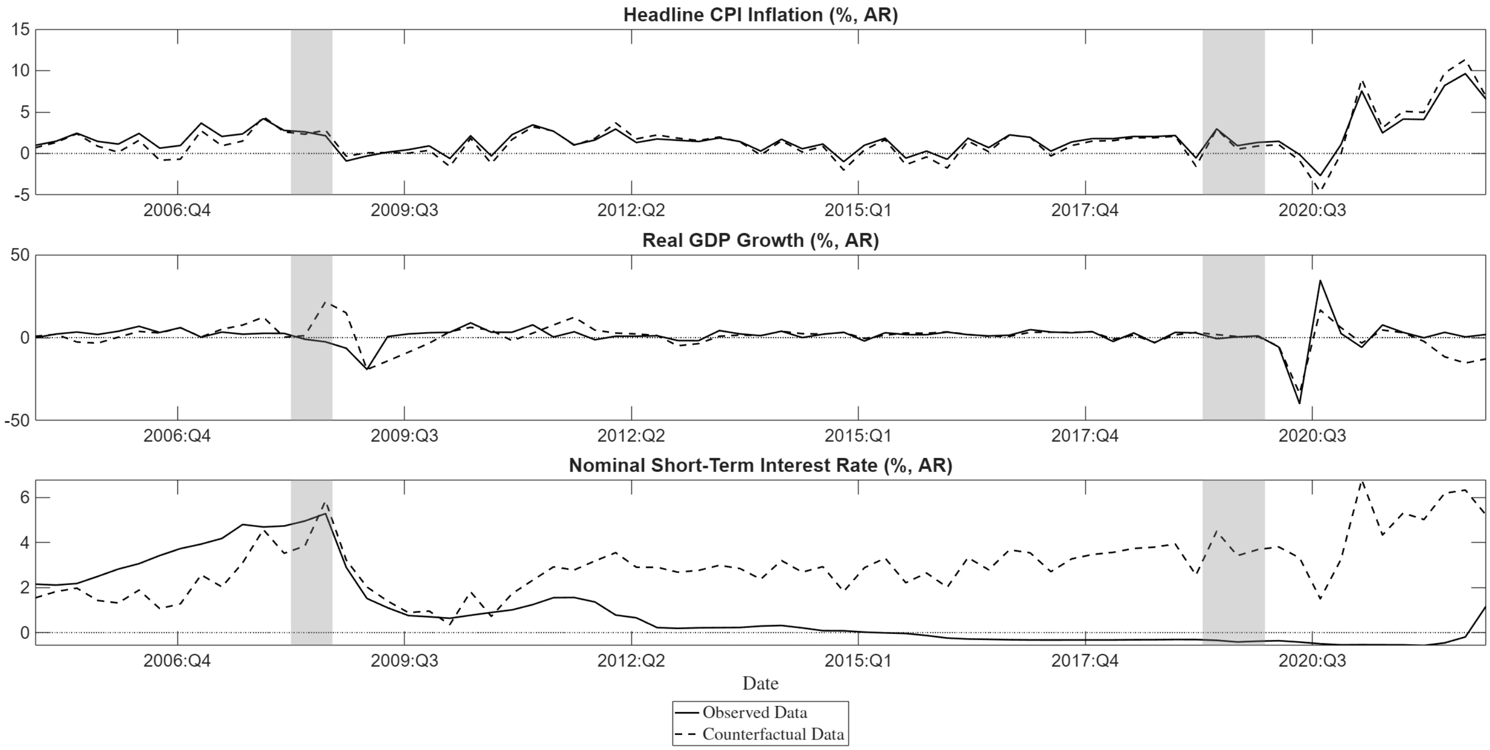

Figure 6: Counterfactual Germany Inflation, Real GDP Growth, and Nominal Short-Term Interest Rate in the Low-Interest-Rate Period (2005:Q3–2022:Q3) Under $\tau = 1$

*Note:*The observed and counterfactual inflation, real GDP growth, and nominal short-term (3-month) interest rates series are quoted in percent annualized. We obtain the simulated data by setting the model parameter values to the posterior mean estimated in the low-interest-rate subsample (except for τ, which is fixed at 1) and feeding in the recovered shocks (including the forward guidance shocks). Shaded bars denote ECRI recession dates for Germany.

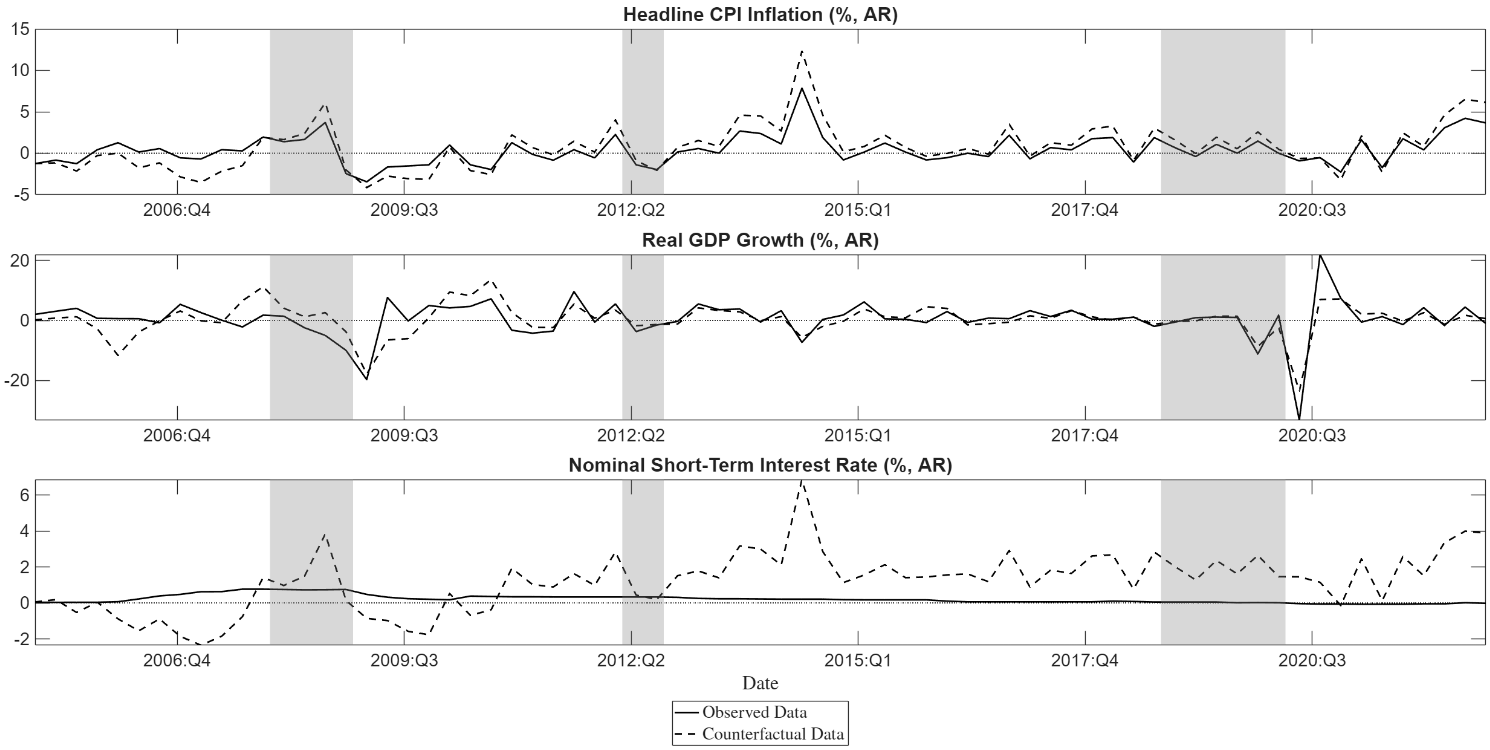

Figure 7: Counterfactual Japan Inflation, Real GDP Growth, and Nominal Short-Term Interest Rate in the Low-Interest-Rate Period (2005:Q3–2022:Q3) Under $\tau = 1$

*Note:*The observed and counterfactual inflation, real GDP growth, and nominal short-term (3-month) interest rates series are quoted in percent annualized. We obtain the simulated data by setting the model parameter values to the posterior mean estimated in the low-interest-rate subsample (except for τ, which is fixed at 1) and feeding in the recovered shocks (including the forward guidance shocks). Shaded bars denote Cabinet Office of Japan recession dates for Japan.

4.5 The Return of Inflation During COVID-19

In the latter half of the 2010s, after several years at the ZLB in the wake of the GFC and its aftermath, interest rates in the U.S. lifted off, and the Federal Reserve began to normalize its balance sheet. These efforts at normalization came to an abrupt end in spring 2020 when the COVID-19 pandemic broke out. The pandemic precipitated an extremely sharp but short-lived recession. Initially, inflation fell, and the Federal Reserve (and other central banks around the world) resorted to using many of the same tools upon which they had relied during the GFC, including extensive forward guidance. The resuscitation of these policies was followed by a quick economic recovery that soon also featured rising inflation. By mid-2021, inflation in developed economies had become high and persistently so. By the end of our sample in 2022:Q3, inflation had only begun to recede, yet it remained well above pre-COVID-19 levels and central banks' own targets.

In the previous subsection, our counterfactual analysis answered the question: would forward guidance have ameliorated the missing inflation post-GFC had it been deployed when it was most potent? We now use the same counterfactual analysis to explore the dynamics of inflation (and other macro variables) during the COVID-19 era. This period is already included in the counterfactual presented in Figures 4– 7, but we hone in on inflation during the COVID-19 period here.

Figure 8 presents the observed (solid lines) and counterfactual (dashed lines) inflation paths for the U.S., the U.K., Germany, and Japan, focusing on the period following the onset of the pandemic. Broadly speaking, the U.S., U.K., and Germany exhibit similar patterns. In the counterfactual scenario, where central banks interact only with FIRE agents ($\tau = 1$), inflation in 2021 would have been higher than observed. However, it would have decreased more sharply across all three countries under $\tau = 1$, and in some cases, earlier. For instance, in the U.S., inflation would have returned to the 2% target by the third quarter of 2022, whereas in actuality, it was still above 5% at that time.

As with previous figures, Japan stands out as an outlier. In the counterfactual simulation for Japan, inflation would have been slightly higher than realized inflation in 2021 and into 2022, similar to the other countries. However, unlike the U.S., U.K., and Germany, Japan's counterfactual inflation would not have decreased toward the end of the sample period.

Overall, the counterfactual analysis presented in this and the previous subsection provides intriguing and compelling insights. In all countries, had the public formed expectations based on FIRE that fully incorporated forward guidance, inflation would have been higher after the GFC, and the ZLB would have remained binding for a much shorter period. Additionally, for three countries—the U.S., the U.K., and Japan—inflation would have turned around and come nearer its target by the end of 2022 in the counterfactual with $\tau = 1$, before actual policy rates began to rise, rather than remaining elevated as observed.

