A Model of Fed Information Effect

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Abstract: A significant fraction of measured surprise central bank interest rate hikes is associated with simultaneous stock market run-ups and upward revisions in economic growth forecasts. This evidence is often interpreted as contradicting the standard New Keynesian transmission mechanism and as indicating that the Fed possesses superior information about economic fundamentals. We present a quantitative New Keynesian model in which investors are uncertain about the Fed's long-run monetary policy objectives and learn from observed Fed actions. Our model does not assume that the Fed has superior information about the economy, but it nonetheless generates a "Fed information effect", that is, a positive co-movement between interest rate surprises, revisions in expected growth, and stock returns as an equilibrium outcome. We show that the key predictions of our model are consistent with empirical evidence on asset market responses to measured Fed information shocks.

Keywords: Fed information, New Keynesian model, monetary policy expectation.

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1 Introduction

Recent literature on high-frequency identification of monetary policy often finds the sign of the impact of monetary policy surprises, as measured by surprises interest rate reductions from financial markets, on economic growth forecasts and stock market valuation to be time-varying (for example, Nakamura and Steinsson (2018), Bauer and Swanson (2023a)). This leads Nakamura and Steinsson (2018) to conclude the "Fed information effect". That is, the monetary authority has superior information about the state of the macroeconomy. As a result, monetary policy announcements not only reveal the Fed's plan about the future path of the policy rates, but also its superior information about macroeconomic fundamentals. However, evidence for a substantial information advantage of the Federal Reserve about the real economy over the private sector is rare.[1] If the Fed has superior information, it is more likely to be superior information about its own actions, rather than that about economic fundamentals.

In this paper, we use the term "Fed information effect" to refer to the empirical fact that measured expansionary monetary policy shocks, that is, surprise interest rate reductions, often have contractionary impact on the economy. The purpose of this paper is to develop an equilibrium model to rationalize the above facts. The key element of our model is that the Fed has private information about their long-run policy objectives, which investors need to learn from observe market prices.

Our model is set in a standard New Keynesian framework, where monetary policy follows a Taylor rule with time-varying long-run inflation targets. In this setup, the Fed's interest rate decisions depend on both its long-run targets and its short-run policy preferences. Although an inflation hawk targets a lower long-run inflation, its short-run decisions may temporarily deviate. The market observes the Fed's policy decisions and infers its type when forming forward-looking pricing decisions.

As in standard New Keynesian models, nominal interest rate reductions lead to real interest rate reductions due to price stickiness. In equilibrium, real rate reductions must be associated with lower expected consumption growth. When uncertainty about the Fed's

[1]For example, the Federal Reserve's Greenbook forecasts do not systematically outperform professional survey forecasts from Blue Chip. In addition, media discussions on FOMC decisions often emphasize interest rates decisions and not the information about macroeconomic variables revealed in interest rate decisions. See Bauer and Swanson (2023a).

type is low, monetary policy affects the real economy in the same way as in standard New Keynesian models: temporary policy shocks do not affect the economy's steady state. As a result, the decline in expected consumption growth induced by a rate cut must be offset by a contemporaneous rise in consumption and output, along with a simultaneous increase in stock market valuation.

When uncertainty about the Fed's type is high, a nominal interest rate reduction may arise as the result of a contractionary monetary policy shock and be associated with a stock market decline. When investors prior belief about Fed's long-run policy objective is imprecise, a contractionary monetary policy shock is interpreted as a signal for a persistent monetary policy tightening due to Bayesian updating about long-run policy regime. The equilibrium nominal rate drops for two reasons. First, investors anticipate a long-run tighten monetary policy regime and as a result, a lower steady state level of consumption. As a result, the real interest rate drop due to a negative shock to expected consumption growth. This channel is absent from standard New Keynesian models because monetary policy does not affect the long-run steady state of the economy. In addition, tightening monetary policy shock lowers inflation and inflation expectations. The two effects work together to lower equilibrium nominal interest rate.

At the same time, this contractionary monetary shock lowers consumption, real wage and stock market valuation. Because stock market valuation is forward looking, a long run tighten monetary policy regime is associated with a lower steady-state level of output and hence a lower present value of dividends. In this scenario, nominal interest rate changes and stock market valuations move in the same direction and would be identified as "Fed information shocks" by the methodology of Jarocinski and Karadi (2020).

The key for our model to generate the "Fed information effect" is that belief updates of Fed type alter the relationship between interest rate and current-period output. In standard New Keynesian models, the effect of monetary policy shocks are temporary and they do not affect the long-run steady state of the economy. Intertemporal optimality requires that a lower real rate must be accompanied by lower expected consumption growth. The only way this can happen in equilibrium is that current period consumption rises, because monetary policy does not affect future consumption steady state. When Fed's type is a persistent state variable, however, monetary policy may affect the long-run steady state of the economy by impacting investor's belief about Fed's type. In the above example, a higher interest rate can be consistent with a higher current period consumption if investors belief that economy is transitioning to a higher long-run consumption steady state. Observationally, this is consistent with a Fed information effect because a higher interest rate is associated with upward revisions of future consumption and output.

The above mechanism for Fed information effect implies that Fed information shocks is more likely to happen when uncertainty about the long-run objectives of monetary policy is high. Empirically, we use the monetary uncertainty measure constructed by Bauer, Lakdawala, and Mueller (2022) to test the above implications and find supporting evidence for our model.

Our model is set in continuous time and we focus on the minimum state variable Markov equilibrium. To highlight our new interpretation of the Fed information effect, we stay as close as possible to the textbook New Keynesian model but use fully global solutions to characterize the time-varying steady state of the economy. In our model, Fed type is a persistent state variable modeled as a two-state Markov chain. Beliefs about Fed type is the results of Bayesian learning and is obtained through a filtering problem. They affect aggregate price level because firms' pricing decisions are forward looking. The global solution approach allows us to characterize the nonlinear dynamics uncertainty and study its impact on monetary policy outcomes.

Related literature This paper contributes to the literature on the Fed information effect, which posits that FOMC announcements reveal the central bank's superior information about economic fundamentals. An early discussion of the Fed information effect is Romer and Romer (2000). Several empirical evidences are often interpreted as the Fed information effect. First, about one-third of FOMC announcements since 1990 exhibit positive co-movement between interest rates and stock prices, for example, Jarocinski and Karadi (2020) and Lunsford (2020). Second, professional forecasts of output growth increase and those of unemployment decrease following monetary tightening, see Nakamura and Steinsson (2018) and Campbell, Evans, Fisher, Justiniano, Calomiris, and Woodford (2012). Third, interest rate increases are often accompanied by rising rather than falling prices, for example, Eichenbaum (1992), Sims (1992), and Nakamura and Steinsson (2018).

Different from the above papers, we present an equilibrium model where the monetary authority does not have superior information about economic fundamentals. Rather, monetary policy announcements reflect the Fed's long-run policy objectives. The Fed information effect arises private sector's belief about Fed's type can have persistent impact on economic outcomes, while the impact of monetary policy shock without changes in belief is temporary as in standard New Keynesian models. The economic mechanism of our model therefore differs from the traditional interpretation of the Fed information effect discussed in the above literature as well as the "Fed response to news channel" of Bauer and Swanson (2023a) and Bauer, Pflueger, and Sunderam (2024).

Our paper is related to the literature on high-frequency identification of monetary policy shocks and its impact on the economy. Hanson and Stein (2015), Hanson, Lucca, and Wright (2021), Kekre, Lenel, and Mainardi (2024), and Hillenbrand (2025) focus on the impact of monetary policy on the term structure of interest rates. Bernanke and Kuttner (2005) study the impact of monetary policy shocks on stock market returns. Nakamura and Steinsson (2018), Karnaukh and Vokata (2022), and Bauer and Swanson (2023b) discuss evidence that monetary policy surprises affects economic forecasts of production and employment. Golez and Matthies (2025) use short-term dividend strips to identify Fed information effects through the equity term structure. Cieslak and Pang (2021) decompose monetary policy surprises into news about growth rates, discount rates and risk premiums.

Our paper builds on the large literature on equilibrium models of the impact of monetary policy on financial markets and the real economy. For comprehensive review of this literature, see Friedman, Hahn, and Woodford (2010). Our paper is more related to recent works that study different channels through which monetary policy surprises affect equity prices, including Drechsler, Savov, and Schnabl (2018), Caballero and Simsek (2020), Pflueger and Rinaldi (2022), Kekre and Lenel (2022), Bianchi, Lettau, and Ludvigson (2022), Caramp and Silva (2024), and Nagel and Xu (2024). Bocola, Dovis, Jørgensen, and Kirpalani (2024) and Bocola, Dovis, Jørgensen, and Kirpalani (2025) also use high-frequency inflation swap data at different horizons to study how monetary policy surprises and learning about policy objectives affect long-run inflation expectations. Gomez Cram, Kung, and Lustig (2024) use high-frequency data from the COVID period to show that Fed large-scale asset purchases in response to unfunded fiscal shocks temporarily support Treasury prices at taxpayers' expense, and that bad news about future fiscal surpluses raises Treasury yields.

This paper also relates to the literature that central banks and the public have disagreement or asymmetric information. For example, Cieslak (2018), Caballero and Simsek (2022), and Sastry (2024) study cases where the Fed and the market disagree about future economic fundamentals, such as the unemployment rate and aggregate demand. Our paper differs by focusing on the case in which market agents do not observe the central bank's long-run type directly and must update beliefs from observed monetary policy surprises using Bayes' rule. In related work, Gomez Cram, Kung, et al. (2025) uses high-frequency Treasury yield responses to CBO cost estimates in a model with learning to show that investors update beliefs about the U.S. fiscal stance and the fraction of deficit news that is expected to be unbacked.

The rest of the paper is organized as follows. We first summarize several stylized facts that motivated the study of Fed information effect in Section 2. We describe a continuous-time New Keynesian model with learning in Section 3. We illustrate our model solutions using policy functions and impulse response functions in Section 4. Section 5 provides empirical evidence and model calibration for the learning mechanism and Section 6 concludes.

2 Stylized facts on the Fed information effect

Surprise interest rate reductions identified during short FOMC announcement windows are typically used as measured of expansionary monetary policy shocks. However, empirically, they are associated with a contractionary responses from the asset market in a significant fraction of the data. In this paper, we refer to this pattern of the data as the Fed information effect. We start by documenting several aspects of the Fed information effect.

1. Surprise interest rate reductions can be associated with either positive or negative stock market responses.

   In textbook New Keynesian models, surprise interest rate reductions raises output and, at the same time, reduces discount rate. As a result, the fact that surprise interest rate reductions raise stock market valuation is a robust implication of the standard New Keynesian models. In the data, however, stock market can respond both positively or negatively to interest rate reductions. Updating the evidence of Jarocinski and Karadi (2020) in Figure 1, we plot surprise changes in the short rate, as measured by the innovations in the interest rate futures contact over 30-minute FOMC announcement windows on the horizontal axis and the returns on the S&P500 index during the same

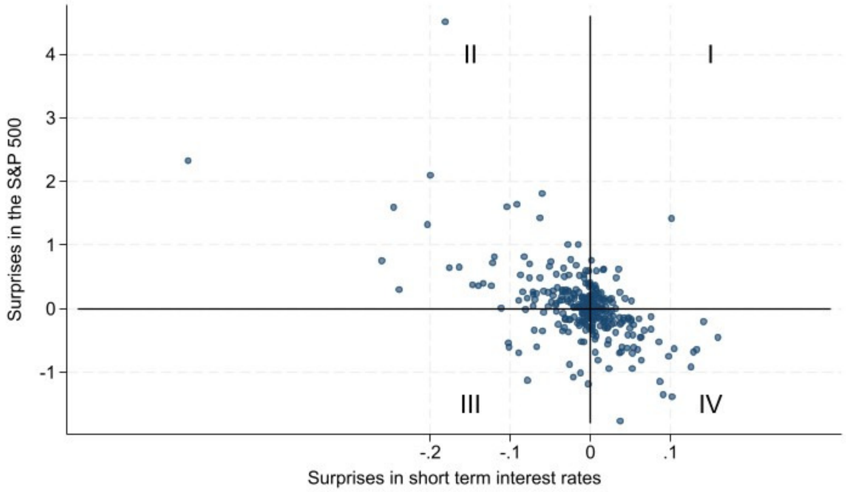


Figure 1: Policy surprises and stock returns around FOMC announcements

Notes: This figure plots the relationship between monetary policy surprises and S&P 500 returns in a 30-minute window around FOMC announcements from 1988 to 2023. The horizontal axis shows surprises in the policy indicator, measured as the first principal component of surprises in interest rate derivatives with maturities from 1 month to 1 year (including federal funds futures and Eurodollar futures), where positive values indicate unexpected monetary tightening. The vertical axis shows percentage changes in the S&P 500 stock index. Data sources: Monetary policy surprises and S&P 500 data from Jarociński and Karadi (updated through 2023).

interval on the vertical axis. Standard New Keynesian models imply that all data points should be in the II and IV quadrants. However, roughly 30% of the time, stock market return and short term interest rate change move in the same direction over short FOMC announcement windows.

The above observation led Jarocinski and Karadi (2020) to decompose monetary policy shocks into two components, monetary policy shocks and central bank information shocks. Using their decomposition, we document two additional facts.

2. The yield curve responds positively to both conventional monetary policy shocks and Fed information shocks, but the response to central bank information shocks is stronger across all maturities.

   Figure 2 presents regression coefficients of high-frequency changes in 2-year, 5-year, 10-year, and 30-year Treasury yields measured around the FOMC announcement windows on the conventional monetary policy shocks (blue line) and those on central bank information shocks (red line). Both types of shocks raise yields at all maturities, but the effect of central bank information shocks is consistently stronger than that of monetary policy shocks.

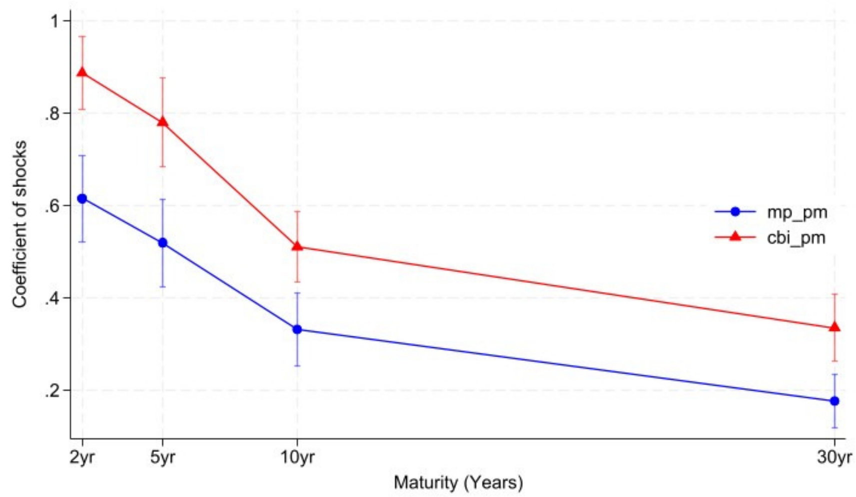


Figure 2: Treasury yield responses to monetary policy vs. information shocks

Notes: This figure plots the estimated coefficients from regressions of Treasury yield changes on monetary policy shocks (mp_pm, shown in blue circles) and central bank information shocks (cbi_pm, shown in red triangles) across different maturities. The horizontal axis shows the maturity of Treasury securities (2-year, 5-year, 10-year, and 30-year bonds). The vertical axis shows the coefficient estimates. Error bars represent 68% confidence intervals (approximately one standard error). The regressions use HAC robust standard errors with bandwidth of 4. Data span from 1990 to 2023. Monetary policy shocks and central bank information shocks are decomposed shocks measured in a 30-minute window around FOMC announcements from Jarocinski and Karadi (2020). High-frequency Treasury yield data and shock series are from Bauer and Swanson (2023b). Detailed regression results including coefficient estimates, standard errors, and difference tests are reported in Appendix Table 7.

