FEDERAL RESERVE BANK OF SAN FRANCISCO

WORKING PAPER SERIES

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September 2025

Working Paper 2025-17

https://doi.org/10.24148/wp2025-17

Suggested citation:

Bundick, Brent, Isabel Cairó, and Nicolas Petrosky-Nadeau. 2025. "Evaluating Macroeconomic Outcomes Under Asymmetries: Expectations Matter." Federal Reserve Bank of San Francisco Working Paper 2025-17. https://doi.org/10.24148/wp2025-17

Evaluating Macroeconomic Outcomes Under Asymmetries: Expectations Matter*

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September 2025

Abstract

Asymmetries play an important role in many macroeconomic models. We show that assumptions on household and firm expectations play a key role in determining the effects of these asymmetries on macroeconomic outcomes. If households and firms have perfect foresight and hence do not account for the possibility of future shocks, then the implied longer-run averages and distributions for unemployment and inflation can differ significantly from their rational expectations counterparts. We first derive this result analytically under either an asymmetric monetary policy rule or a nonlinear Phillips curve before numerically examining some of the key nonlinearities featured in the recent literature.

JEL Classification: E32, E52, J64

Keywords: Macroeconomic Asymmetries, Business Cycles, Expectations

*We thank Ben Johannsen and Nels Lind for helpful discussions. Mariia Dzholos and Wesley Wasserburger provided excellent research assistance. The views expressed are those of the authors and do not necessarily reflect the positions of the Federal Reserve Bank of Kansas City, the Federal Reserve Bank of San Francisco, the Board of Governors, or the Federal Reserve System.

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1 Introduction

Asymmetries are inherent features of actual economies. Some common examples include the effective lower bound on nominal interest rates, borrowing or collateral constraints, asymmetric policymaker preferences over macroeconomic outcomes, and nonlinear dynamics in the labor market or in firm's price-setting decisions. To examine their possible effects on macroeconomic outcomes, a large body of academic literature builds macroeconomic models with asymmetries that help capture these important features of the actual economy. To gauge their importance, the existing literature often compares the macroeconomic outcomes with and without a given asymmetry.[1]

In this paper, we show that assumptions on household and firm expectations play a key role in determining the effects of these asymmetries on macroeconomic outcomes, especially on longer-run average outcomes. Specifically, for workhorse models of nominal rigidities commonly used for macroeconomic analysis, we show that the implied averages of unemployment and inflation can differ widely in magnitude and possibly sign depending on whether households and firms take account of the possibility that future shocks may hit the economy.[2]

We first illustrate this idea analytically using a standard 3-equation New Keynesian model with an asymmetric monetary policy rule, which is in the spirit of the 2020 announcement of the Federal Open Market Committee's (FOMC) desire to stabilize *shortfalls* rather than *deviations* of employment from its maximum level. If households do not take into account the possibility of future shocks (often characterized as a perfect-foresight solution), then the model suggests policymakers that do not directly respond to a tight labor market in an expansion have a *longer-run* tradeoff between higher inflation and lower unemployment. By being more accommodative in expansions, the perfect-foresight solution suggests that policymakers can lower average unemployment by allowing for higher inflation on average. However, once households properly account for future shocks, this longer-run tradeoff disappears and the asymmetric policy rule simply results in higher average inflation with no average effects on the labor market.

We then show that this importance of expectations extends beyond asymmetric policy rules to other asymmetries in model economies. For example, we then consider a model with a symmetric policy rule but with a nonlinear Phillips curve that steepens when the labor

[1]Table A.1 in the Appendix highlights some selected papers in the literature examining macroeconomic asymmetries.

[2]Of course, in the context of linear macroeconomic models, rational expectations and perfect foresight solutions are equivalent.

market is tight. Under perfect foresight, the nonlinearity in the Phillips curve results in slightly higher average inflation but no average effects on unemployment. Once households account for future shocks, however, the results change sign: the economy now experiences zero average inflation but an elevated longer-run unemployment rate. Thus, the average effects on inflation and unemployment can change sign depending on the assumptions about household and firm expectations about future shocks.

In both analytical examples, the key results emerge from the interaction between forward-looking price setters and an inflation-stabilizing central bank. Under rational expectations, an increase in future inflation due to the asymmetry possibly binding in the future causes firms to set higher prices today. This increase in current inflation leads the central bank to set higher policy rates, which leads to lower output and higher unemployment. This offsetting effect is absent under perfect foresight which helps explain why, in models with a macroeconomic asymmetry, longer-run average outcomes can change depending on assumptions about household and firm expectations.

After developing this intuition, we numerically examine key nonlinearities featured in the recent literature and show that both longer-run averages and the distributions of outcomes crucially depend on assumptions about household and firm expectations. We first return to a numerical example involving a shortfalls-stabilization rule in which policymakers do not directly respond to a tight labor market in an expansion. Our numerical results show that the model-implied averages for inflation and nominal interest rates under perfect foresight can easily differ by at least one percentage point from their rational expectations counterparts. Moreover, we show that the simulated distributions for key macroeconomic variables can look quite different under perfect foresight. Specifically, the model simulations under perfect foresight suggest that the distributions of unemployment and inflation feature a significant kinks around their steady-state values. Under rational expectations, however, the distributions are far more symmetric, suggesting a different tradeoff for policymakers considering policies that change depending on the state of the economy.

We then highlight the robustness of our numerical conclusions across several additional macroeconomic environments. First, within the context of our asymmetric monetary policy rule, we consider an alternative in which agents are boundedly rational, and one with additional macroeconomic shocks. Our main conclusions still apply under either of these additional examples: Assumptions about household and firm expectations matter in macroeconomic models with asymmetries. We then examine the case of a kinked Phillips curve which steepens when the labor market is tight. Simulations from our model show that the average outcomes for both unemployment and inflation can differ by roughly 0.3 to 0.4 percentage points between rational expectations and perfect foresight.