We conclude this subsection with a brief caveat. Our counterfactual exercises treat the sequence of smoothed monetary policy shocks, including forward guidance shocks, as exogenous. However, in reality, these shocks may not be orthogonal to the value of τ—for example, central banks might have issued smaller forward guidance shocks had they believed τ was closer to 1, as opposed to much smaller than 1. As a result, the interpretation of our counterfactual results should be approached with caution. Despite this, we believe our analysis offers intriguing and provocative insights, suggesting that the paths of inflation, interest rates, and, to a lesser extent, output growth, could have been markedly different during the GFC and COVID-19 if the public had fully incorporated central banks' forward guidance statements, as FIRE agents do.

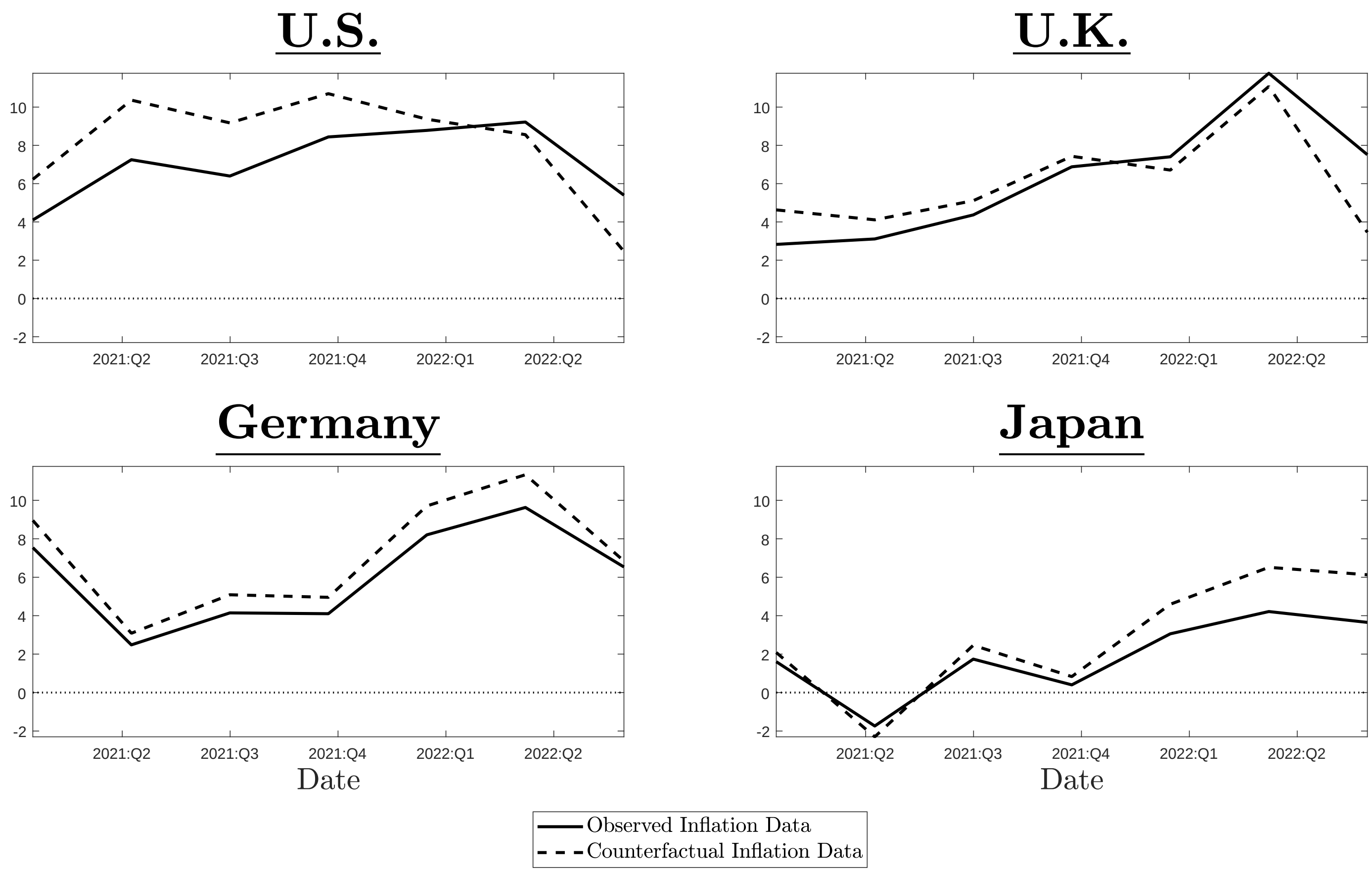

Figure 8: Counterfactual Inflation Across Countries in the Post-COVID-19 Period (2020:Q1–2022:Q3) Under $\tau = 1$

Note: The observed and counterfactual inflation series are quoted in percent annualized. The simulated data are obtained by setting the model parameters to their posterior means estimated for the low-interest-rate period from 2005:Q3 to 2022:Q3, with τ fixed at 1. The recovered shocks, including forward guidance shocks, are then fed into the model. Shaded bars denote the corresponding recession dates according to the NBER, Cabinet Office of Japan, and ECRI.

4.6 Additional Countries

We have thoroughly examined the experiences of the three largest advanced economies—the U.S., Germany, and Japan—along with the U.K., a "smaller" advanced open economy often positioned between the euro area (Germany) and the U.S. In this section, we expand the analysis to include Spain, Italy, France, and Canada, examining the experiences of all G7 countries and Spain, the fourth-largest economy in the euro area. These four countries are "smaller" advanced open economies, akin to the U.K., but with distinct linkages. Canada is closely tied to the U.S., while France, Italy, and Spain have been strongly interconnected with Germany throughout our sample period, initially under the "Maastricht Treaty" criteria for currency union in the 1990s and later through the adoption of the euro. We present the results in Figure 9, based on a rolling estimation exercise similar to that in Subsection 4.3, and in Figure 10, from a counterfactual exercise analogous to that in Subsection 4.5.

Our findings suggest that the behavior of these additional four small open economies did not differ significantly from the baseline results for the U.S. and Germany, in particular. In all these countries, estimates of τ have generally declined over time, leading to a reduction in the effectiveness of forward guidance. As shown in Figure 9, τ estimates have declined over time for all these countries, weakening the impact of forward guidance on output and inflation, as illustrated in the first and second rows. Counterfactual analyses suggest that inflation might have decreased further (and sooner) after COVID-19 if central banks had interacted with FIRE agents fully incorporating forward guidance statements. As shown in Figure 10, the dashed line representing the counterfactual declines faster than the solid line across all countries post-COVID-19. Similar results emerge for the low-inflation period post-GFC. If $\tau = 1$, Appendix B, Figures B1–B4 provide evidence that the ZLB episode would have been shorter, and inflation more in line with central banks' objectives.

Finally, we must add a caveat to these results. An open question remains regarding whether the forward guidance implemented by the central banks of these small open economies was effective on its own or if its impact was due to being "imported" from their respective "anchor" countries (the U.S. for Canada and Germany for France, Italy, and Spain). This issue is especially apparent in the euro area: Was the ECB's forward guidance effective in France, Spain, and Italy because it inherited the credibility of Germany's Bundesbank, or would it have had the same impact if each country's national central bank had implemented it independently? While we cannot fully address this question, we can argue that forward guidance could have at least shortened the low-inflation and low-interest-rate periods had it been deployed when $\tau = 1$—a claim that holds for Canada and the U.K. too.

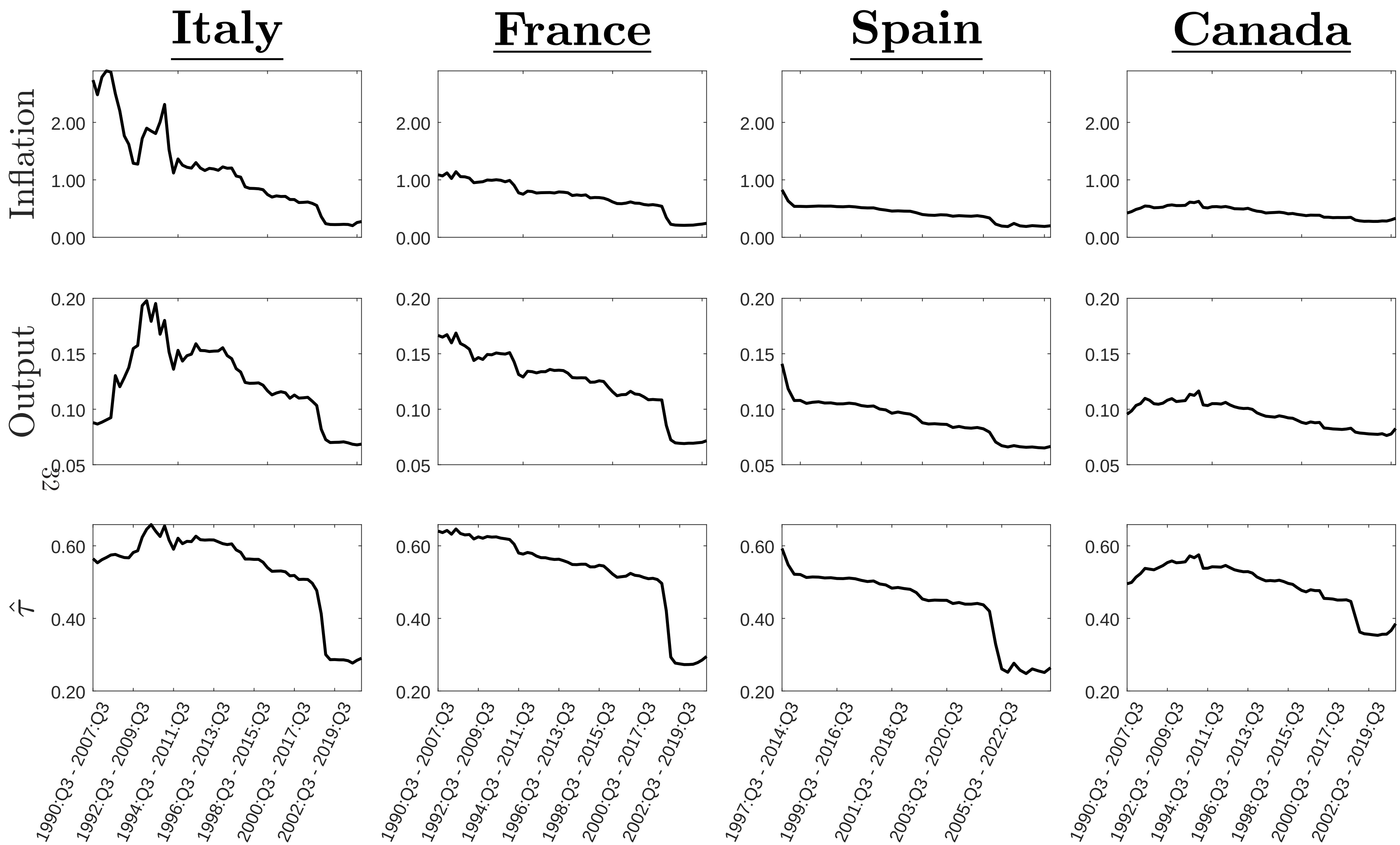

Figure 9: Estimated Impact of a 25 Bps Decrease in $\varepsilon_{5,t}^{FG}$ on Contemporaneous Output and Inflation and Variation in τ over Time and Across Additional Countries

Note: The response of the variables to the forward guidance shock is calculated as the sum under the impulse response function from periods 0–5 (aligning with $\varepsilon_{5,t}^{FG}$). We recalculate the responses for each subsample setting the model parameter values at their estimated posterior mean for the given subsample. Note that inflation is expressed in annualized percentage points and the impact on output in percentage points. Given sample constraints, Spain's data start in 1994:Q3 (not in 1990:Q3, as do those of the other countries).