3. Identified central bank information shocks are positively correlated with stock market returns, growth rate forecast revisions [2], and inflation forecasts.

   Surprise interest rate increases associated with central bank information shocks, by construction, is positively correlated with stock market returns. They are also associated with rises in inflation expectations. To measure the impact of different components

[2] Bu, Rogers, and Wu (2021) regressed Blue Chip forecast revision on the central bank information shocks from Jarocinski and Karadi (2020), and find that survey respondents revise their output forecast upwards after positive central bank information shocks (Table 4 of Bu, Rogers, and Wu (2021))

of monetary policy shocks on inflation expectations, we regress daily price changes in inflation swaps with different maturities on the two components of monetary policy shocks, conventional monetary policy shocks and central bank information shocks, as constructed by Jarocinski and Karadi (2020). Figure 3 reports the regression coefficients on conventional monetary policy shocks (solid line) and central bank information shocks (dashed line), together with one-standard deviation bands. An increase in nominal rate as a conventional monetary policy shock is associated with declines in inflation expectations, as predicted by standard New Keynesian models, although the regression coefficient is not significant. More importantly, an increase in nominal rate, as a central bank information shock, is associated with strong and positive responses in inflation expectations.

The fact that surprise interest hikes may be associated with increases in stock market valuation and growth rate forecasts is puzzling. This pattern leads researchers as such as Nakamura and Steinsson (2018) to conclude the "Fed information effect", that is, the monetary authority has superior information about economic fundamentals. When they announce a contractionary monetary policy, the market reacts positively because it interprets the policy as revealing a stronger than expected macroeconomic fundamentals. Direct evidence for Fed's superior information about macroeconomic fundamentals, however, is rare. In this paper, we present a simple variation of the standard New Keynesian model, where the monetary authority has superior information about its own long-run policy objectives. We show that this mechanism alone can quantitatively explain the above facts without assuming Fed's superior information about macroeconomic fundamentals.

3 A New Keynesian model of Fed type

In this section, we set up a New Keynesian model where Fed long-run policy objective, or Fed type, is driven by a persistent state variable modeled as a Markov process. We stay as close as possible to the textbook New Keynesian setup so that we can focus on the implications of the key mechanism of learning and uncertainty about Fed's long-run policy objective.

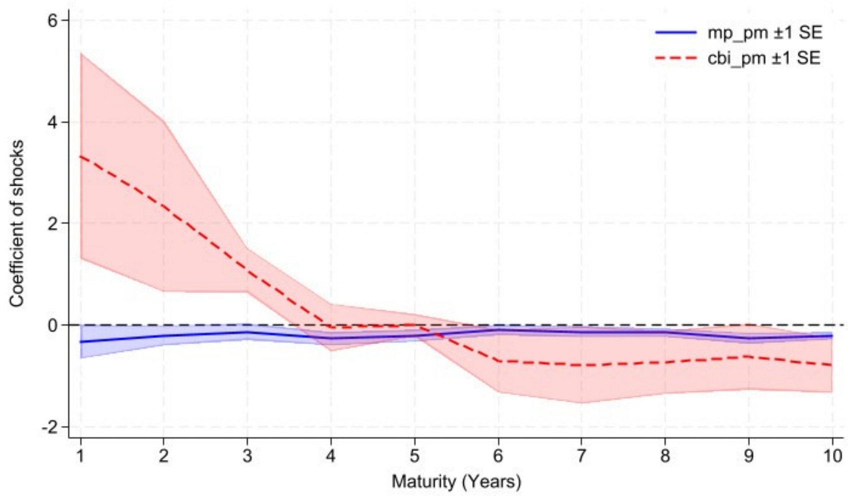


Figure 3: Inflation swap responses to monetary policy vs. information shocks

Notes: This figure plots the estimated coefficients from regressions of inflation swap rate changes on monetary policy shocks (mp_pm, shown in blue solid line) and central bank information shocks (cbi_pm, shown in red dashed line) across different maturities. The horizontal axis shows the maturity of inflation swaps in years (1 to 10 years). The vertical axis shows the coefficient estimates. Shaded areas represent 68% confidence intervals (approximately one standard error). The regressions use HAC robust standard errors with bandwidth of 4. Data span from 2004 to 2023. Inflation swap data are from Bloomberg. Monetary policy shocks and central bank information shocks are decomposed shocks measured in a 30-minute window around FOMC announcements from Jarocinski and Karadi (2020). Detailed regression results including coefficient estimates, standard errors, and difference tests are reported in Appendix Table 6.

3.1 Model setup

Households Time is continuous and infinite. We assume that the representative household's preference is:

$$E\left[\int_0^\infty e^{-\rho t}\left(\frac{C_t^{1-\gamma}}{1-\gamma}-\frac{L_t^{1+\zeta}}{1+\zeta}\right)dt\right], \tag{1}$$

where C_t is consumption of final output, and L_t is labor supply. $\gamma > 0$ is the risk aversion and $\zeta > 0$ is the inverse Frisch elasticity of labor supply. The preference is the standard additively separable expected utility used in textbook New Keynesian models.

The representative consumer seeks to maximize life-time expected utility subject to the budget constraint:

$$E\left[\int_0^\infty \Lambda_t\left(C_t - w_t L_t\right)dt\right] \leq 0,$$

where Λ_t is the stochastic discount factor that prices time-t real consumption into time-0 consumption units, and w_t is real wage at time t.

Firms' production and pricing decisions The final output Y_t is produced using a continuum of intermediate inputs via a CES production function $Y_t = \left[\int_0^1 y_{i,t}^{\frac{\eta-1}{\eta}} di\right]^{\frac{\eta}{\eta-1}}$, where y_{it} denotes output of differentiated commodity variety i. The parameter $\eta > 1$ denotes the elasticity of substitution between different varieties. The final goods producers are fully competitive and their demand for individual variety i is given by

$$y_{it} = (\frac{p_{i,t}}{P_t})^{-\eta} Y_t, \tag{2}$$

where $p_{i,t}$ is the price for commodity i, and P_t is the price of general consumption Y_t. Because the production technology is constant returns to scale, the competitive final goods producer's equilibrium profit is zero, and this in turn implies that $p_{i,t}$ and P_t must be related by

$$P_t = \left[\int p_{i,t}^{1-\eta} dt\right]^{\frac{1}{1-\eta}}. \tag{3}$$

There are a continuum of firms or intermediate good producers indexed by i. Firm i produces good i using a constant returns to scale technology with labor as the only input, $y_{it} = A l_{it}$. As is standard in the New Keynesian setup, firms produce on monopolistically competitive markets to maximize the present value of profit. Given $p_{i,t}$ and P_t, if the time t output of firm i is $y_{i,t}$, firm profit, measured in real consumption terms, is given by $\frac{p_{i,t}}{P_t} y_{i,t} - w_t \frac{y_{i,t}}{A}$. Using the demand function (2), real profit is a function of $\frac{p_{i,t}}{P_t}$, $\Psi\left(\frac{p_{it}}{P_t}\middle| w_t, Y_t\right)$, taking w_t and Y_t as given:

$$\Psi\left(\frac{p_{it}}{P_t}\middle| w_t, Y_t\right) = \frac{p_{it}}{P_t} \times \left(\frac{p_{it}}{P_t}\right)^{-\eta} Y_t - w_t \times \frac{1}{A}\left(\frac{p_{it}}{P_t}\right)^{-\eta} Y_t.$$

Firms pricing decisions are forward looking and subject an adjustment cost, as in Rotemberg (1982). Let π_{it} be the rate of price change at time t, then the law motion of p_{it} is,

$$dp_{i,t} = p_{i,t}\pi_{i,t}dt.$$

The present value of all future profit for firm i at time t is

$$\max_{\{\pi_{i,t}\}_{t=0}^{\infty}} E_t \left[\int_0^{\infty} \Lambda_{t,t+s} \left\{ \Psi \left(\frac{p_{t+s}}{P_{t+s}} \middle| w_{t+s}, Y_{t+s} \right) - h\left(\pi_{i,t+s}\right) Y_{t+s} \right\} ds \right], \tag{4}$$

where $\Lambda_{t,t+s}$ is stochastic discount factor given in (1). The function h is a strictly increasing and strictly convex cost function of price adjustment. We set $h(\pi) = \frac{h_0}{2}\pi^2$, where h_0 is a parameter that governs the magnitude of cost of adjustment as in Rotemberg (1982). The total cost of price adjustment at time t is proportional to total output at time t, Y_t.

Market clearing Goods market clearing requires that total consumption plus total cost of price adjustment must equal total output:

$$C_t + \int h\left(\pi_{i,t}\right) Y_t di = Y_t.$$

In addition, labor market clearing implies that, for all t,

$$\int l_{i,t} di = L_t.$$

Monetary policy rule Individual firm's pricing decisions implies a dynamics of aggregate price index through (3). We denote the rate of change of the aggregate price index as $\pi_t = \frac{dP_t}{P_t}$, that is, π_t is aggregate inflation. Give inflation π_t, the monetary authority follows the Taylor rule when setting the nominal interest rate:

$$i_t = \phi\pi_t - \nu_t, \tag{5}$$

where ν_t is a diffusion process with

$$d\nu_t = a\left(\theta_t - \nu_t\right) dt + \sigma_\nu dB_{\nu,t}. \tag{6}$$

Here, $B_{\nu,t}$ is a standard Brownian motion and θ_t represents the long-run target rate. The above is a continuous-time version of a standard New Keynesian model, for example in Galí (2015). Equation (6) implies that interest rate policy are subject to temporary shocks, $B_{\nu,t}$ but have a tendency to converge to θ_t in the long-run. We can think of $B_{\nu,t}$ as transitory preference shocks from the Fed and θ_t as the long-run target rate. To model learning about Fed's policy target, we now turn to the specification of the dynamics of θ_t.

Our sign convention in the specification of Taylor rule (5) is such that a positive shock to ν_t raises inflation. We refer to θ_H as the high inflation target regime and θ_L as the low inflation target regime.

Learning about Fed type We assume θ_t is a two-state MC with state space $\{\theta_H, \theta_L\}$ and an infinitesimal generator $\begin{bmatrix} -\kappa_H & \kappa_H \\ \kappa_L & -\kappa_L \end{bmatrix}$. Intuitively, the transition matrix of θ_t over a small interval Δ is $\begin{bmatrix} 1-\kappa_H\Delta & \kappa_H\Delta \\ \kappa_L\Delta & 1-\kappa_L\Delta \end{bmatrix}$. We assume $\theta_H > \theta_L$ so that θ_L corresponds to a hawkish Fed with a lower long-run inflation target and θ_H represents a dovish Fed type. A hawkish Fed may set temporarily low interest rates due to preference shocks but will eventually raise rates aggressively in the long run to anchor a lower steady state inflation.

We assume that the true type of the Fed, θ_t is not observable. The private sector measures monetary shocks from each FOMC meetings and observe the history of Fed's interest rate decisions as well. Given the history of interest rate i_t and inflation π_t, it can back out the history of ν_t using Equation (5) but not that of θ_t. Rational investors will form Bayesian beliefs about θ_t using the history of ν_t. Thanks to the assumption of two-sate Markov chain, the posterior mean of θ_t, which we will denote as $\hat{\theta}_t$, is enough to summarize the posterior distribution and serve as a state variable in the Markov equilibrium.

Using Theorem 9.1 in Liptser and Shiryaev (2001), we can write the law of motion of $\hat{\theta}_t$ as:

$$d\hat{\theta}_t = (\kappa_H + \kappa_L)\left(\bar{\theta} - \hat{\theta}_t\right)dt + \left(\theta_H - \hat{\theta}_t\right)\left(\hat{\theta}_t - \theta_L\right)\frac{a}{\sigma_\nu}d\tilde{B}_t, \tag{7}$$

where $\bar{\theta}$ is the steady-state mean of θ, $\bar{\theta} = \frac{\kappa_L\theta_H + \kappa_H\theta_L}{\kappa_L + \kappa_H}$, and the innovation process $d\tilde{B}_t$ is defined as:

$$d\tilde{B}_t = \frac{1}{\sigma_\nu}\left[d\nu_t - a\left(\hat{\theta}_t - \nu_t\right)dt\right].$$

Theorem 9.1 in LS implies that $\tilde{B}_t$ is a Brownian motion with respect to investors' information set. Using the definition of the innovation process above, we can rewrite the monetary shock process as an adapted process with respect to investors' information set:

$$d\nu_t = a\left(\hat{\theta}_t - \nu_t\right)dt + \sigma_\nu d\tilde{B}_{\nu,t}. \tag{8}$$

3.2 Markov Equilibrium

The model we developed in the last section is an otherwise standard New Keynesian model with one difference. That is, Fed's long-run inflation target is time-varying and unobservable. The market observes equilibrium prices, including the prevailing interest rate, and infers Fed's long-run inflation target.

We focus on Markov equilibriums with rational expectations where equilibrium quantities and prices are functions of a minimum set of Markov state variables.[3] Formally, the concept of equilibrium is a set of prices and quantities such that i)given equilibrium prices and quantities, agents in the economy can perfectly infer the state variables, $\left(\nu, \hat{\theta}\right)$, ii) given the history of $\{\nu_t\}$, agents form their optimal belief about θ_t using the optimal filter, (7), and iii) the optimal filter coincides with $\hat{\theta}_t$ inferred from equilibrium quantity and prices.

It is not hard to show that the Markov equilibrium can be constructed as a list of quantities and prices,

1. a wage function $w\left(\hat{\theta}, \nu\right)$, an inflation function $\pi\left(\hat{\theta}, \nu\right)$, real interest rate $r\left(\hat{\theta}, \nu\right)$, and an equilibrium stochastic discount factor $\Lambda\left(\hat{\theta}, \nu\right)$,
2. a labor supply function $L\left(\hat{\theta}, \nu\right)$, a consumption policy function $C\left(\hat{\theta}, \nu\right)$, and an output function $Y\left(\hat{\theta}, \nu\right)$,

such that the following conditions are met:

1. The equilibrium stochastic discount factor, $\Lambda\left(\hat{\theta}, \nu\right)$ is consistent with households in-

[3]Equilibriums are typically not unique in New Keynesian models. As we show by construction, minimum state variables select a unique equilibrium in our setup. Angeletos and Lian (2023) provide a motivation for minimum state variables.

tertemporal optimization over consumption.

$$\Lambda\left(\hat{\theta},\nu\right)=C\left(\hat{\theta},\nu\right)^{-\gamma} \tag{9}$$

2. Given the real wage function, $L\left(\hat{\theta},\nu\right)$ satisfy the intra-temporal optimality condition for labor supply:

$$\frac{L\left(\hat{\theta},\nu\right)^{\zeta}}{C\left(\hat{\theta},\nu\right)^{-\gamma}}=w\left(\hat{\theta},\nu\right). \tag{10}$$

3. Given $\pi\left(\hat{\theta},\nu\right)$ and the law of motion of state variables (7), and (8), we can construct the aggregate prices index using $dP_t=P_t\pi\left(\hat{\theta}_t,\nu_t\right)dt$. Given the dynamics of P_t, and the equilibrium wage and output functions, $w\left(\hat{\theta},\nu\right)$ and $Y\left(\hat{\theta},\nu\right)$, intermediate firms i chooses their symmetric forward-looking optimal price $\pi_i=\pi_i\left(\hat{\theta},\nu\right)$.