While our results show that the differences in outcomes under rational expectations or perfect foresight can be stark, our goal in this paper is *not* to suggest that perfect foresight solutions are flawed. In contrast, in model economies without macroeconomic asymmetries, we show examples under which the perfect foresight and rational expectations solutions are identical. In practice, perfect-foresight solutions can be quite helpful for researchers aiming to estimate larger macroeconomic models or build models with heterogeneity at the micro level.[3] Our goal is simply to show that the implied longer-run average values and distributions for macroeconomic variables can be somewhat sensitive to the assumptions of expectations when evaluating macroeconomic asymmetries. In practice, researchers that need to rely on perfect-foresight techniques to solve larger models may simply want to check the robustness of their conclusions on longer-run averages and the distribution of outcomes using simplified models which can be solved under both perfect foresight and rational expectations. To aid researchers in this endeavor, we provide several versions of code that can quickly and easily solve simple macroeconomic models under various asymmetries and assumptions over expectations.

Moreover, our paper is not the first work to document that alternative assumptions about household and firm expectations can change outcomes when an economy features a macroeconomic asymmetry. For example, work from Adam and Billi (2007) and Nakov (2008) highlights that economies facing a zero lower bound constraint can experience lower inflation both on average and in a downturn when households take account the possibility of future zero lower bound episodes. Table A.1 in the Appendix categorizes some selected papers examining macroeconomic asymmetries by their assumptions on expectations and highlight papers which examine the outcomes under both rational expectations and perfect foresight. However, the key insight from our paper is to highlight that the sign and quantitative implications of a given macroeconomic asymmetry can change depending on the assumptions about household expectations.

The rest of the paper is organized as follows: Section 2 presents the macroeconomic model that serves as case studies in our numerical illustrations in Section 4. In Section 3, we use some simplified examples from that model to illustrate the intuition for our main results analytically. Finally, we present and discuss several model extensions in Section 5.

[3]For example, Bundick and Smith (2020) use a perfect-foresight solution method (OccBin) to estimate a medium-scale macroeconomic model at the zero lower bound using impulse response matching.

2 Macroeconomic Environment

This section lays out a standard 3-equation New Keynesian model with nominal price rigidities which we use to examine the effects of asymmetries in the macroeconomy. This simple economic environment features households which work and consume, firms which employ workers and produce, a simple Okun's law to link output and unemployment gaps, and a central bank which sets the nominal interest rate through a simple monetary policy rule. The model can be summarized by an intertemporal saving (IS) equation, Equation (1), that links economic activity to the central bank's policy rate and a Phillips curve, given by Equation (2) which determines inflation as a function of economic activity and inflation expectations:

$$u_t = \mathbb{E}_t\, u_{t+1} + \frac{1}{c}\Big(i_t - \mathbb{E}_t\, \pi_{t+1} - rn_t\Big), \tag{1}$$

$$\pi_t = \beta\, \mathbb{E}_t\, \pi_{t+1} - \kappa\, c\, u_t. \tag{2}$$

u_t is the unemployment gap defined as the difference between the unemployment rate and its longer-run value. To introduce a concept of unemployment in the standard model, the IS curve (1) uses a simple Okun's law-type relationship that links fluctuations in an unemployment gap to the output gap with c as a parameter (typically around 2 in empirical work): $u_t = -\frac{1}{c}x_t$.[4] π_t represents inflation in deviations from the central bank's objective, and i_t denotes the nominal policy rate in deviations from its steady-state value. β represents the household's discount factor and κ denotes the slope of the Phillips curve. Fluctuations in the economy are driven by shocks to the natural rate of interest, rn_t. These act as demand shocks, moving unemployment and inflation in opposite direction. The stochastic processes for rn_t is given by:

$$rn_t = \rho_{rn} rn_{t-1} + \epsilon_t^{rn}, \tag{3}$$

where $\rho_{rn} < 1$, $\epsilon_t^{rn} \sim N(0, \sigma_{rn}^2)$.

2.1 Monetary Policy

We assume that the central bank follows one of two policy rules. First, as a baseline, policy responds symmetrically to inflation and unemployment gaps. We refer to this rule as a *Deviations* rule as it helps capture the FOMC's symmetric interpretation of its employment mandate prior to the adoption of its 2020 update to the monetary policy framework.

$$i_t = \phi_\pi \pi_t + \phi_u u_t \tag{4}$$

[4] Tables 1 and 2 of Ball, Leigh and Loungani (2017) report empirical values of c ranging from 2.0 to 2.7.

where $\phi_\pi > 1$ and $\phi_u < 0$ are parameters. Second, when illustrating the economic implications of a shortfalls approach to pursuing maximum employment (as in the FOMC's 2020 update of the Statement on Longer-Run Goals and Monetary Policy Strategy), we instead assume that the central bank follows a *Shortfalls* rule:

$$i_t = \begin{cases} \phi_\pi \pi_t + \phi_u u_t & \text{if } u_t \geq 0 \\ \phi_\pi \pi_t & \text{if } u_t < 0. \end{cases} \tag{5}$$

Under a Shortfalls rule, the central bank no longer tightens monetary policy on account of a tight labor market, providing additional accommodation during expansions as compared to the setting of the policy under the symmetric Deviations rule.[5]

2.2 Equilibrium: Rational Expectations and Perfect Foresight

The key difference between outcomes under rational expectations (RE) and perfect foresight (PF) is the specification of the expectations operator $\mathbb{E}_t$. This section defines those equilibria and introduces some notation. The state space of the model consists of the exogenous shock process rn_t . Agents need to form expectations, given current values of the states, over their future values and the decisions they and the economy will take contingent on the realizations of shocks. We denote the expectations operator under rational expectations $\mathbb{E}_t^{RE}[\cdot]$ and $\mathbb{E}_t^{PF}[\cdot]$ under perfect foresight. Similarly, we denote the equilibrium policy functions for unemployment and inflation gaps over the state variables by $u^{RE}(\cdot)$ and $\pi^{RE}(\cdot)$, respectively, under rational expectations, and by $u^{PF}(\cdot)$ and $\pi^{PF}(\cdot)$ under perfect foresight.