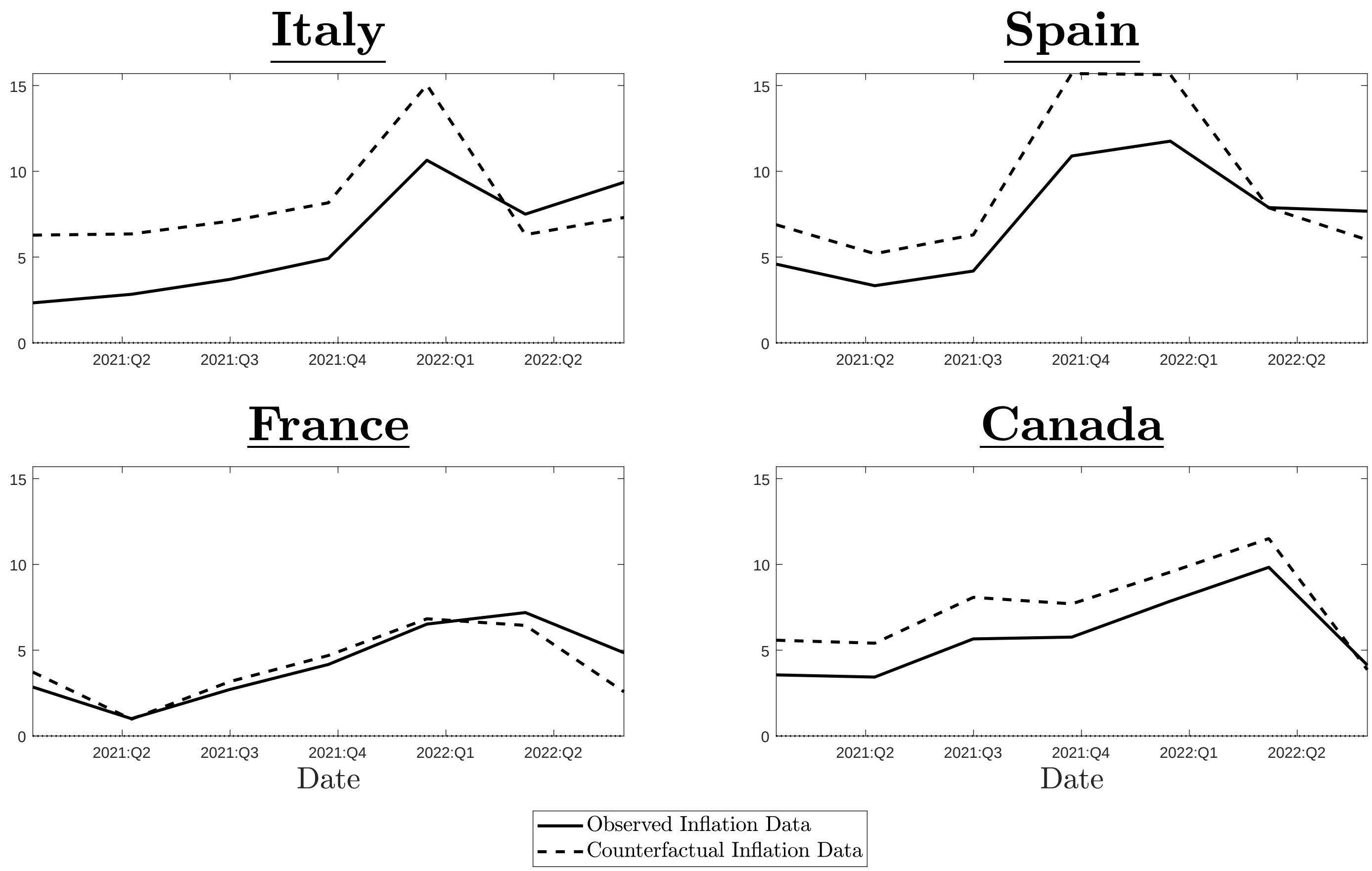

Figure 10: Inflation Counterfactual Across Additional Countries in the Post-COVID-19 Period (2020:Q1–2022:Q3) Under $\tau = 1$

Note: The observed and counterfactual inflation series are percent annualized. The simulated data are obtained by setting the model parameters to their posterior means estimated for the low-interest-rate period from 2005:Q3 to 2022:Q3, with τ fixed at 1. The recovered shocks, including forward guidance shocks, are then fed into the model. Shaded bars denote the corresponding recession dates according to ECRI and the C.D. Howe Institute.

5 Conclusion

Forward guidance, a key tool in the monetary policy arsenal of central banks worldwide, aims to shape expectations by communicating the future policy path. Its effectiveness hinges on whether the public fully incorporates these announcements into their forecasts. When central bank commitments are disregarded, private-sector expectations remain unchanged, nullifying forward guidance's impact on the economy. Conversely, if the public integrates these commitments into their forecasts, forward guidance can anchor expectations and stimulate the economy ahead of the anticipated policy changes.

This paper examines the effectiveness of forward guidance under heterogeneous expectations, both over time and across countries. Our findings reveal key insights. First, the proportion of agents adhering to FIRE and incorporating forward guidance (denoted by τ) varies by country and time. We observe the highest estimate of τ for the U.S., followed closely by Germany and the U.K., while Japan's estimate is notably lower. Additionally, estimates for each country tend to decline over time.

Second, the effectiveness of forward guidance depends on the fraction of FIRE agents incorporating it into their forecasts. Our evidence suggests that monetary policy could have had a stronger impact on supporting inflation and shortening the ZLB period post-GFC if the public fully integrated central banks' forward guidance, as FIRE agents do. This finding helps address the "missing inflation puzzle" that was a focus of the literature before the COVID-19 recession. Notably, we also find that monetary policy could also have played a role in lowering inflation and mitigating its post-COVID-19 surge if the public had fully incorporated central banks' forward guidance.

Altogether, our results suggest that the monetary policies implemented were not inconsistent with the stated objectives of central banks globally, even if their performance may have surprised policymakers, as their effects were weaker than desired (see, e.g., Caldara et al. (2021)). These surprises can, in part, be attributed to the tendency of many central banks' forecasting models to overlook the impact of heterogeneous beliefs in policy analysis and forecasting (see, e.g., Park (2018)). This oversight can reduce the effectiveness of forward guidance and may have caused central banks to apply it more cautiously, fearing overreaction due to its misperceived potency.

Finally, heterogeneity in expectations may reflect underlying credibility issues in central bank communication and policy, presenting a significant challenge to effective policy transmission. If, as Yellen (2006) suggests, misaligned communication fosters expectation heterogeneity, closing the underlying credibility gaps may be key to aligning private-sector expectations and strengthening forward guidance. The cross-country variation in τ points to potential institutional or policy framework differences, while its decline over time raises concerns about the evolution of central bank communication. Further research is needed to examine how credibility influences expectations and policy effectiveness, how forecast heterogeneity can be endogenized, and what this all means for central banking.[21]

[21] A preliminary sketch of an evolutionary game of central bank credibility underpinning τ is provided as an appendix in Cole and Martínez García (2023).

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Appendix

A Data Sources

Observable Variables. The observable variables we use in our estimation include real GDP, headline CPI, and the nominal short-term (3-month) interest rate. These macro data were obtained from the latest vintage available on February 28, 2023. Each of these three observable series is selected to match as closely as possible the counterpart consensus forecasts generated by the private forecasters pooled by Consensus Economics for each country. Each series is properly transformed to be matched with the corresponding endogenous variables of the model collected in the vector $Y_t = [g_t, \pi_t, i_t]'$.

We transform real GDP by computing the log first difference in percentages $\Delta\ln(\text{GDP}_t) \equiv 100{*}(\ln(\text{GDP}_t)\text{-}\ln(\text{GDP}_{t-1}))$, construct headline CPI inflation as the log first difference in percentages $\Delta\ln(\text{CPI}_t) \equiv 100{*}(\ln(\text{CPI}_t)\text{-}\ln(\text{CPI}_{t-1}))$, and convert the nominal short-term (3-month) interest rate, which is reported in annualized rates, to nonannualized percentages by dividing each observation by four such that we end up with $\text{INTEREST}_t/4$.

The data are measured at quarterly frequency and, after being transformed, span the period from third quarter 1990 until third quarter 2022 (129 observations) for Canada, France, Germany, Italy, Japan, the U.K., and the U.S. For Spain, we collect a slightly shorter time series that, because of data limitations, starts only in third quarter 1994 but still ends in third quarter 2022 (113 observations).

The sources of the observable variables used in our analysis by country are as follows:

Real GDP: Canada Gross Domestic Product (SA, Mil. Chained 2012 C$) from Haver/Statistics Canada (mnemonic: S156NGPC@G10); France Gross Domestic Product (SWDA, Mil. Chained 2014 Euros) from Haver/Institut National de la Statistique et des Etudes Economiques (mnemonic: S132NGPC@G10); Germany Gross Domestic Product (SWDA, Bil. Chained 2015 Euros) from Haver/Deutsche Bundesbank (mnemonic: S134NGPC@G10); Italy Gross Domestic Product (SWDA, Mil. Chained 2015 EUR) from Haver/Istituto Nazionale di Statistica (mnemonic: S136NGPC@G10); Japan Gross Domestic Product (SA, Bil. Chained 2015 Yen) from Haver/Cabinet Office of Japan (mnemonic: S158NGPC@G10); Spain Gross Domestic Product (SWDA, Mil. Chained 2015 Euros) from Haver/Instituto Nacional de Estadistica (mnemonic: S184NGPC@G10) starting in first quarter 1995 extended backward with the growth rates of another series, Spain Gross Domestic Product, Volume, Market Prices (SAAR, Mil. Chained 2015 Euros) from Haver/OECD (mnemonic: Q184GDPC@OUTLOOK); U.K. Gross Domestic Product (SA, Mil. Chained 2019 Pounds) from Haver/Office for National Statistics (mnemonic: S112NGPC@G10); U.S. Gross Domestic Product (SA, Bil. Chained 2012$) from Haver/Bureau of Economic Analysis (mnemonic: S111NGPC@G10).

Headline CPI: Canada Consumer Price Index (SA/H, 2002=100) from Haver/Statistics Canada (mnemonic: H156PC@G10); France Consumer Price Index (SA/H, 2015=100) from Haver/Institut National de la Statistique et des Etudes Economiques (mnemonic: H132PC@G10); Germany Consumer Price Index (SA, 2020=100) from Haver/Deutsche Bundesbank (mnemonic: S134PC@G10); Italy Consumer Price Index (SA, 2015=100) from Haver/Istituto Nazionale di Statistica (mnemonic: H136PC@G10); Japan Consumer Price Index (SA/H, 2020=100) from Haver/Ministry of Internal Affairs and Communications of Japan (mnemonic: H158PC@G10); Spain Consumer Price Index (SA, 2021=100) from Haver/Instituto Nacional de Estadistica (mnemomic: H184PC@G10); U.K. CPI Harmonized: All Items (SA, 2015=100) from Haver/Office for National Statistics (mnemonic: H112PC@G10) starting in fourth quarter 2003 to compute the corresponding inflation rates from first quarter 2004 onward and U.K. Retail Price Index: All Items excluding Mortgage Interest Rates (SA, 2010=100) from Haver/OECD (mnemonic: C112PRXN@OECDMEI) to compute the inflation rates up to fourth quarter 2003;[22] U.S. Consumer Price Index (SA, 1982-84=100) from Haver/Bureau of Labor Statistics (mnemonic: S111PC@G10).