4. Intermediate output is symmetric across firms as well:

$$Y\left(\hat{\theta},\nu\right)=AL\left(\hat{\theta},\nu\right). \tag{11}$$

5. Aggregate resource constraint is satisfied, that is,

$$C\left(\hat{\theta},\nu\right)+h\left(\pi\left(\hat{\theta},\nu\right)\right)Y\left(\hat{\theta},\nu\right)=Y\left(\hat{\theta},\nu\right), \tag{12}$$

6. The real interest rate is derived from the stochastic discount rate via the no-arbitrage relationship:

$$r\left(\hat{\theta},\nu\right)=-E\left[\frac{d\Lambda(\hat{\theta},\nu)}{\Lambda(\hat{\theta},\nu)}\right].$$

7. The nominal interest, $i\left(\hat{\theta},\nu\right)=r\left(\hat{\theta},\nu\right)+\pi\left(\hat{\theta},\nu\right)$ satisfies Taylor rule (5).

The above conditions can be simplified to derive a set of functional equations that can be used to solve for the equilibrium[4].

[4] We solve the system using two independent numerical methods that yield numerically identical solutions.

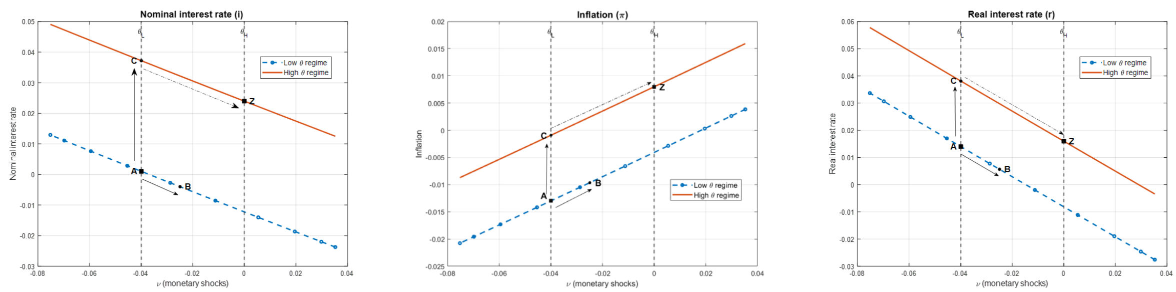
4 Model implications

Observable Fed type In our model, realizations of monetary policy shock ν_t has two effects. First, it acts as a conventional monetary policy shock in standard New Keynesian models. That is, it raises the current period nominal rate without affecting beliefs about long-run nominal rate. Second, it impacts investors' belief about the long-run inflation target. The second channel is what distinguishes our model from traditional New Keynesian models. To illustrate these implications, we first consider the case where θ_t is known, so that ν_t does not affect investor beliefs.

We plot the impact of monetary policy shocks on nominal rate (left panel), inflation (middle panel), and real interest rate (right panel) in Figure 4. In Figure 5, we plot the same policy functions for real wage (left panel), labor input (middle panel) and consumption (right panel). The horizontal axis is the value of the monetary policy shock, ν. The blue dashed lines are policy functions for $\theta_t = \theta_L$ and the red solid lines are policy functions for $\theta_t = \theta_H$, which correspond to low and high long-run inflation targets, respectively. We make several observations. First, keeping the policy regime θ fixed, a positive shock to Taylor rule, ν, lowers the real interest rate and the nominal rate, raises inflation, and has an expansionary effect on labor supply and consumption. Assuming a starting point from the θ_L regime, we illustrate this effect in the figures as a movement from A to B along the blue dashed line of low θ regime. This effect is the classical New Keynesian channel of monetary shocks. To understand this, note that the Taylor rule implies $r = (\phi - 1)\,\pi - \nu$. In a flexible price equilibrium, a positive shock to ν cannot affect the real rate r, and if $\phi > 1$, it must be completely offset by an increase in inflation π. Under sticky price, adjustment in π is costly and therefore not enough to completely offset the change in ν. As a result, real rate r must go down as well to keep the relationship $r = (\phi - 1)\,\pi - \nu$ satisfied. Because the nominal rate $i = r + \pi$, a small increase in π combined with a drop in real rate r implies a lower nominal rate as shown in the right panel of Figure 4. Under sticky price, an increase in inflation is associated with a rise in real wage. As a result, the shock raises labor supply,

The first, implemented in MATLAB, is a spectral method that approximates the unknown functions on a Chebyshev tensor grid in $(\hat{\theta}, \nu)$. The second, implemented in Python, is a physics-informed neural network (PINN) approach: each unknown function is represented as a feed-forward neural network and trained, by stochastic gradient descent, to satisfy the functional equations on randomly sampled points in the state space. The agreement between the two solutions serves as a robustness check on the equilibrium objects used throughout the paper and results in an increase in aggregate consumption and output.

Figure 4: Inflation and interest rates



*Notes:*This figure plots the policy functions of nominal rate (left panel), inflation (middle panel), and real interest rate (right panel) as a function of state variables $\{\theta, \nu\}$. The horizontal axis is the monetary policy shock ν. The blue dashed lines are policy function for the low inflation target regime, θ_L and the red solid lines are the policy functions for the high inflation target regime, θ_H.

Second, keeping monetary policy variable ν fixed, the immediate impact of an increase in the long-run inflation rate θ, raises the nominal rate, increases inflation, as shown in Figure 4, but lowers the equilibrium real wage, labor supply and aggregate consumption, as in Figure 5. We illustrate this dynamics as a movement from A to C in the figures. This is quite different from the standard New Keynesian effect. An increase in long-run inflation target, that is, a switch from θ_L to θ_H, raises expectation about future inflation. Because firms' pricing decisions are forward looking, a higher inflation expectation immediately translates into a rise in current inflation. Given that ν is kept fixed, the Taylor rule $r = (\phi - 1)\,\pi - \nu$ implies that a higher π must be associated with a higher real rate r. Finally, nominal $i = r + \pi$ must also rise as both r and π do.

In Figure 5, the immediate drop in real wage, labor supply and aggregate consumption in response to an increase in long run expectation may be surprising, but it is the result of firms' forward looking price adjustment decisions. The discrete-time version of firms' optimal price adjustment decision take the familiar form in standard Rotemberg models:

$$h'\left(\pi_t\right) = \left[\eta \left(\frac{A}{w\left(\hat{\theta}, \nu\right)}\right)^{-1} - (\eta - 1)\right] + E\left[h'\left(\pi_{t+\Delta}\right)\right]. \tag{13}$$

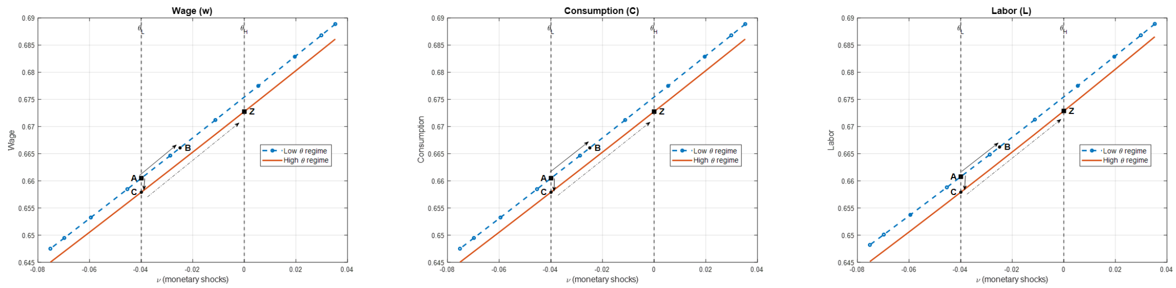
The left hand side, $h'(\pi_t)$, is the current-period marginal cost of price adjustment. The right hand side is the marginal benefit of price adjustment, including the marginal benefit in terms of current period profit, $\left[\eta\left(\frac{A}{w(\hat{\theta},\nu)}\right)^{-1}-(\eta-1)\right]$, and the benefit of saving future cost of price adjustment, $E\left[h'\left(\pi_{t+\Delta}\right)\right]$. Keeping inflation expectation, $E\left[h'\left(\pi_{t+\Delta}\right)\right]$ constant, a rise in current inflation π_t is expansionary, because it must be accompanied by a rise in the marginal profit $\left[\eta\left(\frac{A}{w(\hat{\theta},\nu)}\right)^{-1}-(\eta-1)\right]$, which is a decreasing function of markup, $\frac{A}{w(\hat{\theta},\nu)}$. Lower markup raises wage and labor supply. This is the standard New Keynesian mechanism.

However, an increase in the long-run inflation expectation, $E\left[h'\left(\pi_{t+\Delta}\right)\right]$, keeping π_t equal, must be accompanied by a decrease in marginal profit, $\left[\eta\left(\frac{A}{w(\hat{\theta},\nu)}\right)^{-1}-(\eta-1)\right]$, which represents an increase in markup and is therefore contractionary upon impact. In equilibrium, π_t will not be kept equal, because current price level will respond to expectations about future policy, as shown in Figure 4. However, under sticky price, adjustment in π_t will not completely offset the initial impact of changes in inflation expectation, and the aforementioned effect still holds. In summary, Equation (13) implies that current inflation and future inflation expectation have opposite impacts on markup. Increasing current period inflation lowers markup, while higher inflation expectation, keeping everything else equal, has the opposite impact.

Finally, note that the high long-run inflation regime, C, is associated with both a higher inflation and higher real rate, and, as a result, a higher nominal rate. C has a higher real rate compared to A because the consumption level of C is lower, and, as a result, the expected consumption growth is higher, due to the mean reversion nature of θ. The fact that the high long-run cash flow steady state is associated with a higher nominal rate is the key for generating the Fed information effect in our model.

Third, we observe that there are two steady states in the economy, represented by A and Z in Figures 4 and 5. In the low inflation expectation regime, θ_L, represented by point A, ν tends to mean reverts to θ_L in the long run. This regime is associated with a low long-run nominal rate, a low long-run inflation and a low long-run output. An increase from θ_L to θ_H, raises the nominal rate upon impact from A to C, but the equilibrium eventually will converge to Z, with a lower nominal rate than the initial impact. The increase in long-run inflation target is contractionary upon impact, but the equilibrium eventually converge to a

Figure 5: Real impact of monetary policy



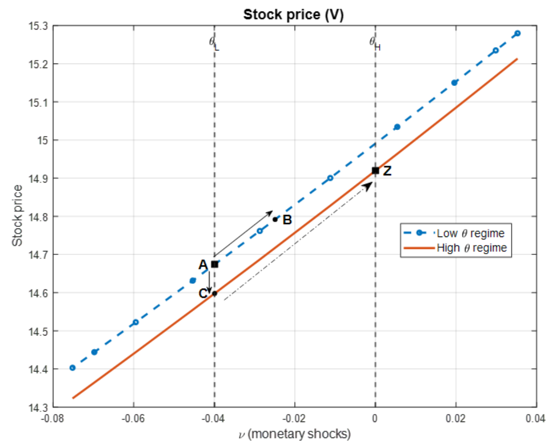
Notes: This figure plots the policy functions of real wage (left panel), labor supply (middle panel), and consumption (right panel) as a function of state variables $\{\theta, \nu\}$. The horizontal axis is the monetary policy shocks ν.The blue dashed lines are policy functions for the low-inflation regime, θ_L and the red solid lines are the policy functions for the high-inflation regime, θ_H.

higher steady state real wage, labor supply, and output at point Z as illustrated in Figure 5.

Finally, we plot the model's implications on asset prices in Figure 6. For a given regime, the equity value of a firm is an increasing function of ν. That is, an expansionary shock to ν lowers the real interest rate and raises equity market valuation. This is consistent with the standard New Keynesian effect of monetary policy shocks. Keeping the value of ν constant, an increase in long-run inflation target lowers equity valuations upon impact, because of the increase in the real rate (Figure 4) and the drop in consumption (Figure 5) work in the same direction to lower equity valuation. However, in the long run, the equilibrium will slowly converge to the new steady state Z with higher long-run inflation and long-run valuations.

Learning about Fed type In this section, we illustrate the implications of our full model where Fed's policy regime is not directly observable and has to be inferred from past actions of monetary policy. In this case, a positive innovation in the monetary policy shock ν has two effects. First, it lowers the nominal interest rate because it raises current period consumption without affecting steady state consumption, just like in conventional New Keynesian models. When uncertainty about Fed's policy regime is low, this is the dominating effect. Second, it impacts the private sector's belief about Fed's long-run inflation target and therefore belief about the long-run steady state of the economy. The anticipation of the higher long-run level of consumption will increase both the real and the nominal interest rate, even though the initial shock is expansionary, giving rise to a Fed information effect. When uncertainty

Figure 6: Policy Function with Regime Switch and Perfect Information



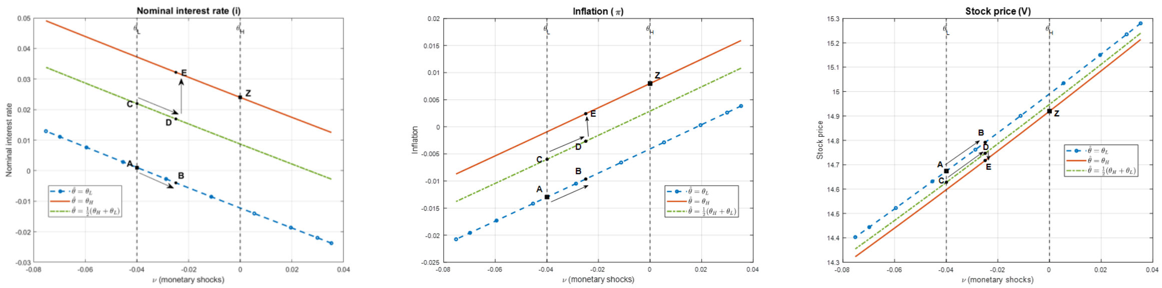
Notes: This figure plots the policy functions of equity price as a function of state variables $\{\theta, \nu\}$. The horizontal axis is the monetary policy shocks ν.The blue dashed lines are policy functions for the low inflation regime, θ_L and the red solid lines are the policy functions for the high inflation regime, θ_H.

about Fed type is high, the second effect is the dominant force.

To illustrate the different impact of the two types of monetary policy shocks, in Figure 7, we start from the low inflation steady state A and assume that the current-period value of ν is $\nu_0 = \theta_L$. Consider the first scenario where $\hat{\theta} = \theta_L$, that is, investors believe with probability 1 a low long run inflation target regime. In this case, investors have little uncertainty about the value of θ_0 and as a result, shocks to ν_0 does not affect the belief about $\hat{\theta}_0$. As a result, as in standard New Keynesian models, the equilibrium moves from A to B. An expansionary shock to ν_0 lowers the nominal interest rate, raises inflation, raises real wage, consumption, output, and stock market valuation. The Jarocinski and Karadi (2020) methodology will classify this as a conventional monetary policy shock, because it triggers a simultaneous reduction in nominal rate and a rise in stock market valuation.

We plot the above path of shocks in the impulse response functions on the left panel in Figure 8. In the top figure, an expansionary shock moves ν_t upwards from θ_L immediately, before it recovers in the next period and slowly converges back to the steady state of $\bar{\theta} = \frac{\kappa_L \theta_H + \kappa_H \theta_L}{\kappa_L + \kappa_H}$, because belief about θ_t does. In the second figure on the left panel, the belief about $\hat{\theta}_t$ does not respond to the shock because the prior belief, $\hat{\theta}_0 = \theta_L$ focuses on θ_L with little uncertainty. It merely converges to steady state of $\bar{\theta}$ in the long run. Consistent with

Figure 7: Inflation and interest rates under learning about the Fed type



Notes: This figure plots the policy functions of equity price as a function of state variables $\{\theta, \nu\}$. The horizontal axis is the monetary policy shocks ν.The blue dashed lines correspond to policy functions for low inflation regime, θ_L, and the red solid lines correspond to policy functions for high inflation regime, θ_H. Both are low-uncertainty cases regarding policy regimes while the green dashed lines are for high-uncertainty case.