Under either approach to expectations formation, the equilibrium policy functions must satisfy the following conditions:

$$u^j(rn_t) = \mathbb{E}_t^j \left[u^j(rn_{t+1})|rn_t\right] + \frac{1}{c}\Big(i_t - \mathbb{E}_t^j \left[\pi^j(rn_{t+1})|rn_t\right] - rn_t\Big), \tag{6}$$

$$\pi^j(rn_t) = \beta \mathbb{E}_t^j \left[\pi^j(rn_{t+1})|rn_t\right] - \kappa\, c\, u^j(rn_t), \tag{7}$$

where $j = \{RE\}$ or $\{PF\}$, the nominal policy rate i_t is given by either Equation (4) or (5), and the exogenous state variable follows Equation (3). Equations (6) and (7) highlight that

[5] In Bundick and Petrosky-Nadeau (2025), Cairó and Lipton (2025), and Bundick, Cairó and Petrosky-Nadeau (2025), we provide further motivation for this specification of a Shortfalls rule and analysis of its implications. In this paper, we focus on how assumptions regarding expectations can affect these implications especially longer-run averages and distributional outcomes for key macroeconomic aggregates. Moreover, we show that this dependence on expectations assumptions extends to other macroeconomic asymmetries examined in the literature.

the key difference between the two approaches is how they treat conditional expectations in equilibrium conditions.

3 Possible Perils of Perfect Foresight: Two Simple Examples

We now slightly simplify the environment of Section 2 to analytically show and provide intuition for the differences between perfect foresight and rational expectations equilibria. We consider two different types of macroeconomic asymmetries: (i) an asymmetric monetary policy rule that incorporates a shortfalls approach to unemployment fluctuations, and (ii) a nonlinearity in the Phillips curve.

In this simplified environment, the natural rate of interest is discretized to take on three possible values with equal probability and no persistence:

$$rn_t = \begin{cases} rn^L < 0 & \text{with probability } 1/3 \\ rn^0 = 0 & \text{with probability } 1/3 \\ rn^H > 0 & \text{with probability } 1/3 \end{cases}$$

Under rational expectations, households and firms form expectations under a state transition matrix P^{RE} with equal probably of moving from a given state today to any other in the next period. In contrast, under perfect foresight, they do not expect future shocks to occur and therefore expect the natural rate to be at its longer-run value next period regardless of the current state. Thus, expectations under perfect foresight use the state transition matrix P^{PF} below:

$$P^{RE} = \begin{matrix} & {\scriptstyle L} & {\scriptstyle 0} & {\scriptstyle H} \\ {\scriptstyle L} & 1/3 & 1/3 & 1/3 \\ {\scriptstyle 0} & 1/3 & 1/3 & 1/3 \\ {\scriptstyle H} & 1/3 & 1/3 & 1/3 \end{matrix} \qquad P^{PF} = \begin{matrix} & {\scriptstyle L} & {\scriptstyle 0} & {\scriptstyle H} \\ {\scriptstyle L} & 0 & 1 & 0 \\ {\scriptstyle 0} & 0 & 1 & 0 \\ {\scriptstyle H} & 0 & 1 & 0 \end{matrix}$$

Finally, we assume $c = 1$ and, for some results, we also assume $\beta = 1$ to make the resulting expressions easier to interpret.

3.1 Example 1: Shortfalls Approach to Pursuing Maximum Employment

To capture the aims of the shortfalls approach to stabilizing the labor market, we also make a slight modification to the rule in Equation (5) for this simplified example:

$$i^{j,s} = \begin{cases} rn^s + \phi_\pi \pi^{j,s} & \text{if } s = L \text{ or } 0 \\ rn^s + \phi_\pi \pi^{j,s} - 3\Delta & \text{if } s = H, \end{cases} \tag{8}$$

where $s = L$, 0, or H denotes one of three values for the exogenous state, $\Delta > 0$ and again $j = RE$ or PF. For analytical tractability, Equation (8) assumes that the central bank tracks the natural rate of interest in each state of the world. However, in the high demand state of the world, the central bank is less restrictive as compared to a symmetric rule (which would occur if we set $\Delta = 0$). This additional accommodation in the high-demand state simply captures the behavior of a dual-mandate central bank that refrains from monetary tightening in response to declining unemployment gaps during an economic expansion. The inclusion of the scalar 3 in the high-demand state is not needed but further helps simplify the resulting expressions.

Perfect Foresight Equilibrium

To solve for the equilibrium under perfect foresight, recall that agents do not expect future shocks to occur and thus expect next period unemployment and inflation gaps to be equal to their longer-run values $u^{PF,0}$ and $\pi^{PF,0}$, respectively. That is:

$$\mathbb{E}_t^{PF} u_{t+1} = u^{PF,0} \quad \text{and} \quad \mathbb{E}_t^{PF} \pi_{t+1} = \pi^{PF,0}.$$

Given those expectations, the monetary policy rule specified in Equation (8), and the equilibrium conditions in Equations (6) and (7), the unemployment and inflation gaps in each of the three states are:

$$\left(u^{PF,s}, \pi^{PF,s}\right) = \begin{cases} \left(\quad 0 \quad , \quad 0 \quad \right) & \text{if } s = L \text{ or } 0 \\ \left(\dfrac{-3\Delta}{1+\phi_\pi \kappa}, \dfrac{3\Delta\kappa}{1+\phi_\pi \kappa} \right) & \text{if } s = H. \end{cases}$$

To build intuition for the perfect-foresight solution, first suppose that the economy experiences the steady-state demand state (i.e., $rn_t = 0$). Under perfect foresight, households and firms expect the economy to remain in that state next period. Since the central bank perfectly tracks the natural rate in the steady-state demand state, then the unemployment and inflation gaps are zero. In the low-demand state, the central bank continues to track the natural rate and the expectations of inflation and unemployment gaps are also zero from the solution in the previous steady-state demand state. This then implies that unemployment and inflation are zero in the low-demand state. In the high-demand state, the central bank does not fully offset the economic expansion, which results in a decline in the unemployment rate and slightly elevated inflation.

To determine the longer-run average outcomes under perfect foresight, we can compute a simple weighted-average of the outcomes across the three states and obtain:

$$\bar{u}^{PF} = \frac{-\Delta}{(1+\phi_\pi \kappa)} < 0, \qquad \bar{\pi}^{PF} = \frac{\Delta \kappa}{(1+\phi_\pi \kappa)} > 0.$$

Under perfect foresight, this simple example suggests that the asymmetric policy rule in Equation (8) implies a *longer-run* tradeoff for monetary policymakers. By choosing larger values for Δ, policymakers can lower average unemployment at a modest cost to average inflation.