Nominal Short-Term (3-month) Interest Rate (end of period (EOP)): Canada 3-Month Treasury Bill Yield (EOP, % per annum) from Haver/Bank of Canada (mnemonic: N156G3ME@G10); 3-Month EURIBOR Euro Interbank Offered Rate Rate (EOP, % per annum) from Haver/Deutsche Bundesbank (mnemonic: N023RI3E@G10) starting in first quarter 1999 and France 3-Month PIBOR Paris Interbank Offered Rate (EOP, % per annum) from Haver/OECD (mnemonic: C132FRIO@OECDMEI) until fourth quarter 1998; 3-Month EURIBOR Euro Interbank Offered Rate (EOP, % per annum) from Haver/Deutsche Bundesbank (mnemonic: N023RI3E@G10) starting in first quarter 1999 and Germany 3-Month FIBOR Frankfurt Interbank Offered Rate (EOP, % per annum) from Haver/OECD (mnemonic: C134FRIO@OECDMEI) until fourth quarter 1998; 3-Month EURIBOR Euro

[22] The retail price index excluding mortgage interest payments was the U.K.'s target inflation measure from fourth quarter 1992 to fourth quarter 2003 and was replaced as the Bank of England's official inflation target by the consumer price index starting only in 2004.

Interbank Offered Rate (EOP, % per annum) from Haver/Deutsche Bundesbank (mnemonic: N023RI3E@G10) starting in first quarter 1999 and Italy 3-Month Interbank Deposit Rate (EOP, % per annum) from Haver/OECD (mnemonic: C136FRIO@OECDMEI) until fourth quarter 1998; Japan 3-Month Japanese Yen TIBOR Tokyo Interbank Offered Rate (EOP, % per annum) from Haver/Refinitiv (mnemonic: T158Y3ME@INTWKLY) starting in second quarter 2010 and Japan 3-Month Certificates of Deposit (Gensaki) Rate (EOP, % per annum) from Haver/OECD (mnemonic: C136FRIO@OECDMEI) until first quarter 2010;[23] 3-Month EURIBOR Euro Interbank Offered Rate (EOP, % per annum) from Haver/Deutsche Bundesbank (mnemonic: N023RI3E@G10) starting in first quarter 1999 and Spain 86–96 Day Interbank Rate (EOP, % per annum) from Haver/OECD (mnemonic: C184FRIO@OECDMEI) until fourth quarter 1998; U.K. 3-Month LIBOR London Interbank Offered Rate based on the British Pound (EOP, % per annum) from Haver/Intercontinental Exchange (mnemonic: N112RI3E@G10); U.S. 3-Month Treasury Bill Rate, Secondary Market (EOP, % per annum) from Haver/Federal Reserve Board (mnemonic: FTBS3@DAILY).

Recession dates: The recession dates used for the shaded bars are from ECRI, the Cabinet Office of Japan, C.D. Howe Institute, and the NBER (Haver mnemonic for Canada: N156VRM@G10; Haver mnemonic for France: N132VRM@G10; Haver mnemonic for Germany: N134VRM@G10; Haver mnemonic for Italy: N136VRM@G10; Haver mnemonic for Japan: N158VRM@G10; Haver mnemonic for Spain: N184VRM@G10; Haver mnemonic for the U.K.: N112VRM@G10; and Haver mnemonic for the U.S.: N111VRM@G10).

Private Forecasts. We collect the mean of all relevant private forecasts—that is, the mean forecasts for $\left(\mathbb{E}_t\left(\Delta^4 y_{t+1}\right), \mathbb{E}_t\left(\Delta^4 y_{t+2}\right), \mathbb{E}_t\left(\Delta^4 p_{t+1}\right), \mathbb{E}_t\left(i_{t+1}\right), ..., \mathbb{E}_t\left(i_{t+L}\right)\right)$—which are part of the vector of observables $\overline{Y}_t$ (as indicated in (19)). The mean (consensus) forecasts correspond to the arithmetic average of the forecasts of all private forecasters pooled by Consensus Economics for each variable and country. Given that not every forecasting organization specializes in the same countries, the pool of private forecasters varies across the eight G7+ countries included in the sample.

The last release of private forecasts available for our analysis is that of December 5, 2022, while the first near-complete release we can use is that of July 2, 1990 (except for

[23]The Japanese yen TIBOR rate was introduced in fourth quarter 1995 as the daily reference interest rate at which banks offer to lend unsecured funds to each other in the interbank market. However, the private forecasters pooled by Consensus Economics were not asked to start forecasting the TIBOR rate until second quarter 2010, once the TIBOR rate was already well established. For consistency, we adopt the same switch date implemented for the private forecasts for the corresponding observable series.

Spain, for which the complete forecasting data start only with the release of December 12, 1994).[24] There are four quarterly releases of private forecasts per year that are available simultaneously for each country at fairly regular intervals from 1992 onward; however, there are only three forecast releases for the years 1990 and 1991, and we need to complete the data for those two years by interpolating appropriately.

We map each of the two years that have three releases (1990 and 1991) into four-quarterly series per year, matching the release of July 2, 1990, with third quarter 1990, the release of November 5, 1990, with fourth quarter 1990, the release of February 4, 1991, with first quarter 1991, the release of July 1, 1991, with third quarter 1991, and the release of November 4, 1991, with fourth quarter 1991. Then, we complement these series by averaging the corresponding forecasts from the releases of February 4 and July 1, 1991, to impute a series of plausible forecasts for the missing series corresponding to second quarter 1991. For the sake of completeness, the first full release that we end up using for all countries other than Spain is the November 5, 1990, one because the release of July 2, 1990, has a shorter forecasting horizon than that available in all subsequent releases.[25]

Measurement concept. From each release, we collect the mean forecasts for real GDP growth (4-quarter percent change), headline CPI inflation (4-quarter percent change), and the nominal short-term (3-month) interest rate (EOP, % per annum). All forecasts are based on the measurement concept of the observed real GDP, headline CPI, and nominal 3-month interest rate series described earlier for each country. As indicated before, the inflation forecasts for the U.K. switched from an inflation rate based on the retail price index (all items excluding mortgage interest rates) prior to first quarter 2004 to the headline CPI inflation rate from first quarter 2004. Similarly, Japan's 3-month interest rate forecasts switched to the TIBOR rate starting in second quarter 2010 but refer to the 3-month

[24]There are two prior releases from November 10, 1989, and March 5, 1990, that we simply cannot use because they do not include any forecasts of the 3-month interest rate.

[25]In our empirical analysis, we are able to reasonably extrapolate the forecasts for the nominal short-term interest rate up to 8 quarters ahead to consider this longer forecasting horizon in a robustness check. Forecasts for the nominal 3-month interest rates are available up to 7 quarters ahead in almost all cases except for July 2, 1990, for which the forecasts are available only up to 6 quarters ahead. Furthermore, for approximately half the releases, there is a full set of 8-quarter-ahead forecasts. We drop the July 2, 1990, release and extend the missing eighth forecast for the 7-quarter-ahead releases by simply replicating the last forecast reported in place of the forecast for eighth-quarter horizon. Dropping the first release of July 2, 1990, to avoid dealing with the two missing observations, however, is without loss of generality and does not appear to materially affect our results. As an additional robustness check, we considered dropping the years 1990 and 1991 to start our sample in first quarter 1992 to avoid entirely the years with only three forecast releases. Our findings with a 5-quarter-ahead (and even an 8-quarter-ahead) forecasting horizon are robust when we use this shorter time series sample, as well.

certificate of deposit (gensaki) rate prior to second quarter 2010. We adopt the same conceptual switches for the observed data.

Variable matching for forecasts. To ensure that the mapping between the model-based expectations and the forecasting data from Consensus Economics is as close as possible, we need to transform the forecasted variables. Both the real GDP growth rate and the headline CPI inflation rate forecasts are given in 4-quarter percentage changes that can be approximated as $\Delta^4\ln(\mathrm{GDP}_t) \equiv 100^*(\ln(\mathrm{GDP}_t)\text{-}\ln(\mathrm{GDP}_{t-4}))$ and $\Delta^4\ln(\mathrm{CPI}_t) \equiv 100^*(\ln(\mathrm{CPI}_t)\text{-}\ln(\mathrm{CPI}_{t-4}))$, respectively. To make practical the estimation of the model with the given forecasts, we added two measurement equations that approximate the relationship between the quarter-over-quarter growth rates defined by the model and the 4-quarter percentage change forecast data we collect (as can be seen in Section 3, equation (20)). We simply divide the nominal short-term (3-month) interest rate forecasts in percent per annum by 4 to express them in (nonannualized) percent terms as we do for the corresponding observed nominal 3-month interest rate.

Forecast timing. The timing of the forecasts is conditioned on the information available to the private forecasters. All forecasting data are expressed at quarterly frequency, and each release adds forecasts up to at most 8 quarters ahead starting from the current quarter. For example, the latest release available at the time of this analysis came out on December 5, 2022, for all countries and included seven forecasts from fourth quarter 2022 until second quarter 2024. The private forecasters' data collection procedures require that the forecasts included in the December 5, 2022, release were submitted by the middle of the fourth quarter 2022, if not earlier. Hence, given that monetary policy shifts that can meaningfully alter the nominal 3-month interest rate are infrequent—in the U.S., for example, six or seven weeks pass between each regular Federal Open Market Committee (FOMC) meeting—and to account for the known publication lags on macro data in particular, we argue that the information set available to private forecasters when predicting fourth quarter 2022 and subsequent quarters for the December 5, 2022 release is likely based on information only up to third quarter 2022.[26] We adopt this timing convention when matching the model-based

[26]As indicated earlier, the date of each release is the same for all countries. However, over time, the timing of the releases has varied somewhat between mid-February and mid-March for the first quarter of the year, between mid-May and mid-June for the second quarter, between mid-August and mid-September for the third quarter, and between mid-November and mid-December for the fourth quarter. The earlier dates on prior releases, however, reinforce our view that the information set used for forecasting likely contained information up to the quarter preceding the release.

expectations to the survey-based forecasts for all releases and across all countries. Other timing matching conventions are explored by Cole and Martínez García (2023), who find that the impact on the results is largely negligible.

Forecasting horizon selection. As indicated in Section 3, we collect the one-quarter-ahead and two-quarter-ahead forecast data for the real GDP growth rate (4-quarter percent change) and the one-quarter-ahead data for the headline CPI inflation rate (4-quarter percent change). For the nominal 3-month interest rate, we collect forecasts completed or extrapolated up to 8 quarters ahead. However, in our benchmark estimation, we rely on data up to 5 quarters ahead (all of which require no manipulation or interpolation/extrapolation). What our use of 5-quarter-ahead forecasts means is that, from the last available release of December 5, 2022, we have forecasts based on information up to third quarter 2022 that start with the 3-month interest rate projected for fourth quarter 2022 to fourth quarter 2023. (In turn, the extension to 8-quarter-ahead forecasts that we pursue as a robustness check means that these projections go from fourth quarter 2022 up to third quarter 2024, with the last quarter being extrapolated based on the prediction for second quarter 2024).