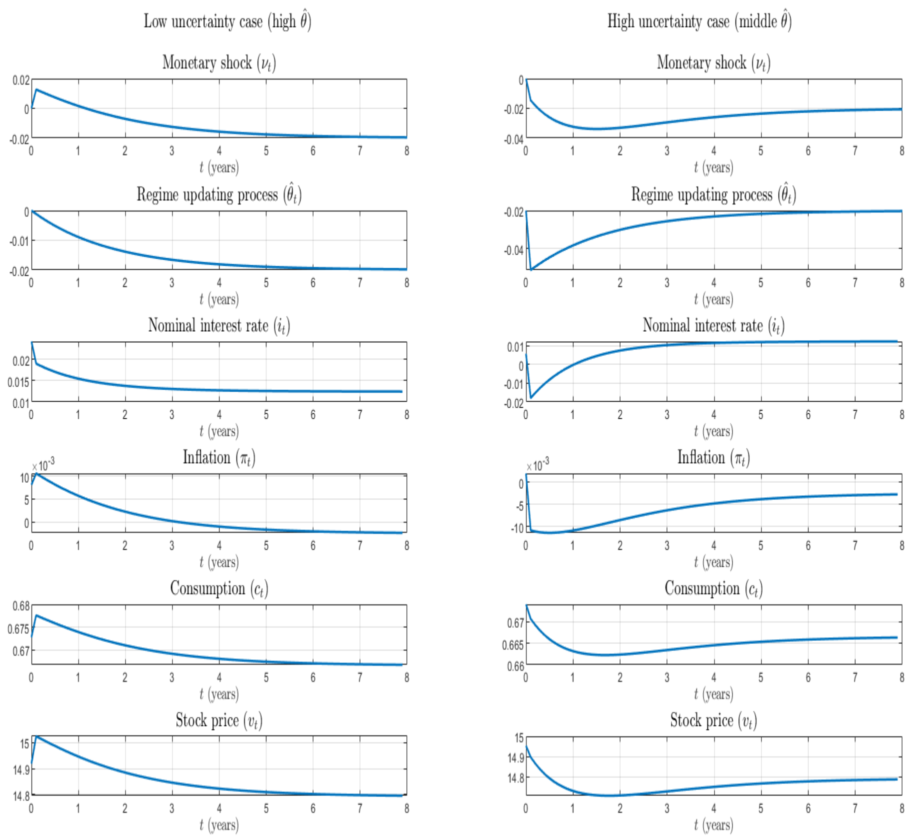
the policy functions in Figure 7, the nominal rate drops immediately, and inflation rises immediately, and converges to the steady state in the long run. Steady-state inflation is lower than its initial level, because the steady state level of ν_t is $\bar{\theta}$[5], higher than the initial level of $\nu_0 = \theta_L$. The rest of the impulse response functions all follow the same pattern: real wage, consumption and stock price all increase upon impact and converge to a lower steady state in the long-run as ν_t converges to $\bar{\theta}$.

Consider now the second case where $\nu_0 = \theta_L$ but $\hat{\theta}_0 = \frac{1}{2}(\theta_H + \theta_L)$, represented by point C in Figure 7. In our setup, $\hat{\theta}_t \in [\theta_L, \theta_H]$. The posterior probability is $P(\theta_t = \theta_H | t) = \frac{\hat{\theta} - \theta_L}{\theta_H - \theta_L}$, and the posterior variance of agents' belief is $Var[\theta_t | t] = \frac{\hat{\theta}_t - \theta_L}{\theta_H - \theta_L}\left(\theta_H - \hat{\theta}_t\right)^2 + \frac{\theta_H - \hat{\theta}_t}{\theta_H - \theta_L}\left(\theta_L - \hat{\theta}_t\right)^2$. Clearly, posterior variance is minimized at $\hat{\theta} = \theta_H$ or $\hat{\theta} = \theta_L$ and maximized at $\hat{\theta} = \frac{1}{2}(\theta_H + \theta_L)$. At $\hat{\theta}_0 = \frac{1}{2}(\theta_H + \theta_L)$, the prior belief about θ_0 is highly uncertain, and the posterior belief will be highly sensitive to variations in ν. In this case, shocks to ν will lead to significant updates of the posterior belief about θ.

Consider a positive shock to ν_0. We demonstrate that this expansionary shock will lead to a simultaneous rise in both interest rate and stock market valuation. As a result, it will be measured as a Fed information shock by the Jarocinski and Karadi (2020) methodology. To see this, note that the New Keynesian channel moves the nominal rate from point C to point D along the dash-dotted line if the posterior belief, $\hat{\theta}$, were kept constant. However,

[5] As the law of motion indicates, ν_t has two local steady state, θ_L and θ_H, and in the long run, it converges to the long-run mean of θ, $\bar{\theta}$.

Figure 8: Impulse responses functions of prices and quantities



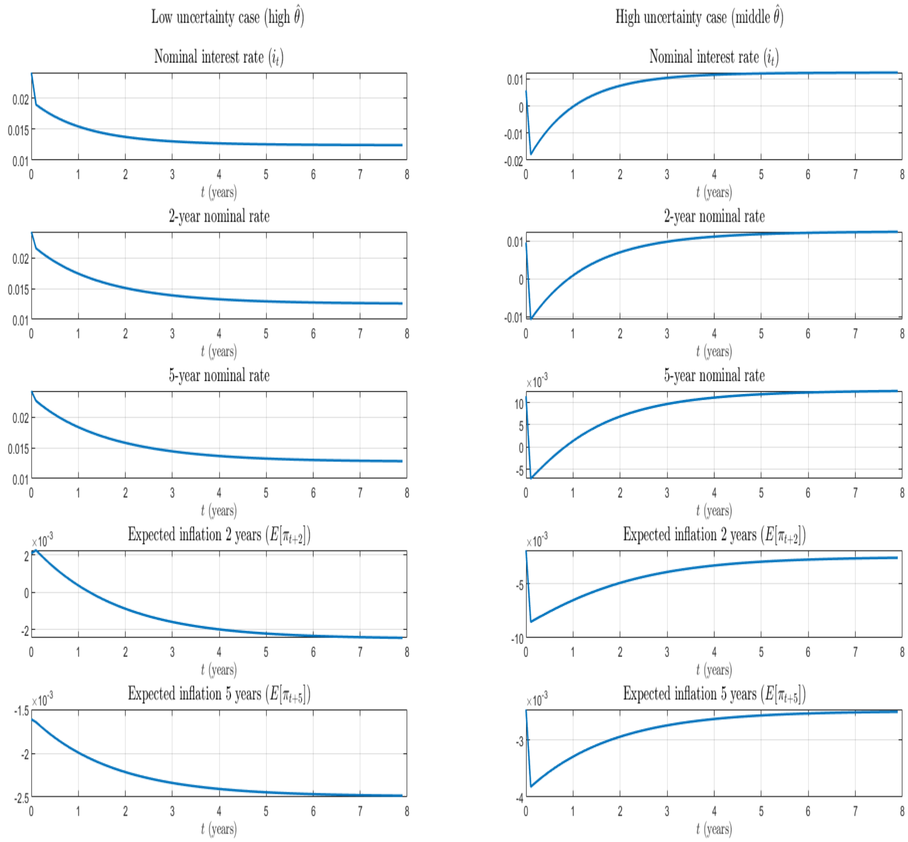
Bayesian updating requires investors to revise their posterior belief upwards from $\hat{\theta} = \bar{\theta}$, that is, from C to E in the figure, where for the purpose of illustration, we assume that the belief revision moves $\hat{\theta}$ all the way to θ_H. Investors are uncertain about whether a positive shock to ν is originated from the temporal Brownian motion shock $dB_{\nu,t}$ or is due to a persistent change in the interest rate target θ. As a result of Bayesian learning, they rationally assign a non-trivial probability to a regime change in θ and update belief from $\bar{\theta}$ to θ_H. On the left panel of Figure 7, an expansionary shock lowers the nominal rate from C to D due to the traditional New Keynesian effect, and, additionally, from D to E, a higher nominal rate regime, because the long-run inflation steady state is associated with high nominal rates, as we show in the last section.

At the same time, stock price also moves down from C to D and from D to E due the anticipation of a higher inflation in the future. The change in stock price from D to E is relatively small, so that the New Keynesian effect dominates for stock price and an increasing ν results in a rise of stock market valuation. The relative small magnitude of the Bayesian updating impact on stock price can be explained by two offsetting effects. First, an increase in the posterior belief $\hat{\theta}$ lowers real wage and total output keeping the current value of ν_t fixed, which tend to lower stock market valuation. Second, and more importantly, a higher posterior belief of $\hat{\theta}$ also implies that the economy will converge to a new steady state with a persistently higher ν, because θ_t is the long-run value of ν_t. The new steady state is associated with a higher long-run output. Because stock market valuation is forward looking, the increase in stock price due to the first channel of Bayesian updating is relatively small, and second channel reinforces the traditional New Keynesian effect to generate a positive stock price response to the initial shock in ν_0.

Finally, the impact of the shock on aggregate consumption is similar: from C to D and then to E, representing a net positive impact on aggregate consumption and output. The combination of a higher nominal rate and a higher stock market valuation and higher expectation of long run consumption is what is typically identified as the Fed information shock in the literature.

In summary, when uncertainty is high, an increase in ν_t leads to a simultaneous rise in nominal interest rate and in stock market valuation, even though in our model, the Fed does not have superior information about macroeconomic fundamentals. We illustrate the impulse response to this "Fed information shock" in the right panel in Figure 8. In the second panel, a positive shock to ν_0 when $\hat{\theta}_0 = \bar{\theta}$ raises $\hat{\theta}$ immediately due to Bayesian updating in contrast to the lack of response of $\hat{\theta}$ on the left panel. The nominal rate rises. At the same time, consumption and stock price both rise upon impact, that is, the nominal interest rate and stock price respond in the same direction to monetary policy shocks.

Figure 9: Impulse responses functions of nominal yields and inflation expectations



To illustrate the impact of the two types of shocks on the term structure of interest rates and on inflation expectations, we plot in Figure 9 the impulse response functions of nominal yields and inflation expectations at the two- and five-year maturities. The left panel reports responses to a conventional monetary policy shock (i.e., a positive shock to ν when uncertainty about θ is low), and the right panel reports responses to a Fed information shock (i.e., a negative shock to ν when uncertainty about θ is high). In the figure, both types of shocks manifest themselves as a rate cut in the instantaneous nominal rate on impact.

The two shocks differ sharply, however, in how this reduction transmits along the yield curve. On the left panel, the conventional monetary policy shock leads to an immediate decline in the nominal rate, but the magnitude of the decline drops significantly at the two-year maturity and almost vanishes at the five-year maturity, reflecting the low persistence of the shock. By contrast, on the right panel, the Fed information shock results in a larger and more persistent decline in nominal rates across maturities, because it impacts the long-run steady state of the economy.

The same contrast carries over to inflation expectations, shown in the bottom two rows. The reduction in the nominal rate induced by the conventional shock is associated with a mild increase in current inflation, but the impact on inflation expectations vanishes quickly as the horizon increases to two and five years. The Fed information shock, by contrast, is associated with a strong immediate decline in inflation whose impact persists even at the five-year horizon. Both patterns—for the term structure of yields and for inflation expectations—are consistent with the stylized facts we document in Section 2.

5 Empirical evidence and quantitative results

The key implication of our model is that monetary policy shocks are more likely to impact the economy as a conventional monetary policy shock when uncertainty about policy regime is low and is more likely to generate a Fed information effect when uncertainty about monetary policy is high. In this section, we provide several tests on this unique implication of our theoretical framework. We also calibrate our model and replicate these empirical tests in model simulated data to demonstrate the model's ability to quantitatively account for the Fed information effect.

Model calibration We calibrate preference and technology parameters that are common to the New Keynesian literature by taking values of these parameters directly from the previous literature. We set the annual discount rate $\rho = 0.020$, the risk-aversion coefficient $\gamma = 1$, productivity $A = 1$, the Taylor coefficient $\phi = 3$, and the inverse Frisch elasticity of labor supply $\zeta = 0$. We also set the intermediate-goods substitution elasticity $\eta = 3$. They are values commonly used in the New Keynesian literature, for example, (Galí, 2015).

We set the Rotemberg price-adjustment cost $h_0 = 5$ so that the steady state slope of the New Keynesian Phillips curve is the same as a Calvo model with an expected price duration of roughly two quarters, a value broadly consistent with the posted-price (including sales) duration of around four to five months that Nakamura and Steinsson (2008) document for U.S. consumer prices.

The second group of parameters are unique to our model. We set the transition rates of the policy regime symmetrically to $\kappa_L = \kappa_H = 0.105$, implying an expected duration of each regime as $1/\kappa \approx 9.5$, broadly consistent with the modern historical average tenure of Federal Reserve Chairs. We normalize $\theta_L = 0$, leaving three free parameters $(\theta_H, a, \sigma_\nu)$ to be chosen jointly to match three empirical moments: the mean, the standard deviation, and the first order autocorrelation of nominal interest rates. All calibrated parameters are listed in Table 9

We simulate model and report several asset pricing moments in model simulation and their empirical counterparts. Most of these moments are for asset prices which we will later use to test our model implications. MPS is the monetary policy shock measured as innovations in the nominal interest rate over short FOMC announcement windows. Empirically, we use the orthogonalized monetary policy shock from Bauer and Swanson (2023b) measured during the 30-minute window around FOMC announcements as a measure of MPS.[6] MPU is monetary policy uncertainty, measured as the neutral standard deviation of a 3-month forward rate with 2 year maturity. Empirically, we follow Bauer, Lakdawala, and Mueller (2022) to construct MPU from Eurodollar option prices (SOFR option prices since October 2022) interpolated to a 24-month maturity. $R_{t,t+\Delta}$ is the stock market return, measured as the SP 500 return over short FOMC announcement windows. $\Delta\pi^n_{t,t+\Delta}$ is the innovation in the risk-neutral expectation of n-year ahead annual inflation rate over short FOMC announcement windows, empirically measured as the changes in inflation swap rate with n year maturity on FOMC announcement days. $\Delta y^n_{t,t+\Delta}$ is the change in nominal yield with n-year maturity over short FOMC announcement windows.

[6] As shown by Cieslak (2018) and Bauer and Swanson (2023a), Fed funds futures price changes measured over high frequency FOMC windows are partly predictable by past macro variables. We follow Bauer and Swanson (2023b) to measure monetary policy surprises by using the component of the high-frequency Fed funds futures price changes that are orthogonal with respect to six macro-financial predictors (denoted MPS in Table 3). By construction, this measurement of monetary policy surprise is not predictable by past publicly available information.