Rational Expectations Equilibrium

In contrast, rational expectations implies a much different longer-run tradeoff between unemployment and inflation under the asymmetric rule. Under rational expectations, agents expect future shocks to occur. Thus, expectations for next period's unemployment and inflation gaps are given by:

$$\mathbb{E}_t^{RE} u_{t+1} = \frac{1}{3}\Big(u^{RE,L} + u^{RE,0} + u^{RE,H}\Big) \quad \text{and} \quad \mathbb{E}_t^{RE} \pi_{t+1} = \frac{1}{3}\Big(\pi^{RE,L} + \pi^{RE,0} + \pi^{RE,H}\Big).$$

Given those expectations, the monetary policy rule specified in Equation (8), and the equilibrium conditions in Equations (6) and (7), the unemployment and inflation gaps in each of the three states are:

$$\left(u^{RE,s}, \pi^{RE,s}\right) = \begin{cases} \left(\dfrac{\Delta}{(1+\phi_\pi \kappa)}, \dfrac{\Delta(1+\kappa)}{(\phi_\pi - 1)(1+\phi_\pi \kappa)}\right) & \text{if } s = L \text{ or } 0 \\ \left(\dfrac{-2\Delta}{(1+\phi_\pi \kappa)}, \dfrac{\Delta(1-2\kappa+3\phi_\pi \kappa)}{(\phi_\pi - 1)(1+\phi_\pi \kappa)}\right) & \text{if } s = H. \end{cases}$$

Under rational expectations, households and firms understand that, regardless of today's state, there is some probability of ending up in the high-demand state next period. Since the asymmetric policy rule does not fully offset the natural rate in the high-demand state, the potential for higher inflation and lower unemployment if the high-state occurs tomorrow increases inflation expectations and lowers expectations for unemployment. Through the forward-looking Phillips curve, this increase in inflation expectations leads to higher inflation today. Through its policy response to inflation (controlled by the parameter ϕ_π), the central bank leans against this expectations-driven increase in inflation with higher policy rates. This offsetting contractionary force implies a slightly increase in unemployment in both the low and steady-state demand states. In the high demand-state, the economy still experiences a negative unemployment gap and a positive inflation gap. However, the contractionary policy response to higher inflation expectations results in a smaller decline in unemployment under the high-demand state relative to the perfect foresight case.

Recomputing longer-run outcomes under rational expectations implies a zero unemployment gap and a positive inflation gap on average:

$$\bar{u}^{RE} = 0, \qquad \bar{\pi}^{RE} = \frac{\Delta}{(\phi_\pi - 1)}.$$

Under rational expectations, this simple example suggests *no* longer-run benefits to unemployment from adopting a Shortfalls rule. Instead, increasing Δ simply leads to higher average inflation with no benefits in terms of lowering average inflation.

Comparing Perfect Foresight and Rational Expectations Equilibria

This simplified example shows that the effects of a Shortfalls rule depends on the assumptions regarding expectations formation. Under both perfect foresight and rational expectations, the unemployment gap is negative and the inflation gap is positive in the high-demand state. However, the magnitude of the negative unemployment gap is smaller under rational expectations than under perfect foresight, while the magnitude of the positive inflation gap under rational expectations is larger than under perfect foresight. However, in both the low and steady-state demand states, we see that the inflation outcomes change from zero under perfect foresight to positive under rational expectations. Intuitively, expectations of the more accommodative policy stance in the high-demand states causes firms to raise prices by more in anticipation of stronger demand and the economy experiences higher inflation in all states of the world.

When comparing the average outcomes in our simplified example, we find that

$$\bar{u}^{\text{RE}} - \bar{u}^{\text{PF}} = \frac{\Delta}{(1+\phi_\pi \kappa)} > 0,$$
$$\bar{\pi}^{\text{RE}} - \bar{\pi}^{\text{PF}} = \frac{\Delta(1+\kappa)}{(\phi_\pi - 1)(1+\phi_\pi \kappa)} > 0.$$

Thus, the inflation gap is on average higher under rational expectations than under perfect foresight. Because of the assumed monetary policy rule, higher inflation will in turn imply higher interest rate, reducing the expansionary effects of the Shortfalls rule in the labor market. As a result, the unemployment gap is on average higher under rational expectations than under perfect foresight.

3.2 Equivalence Between Rational Expectations and Perfect Foresight Under a Symmetric Policy Rule

The previous results show that alternative assumptions on expectations can generate significantly different outcomes when policymakers follow an asymmetric Shortfalls rule. However, we note that, if policymakers instead followed a symmetric Deviations rule (setting $\Delta = 0$), then assuming perfect foresight or rational expectations would deliver identical outcomes. Under such a Deviations rule, the solutions under both rational expectations and perfect foresight would be characterized by zero unemployment and inflation gaps as the policy rate would fully offset the shock in each state and the rest of the model retains a linear structure. Thus, it is the interaction between the macroeconomic asymmetry and the central bank's response to stabilizing inflation that generates the differences in outcomes under rational expectations and perfect foresight.

3.3 Example 2: Nonlinear Phillips Curve

We now examine a second type of macroeconomic asymmetry: A nonlinear Phillips curve that steepens when the labor market is tight. For this simple example, we modify the Phillips curve with additional inflationary pressures in the high-demand state:

$$\pi^{j,s} = \begin{cases} \beta \mathbb{E}_t^j \left[\pi^j(rn_{t+1})|rn^s\right] - \kappa\, c\, u^{j,s} & \text{if } s = L \text{ or } 0 \\ \beta \mathbb{E}_t^j \left[\pi^j(rn_{t+1})|rn^s\right] - \kappa\, c\, u^{j,s} + 3\Delta^{pc} & \text{if } s = H, \end{cases} \tag{9}$$

where $j = RE$ or PF and $\Delta^{pc} > 0$. For a given level of unemployment, the economy experiences higher inflation in the high-demand state.[6] For this example involving a nonlinear Phillips curve, we return to a symmetric deviations-type rule.

$$i^{j,s} = \phi_\pi \mathbb{E}_t^j \left[\pi^j(rn_{t+1}) | rn^s \right]. \tag{10}$$

Assuming that the central bank responds to the expected inflation gap (instead of current inflation gap) simplifies the expressions that allow us to highlight the central role played by assumptions on expectations formation. Also, to further simplify the algebra, we assume $rn^H = -rn^L = \epsilon$ and $rn^0 = 0$, all of which occur with 1/3 probability.