B Additional Tables and Figures

Table B1: **U.S. Prior and Posterior Estimates of Structural Parameters**

	Prior Distr.	Posterior Distribution								
		Full Sample (1990:Q3–2022:Q3)			Great Moderation (1990:Q3–2007:Q3)			Low-Interest-Rate Period (2005:Q3–2022:Q3)		
Par.	Prior	Mean	5%	95%	Mean	5%	95%	Mean	5%	95%
τ	U(0, 1)	0.47	0.44	0.5	0.55	0.49	0.6	0.39	0.35	0.43
ρ	B(0.75, 0.10)	0.98	0.97	0.99	0.97	0.95	0.98	0.98	0.97	0.99
χ_π	N(1.50, 0.10)	1.48	1.31	1.64	1.48	1.32	1.65	1.49	1.32	1.65
χ_x	N(0.125, 0.05)	0.12	0.04	0.19	0.13	0.04	0.21	0.12	0.04	0.20
ρ_μ	B(0.50, .20)	0.03	0.00	0.06	0.03	0.00	0.06	0.08	0.01	0.14
ρ_γ	B(0.50, 0.10)	0.10	0.09	0.11	0.14	0.11	0.17	0.10	0.09	0.11
η	B(0.50, 0.01)	0.47	0.45	0.48	0.50	0.48	0.51	0.48	0.47	0.50
ξ_p	G(0.15, 0.05)	0.16	0.07	0.24	0.15	0.07	0.22	0.15	0.07	0.22
σ_γ	IG(0.30, 0.30)	1.83	1.64	2.02	0.72	0.61	0.82	2.27	1.96	2.58
σ_μ	IG(0.30, 2.00)	0.44	0.4	0.49	0.31	0.26	0.35	0.56	0.48	0.63
σ_{MP}	IG(0.30, 2.00)	0.21	0.18	0.24	0.18	0.14	0.21	0.23	0.18	0.29
σ_1^{FG}	IG(0.30, 2.00)	0.18	0.14	0.22	0.17	0.13	0.20	0.17	0.08	0.26
σ_2^{FG}	IG(0.30, 2.00)	0.12	0.10	0.14	0.09	0.07	0.11	0.18	0.12	0.24
σ_3^{FG}	IG(0.30, 2.00)	0.06	0.05	0.06	0.06	0.04	0.07	0.07	0.05	0.09
σ_4^{FG}	IG(0.30, 2.00)	0.04	0.04	0.05	0.05	0.04	0.06	0.06	0.05	0.07
σ_5^{FG}	IG(0.30, 2.00)	0.07	0.06	0.08	0.06	0.05	0.07	0.07	0.06	0.09
var_{1x1}	B(0.50, 0.20)	0.97	0.92	1.00	0.32	0.07	0.55	0.72	0.49	0.94
var_{1x2}	B(0.50, 0.20)	0.91	0.86	0.97	0.72	0.49	0.95	0.62	0.32	0.94
$var_{2\pi}$	B(0.50, 0.20)	0.08	0.03	0.13	0.06	0.01	0.10	0.10	0.03	0.16
var_{3i}	B(0.50, 0.20)	0.90	0.86	0.94	0.85	0.78	0.91	0.87	0.82	0.93
var_{3i2}	B(0.50, 0.20)	0.84	0.78	0.90	0.83	0.75	0.91	0.85	0.78	0.92
var_{3i3}	N(0.50, 0.20)	0.81	0.74	0.89	0.81	0.72	0.90	0.82	0.74	0.90
var_{3i4}	N(0.10, 0.20)	0.78	0.69	0.87	0.76	0.66	0.86	0.79	0.70	0.88
var_{3i5}	N(0.10, 0.20)	0.73	0.63	0.83	0.66	0.55	0.78	0.75	0.65	0.85

Note: The forecasting relationships for the private agents who rely on a VAR model are

$$\begin{bmatrix} \mathbb{E}_t^{VAR}(\Delta y_{t+1}) \\ \mathbb{E}_t^{VAR}(\Delta y_{t+2}) \\ \mathbb{E}_t^{VAR}(\pi_{t+1}) \\ \mathbb{E}_t^{VAR}(i_{t+1}) \\ \mathbb{E}_t^{VAR}(i_{t+2}) \\ \mathbb{E}_t^{VAR}(i_{t+3}) \\ \mathbb{E}_t^{VAR}(i_{t+4}) \\ \mathbb{E}_t^{VAR}(i_{t+5}) \end{bmatrix} = \begin{bmatrix} var_{1x1} & 0 & 0 \\ var_{1x2} & 0 & 0 \\ 0 & var_{2\pi} & 0 \\ 0 & 0 & var_{3i} \\ 0 & 0 & var_{3i2} \\ 0 & 0 & var_{3i3} \\ 0 & 0 & var_{3i4} \\ 0 & 0 & var_{3i5} \end{bmatrix} \begin{bmatrix} y_t \\ \pi_t \\ i_t \end{bmatrix}.$$

Table B2: **U.K. Prior and Posterior Estimates of Structural Parameters**

	Prior Distr.	Posterior Distribution								
		Full Sample (1990:Q3–2022:Q3)			Great Moderation (1990:Q3–2007:Q3)			Low-Interest-Rate Period (2005:Q3–2022:Q3)		
Par.	Prior	Mean	5%	95%	Mean	5%	95%	Mean	5%	95%
τ	U(0, 1)	0.42	0.39	0.45	0.57	0.52	0.62	0.32	0.28	0.36
ρ	B(0.75, 0.10)	0.94	0.92	0.95	0.94	0.92	0.96	0.94	0.92	0.95
χ_π	N(1.50, 0.10)	1.47	1.31	1.63	1.49	1.32	1.65	1.49	1.33	1.66
χ_x	N(0.125, 0.05)	0.21	0.16	0.27	0.15	0.08	0.20	0.21	0.15	0.27
ρ_μ	B(0.50, .20)	0.04	0.01	0.08	0.10	0.01	0.18	0.07	0.01	0.12
ρ_γ	B(0.50, 0.10)	0.12	0.11	0.13	0.15	0.12	0.19	0.12	0.11	0.13
η	B(0.50, 0.01)	0.45	0.44	0.46	0.50	0.49	0.52	0.47	0.45	0.48
ξ_p	G(0.15, 0.05)	0.18	0.09	0.26	0.18	0.09	0.27	0.17	0.08	0.26
σ_γ	IG(0.30, 0.30)	3.75	3.36	4.13	0.71	0.59	0.82	4.88	4.21	5.54
σ_μ	IG(0.30, 2.00)	0.25	0.22	0.28	0.23	0.18	0.27	0.29	0.25	0.33
σ_{MP}	IG(0.30, 2.00)	0.26	0.23	0.30	0.16	0.13	0.19	0.35	0.28	0.43
σ_1^{FG}	IG(0.30, 2.00)	0.27	0.23	0.32	0.17	0.14	0.21	0.36	0.28	0.44
σ_2^{FG}	IG(0.30, 2.00)	0.14	0.12	0.16	0.09	0.07	0.11	0.20	0.15	0.24
σ_3^{FG}	IG(0.30, 2.00)	0.07	0.05	0.08	0.06	0.05	0.07	0.09	0.07	0.11
σ_4^{FG}	IG(0.30, 2.00)	0.05	0.04	0.06	0.05	0.04	0.06	0.07	0.05	0.08
σ_5^{FG}	IG(0.30, 2.00)	0.07	0.06	0.08	0.06	0.05	0.07	0.08	0.06	0.10
var_{1x1}	B(0.50, 0.20)	0.98	0.96	1.00	0.99	0.98	1.00	0.96	0.93	0.99
var_{1x2}	B(0.50, 0.20)	0.74	0.66	0.83	0.88	0.82	0.94	0.72	0.58	0.86
$var_{2\pi}$	B(0.50, 0.20)	0.73	0.67	0.80	0.35	0.12	0.57	0.76	0.68	0.84
var_{3i}	B(0.50, 0.20)	0.84	0.82	0.87	0.79	0.74	0.84	0.85	0.81	0.89
var_{3i2}	B(0.50, 0.20)	0.77	0.74	0.81	0.73	0.66	0.79	0.78	0.73	0.83
var_{3i3}	N(0.50, 0.20)	0.73	0.68	0.77	0.67	0.59	0.75	0.73	0.67	0.79
var_{3i4}	N(0.10, 0.20)	0.69	0.64	0.74	0.62	0.52	0.72	0.70	0.63	0.77
var_{3i5}	N(0.10, 0.20)	0.66	0.61	0.72	0.60	0.49	0.71	0.66	0.58	0.74

Note: The parameters $var_{1x1}, var_{1x2}, \ldots, var_{3i5}$ are defined in Table B1.

Table B3: **Germany Prior and Posterior Estimates of Structural Parameters**

	Prior Distr.	Posterior Distribution								
		Full Sample (1990:Q3–2022:Q3)			Great Moderation (1990:Q3–2007:Q3)			Low-Interest-Rate Period (2005:Q3–2022:Q3)		
Par.	Prior	Mean	5%	95%	Mean	5%	95%	Mean	5%	95%
τ	U(0, 1)	0.43	0.40	0.47	0.45	0.40	0.49	0.33	0.29	0.37
ρ	B(0.75, 0.10)	0.96	0.95	0.97	0.98	0.97	0.99	0.98	0.97	0.99
χ_π	N(1.50, 0.10)	1.47	1.31	1.63	1.49	1.32	1.66	1.50	1.33	1.66
χ_x	N(0.125, 0.05)	0.21	0.14	0.29	0.11	0.03	0.19	0.12	0.04	0.21
ρ_μ	B(0.50, .20)	0.03	0.00	0.06	0.03	0.00	0.06	0.12	0.02	0.21
ρ_γ	B(0.50, 0.10)	0.11	0.10	0.12	0.11	0.09	0.13	0.11	0.10	0.12
η	B(0.50, 0.01)	0.46	0.44	0.47	0.50	0.48	0.51	0.47	0.46	0.49
ξ_p	G(0.15, 0.05)	0.16	0.07	0.24	0.16	0.07	0.24	0.14	0.07	0.22
σ_γ	IG(0.30, 0.30)	2.14	1.92	2.36	1.28	1.09	1.46	2.62	2.25	2.97
σ_μ	IG(0.30, 2.00)	0.38	0.34	0.41	0.35	0.31	0.40	0.38	0.32	0.43
σ_{MP}	IG(0.30, 2.00)	0.19	0.16	0.22	0.19	0.15	0.23	0.23	0.18	0.28
σ_1^{FG}	IG(0.30, 2.00)	0.17	0.13	0.22	0.19	0.13	0.24	0.13	0.08	0.19
σ_2^{FG}	IG(0.30, 2.00)	0.14	0.11	0.17	0.10	0.07	0.13	0.23	0.17	0.29
σ_3^{FG}	IG(0.30, 2.00)	0.06	0.05	0.07	0.06	0.05	0.08	0.08	0.06	0.10
σ_4^{FG}	IG(0.30, 2.00)	0.05	0.04	0.06	0.06	0.04	0.07	0.07	0.05	0.08
σ_5^{FG}	IG(0.30, 2.00)	0.06	0.05	0.07	0.06	0.05	0.07	0.07	0.05	0.08
var_{1x1}	B(0.50, 0.20)	0.98	0.97	1.00	0.90	0.86	0.94	0.78	0.62	0.94
var_{1x2}	B(0.50, 0.20)	0.84	0.78	0.90	0.67	0.55	0.78	0.67	0.41	0.93
$var_{2\pi}$	B(0.50, 0.20)	0.05	0.01	0.09	0.05	0.01	0.09	0.09	0.02	0.16
var_{3i}	B(0.50, 0.20)	0.89	0.86	0.92	0.88	0.84	0.92	0.86	0.81	0.91
var_{3i2}	B(0.50, 0.20)	0.81	0.77	0.86	0.81	0.76	0.86	0.81	0.75	0.87
var_{3i3}	N(0.50, 0.20)	0.74	0.69	0.8	0.72	0.66	0.79	0.78	0.72	0.84
var_{3i4}	N(0.10, 0.20)	0.69	0.63	0.75	0.65	0.58	0.73	0.77	0.70	0.83
var_{3i5}	N(0.10, 0.20)	0.65	0.58	0.72	0.59	0.51	0.68	0.75	0.68	0.83

Note: The parameters $var_{1x1}, var_{1x2}, \ldots, var_{3i5}$ are defined in Table B1.