Table 1: Parameter Values for Quantitative Assessment

Parameter	Description	Value
ρ	discount rate	0.020
A	productivity	1
θ_L	low long-run rate	0
θ_H	high long-run rate	0.060
$\bar{\theta}$	middle long-run rate	0.030
γ	risk aversion	1
η	substitution elasticity of intermediate goods	3
ζ	inverse of labor elasticity	0
κ_H	transition probability from high to low regime	0.105
κ_L	transition probability from low to high regime	0.105
ϕ	Taylor coefficient	3
a	mean-reverting rate of transitory shocks	0.90
h_0	price adjustment cost	5
σ_ν	std dev of monetary shock	0.025

Notes: This table reports the calibration used for the 50-year daily simulation and the FOMC-day regressions analyzed in Section 5. Four parameters are recalibrated relative to the model-solution / impulse-response calibration of Table 9: the regime gap is widened (θ_H: $0.04 \to 0.060$, $\bar{\theta}$: $0.02 \to 0.030$); the expected regime dwell time is lengthened ($1/\kappa$: 4 years $\to\approx$ 9 years); the monetary shock is made more persistent (a: $0.99 \to 0.90$); and the discount rate is slightly raised (ρ: $0.015 \to 0.020$). The two calibrations serve complementary purposes. The parameters in Table 9 are chosen for illustrative clarity: they make the underlying mechanism of the Fed-information effect — the dependence of equilibrium quantities on the filtered posterior $\hat{\theta}_t$ — directly visible in the policy-function and impulse-response plots. Precisely because the mechanism is so cleanly exposed under that calibration, however, the resulting effect is too prominent for quantitative work: simulating the model under the Table 9 parameters would produce positive co-movement between stock returns and policy-rate surprises on FOMC days at a frequency well above the empirical counterpart. The parameters here are therefore chosen to bring the simulated frequency of the effect into alignment with the data, while preserving the same underlying mechanism — in particular, the stationary distribution of $\hat{\theta}_t$ remains sharply bimodal (Figure 11), so the same belief-uncertainty channel that drives the qualitative implications of the model also produces the simulated regression results. The diffusion coefficient $\sigma_\nu \approx 0.025$ is reported here because it directly governs the realized dispersion of ν_t in the simulation; together with $a = 0.90$ it implies an unconditional standard deviation of ν_t around its target of $\sigma_\nu/\sqrt{2a} \approx 0.019$. All other parameters are unchanged.

All moments are report in Table 2. We simulate our continuous time model at the daily frequency. To model FOMC announcements, in simulations, we keep the total volatility of an announcement cycle constant ($\sigma_\nu \times \sqrt{\frac{1}{8}}$ as one FOMC announcement cycle is $\frac{1}{8}$ year), and allocation the volatility of $dB_{\nu t}$ on FOMC announcement days to match exactly the standard deviation of MPS. As a result, our model matches this moment exactly by construction.

Our model matches other moments in the data fairly closely. The average monetary policy uncertainty, $\mathbb{E}[\text{MPU}]$ is 1.39% in the data and 0.86% in the model, and $\sigma(\text{MPU})$ is 0.38% in the data and 0.19% in the model. The standard deviation of the one-year nominal yield change is 0.07% in both data and model, and the standard deviations of the five-year nominal yield change and of the one- and five-year inflation expectation changes are all of the same order of magnitude as their empirical counterparts. The model also reproduces the empirical sign pattern of the co-movement between equity returns and the policy shock: in the data, $R_{t,t+\Delta}$ and MPS_t share the same sign in 34.83% of FOMC windows, and the model generates a comparable share (20.78%) of same-sign observations. This indicates that the standard New Keynesian negative co-movement dominates on average, while the Fed information shocks responsible for positive co-movement arise endogenously in a non-trivial fraction of windows. The one moment on which the model falls short is the volatility of equity returns on FOMC days: $\sigma(R_{t,t+\Delta})$ is 0.56% in the data and 0.14% in the model. This reflects the excess volatility puzzle in standard macro models.

In what follows, we design several tests for the unique implication of our model that Fed information effect is more likely to happen when uncertainty about Fed type is high. To validate the empirical design, and to demonstrate our model's ability to quantitatively account for the Fed information effect, we also replicate these empirical tests in simulated model.

Fed information effect on stock prices Our first test is on the Fed information effect on stock prices. Our model predicts that Fed information shocks are more likely to happen when uncertainty about the longer-term interest rate target is high. When monetary policy uncertainty is low, our model behaves like a standard New Keynesian model and nominal rates reductions are associated with stock price appreciations. When monetary policy uncertainty is high, the Fed information effect dominates and nominal rate reductions are associated with stock market declines. We test this implications of our model by using the

Table 2: Targeted Moments: Data vs. Model

Moment	Note	Data (%)	Sim. (%)
$\mathbb{E}[\text{MPS}]$	Mean of mon. shock	0.00	0.00
$\sigma(\text{MPS})$	S.D. of mon. shock	0.06	0.06
$\mathbb{E}[\text{MPU}]$	Mean of MPU	1.39	0.86
$\sigma(\text{MPU})$	S.D. of MPU	0.38	0.19
$\mathbb{E}[R_{t,t+\Delta}]$	Mean S&P return	0.02	-0.00
$\sigma(R_{t,t+\Delta})$	S.D. of S&P return	0.56	0.14
$\Pr(R_{t,t+\Delta} \cdot \text{MPS}_t > 0)$	Freq. same-dir. mvmt.	34.83	20.78
$\sigma(\Delta\pi^1_{t,t+\Delta})$	S.D. of 1y infl. exp. chg.	0.12	0.07
$\sigma(\Delta\pi^5_{t,t+\Delta})$	S.D. of 5y infl. exp. chg.	0.05	0.02
$\sigma(\Delta y^1_{t,t+\Delta})$	S.D. of 1y nom. yield chg.	0.07	0.07
$\sigma(\Delta y^5_{t,t+\Delta})$	S.D. of 5y nom. yield chg.	0.08	0.04

Notes: All moments are reported in percent. Empirical moments are computed over the sample of FOMC announcements with non-missing MPS_t used in Tables 3–5. Simulated moments are computed over 6,718 in-domain FOMC observations drawn from the model at the parameter values in Table 1. The standard deviation of MPS_t on FOMC days, and the mean and standard deviation of MPU_t, are the three calibration targets used to set $(\theta_H, a, \sigma_\nu)$; all other moments are untargeted predictions of the model. $\Delta\pi^n_{t,t+\Delta}$ denotes the announcement-window change in m-maturity inflation expectations, and $\Delta y^n_{t,t+\Delta}$ the announcement-window change in the m-maturity nominal yield. The same-direction frequency is the share of observations in which $R_{t,t+\Delta}$ and MPS_t share the same sign.

following regression specification:

$$R_{t,t+\Delta} = \beta_0 + \beta_I \,\mathrm{MPS}_t + \beta_S \,\mathrm{MPU}_{t-1} + \beta_{\mathrm{Inter}} \,(\mathrm{MPS}_t \times \mathrm{MPU}_{t-1}) + \epsilon_t, \tag{14}$$

where $R_{t,t+\Delta}$ is the S&P 500 return over the 30-minute FOMC announcement window and MPU_{t-1} is monetary policy uncertainty measured the day before the monetary policy announcement.

Under the null hypothesis of the model, interest rate rises are associated with stock market declines when uncertainty is low. As a result, $\beta_I < 0$. The negative relationship between interest rate surprise and stock market price changes becomes positive when uncertainty about monetary policy is elevated, that is, $\beta_{Inter} > 0$. We report our regression results in Table 3. Column (1) reports the baseline relationship: a one percentage point contractionary shock reduces stock returns by 5.34 percentage points unconditionally. Column (2) adds MPU and its interaction with the policy shock. The coefficient on the interaction term, β_{Inter}, is positive (3.43) and statistically significant at the 5% level. These results are consistent with our model's predictions.

In the model, S&P 500 returns load negatively on the policy surprise and positively on its interaction with MPU_{t-1}, with simulated point estimates of -3.62 and $+2.78$ that are close to the empirical estimates of -6.12 and $+3.43$.

Inflation expectations As shown in Figure 9, inflation responds negatively to nominal interest rate increases when monetary policy uncertainty is low. However, when monetary policy uncertainty is high inflation and inflation expectations can respond positively to surprise nominal rate increases, especially over longer maturities. Using inflation swap returns on FOMC announcement days as a measure of changes in inflation expectations, we use the following regression to test the Fed information effect on inflation expectations implied by our model:

$$\Delta\pi^n_{t,t+\Delta} = \beta_0 + \beta_I \,\mathrm{MPS}_t + \beta_S \,\mathrm{MPU}_{t-1} + \beta_{\mathrm{Inter}} \big(\mathrm{MPS}_t \times \mathrm{MPU}_{t-1}\big) + \epsilon_{t,t+\Delta}. \tag{15}$$

In the above Equation, $\Delta\pi^n_{t,t+\Delta}$ is the changes in inflation expectation with maturity m measured by inflation swap returns of corresponding maturity on FOMC announcement days. Under the null hypothesis implied by the model, surprise nominal rate increases lower

Table 3: S&P 500 Returns and Monetary Policy Uncertainty: Data vs. Model

	(1) Baseline		(2) + MPU and interaction	
	Data	Sim.	Data	Sim.
MPS	-5.34^{***}	-0.83^{***}	-6.12^{***}	-3.62^{***}
	(-6.11)	(-16.08)	(-5.83)	(-9.36)
MPU_{t-1}			-0.15^{**}	-0.01
			(-2.53)	(-0.75)
$\text{MPS}\times\text{MPU}_{t-1}$			3.43^{**}	2.78^{***}
			(1.98)	(7.83)
R^2	0.29	0.24	0.31	0.45
n_{obs}	290	6,718	290	6,718

Notes: This table compares estimates of the S&P 500 return regression on empirical data and on simulated FOMC observations from the model at the calibrated parameter values. The dependent variable is 100 times the log change in S&P 500 futures over the 30-minute window around FOMC announcements; the empirical sample spans February 8, 1990 to December 13, 2023. We combine high-frequency S&P 500 data from Marek Jarociński's website with the MPS_ORTH series on FOMC days from Michael Bauer's website to obtain the longest possible sample, as the latter does not have S&P 500 data after 2019. MPS_ORTH is the orthogonalized monetary policy shock of Bauer and Swanson (2023b), measured in the same window; MPU is monetary policy uncertainty measured one day before FOMC meetings from Eurodollar (later SOFR) options on the 3-month rate, interpolated to 24-month maturity, from Bauer, Lakdawala, and Mueller (2022). Heteroskedasticity- and autocorrelation-robust t-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels.

inflation and inflation expectations and as a result, we expect $\beta_I < 0$. In addition, when MPU is high, inflation expectations respond positively to unexpected nominal rate changes, and our models implies $\beta_{Inter} > 0$. Because Fed information effect in our model affect the long-run steady state of the economy, our model implies that the point estimate for β_{Inter} to be significant over longer horizons. The regression results we report in Table 4 are consistent with the above model implications.

Similarly, in the model, the loading of inflation expectations on the policy surprise is negative at every maturity in both data and model, while the interaction coefficient β_{Inter} is positive at every maturity in both data and model.

Table 4: Inflation Expectations Response: Data vs. Model

	β_I		β_{Inter}	
Maturity	Data	Sim.	Data	Sim.
1 year	-0.35	-0.64^{***}	0.08	0.93^{***}
5 year	-0.35^{***}	-0.23^{***}	-0.01	0.40^{***}
7 year	-0.24^{***}	-0.14^{***}	0.32^{*}	0.26^{***}
8 year	-0.23^{***}	-0.11^{***}	0.43^{**}	0.21^{***}
9 year	-0.30^{***}	-0.09^{***}	0.28	0.17^{***}
10 year	-0.28^{***}	-0.08^{***}	0.35^{**}	0.14^{***}
12 year	-0.33^{***}	-0.05^{***}	0.28^{*}	0.09^{***}

*Notes:*This table compares estimates of the inflation-expectations regression on empirical data and on simulated FOMC observations from the model at the calibrated parameter values. The dependent variable is the daily change in inflation swap rates of maturity m on FOMC announcement days. The empirical sample spans August 10, 2004 (when inflation swap data first become available) to November 1, 2023, covering 154 FOMC meetings. MPS_ORTH is the orthogonalized monetary policy shock of Bauer and Swanson (2023b), measured during the 30-minute window around FOMC announcements; MPU is monetary policy uncertainty measured one day before FOMC meetings from Eurodollar (later SOFR) options on the 3-month interest rate, interpolated to a 24-month maturity, from Bauer, Lakdawala, and Mueller (2022). Inflation swap data are from Bloomberg. Each row reports results for a different maturity. Heteroskedasticity- and autocorrelation-robust t-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels.

Term structure of interest rates Finally, we test our model implication on the Fed information effect on the term structure of interest rates. Similarly to Equation 15, we regress nominal rates of different maturities on measured monetary policy surprises and an interaction term with MPU:

$$\Delta y^{n}_{t,t+\Delta} = \beta_0 + \beta_I \,\mathrm{MPS}_t + \beta_S \,\mathrm{MPU}_{t-1} + \beta_{\mathrm{Inter}} \big(\mathrm{MPS}_t \times \mathrm{MPU}_{t-1}\big) + \epsilon_{n,t,t+\Delta}. \tag{16}$$

We report the regression results in Table 5.

And we can see from Table 5 that the interaction term is positive, as expected, and the underlying intuition is straightforward–when uncertainty around the long-run interest rate target is high, the public updates more and henceforth the longer the maturity, the changes in nominal yields are more affected by the current level of monetary policy uncertainty.

Likewise, in the model, the direct loading of nominal yields on the policy surprise declines monotonically with maturity, while the interaction coefficient rises with maturity, both in the data and in the simulation. This last pattern is consistent with the central prediction of the Fed information mechanism: when uncertainty about the long-run policy regime is high, Bayesian updating amplifies the response of long-horizon variables to monetary policy surprises and, in extreme cases, reverses the sign of the equity-return response, generating Fed information shocks endogenously. Taken together, the above evidence provides support for our learning based mechanism for the Fed information effect.

6 Conclusion

We develop an equilibrium model of monetary policy announcements to account for the Fed information effect— the empirical fact that measured expansionary monetary policy shocks, that is, surprise interest rate reductions, often have contractionary impact on the economy. Our model does not rely on the assumption that the Fed has superior information about economic fundamentals. Instead, we introduce asymmetric information about the Fed's long-run policy objective for the target rate. The model implies that the Fed information effect is more likely to occur when uncertainty about monetary policy is high, and we provide several pieces of empirical evidence supporting this unique implication.