Perfect Foresight Equilibrium

Under perfect foresight, agents do not expect future shocks to occur, and the solution to the system of Equations (6), (9), and (10) is given by:

$$\left(u^{PF,s}, \pi^{PF,s}\right) = \begin{cases} (\epsilon, -\kappa\epsilon) & \text{if } s = L. \\ (0, 0) & \text{if } s = 0. \\ (-\epsilon, \kappa\epsilon + 3\Delta^{pc}) & \text{if } s = H. \end{cases}$$

Average unemployment and average inflation gaps under perfect foresight are then given by:

$$\bar{u}^{PF} = 0, \qquad \bar{\pi}^{PF} = \Delta^{pc}$$

Under perfect foresight, households and firms do not take into account the possibility of future shocks and thus do not anticipate the increase in future inflation (and its associated interaction with the monetary policy rule) that will result from a steeper Phillips curve when the labor market is tight. As a result, under perfect foresight, a nonlinearity in the Phillips curve implying higher inflation in the high-demand state leads to an increase in average inflation but no effect on the unemployment gap.

Rational Expectations Equilibrium

Under rational expectations, agents expect future shocks to occur, and the solution to the

[6] Using an additive term, rather than changing the actual slope of the Phillips curve itself, allows us to derive simple analytical expressions. In Section 5.2, we numerically examine a model in which the slope of the Phillips curve changes with the state of the economy. As in our previous example, the scalar 3 is unnecessary but helps simplify expressions since the natural rate has 3 states that occur with equal probability.

system of Equations (6), (9), and (10) is given by:

$$\left(u^{PF,s}, \pi^{PF,s}\right) = \begin{cases} \left(\epsilon + \dfrac{\Delta^{pc}}{\kappa}, -\kappa\epsilon - \Delta^{pc}\right) & \text{if } s = L. \\ \left(\dfrac{\Delta^{pc}}{\kappa}, \quad - \Delta^{pc}\right) & \text{if } s = 0. \\ \left(-\epsilon + \dfrac{\Delta^{pc}}{\kappa}, \kappa\epsilon + 2\Delta^{pc}\right) & \text{if } s = H. \end{cases}$$

Average unemployment and average inflation gaps under rational expectations are then given by:

$$\bar{u}^{RE} = \frac{\Delta^{pc}}{\kappa}, \qquad \bar{\pi}^{RE} = 0$$

Different from the perfect foresight case, under rational expectations, agents do take into account that future shocks can lead to higher inflation when the labor market is tight. Thus, an increase in future in inflation due to the nonlinear Phillips curve possibly binding in the future causes firms to set higher prices today. This increase in expected future inflation leads the central bank to set higher policy rates today, which leads to lower output and higher unemployment. Importantly, this offsetting effect occurs even in absence of the economy being hit with a shock and the economy experiences, on average, a positive unemployment gap and a zero inflation gap.

Comparing Perfect Foresight and Rational Expectations Equilibria

This simplified example of a nonlinear Phillips curve implying higher inflation when the labor market is tight shows that alternative expectation assumptions can change longer-run average outcomes:

$$\bar{u}^{\text{RE}} - \bar{u}^{\text{PF}} = \frac{\Delta^{pc}}{\kappa} > 0,$$
$$\bar{\pi}^{\text{RE}} - \bar{\pi}^{\text{PF}} = -\Delta^{pc} < 0.$$

Under rational expectations, unemployment is higher in all states of the world than under perfect foresight, while inflation is higher in the high-demand state, but lower otherwise, than under perfect foresight. The results from this section suggest that the effects of asymmetries in both the structural macroeconomic model and policymaker behavior can depend crucially on assumptions about household and firm expectations.

4 Macroeconomic Implications of an Asymmetric Monetary Policy Rule

Building on the intuition from the simple examples in the previous section, we return to the model presented in Section 2 to analyze the quantitative implications of an asymmetric monetary policy rule for key macroeconomic outcomes, under varying assumptions about household and firm expectations. After parameterizing the model, we present and discuss the policy functions for unemployment and inflation gaps over current values of the natural rate obtained under perfect foresight and rational expectations. We then contrast the implications for first, second and higher-order moments of key macroeconomic outcomes. Finally, we discuss the differences in model dynamics using impulse response functions.

4.1 Parameterization and Solution Method

The model unit of time is a quarter and we apply standard quarterly parameter values from the literature by setting $\beta = 0.99$, $\kappa = 0.01$, $\phi_\pi = 1.5$. We assume demand shocks are persistent $\rho_{rn} = 0.9$. We assume $\epsilon_t^{rn} \sim N(0, \sigma_{rn})$ and set $\sigma_{rn} = 0.025$ to match a 1-percentage point standard deviation of the unemployment gap under the baseline symmetric monetary policy rule. In models without a concept of unemployment, previous work often assumes that monetary policy instead reacts to the output gap with a reaction coefficient of 0.125. Using our Okun's law relation with $c = 2$, this common parameterization implies a response to unemployment $\phi_u = -0.25$. Table 1 summarizes the parameter values.

Table 1: Baseline Model Parameter Values

Parameter	Notation	Value
Preferences and technology:		
Discount factor	β	$e^{(-1.5/400)}$
Slope of the Phillips curve	κ	0.01
Slope to Okun's law	c	2
Monetary policy:		
Weight on inflation gap	ϕ_π	1.50
Weight on unemployment gap	ϕ_u	-0.25
Shock processes:		
Natural rate: persistence	ρ_{rn}	0.9
Natural rate: standard deviation	σ_{rn}	0.0025

Notes: Model's unit of time is a quarter.