Table B4: **Japan Prior and Posterior Estimates of Structural Parameters**

	Prior Distr.	Posterior Distribution								
		Full Sample (1990:Q3–2022:Q3)			Great Moderation (1990:Q3–2007:Q3)			Low-Interest-Rate Period (2005:Q3–2022:Q3)		
Par.	Prior	Mean	5%	95%	Mean	5%	95%	Mean	5%	95%
τ	U(0, 1)	0.23	0.21	0.25	0.33	0.29	0.37	0.12	0.10	0.14
ρ	B(0.75, 0.10)	0.98	0.97	0.99	0.98	0.97	0.99	0.98	0.96	0.99
χ_π	N(1.50, 0.10)	1.46	1.37	1.52	1.49	1.32	1.66	1.49	1.32	1.65
χ_x	N(0.125, 0.05)	0.19	0.15	0.23	0.12	0.04	0.20	0.12	0.04	0.21
ρ_μ	B(0.50, .20)	0.04	0.01	0.07	0.05	0.01	0.08	0.10	0.02	0.19
ρ_γ	B(0.50, 0.10)	0.12	0.11	0.13	0.13	0.11	0.15	0.11	0.10	0.12
η	B(0.50, 0.01)	0.50	0.49	0.51	0.49	0.48	0.51	0.48	0.46	0.49
ξ_p	G(0.15, 0.05)	0.18	0.14	0.22	0.15	0.07	0.22	0.15	0.07	0.22
σ_γ	IG(0.30, 0.30)	1.67	1.54	1.80	0.91	0.78	1.03	2.16	1.86	2.45
σ_μ	IG(0.30, 2.00)	0.41	0.37	0.45	0.38	0.32	0.43	0.42	0.36	0.48
σ_{MP}	IG(0.30, 2.00)	0.17	0.15	0.20	0.15	0.12	0.19	0.19	0.14	0.22
σ_1^{FG}	IG(0.30, 2.00)	0.11	0.08	0.14	0.10	0.07	0.14	0.09	0.07	0.12
σ_2^{FG}	IG(0.30, 2.00)	0.14	0.11	0.16	0.11	0.08	0.14	0.12	0.08	0.15
σ_3^{FG}	IG(0.30, 2.00)	0.06	0.05	0.07	0.06	0.05	0.08	0.09	0.06	0.11
σ_4^{FG}	IG(0.30, 2.00)	0.05	0.04	0.06	0.06	0.04	0.07	0.08	0.06	0.11
σ_5^{FG}	IG(0.30, 2.00)	0.07	0.06	0.08	0.07	0.05	0.08	0.08	0.06	0.10
var_{1x1}	B(0.50, 0.20)	0.62	0.52	0.73	0.55	0.33	0.77	0.67	0.50	0.85
var_{1x2}	B(0.50, 0.20)	0.29	0.12	0.49	0.42	0.14	0.69	0.44	0.15	0.73
$var_{2\pi}$	B(0.50, 0.20)	0.07	0.02	0.11	0.07	0.02	0.12	0.08	0.03	0.13
var_{3i}	B(0.50, 0.20)	0.84	0.82	0.86	0.83	0.81	0.86	0.86	0.79	0.93
var_{3i2}	B(0.50, 0.20)	0.81	0.78	0.83	0.80	0.77	0.84	0.79	0.71	0.87
var_{3i3}	N(0.50, 0.20)	0.79	0.76	0.82	0.79	0.74	0.83	0.72	0.63	0.81
var_{3i4}	N(0.10, 0.20)	0.79	0.76	0.83	0.78	0.72	0.83	0.73	0.64	0.83
var_{3i5}	N(0.10, 0.20)	0.80	0.76	0.84	0.78	0.72	0.84	0.77	0.67	0.87

Note: The parameters $var_{1x1}, var_{1x2}, \ldots, var_{3i5}$ are defined in Table B1.

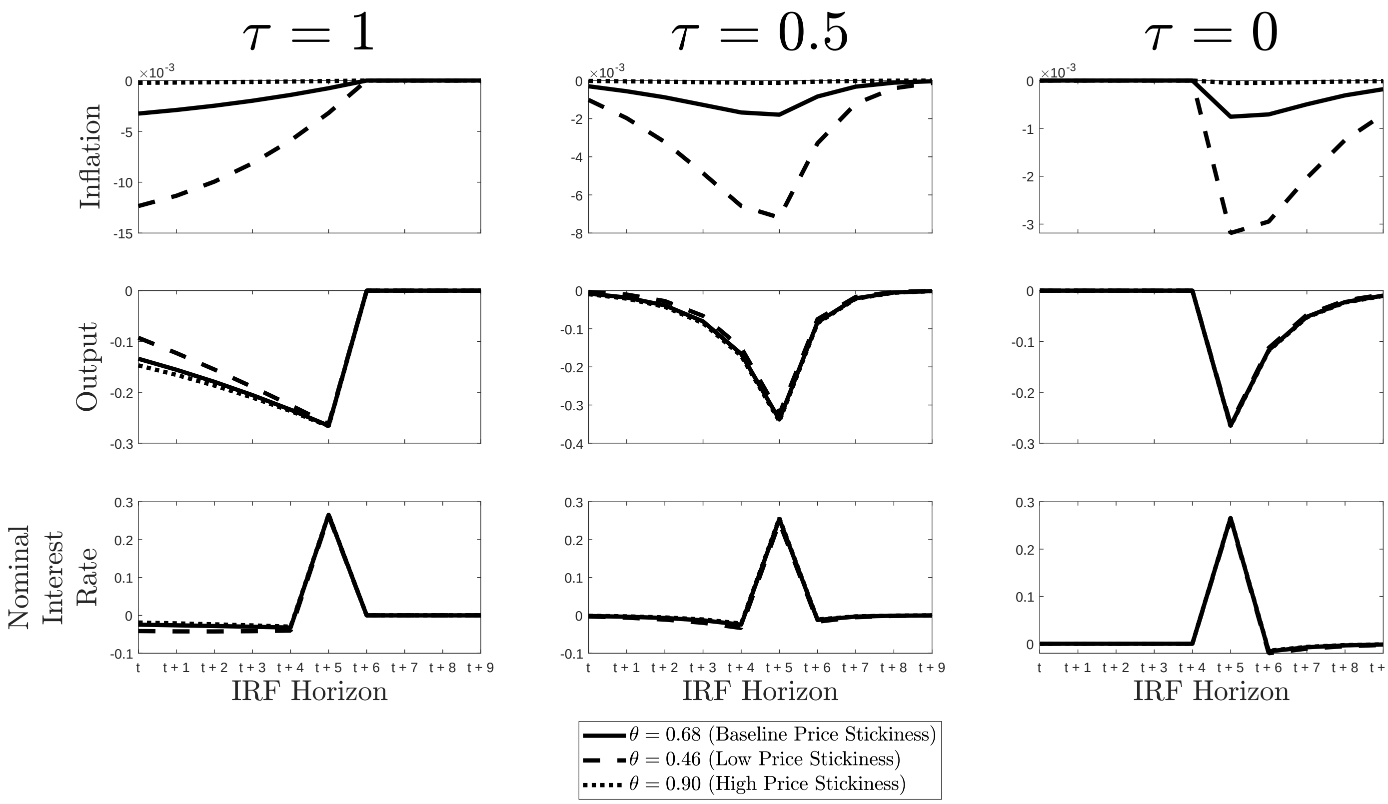

Figure B1: Impulse Responses Under Varying Degrees of Price Stickiness

Note: Benchmark model of Section 2, but with no habit in consumption ($\eta = 0$), no price indexation ($\iota_p = 0$), and no interest rate smoothing ($\rho = 0$). 30-basis-point (bp) increase.

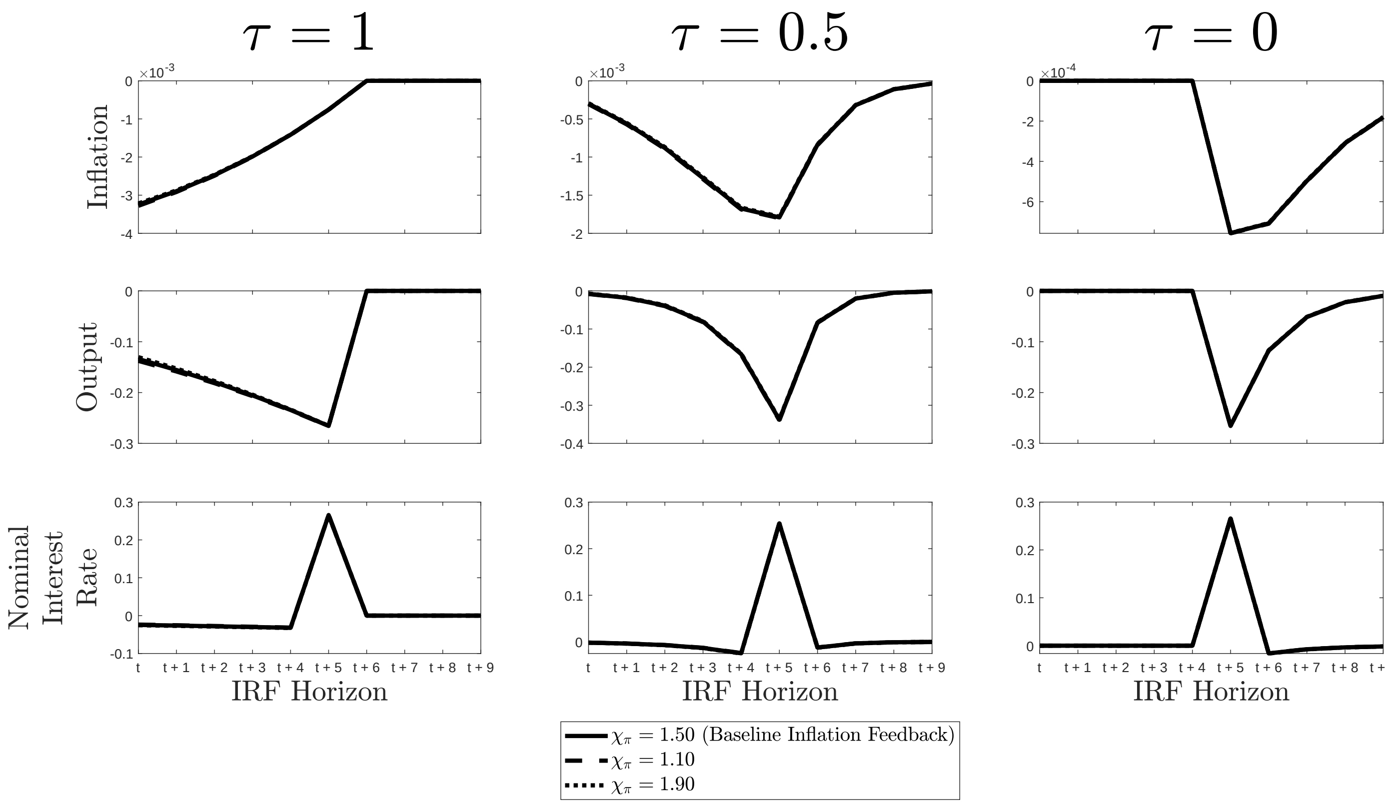

Figure B2: Impulse Responses Under Lower and Higher Values of the Inflation Feedback Parameter