Table 5: Nominal Yields Response: Data vs. Model

	β_I		β_{Inter}	
Maturity	Data	Sim.	Data	Sim.
1 year	0.59***	0.75***	0.09	−0.02
5 year	0.51***	0.17***	0.17	0.24***
10 year	0.28**	0.03	0.21	0.22***
16 year	0.12*	0.01	0.29*	0.16***
18 year	0.09	0.00	0.32*	0.15***
20 year	0.05	0.00	0.35**	0.14***

Notes: This table compares estimates of regressions of the nominal interest rate of multiple maturities on empirical data and on simulated FOMC observations from the model at calibrated parameter values . The dependent variable is the daily change in nominal Treasury yields of maturity m on FOMC announcement days. The dataset spans from February 8, 1990 to December 13, 2023, covering 292 FOMC meetings. MPS_ORTH is the orthogonalized monetary policy shock of Bauer and Swanson (2023b), measured during the 30-minute window around FOMC announcements; MPU is monetary policy uncertainty measured one day before FOMC meetings from Eurodollar (later SOFR) options on the 3-month interest rate, interpolated to a 24-month maturity, from Bauer, Lakdawala, and Mueller (2022). Yield data are from the Federal Reserve website, computed by Gürkaynak, Sack, and Wright (2007). Each row reports results for a different maturity. This table has two more observations than the S&P 500 table because Jarocinski and Karadi (2020) exclude two meetings (January 22 and October 8, 2008) relative to Bauer and Swanson (2023b), as the Fed took significant measures to cope with the Global Financial Crisis during this period; the results are robust to excluding these meetings. Heteroskedasticity- and autocorrelation-robust t-statistics are reported in parentheses below both the empirical and simulated estimates. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

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Appendix

A.1 Additional Figures and Tables

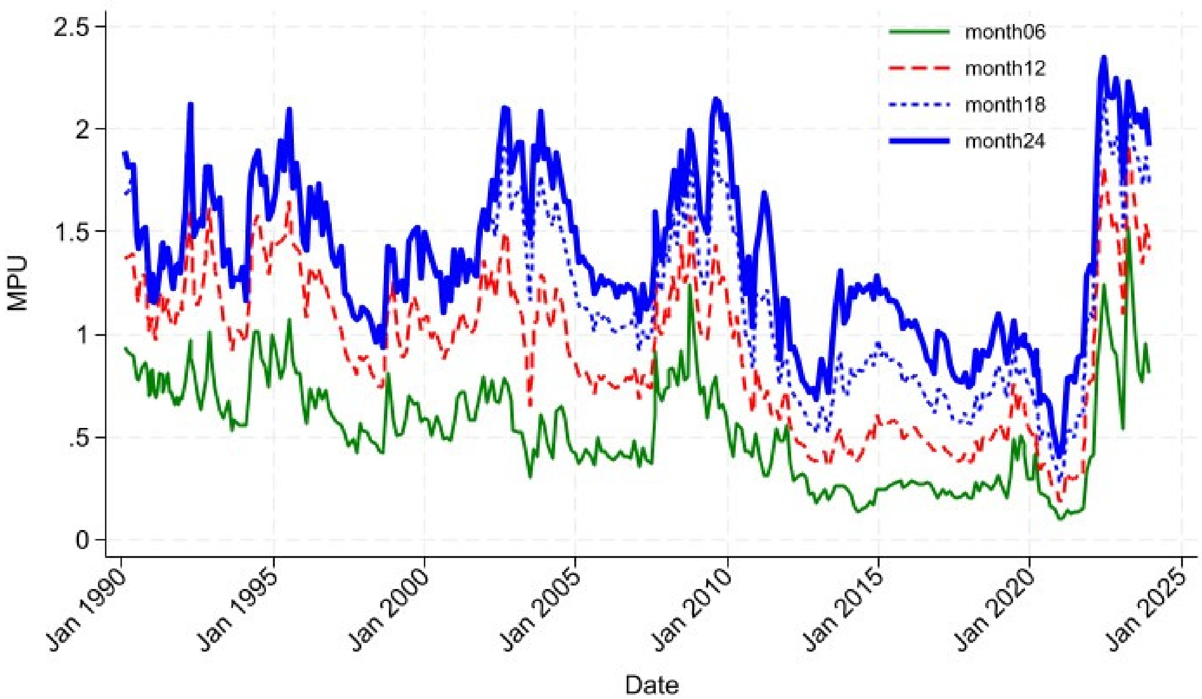

Figure 10: Time Series of Existing Monetary Policy Uncertainty Before FOMC Meetings

Notes: This figure plots the time series of market-based monetary policy uncertainty (MPU) measured one day before each FOMC meeting from January 1990 to December 2023. MPU is calculated as the square root of the model-free variance derived from money market derivatives prices, following the methodology of Bauer, Lakdawala, and Mueller (2022). Four series are shown corresponding to different forecast horizons: 6 months (green solid line), 12 months (red dashed line), 18 months (blue dash-dot line), and 24 months (thick blue solid line). The measure is based on Eurodollar futures and options through September 2022, and SOFR (Secured Overnight Financing Rate) futures and options from October 2022 onwards, reflecting the phasing-out of LIBOR. In our benchmark empirical analysis, we use the 24-month maturity series because the policy uncertainty under study is about long-run short term policy rate uncertainty.

Table 6: Inflation swap responses to monetary policy and information shocks

maturity	$\beta_{\text{mp\_pm}}$	$\beta_{\text{cbi\_pm}}$	$H_0: \beta_{\text{mp\_pm}} - \beta_{\text{cbi\_pm}} = 0$
1 year	−0.32	3.34	−3.66
t-stat	−0.98	1.65	−1.78
2 year	−0.20	2.34	−2.54
t-stat	−1.01	1.39	−1.50
3 year	−0.13	0.44	−1.21
t-stat	−0.79	2.46	−2.59
n_{obs}	163	163	163

Notes: This table reports regression coefficients from estimating the response of inflation swap rate changes to monetary policy shocks (mp_pm) and central bank information shocks (cbi_pm) across different maturities. Rows labeled *t-stat* report t-statistics computed using HAC-robust standard errors with a bandwidth of 4. The third column tests the null hypothesis that the two coefficients are equal. The data span 163 FOMC announcements from 2004 to 2023.[a] Inflation swap data are from Bloomberg, and shock series are from Bauer and Swanson (2023a).

[a]When using decomposed shocks from Jarocinski and Karadi (2020) for inflation swap regressions, we have 7 more observations than in Table 4, which uses shocks from Bauer and Swanson (2023a). This difference occurs because Bauer and Swanson (2023a) exclude all FOMC meetings from March to October 2020 when constructing their shocks, whereas Jarocinski and Karadi (2020) exclude only the unscheduled meetings from this period. The results are robust to excluding these additional meetings.

Table 7: Treasury yield responses to monetary policy and information shocks

maturity	$\beta_{\text{mp\_pm}}$	$\beta_{\text{cbi\_pm}}$	$H_0:\ \beta_{\text{mp\_pm}} - \beta_{\text{cbi\_pm}} = 0$
2 year	0.62	0.89	−0.27
t-stat	6.63	11.23	−2.25
5 year	0.52	0.78	−0.26
t-stat	5.46	8.14	−1.94
10 year	0.33	0.51	−0.18
t-stat	4.19	6.67	−1.62
30 year	0.18	0.34	−0.16
t-stat	3.05	4.66	−1.72
n_{obs}	297	297	297

Notes: This table reports regression coefficients from estimating the response of Treasury yield changes to monetary policy shocks (mp_pm) and central bank information shocks (cbi_pm) across different maturities. Rows labeled *t-stat* report t-statistics computed using HAC-robust standard errors with a bandwidth of 4. The third column tests the null hypothesis that the two coefficients are equal. The data span 297 FOMC announcements from 1990 to 2023.[a] High-frequency Treasury yield data and shock series are from Bauer and Swanson (2023b).

[a]When using decomposed shocks from Jarocinski and Karadi (2020) for Treasury yield regressions, we have 7 more observations than in Table 3, which uses shocks from Bauer and Swanson (2023a). This difference occurs because Bauer and Swanson (2023a) exclude all FOMC meetings from March to October 2020 when constructing their shocks, whereas Jarocinski and Karadi (2020) exclude only the unscheduled meetings from this period. The results are robust to excluding these additional meetings.

Table 8: Nominal Yields and Monetary Policy Uncertainty: Robustness with Filipović, Pelger, and Ye (forthcoming) Zero-Coupon Yields

Maturity	β_I	β_{Inter}	R^2	n_{obs}
1 year	0.72^{***}	-0.09	0.37	292
5 year	0.66^{***}	0.10	0.21	292
10 year	0.39^{***}	0.19	0.11	292
16 year	0.15	0.39^{**}	0.06	292
18 year	0.12	0.40^{**}	0.05	292
20 year	0.11	0.38^{**}	0.05	292
25 year	0.08	0.37^{**}	0.04	292
30 year	0.06	0.41^{**}	0.04	292

Notes: This table presents robustness results using an alternative measure of nominal Treasury yields. The regression specification is identical to Table 5:

$$\Delta y^n_{t,t+\Delta} = \beta_0 + \beta_I \,\text{MPS}_t + \beta_S \,\text{MPU}_t + \beta_{\text{Inter}} \big(\text{MPS}_t \times \text{MPU}_t\big) + \epsilon_{n,t},$$

where the dependent variable $\Delta y^n_{t,t+\Delta}$ is now the daily change in zero-coupon nominal Treasury yields of maturity m estimated using the nonparametric method of Filipović, Pelger, and Ye (forthcoming), rather than the yields from the Federal Reserve website, computed by the method of Gürkaynak, Sack, and Wright (2007) used in the main specification. All other variables and the sample period (February 8, 1990 to December 13, 2023, covering 292 FOMC meetings) remain identical to the baseline specification. Heteroskedasticity and autocorrelation-robust t-statistics are used to compute significance levels: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 9: Parameter Values of Model Solution

Parameter	Description	Value
ρ	discount rate	0.015
A	productivity	1
θ_L	low long-run rate	0
θ_H	high long-run rate	0.04
$\bar{\theta}$	middle long-run rate	0.02
γ	risk aversion	1
η	substitution elasticity of intermediate goods	3
ζ	inverse of labor elasticity	0
κ_H	transition probability from high to low regime	0.25
κ_L	transition probability from low to high regime	0.25
ϕ	Taylor coefficient	3
a	mean-reverting rate of transitory shocks	0.99
h_0	price adjustment cost	5

Notes: Parameter values used in calibration.

A.2 Solution of the Markov Equilibrium

The solution of our model is related to the literature on macroeconomic models with financial frictions, especially continuous-time models such as Brunnermeier and Sannikov (2014) and He and Krishnamurthy (2013). With monopolistic competition, we cannot solve the equilibrium as a social planner's problem and equilibrium prices and quantities have to be simultaneously determined by a set of equilibrium conditions. We borrow the equilibrium selection device of Angeletos and Lian (2023) and focus on Markov equilibrium with minimal state variables.

Combing the production function (11) and the resource constraint (12), we can write consumption as a function of labor supply:

$$C\left(\hat{\theta},\nu\right)=\left[1-h\left(\pi\left(\hat{\theta},\nu\right)\right)\right]AL\left(\hat{\theta},\nu\right). \tag{17}$$

Assuming log preference, i.e. $u\left(C\right)=\ln C$, Equation (10) can be used to write $L\left(\hat{\theta},\nu\right)$ as a function of real wage:

$$\left[1-h\left(\pi\left(\hat{\theta},\nu\right)\right)\right]AL^{1+\zeta}\left(\hat{\theta},\nu\right)=w\left(\hat{\theta},\nu\right). \tag{18}$$

The above two equations together allows us to solve consumption as a function of real wage and write the risk-free rate as:

$$r\left(\hat{\theta},\nu\right)=\beta-\frac{\mathcal{L}\left\{\left[A\left(1-\frac{1}{2}h\left(\pi\left(\hat{\theta},\nu\right)\right)\right)\right]^{-\frac{\zeta}{1+\zeta}}w\left(\hat{\theta},\nu\right)^{-\frac{1}{1+\zeta}}\right\}}{\left[A\left(1-\frac{1}{2}h\left(\pi\left(\hat{\theta},\nu\right)\right)\right)\right]^{-\frac{\zeta}{1+\zeta}}w\left(\hat{\theta},\nu\right)^{-\frac{1}{1+\zeta}}}. \tag{19}$$

Here, the operator $\mathcal{L}$ is defined as $\mathcal{L}X_t=\lim_{\Delta\to 0}\frac{1}{\Delta}E_t\left[X_{t+\Delta}-X_t\right]$ for any random variable X where the limit is defined.

Proposition 1. *(Markov Equilibrium)*

Real wage and real interest rate $\left\{w\left(\hat{\theta},\nu\right),r\left(\hat{\theta},\nu\right)\right\}$ *are jointly determined as the solution to the following two functional equations. The first is the optimal pricing setting* *equation:*

$$\rho h'\left(\pi\left(\hat{\theta},\nu\right)\right)=(\eta-1)\left[\hat{\mu}\frac{w\left(\hat{\theta},\nu\right)}{A}-1\right]+\mathcal{L}\left[h'\left(\pi\left(\hat{\theta},\nu\right)\right)\right], \tag{20}$$

where $\hat{\mu}=\frac{\eta}{\eta-1}$ is the optimal markup in a flexible price equilibrium. The second equation is the requirement of Taylor rule:

$$\beta-\frac{\mathcal{L}\left\{\left[A\left(1-\frac{1}{2}h\left(\pi\left(\hat{\theta},\nu\right)\right)\right)\right]^{-\frac{\zeta}{1+\zeta}}w\left(\hat{\theta},\nu\right)^{-\frac{1}{1+\zeta}}\right\}}{\left[A\left(1-\frac{1}{2}h\left(\pi\left(\hat{\theta},\nu\right)\right)\right)\right]^{-\frac{\zeta}{1+\zeta}}w\left(\hat{\theta},\nu\right)^{-\frac{1}{1+\zeta}}}=(\phi-1)\,\pi\left(\hat{\theta},\nu\right)+\nu. \tag{21}$$

Given $\left\{w\left(\hat{\theta},\nu\right),r\left(\hat{\theta},\nu\right)\right\}$, we can recover labor supply from (18), consumption from (17), risk-free interest rate from (19) and the output function from (11).

The key mechanism of the Fed information effect of our model operates through Equation (20). As we show in Appendix A, this equation is the optimality condition for firms' pricing setting decisions. The left hand side of (20) represents the marginal cost of price adjustment. The term $(\eta-1)\left[\hat{\mu}\frac{w(\hat{\theta},\nu)}{A}-1\right]$ is the current period flow benefit of price adjustment. Note that $\hat{\mu}$ is optimal markup under the flexible price equilibrium. $\hat{\mu}\frac{w(\hat{\theta},\nu)}{A}>1$ implies that markup is lower than the flexible price optimum. In this case, the marginal benefit of raising prices is positive. For the same reason, $\hat{\mu}\frac{w(\hat{\theta},\nu)}{A}<1$ corresponds to the case where markup is lower than the flexible price optimum, and the marginal benefit of raising price is negative. The term $\mathcal{L}\left[h'\left(\pi\left(z\right)\right)\right]$ represents expected future benefit of price adjustment.

By equation (20), keeping the expectation about future inflation, $\mathcal{L}\left[h'\left(\pi\left(\hat{\theta},\nu\right)\right)\right]$, fixed, a rise in inflation $\pi\left(\hat{\theta},\nu\right)$ must be associated with a rise in real wage $w\left(\hat{\theta},\nu\right)$ and therefore employment and output. This is the standard expansionary effect of monetary policy in New Keynesian models. Consider now the effect of an information about $\hat{\theta}$ keeping current inflation fixed. A expectation of a higher $\hat{\theta}$ is associated with a higher long-run interest rate target and a lower inflation expectation. Keeping current inflation constant, a lower inflation expectation must imply a lower $\mathcal{L}\left[h'\left(\pi\left(\hat{\theta},\nu\right)\right)\right]$ and a higher real wage $w\left(\hat{\theta},\nu\right)$. In this case, a rise in interest rate can be associated with a higher real wage, a greater employment, and an increase in output.

A.3 Derivation of Asset Prices from the Model

A.3.1 Equity Prices

To compute asset prices, we first compute the pricing kernel:

$$\Lambda_t = e^{-\rho t} C\left(\hat{\theta}_t, \nu_t\right)^{-\gamma},$$

where $C\left(\hat{\theta}_t, \nu_t\right) = \left[1 - h\left(\hat{\theta}_t, \nu_t\right)\right] A^{\frac{\zeta}{1+\zeta}} w\left(\hat{\theta}_t, \nu_t\right)^{\frac{1}{1+\zeta}}$ is the consumption policy.