We solve the model both under rational expectations and perfect foresight with a global solution method. That is, we implement a discrete state space projection method where the only difference across RE and PF solutions is the parameterization of the exogenous state transition matrix. In particular, we first approximate the persistent processes for rn_t using the Rouwenhorst (1995) method with 105 grid points, which provides a discrete grid for the natural rate rn_t and a state transition matrix P^{RE}. We then build a PF state transition matrix on the same grid for rn_t. For illustration only, the following two matrices show the resulting RE and PF state transition matrices under a 3 grid-point example.

$$P^{RE} = \begin{bmatrix} p^2 & 2p(1-p) & (1-p)^2 \\ p(1-p) & p^2+(1-p)^2 & p(1-p) \\ (1-p)^2 & 2p(1-p) & p^2 \end{bmatrix} \qquad P^{PF} = \begin{bmatrix} \rho_{rn} & 1-\rho_{rn} & 0 \\ 0 & 1 & 0 \\ 0 & 1-\rho_{rn} & \rho_{rn} \end{bmatrix}$$

where $p = (\rho_{rn}+1)/2$. The policy functions $u^j(rn_t)$ and $\pi^j(rn_t)$ are then parameterized over the grid for the state variables to solve the two functional Equations (6) and (7) for $j = RE$ or PF depending on whether we are solving for the RE or PF equilibrium.[7]

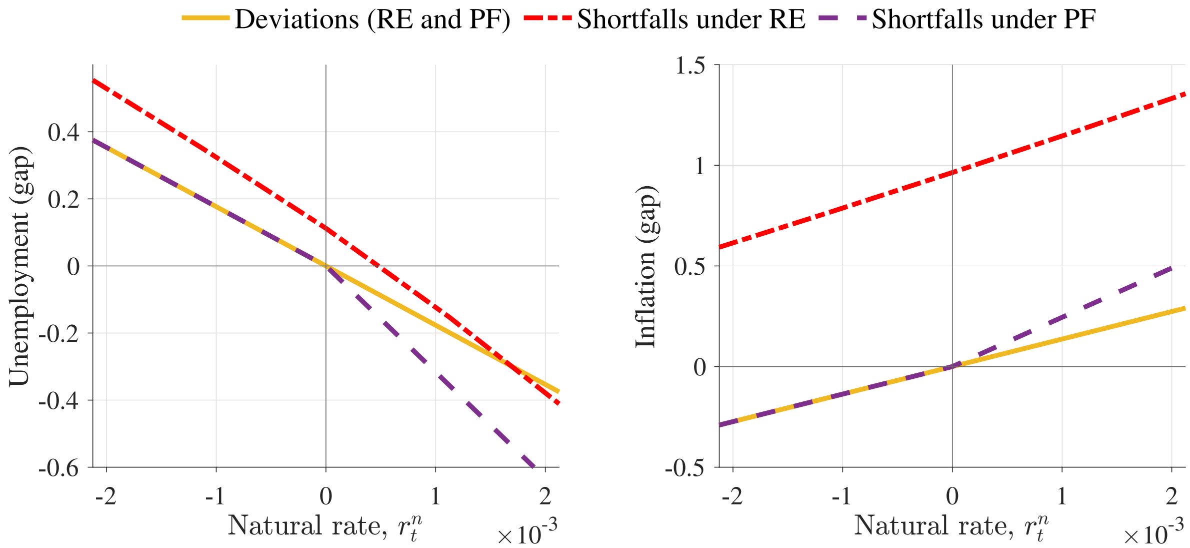
4.2 Equilibrium Policy Functions

As discussed above, RE and PF solutions to the policy functions are the same when the economic environment is everywhere linear. This is further illustrated here with the macroeconomic model of Section 2: the unemployment and inflation gap policy functions are identical under RE and PF when monetary policy follows the Deviations rule given by Equation (4). They are both continuous linear functions of the natural rate: unemployment is decreasing and inflation increasing in the current value of the natural rate rn_t. This is shown in the two panels of Figure 1 with the equilibrium policy functions when the central bank applies a symmetric Deviations rule under RE and PF as a solid gold line.

This equivalence breaks down when an equilibrium condition contains a nonlinearity. If the central bank follows an asymmetric monetary policy rule, such as the Shortfalls rule given by Equation (5), the RE (solid red) and PF (dashed purple) equilibrium policy functions will diverge. The policy functions under PF continue to pass through 0 at the steady state for the natural rate (see the dashed purple lines at $rn_t = 0$ in Figure 1). However,

[7] See the Appendix for greater details on the solution methods. We also show that this approach to solving the perfect foresight equilibrium is equivalent to the more common shooting algorithms and orders of magnitude faster.

Figure 1: Unemployment and Inflation Gap Policy Functions over the Natural Rate



Note: Unemployment and inflation gap policy functions are shown over a limited range of the of the natural rate, between ± 0.85 of σ_{rn}. Policy functions over 3 standard deviations for the natural rate around its mean are shown in Figure C.2 in the appendix.

under RE both the unemployment and inflation gaps are positive at $rn_t = 0$. In the chart, this can be seen as an upward shift in the unemployment and inflation gap policy functions for the shortfalls rule case solved under RE when compared to its PF counterpart.

Second, beyond the level shifts in the policy functions, there are differences in slopes across RE and PF solutions. For example, under PF the slopes of unemployment and inflation gaps are identical when the natural is negative whether the central bank follows a symmetric Deviations or asymmetric Shortfalls rule. This follows from the fact the model equations are the same when the unemployment gap is negative in a PF equilibrium as agents do not anticipate a possibility of being in the expansionary state. However, the RE equilibrium takes into account the possibility of being in an expansionary state in the future, changing the slope of the policy functions under a shortfalls rule even when the natural rate is currently negative.

Finally, rational expectations lead to a degree of smoothing out of the kink in the unemployment and inflation gap policy functions, moderating the asymmetric effects of the shortfalls policy rule in both outcomes of interest. This smoothing arises from agents' consideration of multiple potential outcomes, incorporating uncertainty about future shocks–and the interactions of those shocks with the asymmetric monetary policy rule–into their

Table 2: Model-Implied Moments: Rational Expectations and Perfect Foresight

	Deviations Rule(1)	Shortfalls Rule	
		Rat. Exp.	Perf. Fores.
Means:			
u	0.00	-0.05	-0.32
π	0.00	1.02	0.25
i	0.01	1.03	-0.03
Standard deviations:			
u	1.00	1.33	1.42
π	0.77	1.03	1.10
i	2.16	2.14	2.12

Notes: (1) Moments for the model with a deviations rule are identical under RE and PF solutions and not reported separately. Moments calculated on 3000 simulations each of 1000 period length. Unemployment gap (u) reported in percentage points. Inflation gap (π) and nominal interest rate gap (i) reported in annualized percentage points.