Note: Benchmark model of Section 2, but with no habit in consumption ($\eta = 0$), no price indexation ($\iota_p = 0$), and no interest rate smoothing ($\rho = 0$). 30-basis-point (bp) increase.

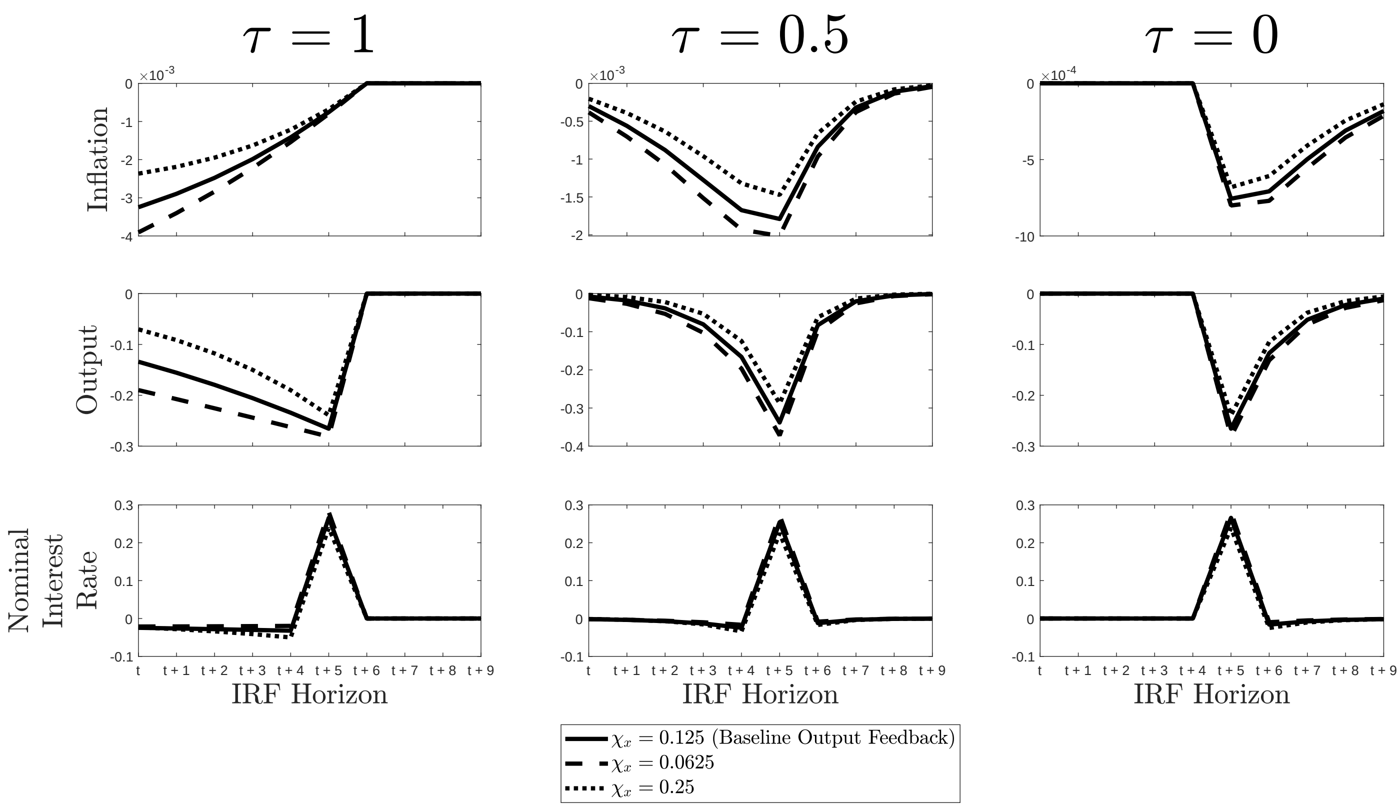

Figure B3: Impulse Responses Under Lower and Higher Values of the Output Gap Feedback Parameter

Note: Benchmark model of Section 2, but with no habit in consumption ($\eta = 0$), no price indexation ($\iota_p = 0$), and no interest rate smoothing ($\rho = 0$). 30-basis-point (bp) increase.

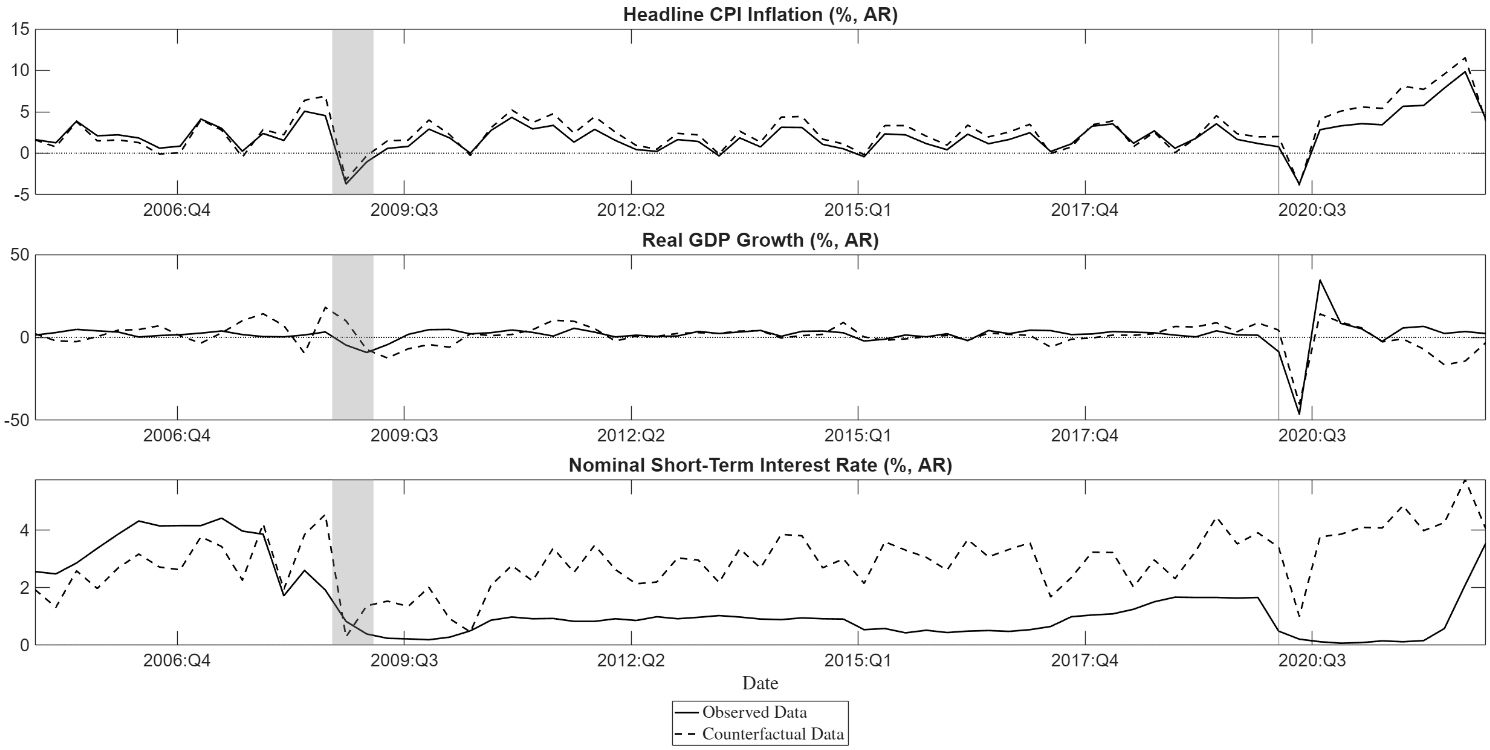

Figure B4: Counterfactual Canada Inflation, Real GDP Growth, and Nominal Short-Term Interest Rate in the Low-Interest-Rate Period (2005:Q3–2022:Q3) Under $\tau = 1$

Note: The observed and counterfactual inflation, real GDP growth, and nominal short-term (3-month) interest rates series are quoted in percent annualized. We obtain the simulated data by setting the model parameter values at the posterior mean estimated in the low-interest-rate subsample (except for τ, which is fixed at 1) and feeding in the recovered shocks (including the forward guidance shocks). Shaded bars denote C.D. Howe Institute recession dates for Canada.