Note that firm value, $V\left(\hat{\theta}, \nu\right)$ is given by (4). In equilibrium, $p\left(\hat{\theta}, \nu\right) = P\left(\hat{\theta}, \nu\right)$, and this equation can be written recursively and greatly simplified:

$$\rho V\left(\hat{\theta}, \nu\right) = \Psi\left(1 | \, w\left(\hat{\theta}, \nu\right), 1\right) - h\left(\pi\left(\hat{\theta}, \nu\right)\right) + \mathcal{L}V\left(\hat{\theta}, \nu\right),$$

where

$$\Psi\left(1 | \, w\left(\hat{\theta}, \nu\right), 1\right) = \left(\frac{p}{P}\right)^{-\eta} Y \left[\frac{p}{P} - \frac{\bar{k}(w)}{A}\right]\Bigg|_{p=P;Y=1} = 1 - \frac{w\left(\hat{\theta}, \nu\right)}{A}.$$

is the per period profit of the firm. There are two simplifications here. First, $p_t = P_t$ so that all firms are identical. Second, under the assumption of log preference, we can work with the normalized value function and the normalized profit function. Once we computed $V\left(\hat{\theta}, \nu\right)$, the firm's equity value is given by: $\bar{V}\left(\hat{\theta}, \nu, Y\right) = V\left(\hat{\theta}, \nu\right) Y\left(\hat{\theta}, \nu\right)$. In the learning case with regime switch, we have two continuous state variables, and the firm value function equation becomes:

$$\rho V\left(\hat{\theta}, \nu\right) = 1 - \frac{w\left(\hat{\theta}, \nu\right)}{A} - \frac{h_0}{2}\pi^2\left(\hat{\theta}, \nu\right) + \mathcal{L}V\left(\hat{\theta}, \nu\right)$$

A.3.2 Expected Inflation

Let $\pi\left(\hat{\theta}, \nu\right)$ be the policy function of inflation. Fix a τ, for any $t < \tau$, define:

$$\tilde{\pi}\left(\hat{\theta}, \nu, t; \tau\right) = E\left[\pi\left(\hat{\theta}_\tau, \nu_\tau\right) \Big| \, \hat{\theta}_t = \hat{\theta}, \nu_t = \nu\right].$$

Here, $\left\{\tilde{\pi}\left(\hat{\theta},\nu,t;\tau\right)\right\}_{t\in(0,\tau)}$ is a family of conditional expectations. Clearly, $\tilde{\pi}\left(\hat{\theta}_t,\nu_t,t;\tau\right)$ is a martingale. This function can be determined by:

1. Boundary condition: $\tilde{\pi}\left(\hat{\theta},\nu,\tau;\tau\right)=\pi\left(\hat{\theta},\nu\right)$ for all $\left(\hat{\theta},\nu\right)$
2. $\mathcal{L}\tilde{\pi}\left(\hat{\theta}_t,\nu_t,t;\tau\right)=0$ in the interior of $(nT,(n+1)\,T)$
3. At nT: $\tilde{\pi}\left(\hat{\theta},\nu,nT;\tau\right)=E\left[\tilde{\pi}\left(\hat{\theta}^+_{nT},\nu^+_{nT},nT;\tau\right)\middle|\,\hat{\theta}_{nT}=\hat{\theta},\nu_{nT}=\nu\right]$

Once we computed $\tilde{\pi}\left(\hat{\theta},\nu,t;\tau\right)$, we plot:

$$\tilde{\pi}\left(\hat{\theta}^+_0,\nu^+_0,0^+;\tau\right)-\tilde{\pi}\left(\hat{\theta}_0,\nu_0,0;\tau\right),$$

for a set of maturities, τ.

PDE for Expected Inflation:

Since $\tilde{\pi}\left(\hat{\theta}_t,\nu_t,t;\tau\right)$ is a martingale when we fix $\tau=1,2,\ldots$, we have:

$$\begin{aligned}0=&\frac{\partial\tilde{\pi}(\hat{\theta}_t,\nu_t,t;\tau)}{\partial t}+a(\hat{\theta}_t-\nu_t)\,\tilde{\pi}_\nu(\hat{\theta}_t,\nu_t,t;\tau)\\&+(\lambda_H+\lambda_L)(\bar{\theta}-\hat{\theta}_t)\,\tilde{\pi}_{\hat{\theta}}(\hat{\theta}_t,\nu_t,t;\tau)\\&+a(\theta_H-\hat{\theta}_t)(\hat{\theta}_t-\theta_L)\,\tilde{\pi}_{\nu\hat{\theta}}(\hat{\theta}_t,\nu_t,t;\tau)\\&+\tfrac{1}{2}\sigma_\nu^2\,\tilde{\pi}_{\nu\nu}(\hat{\theta}_t,\nu_t,t;\tau)\\&+\tfrac{1}{2}\frac{a^2}{\sigma_\nu^2}(\theta_H-\hat{\theta}_t)^2(\hat{\theta}_t-\theta_L)^2\,\tilde{\pi}_{\hat{\theta}\hat{\theta}}(\hat{\theta}_t,\nu_t,t;\tau).\end{aligned}$$

For the inflation expectation, we compute backwards just as for the yields. We write:

$$\frac{\partial\tilde{\pi}\left(\hat{\theta}_t,\nu_t,t;\tau\right)}{\partial t}=\frac{\tilde{\pi}_t-\tilde{\pi}_{t-\Delta t}}{\Delta t}.$$

Denote the drift terms as:

$$\begin{aligned}\widehat{\pi}_t^{\text{Terms}} &= a(\hat{\theta}_t - \nu_t)\,\tilde{\pi}_\nu(\hat{\theta}_t, \nu_t, t; \tau) + (\lambda_H + \lambda_L)(\bar{\theta} - \hat{\theta}_t)\,\tilde{\pi}_{\hat{\theta}}(\hat{\theta}_t, \nu_t, t; \tau) \\ &\quad + a(\theta_H - \hat{\theta}_t)(\hat{\theta}_t - \theta_L)\,\tilde{\pi}_{\nu\hat{\theta}}(\hat{\theta}_t, \nu_t, t; \tau) \\ &\quad + \tfrac{1}{2}\sigma_\nu^2\,\tilde{\pi}_{\nu\nu}(\hat{\theta}_t, \nu_t, t; \tau) \\ &\quad + \tfrac{1}{2}\frac{a^2}{\sigma_\nu^2}(\theta_H - \hat{\theta}_t)^2(\hat{\theta}_t - \theta_L)^2\,\tilde{\pi}_{\hat{\theta}\hat{\theta}}(\hat{\theta}_t, \nu_t, t; \tau).\end{aligned}$$

Then start from $\tilde{\pi}_\tau = \pi\left(\hat{\theta}_\tau, \nu_\tau\right)$ and recursively solve for $\tilde{\pi}_{t-\Delta t}$ as $\tilde{\pi}_t + \Delta t \times \widehat{\pi}_t^{\text{Terms}}$, working backwards up to 20 years earlier.

A.3.3 Nominal Yields

Consider a one-dollar payment at time T. The price of a nominal bond is equivalent to the present value of this payoff at time t is given by:

$$Q\left(t, \hat{\theta}_t, \nu_t\right) = E_t\left[\frac{\Lambda_T}{\Lambda_t}\frac{P_t}{P_T} Q\left(T, \hat{\theta}_T, \nu_T\right)\right] = E_t\left[e^{-\rho(T-t)}\left[\frac{C\left(\hat{\theta}_T, \nu_T\right)}{C\left(\hat{\theta}_t, \nu_t\right)}\right]^{-\gamma} e^{-\int_t^T \pi\left(\hat{\theta}_s, \nu_s\right) ds}\right].$$

This implies that:

$$\frac{\Lambda_t Q\left(t, \hat{\theta}_t, \nu_t\right)}{P\left(t, \hat{\theta}_t, \nu_t\right)} = E_t\left[\frac{\Lambda_T}{P_T}\right].$$

Clearly, $\frac{\Lambda_t Q\left(t, \hat{\theta}_t, \nu_t\right)}{P\left(t, \hat{\theta}_t, \nu_t\right)}$ is a martingale, and we have:

$$\mathcal{L}\left[\frac{\Lambda_t Q\left(t, \hat{\theta}_t, \nu_t\right)}{P\left(t, \hat{\theta}_t, \nu_t\right)}\right] = 0. \tag{22}$$

This yields:

$$\frac{\partial Q\left(t, \hat{\theta}, \nu\right)}{\partial t} + Q^{\text{terms}} = \frac{Q\left(t, \hat{\theta}, \nu\right) - Q\left(t - \Delta t, \hat{\theta}, \nu\right)}{\Delta t} + Q^{\text{terms}} = 0,$$

and we can get:

$$Q\left(t-\Delta t,\hat{\theta},\nu\right)=\Delta t\times Q^{\text{terms}}+Q\left(t,\hat{\theta},\nu\right).$$

where Q^{terms} is similar to $\widehat{\pi}_t^{\text{Terms}}$ from the computation of inflation expectation. We compute backwards all the way to 20 years before T, and this corresponds to the price of a 20-year-maturity zero-coupon bond. Given $\hat{\theta}$ and ν, we can compute the term structure $y\left(\hat{\theta},\nu;t\right)$ as a function of maturity t.

A.3.4 Monetary Policy Uncertainty

To construct the model counterpart of the empirical MPU measure of Bauer, Lakdawala, and Mueller (2022), we compute the conditional standard deviation of the short-term nominal risk-free rate, used as a proxy for the policy rate, h periods ahead. Let $i(\hat{\theta},\nu)$ denote the model-implied short-term nominal rate as a function of the state. Define

$$\tilde{i}(\hat{\theta},\nu,t;h)=E\left[i(\hat{\theta}_{t+h},\nu_{t+h})\middle|\,\hat{\theta}_t=\hat{\theta},\nu_t=\nu\right].$$

For fixed h, $\{\tilde{i}(\hat{\theta}_t,\nu_t,t;h)\}_t$ is a martingale, with boundary condition $\tilde{i}(\hat{\theta},\nu,h;h)=i(\hat{\theta},\nu)$ and law of motion governed by the generator $\mathcal{L}$:

$$\begin{aligned}0=&\frac{\partial\tilde{i}(\hat{\theta}_t,\nu_t,t;h)}{\partial t}+a(\hat{\theta}_t-\nu_t)\,\tilde{i}_\nu(\hat{\theta}_t,\nu_t,t;h)\\&+(\kappa_H+\kappa_L)(\bar{\theta}-\hat{\theta}_t)\,\tilde{i}_{\hat{\theta}}(\hat{\theta}_t,\nu_t,t;h)+a(\theta_H-\hat{\theta}_t)(\hat{\theta}_t-\theta_L)\,\tilde{i}_{\nu\hat{\theta}}(\hat{\theta}_t,\nu_t,t;h)\\&+\tfrac{1}{2}\sigma_\nu^2\,\tilde{i}_{\nu\nu}(\hat{\theta}_t,\nu_t,t;h)+\tfrac{1}{2}\frac{a^2}{\sigma_\nu^2}(\theta_H-\hat{\theta}_t)^2(\hat{\theta}_t-\theta_L)^2\,\tilde{i}_{\hat{\theta}\hat{\theta}}(\hat{\theta}_t,\nu_t,t;h).\end{aligned}$$

Analogously, the second moment

$$\widetilde{i^2}(\hat{\theta},\nu,t;h)=E\left[i(\hat{\theta}_{t+h},\nu_{t+h})^2\middle|\,\hat{\theta}_t=\hat{\theta},\nu_t=\nu\right]$$

is a martingale governed by the same generator $\mathcal{L}$, with boundary condition $\widetilde{i^2}(\hat{\theta}, \nu, h; h) = i(\hat{\theta}, \nu)^2$. The conditional variance of the short-term nominal rate at horizon h is then

$$\mathrm{Var}(\hat{\theta}, \nu; h) = \widetilde{i^2}(\hat{\theta}, \nu, t; h) - \tilde{i}(\hat{\theta}, \nu, t; h)^2.$$

We compute $\tilde{i}$ and $\widetilde{i^2}$ by solving each PDE backwards from the relevant boundary condition using the same finite-difference scheme described for $\tilde{\pi}(\hat{\theta}, \nu, t; \tau)$ in Appendix A.3. The model counterpart of MPU_t is the conditional standard deviation $\sqrt{\mathrm{Var}(\hat{\theta}_t, \nu_t; h)}$ evaluated at $h = 24$ months, matching the horizon of the empirical measure of Bauer, Lakdawala, and Mueller (2022).

A.4 More results from the Model

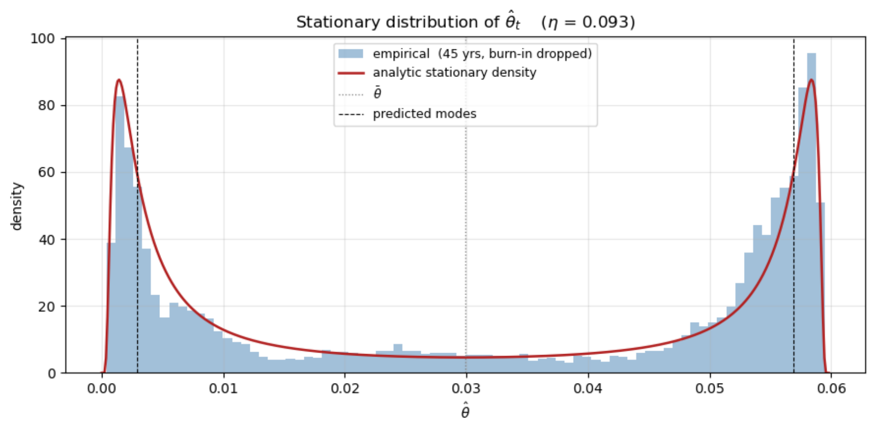

Figure 11: Stationary distribution of $\hat{\theta}_t$

Notes: Notes: This figure is a snapshot of the long path simulation described in the text. We simulate the joint process $(\theta_t, \nu_t, \hat{\theta}_t)$ at daily resolution for 50 years, drop the first 5 years as burn-in, and plot the empirical histogram of the filtered posterior $\hat{\theta}_t$ in gray bars. The solid red curve plots the corresponding analytic stationary density implied by the filtering problem, mapped onto the same $\hat{\theta}$ axis. The vertical dashed lines mark the two predicted modes, and the vertical dotted line marks the midpoint between the two regime targets. The simulated distribution is clearly bimodal: the posterior spends most of its time close to one of the two regime targets and only occasionally moves through the middle. This shows that, in the simulation, investors are usually confident about which regime is active, even though regime switches are infrequent. The close agreement between the histogram and the red curve provides a consistency check on the discretized SDE and Wonham-filter implementation used throughout the paper.