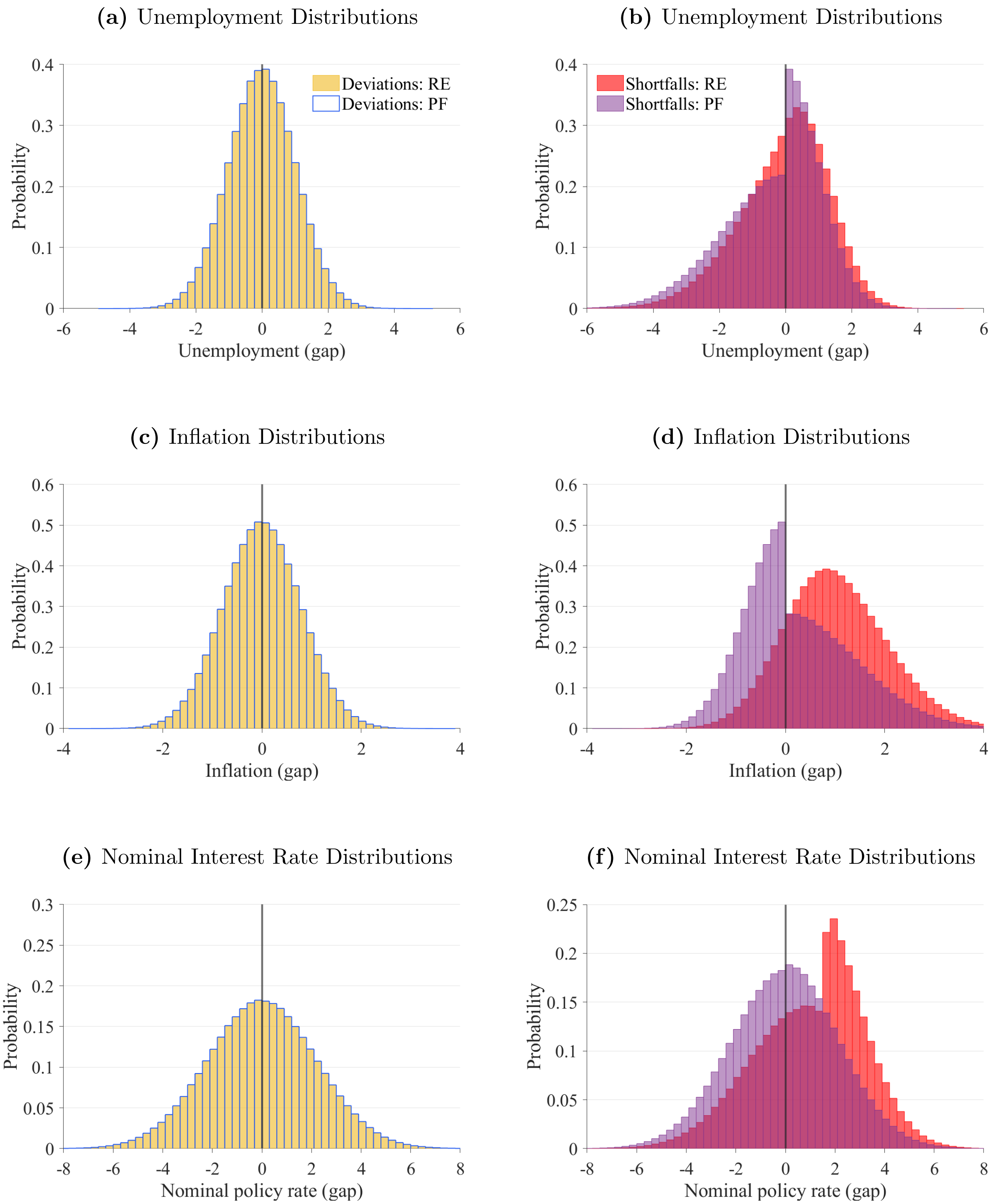
decision-making. The probabilistic nature of rational expectations leads to more gradual behavioral changes around the policy shift point. We return to this in the next subsection.

4.3 Moments From the Stationary Distribution

Table 2 reports key first and second moments from model simulations. The first column reports the moments when the central bank follows the deviations rule in Equation (4). The model-implied moments are identical under RE and PF. The next columns report the same set of moments when the central bank follows the shortfalls rule (5), reporting first the results for the RE solution and second the PF solution.

Unemployment and inflation gaps are, on average, equal to zero in the model with a Deviations rule. This is the case regardless of whether agents have PF or RE, as expected given the previous discussions. The average unemployment gap is notably negative in the model with a Shortfalls rule solved under PF: the systematic expansionary effects of the shortfalls rule appear to yield long-term benefits of a lower average rate of unemployment. However, this gain essentially disappears when the model is solved under RE: the average unemployment gap is smaller than a tenth of a percentage point. The inflation gap, in contrast, is significantly larger (nearly five times) under RE compared to PF: a Shortfalls rule adds 1 percentage point to average inflation under RE compared to 0.2 percentage points under PF, relative to a Deviations rule. In other words, PF suggests policymakers can lower average unemployment with little cost from higher average inflation. However, such a favor-

Figure 2: Distributions of Unemployment, Inflation, and Nominal Policy Rate Gaps for Rational Expectations and Perfect Foresight under Deviation and Shortfalls policy rules



Note: Distributions shown for 3000 simulations of 1000 periods each. Unemployment gap reported in percentage points. Inflation and nominal policy rate gaps reported in annualized percentage points.

able tradeoff disappears under rational expectations.

The next three rows of Table 2 report the standard deviations of the gaps under both policy rules and approaches to expectations. The unemployment and inflation gaps are more volatile when the central bank follows a Shortfalls rule as compared to a Deviations rule, regardless of the way agents form expectations. However, the standard deviations for the unemployment and inflation gaps are somewhat smaller under RE than under PF. In Section 4.4, we discuss the intuition for this result when we examine the impulse responses to a demand shock under each case.