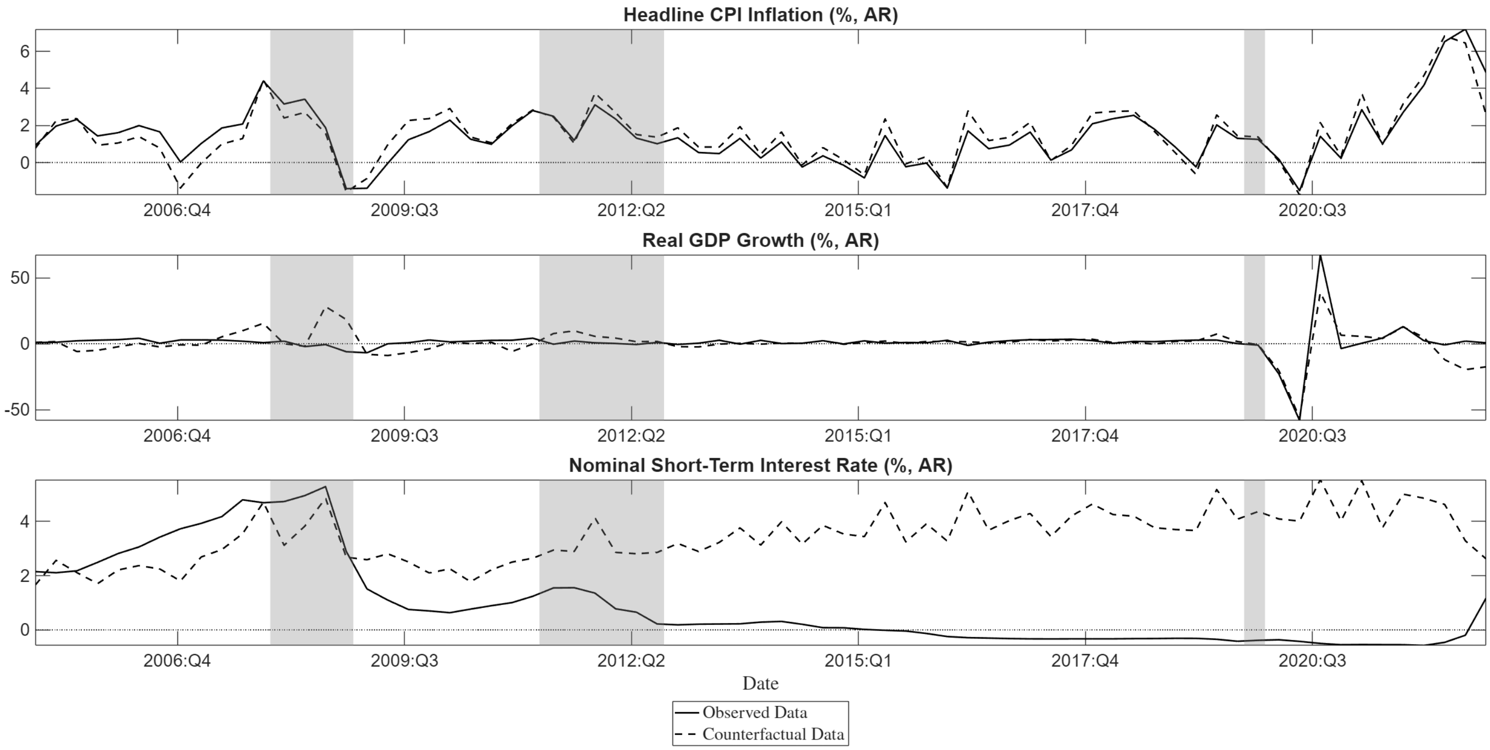

Figure B5: Counterfactual France Inflation, Real GDP Growth, and Nominal Short-Term Interest Rate in the Low-Interest-Rate Period (2005:Q3–2022:Q3) Under $\tau = 1$

Note: The observed and counterfactual inflation, real GDP growth, and nominal short-term (3-month) interest rates series are quoted in percent annualized. We obtain the simulated data by setting the model parameter values at the posterior mean estimated in the low-interest-rate subsample (except for τ, which is fixed at 1) and feeding in the recovered shocks (including the forward guidance shocks). Shaded bars denote ECRI recession dates for France.

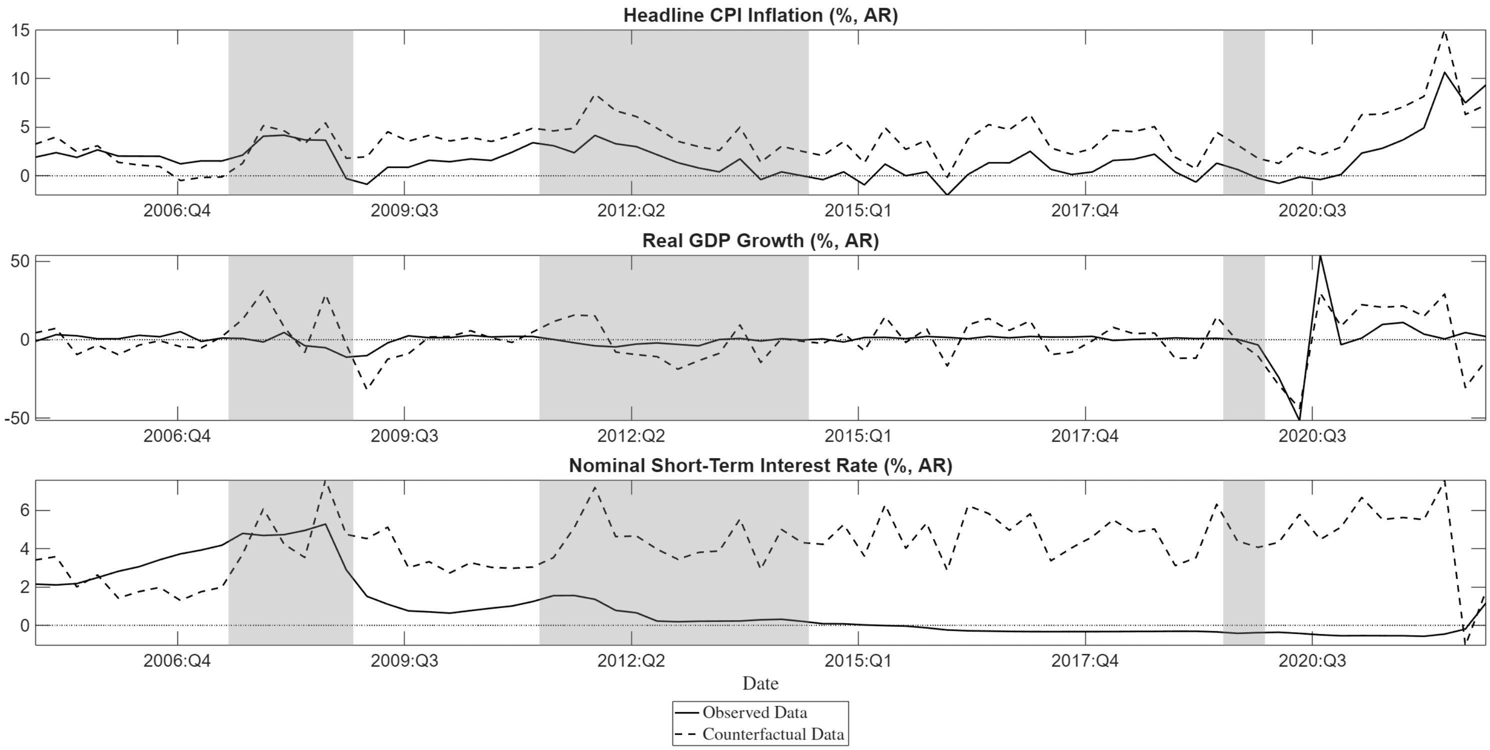

Figure B6: Counterfactual Italy Inflation, Real GDP Growth, and Nominal Short-Term Interest Rate in the Low-Interest-Rate Period (2005:Q3–2022:Q3) Under $\tau = 1$

Note: The observed and counterfactual inflation, real GDP growth, and nominal short-term (3-month) interest rates series are quoted in percent annualized. We obtain the simulated data by setting the model parameter values at the posterior mean estimated in the low-interest-rate subsample (except for τ, which is fixed at 1) and feeding in the recovered shocks (including the forward guidance shocks). Shaded bars denote ECRI recession dates for Italy.

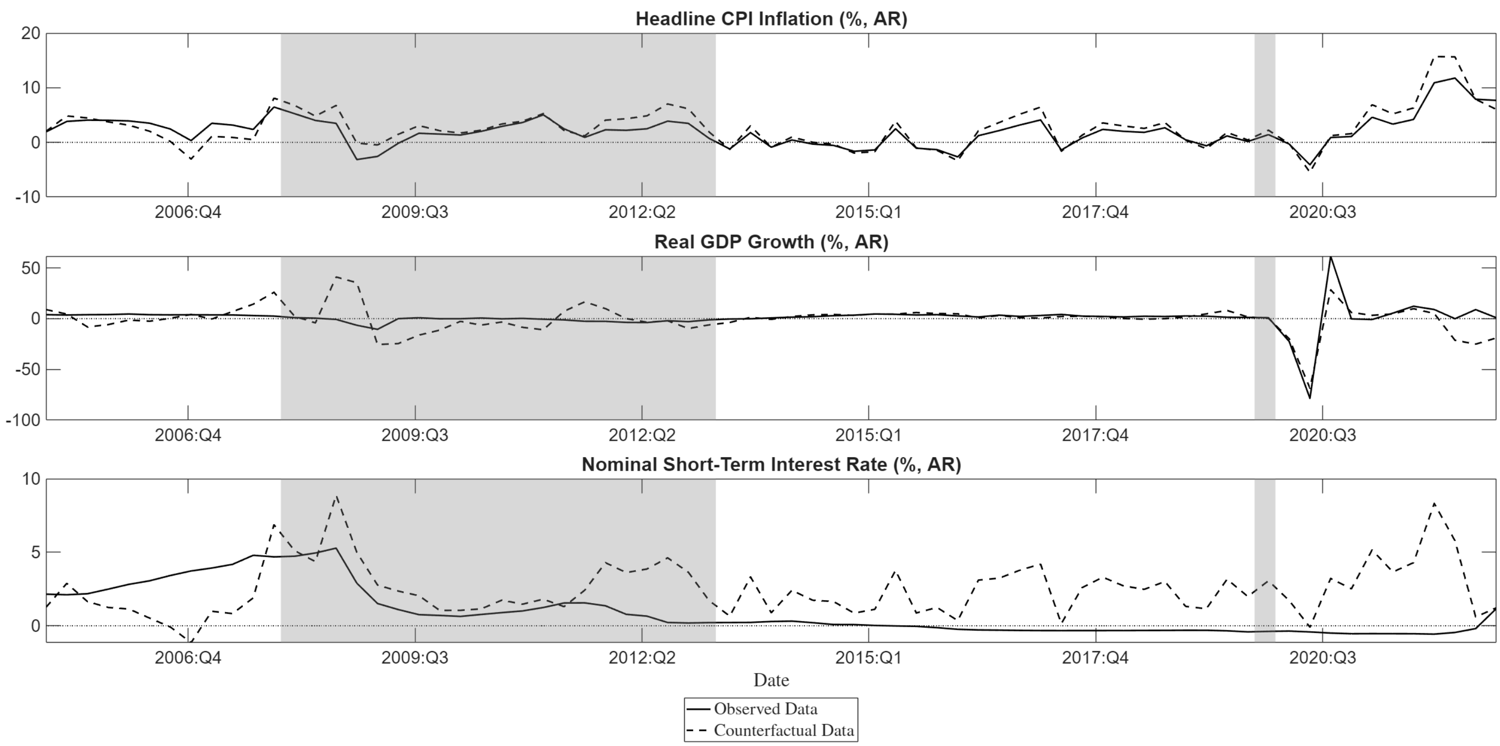

Figure B7: Counterfactual Spain Inflation, Real GDP Growth, and Nominal Short-Term Interest Rate in the Low-Interest-Rate Period (2005:Q3–2022:Q3) Under $\tau = 1$

Note: The observed and counterfactual inflation, real GDP growth, and nominal short-term (3-month) interest rates series are quoted in percent annualized. We obtain the simulated data by setting the model parameter values at the posterior mean estimated in the low-interest-rate subsample (except for τ, which is fixed at 1) and feeding in the recovered shocks (including the forward guidance shocks). Shaded bars denote ECRI recession dates for Spain.