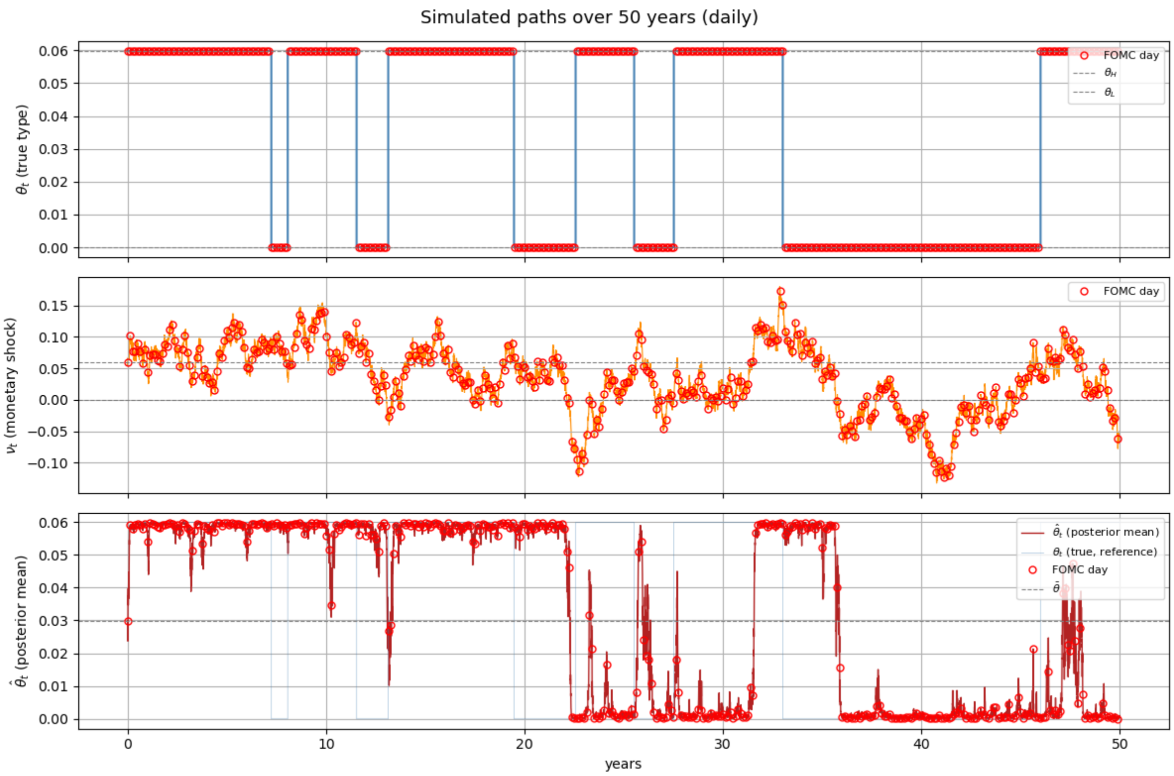

Figure 12: Simulated paths of the state variables

Notes: This figure is a snapshot of the long path simulation described in the text and used in the empirical analysis. We simulate the joint process at daily resolution for 50 years and plot the realized trajectories of the three state variables. The top panel shows the latent regime θ_t, a continuous-time Markov chain that jumps between the two targets $\theta_L = 0$ and $\theta_H = 0.06$ at rate $\kappa_L = \kappa_H = 0.105$ per year (mean dwell time ≈ 9.5 years). The middle panel shows the observed monetary shock ν_t, an Ornstein–Uhlenbeck process mean-reverting toward the current regime θ_t with speed a and diffusion σ_ν; investors observe ν_t but not θ_t. The bottom panel shows the Wonham-filter posterior mean $\hat{\theta}_t \equiv \mathbb{E}[\theta_t \mid \mathcal{F}_t^\nu]$, which the agent uses as the relevant state for pricing. Red circles mark the FOMC days used in the empirical regressions (eight per year, evenly spaced). The posterior $\hat{\theta}_t$ tracks the true regime closely most of the time — consistent with the bimodality of its stationary distribution (Figure 11) — but occasionally drifts toward, reflecting transient uncertainty. These episodes of belief uncertainty are precisely what generates monetary-policy uncertainty (MPU) and drive the asset-pricing implications studied in Section 5.

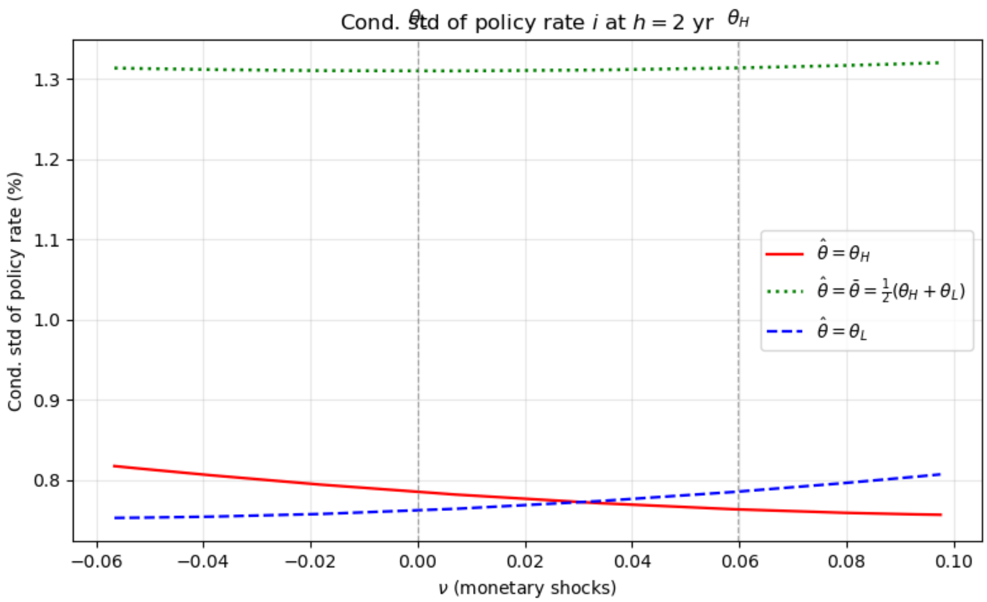

Figure 13: Conditional standard deviation of the policy rate at $h = 2$ years

Notes: This figure plots the conditional standard deviation of the instantaneous nominal policy rate i_{t+h} at horizon $h = 2$ years (in percent), as a function of the current monetary shock ν_t on the horizontal axis, for three values of the filtered posterior $\hat{\theta}_t$: the high regime target θ_H (red solid), the ergodic mean $\bar{\theta} = \frac{1}{2}(\theta_H + \theta_L)$ (green dotted), and the low regime target θ_L (blue dashed). The conditional moments $\mathbb{E}[i_{t+h}^k \mid \nu_t, \hat{\theta}_t]$ for $k = 1, 2$ are obtained by solving the backward Kolmogorov PDE for i_{t+h} on a Chebyshev tensor-product grid in $(\nu, \hat{\theta})$; the conditional standard deviation is then $\sqrt{\mathbb{E}[i_{t+h}^2] - (\mathbb{E}[i_{t+h}])^2}$. The vertical dashed gray lines mark the two regime targets $\theta_L = 0$ and $\theta_H = 0.06$. Conditional uncertainty is roughly $1.7\times$ larger when the posterior sits at the interior $\bar{\theta}$ than at either corner: when investors are confident which regime is active ($\hat{\theta}_t \approx \theta_L$ or θ_H), they know the long-run target of i and two-year forecasts are accurate; when they are unsure ($\hat{\theta}_t \approx \bar{\theta}$), forecasts must mix across regimes that differ by $\theta_H - \theta_L \approx 6$ percentage points, which inflates the conditional variance. This $\hat{\theta}$-dependence is the central source of monetary-policy uncertainty (MPU) in the model and drives FOMC-day asset-pricing implications studied in Section 5.

A.5 Robustness checks

This appendix collects robustness checks for the empirical analysis in Section 5. We first examine the sensitivity of our main S&P 500 results to alternative measures of monetary policy uncertainty constructed at different horizons. We then re-estimate the three regressions in the main text on a pre-2020 subsample to verify that our findings are not driven by the unusual policy environment surrounding the COVID-19 pandemic and the Federal Reserve's revised policy framework in 2020.

A.5.1 MPU at alternative maturities

We first revisit the S&P 500 results in Table 3 using alternative measures of monetary policy uncertainty from Bauer, Lakdawala, and Mueller (2022). Our baseline analysis uses the 24-month MPU measure, which is a natural horizon for capturing uncertainty about the persistent policy regime in the model. As a robustness check, Table 10 re-estimates Equation (14) using analogous MPU measures constructed at 6-, 12-, and 18-month horizons, while holding the dependent variable, policy-shock measure, and sample fixed.

The results are stable across maturities. The direct loading on MPS remains negative and highly significant, while the interaction between MPS and lagged MPU is positive at every horizon. The interaction is weaker and statistically insignificant at the 6-month horizon, but becomes significant at the 12-, 18-, and 24-month horizons. This pattern is consistent with the model's mechanism: uncertainty measured at longer horizons is more likely to reflect beliefs about the persistent policy regime, whereas short-horizon MPU is more closely tied to uncertainty about near-term policy moves.

A.5.2 Pre-2020 subsample

We next examine whether our results are driven by the unusual policy environment after 2019. The post-2019 sample includes the COVID-19 pandemic, the geopolitical conflicts, large-scale unconventional policy interventions, and the Federal Reserve's adoption of Flexible Average Inflation Targeting in August 2020. These events may represent changes in the policy environment that are conceptually distinct from the belief-updating mechanism in our model. We therefore re-estimate our three benchmark regressions on the subsample

Table 10: S&P 500 Returns and MPU at Alternative Maturities

	Baseline	MPU 6m	MPU 12m	MPU 18m	MPU 24m
MPS	-5.34^{***}	-5.70^{***}	-6.17^{***}	-6.32^{***}	-6.12^{***}
	(-6.11)	(-6.06)	(-6.19)	(-6.27)	(-5.83)
MPU_{t-1}		-0.18^{*}	-0.17^{***}	-0.15^{***}	-0.15^{**}
		(-1.92)	(-2.78)	(-2.90)	(-2.53)
$\text{MPS}\times\text{MPU}_{t-1}$		1.92	3.47^{**}	3.56^{***}	3.43^{**}
		(0.72)	(1.96)	(2.61)	(1.98)
R^2	0.29	0.29	0.31	0.31	0.31
n_{obs}	290	290	290	290	290

Notes: This table re-estimates Equation (14) using monetary policy uncertainty measures from Bauer, Lakdawala, and Mueller (2022) constructed at horizons of 6, 12, 18, and 24 months. All MPU series are computed as the conditional standard deviation of the 3-month interest rate implied by Eurodollar (later SOFR) options, interpolated to the indicated maturity. The dependent variable is 100 times the log change in S&P 500 futures over the 30-minute window around FOMC announcements. MPS_t is the orthogonalized monetary policy shock from Bauer and Swanson (2023b) measured during the same window. The sample spans February 8, 1990 to December 13, 2023 and contains 290 FOMC announcements. The "Baseline" column reproduces column (1) of Table 3; the "MPU 24m" column reproduces column (2). Heteroskedasticity- and autocorrelation-robust t-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

ending in December 2019 and report the results in Tables 11–13.

Stock returns Table 11 re-estimates Equation (14) on the pre-2020 subsample. The results are very similar to, and in some cases stronger than, those in the full sample. The direct loading on MPS remains negative and highly significant across all MPU horizons. The interaction between MPS and lagged MPU is positive at every horizon and statistically significant for the 12-, 18-, and 24-month MPU measures. Thus, the main stock-return evidence is not driven by the COVID period or the 2020 change in the Fed's policy framework.

Table 11: S&P 500 Returns and MPU at Alternative Maturities, Pre-2020 Subsample

	Baseline	MPU 6m	MPU 12m	MPU 18m	MPU 24m
MPS	-5.26^{***}	-5.83^{***}	-6.38^{***}	-6.48^{***}	-6.29^{***}
	(-5.67)	(-6.02)	(-6.27)	(-6.36)	(-5.90)
MPU_{t-1}		-0.21^{*}	-0.19^{***}	-0.16^{***}	-0.16^{**}
		(-1.81)	(-2.73)	(-2.81)	(-2.40)
$\text{MPS}\times\text{MPU}_{t-1}$		3.32	5.28^{***}	5.00^{***}	5.27^{***}
		(1.11)	(2.88)	(3.77)	(2.99)
R^2	0.28	0.29	0.31	0.32	0.32
n_{obs}	266	266	266	266	266

Notes: This table re-estimates Equation (14) on FOMC announcements through December 2019. The dependent variable is 100 times the log change in S&P 500 futures over the 30-minute window around FOMC announcements. MPS_t is the orthogonalized monetary policy shock from Bauer and Swanson (2023b) measured during the same window. MPU_{t-1} is the monetary policy uncertainty measure from Bauer, Lakdawala, and Mueller (2022), measured one day before the FOMC announcement and interpolated to the indicated maturity. The "Baseline" column includes only MPS_t; each subsequent column adds the corresponding MPU measure and its interaction with MPS_t. Heteroskedasticity- and autocorrelation-robust t-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Inflation expectations Table 12 re-estimates the inflation-swap regression in Equation (15) on the pre-2020 subsample, using the 24-month MPU measure. The results are broadly consistent with the full-sample evidence. The direct loading on MPS is negative at all maturities and becomes highly significant from the 5-year horizon onward. The interaction between

MPS and lagged MPU turns positive at longer maturities and is statistically significant at several horizons between 7 and 12 years. This pattern supports the interpretation that the Fed information effect is concentrated in long-run inflation expectations and is not driven by the post-2019 policy environment. If anything, the long-maturity interaction estimates are somewhat larger in the pre-2020 subsample than in the full sample.

Table 12: Inflation Expectations Response, Pre-2020 Subsample

Maturity	β_I	β_{Inter}	R^2	n_{obs}
1 year	-0.32	-0.17	0.04	131
	(-1.14)	(-0.18)		
5 year	-0.36^{***}	-0.11	0.14	131
	(-3.69)	(-0.35)		
7 year	-0.27^{***}	0.64^{*}	0.05	131
	(-3.38)	(1.89)		
8 year	-0.29^{***}	0.94^{**}	0.11	131
	(-3.67)	(2.55)		
9 year	-0.34^{***}	0.55	0.05	131
	(-3.72)	(1.00)		
10 year	-0.30^{***}	0.68^{**}	0.10	131
	(-4.03)	(2.45)		
12 year	-0.37^{***}	0.54^{**}	0.08	131
	(-4.72)	(2.13)		

Notes: This table re-estimates Equation (15) on FOMC announcements through December 2019. The dependent variable is the daily change in inflation swap rates of the indicated maturity on FOMC announcement days. MPS_t is the orthogonalized monetary policy shock from Bauer and Swanson (2023b) measured during the 30-minute window around FOMC announcements. MPU_{t-1} is the 24-month monetary policy uncertainty measure from Bauer, Lakdawala, and Mueller (2022), measured one day before the FOMC announcement. Inflation swap data are from Bloomberg. Heteroskedasticity- and autocorrelation-robust t-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Nominal yields Table 13 re-estimates the term-structure regression in Equation (16) on the pre-2020 subsample, using the 24-month MPU measure. The pre-2020 results sharpen the full-sample pattern. The direct loading on MPS declines with maturity and becomes small at the long end of the curve. In contrast, the interaction between MPS and lagged MPU increases with maturity and becomes highly significant at longer horizons. This maturity pattern is consistent with the Fed information effect operating primarily through long-run beliefs rather than through the conventional short-rate channel. The interaction estimates are also larger than in the full sample, suggesting that the post-2019 observations attenuate rather than drive the estimated effect.

Taken together, the pre-2020 results show that the main empirical patterns are not driven by the post-2019 sample. Across stock returns, inflation expectations, and nominal yields, the interaction between policy shocks and monetary policy uncertainty generally has the sign predicted by the model and is strongest at the horizons where the Fed information mechanism is expected to matter most.

Table 13: Nominal Yields Response, Pre-2020 Subsample

Maturity	β_I	β_{Inter}	R^2	n_{obs}
1 year	0.59***	0.26	0.31	268
	(6.20)	(1.56)		
5 year	0.51***	0.41**	0.18	268
	(5.16)	(2.02)		
10 year	0.28***	0.47**	0.10	268
	(3.37)	(2.07)		
16 year	0.12*	0.57***	0.08	268
	(1.72)	(3.09)		
18 year	0.08	0.60***	0.07	268
	(1.18)	(3.58)		
20 year	0.04	0.63***	0.07	268
	(0.66)	(4.04)		
25 year	−0.03	0.68***	0.06	268
	(−0.47)	(4.31)		
30 year	−0.10	0.72***	0.05	268
	(−1.18)	(3.59)		

Notes: This table re-estimates Equation (16) on FOMC announcements through December 2019. The dependent variable is the daily change in zero-coupon nominal Treasury yields of the indicated maturity on FOMC announcement days, constructed by Gürkaynak, Sack, and Wright (2007) and obtained from the Federal Reserve website. MPS_t is the orthogonalized monetary policy shock from Bauer and Swanson (2023b) measured during the 30-minute window around FOMC announcements. MPU_{t-1} is the 24-month monetary policy uncertainty measure from Bauer, Lakdawala, and Mueller (2022), measured one day before the FOMC announcement. Heteroskedasticity- and autocorrelation-robust t-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.