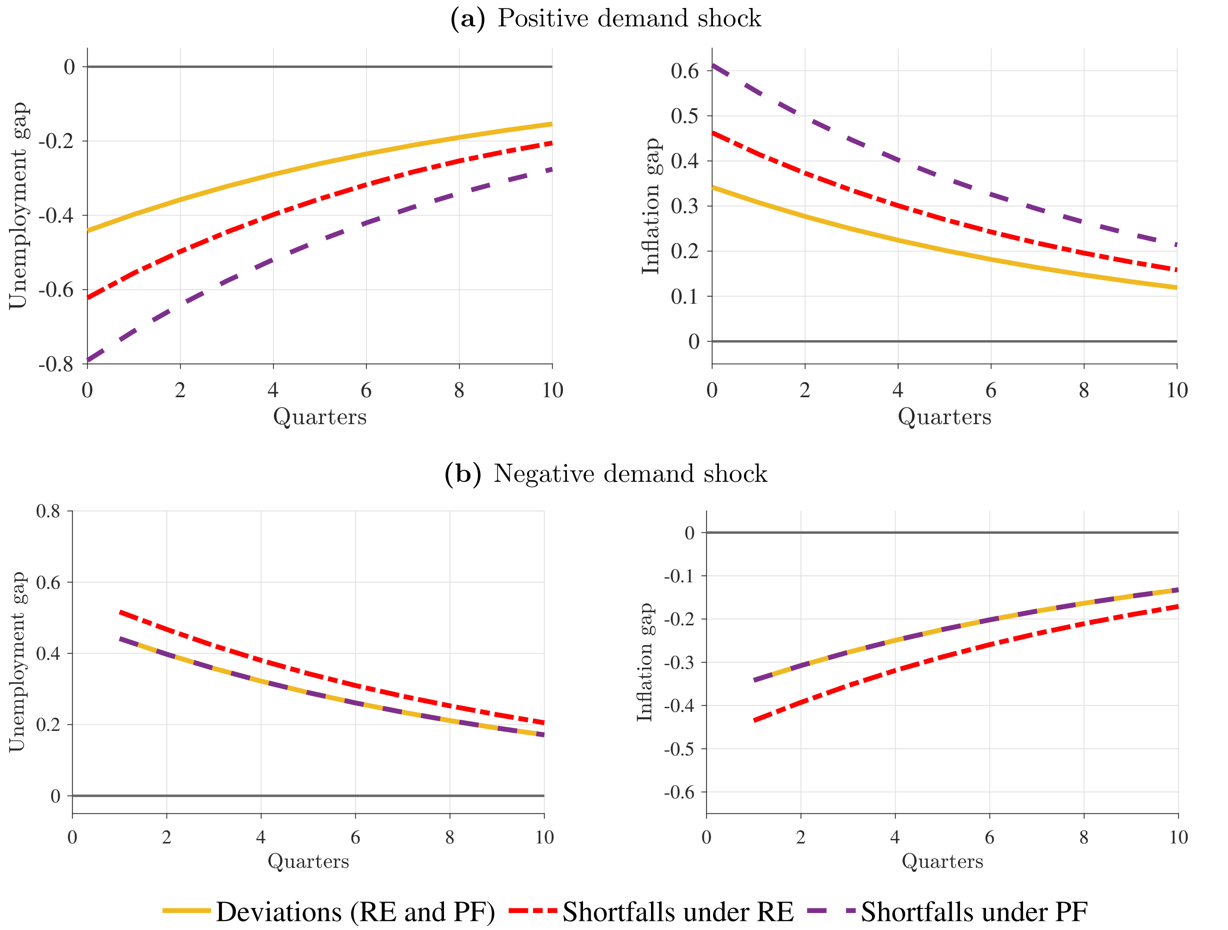
The distribution plots of Figure 2 illustrate the implications for higher moments of the models' outcomes under stochastic realizations of the natural rate shock. The first column shows the distributions of the unemployment, inflation and policy rate gaps for when the central bank follows a Deviations rule and expectations are formed either rationally or under perfect foresight. A couple observations stand out from the Deviations rule case. First, the distributions of outcomes under RE and PF are identical. Second, the distributions are symmetric around the steady state gaps of zero, given the assumed symmetry in the natural rate shock.

The RE and PF distributions in a model with an asymmetric (Shortfalls) monetary policy rule, shown in the second column of Figure 2, diverge noticeably. First, the distribution of the inflation gaps under RE (red) is shifted to the right compared to that under PF (purple), with a mean of 1.0 compare to 0.25 (see Table 2) . Second, there is a pronounced kink in the distributions of inflation and unemployment gaps under PF at the steady state (zero gaps). Echoing the discussion on longer-run averages, alternative assumptions about rational expectations versus perfect foresight suggest a different distributions of outcomes for policymakers considering policies that change depending on the state of the economy.

4.4 Impulse Responses

Differences in the economic outcomes under PF and RE also show up in the model's impulse responses to a given shock under an asymmetric policy rule. Figure 3 plots the impulse responses to a one standard deviation positive or negative natural rate shock. To compute these responses, we first find the stochastic steady state for the economy under both PF and RE. This is the point in which the economy would converge to in absence of shocks. Then, we trace out the responses if we hit each economy with a one-time innovation to the natural

Figure 3: Impulse responses to Natural Rate Shocks



Note: Impulse responses to a one time innovation are computed according to (11) and equilibrium policy functions for unemployment and inflation gaps under either rational expectations or perfect foresight.

rate and assume no further shocks occur afterward. Formally, we can define this impulse response as:

$$IRF(y)_{t+h} = [y_{t+h}|\Omega'] - [y_{t+h}|\Omega] \tag{11}$$

where $[y_{t+h}|\Omega]$ is the path of the variable under a history of shocks Ω while $[y_{t+h}|\Omega']$ the corresponding realizations under the same history of shocks plus a one time innovation ϵ_t at date t. Importantly, this impulse response method allows for the endogenous variables to converge to different longer-run values (as we observed in Table 2).

Under PF, the responses of the model economy to a negative shock look identical under both the symmetric Deviations and asymmetric Shortfalls rules. Under the positive demand shock, however, we see a larger decline in unemployment and bigger increase in inflation when households have perfect foresight and owing to the more accommodative shortfalls rule in expansions. However, once households and firms begin to take account future shocks, we see an additional contractionary force that is present in both the responses to a positive and negative shock. At all times, households and firms under rational expectations understand that the possibility of future positive shocks (in combination with the accommodative policy in booms) lead to an increase in inflation expectations. Through the Phillips curve and the central bank's response to inflation, monetary policy leans against this additional pickup in inflation expectations with higher policy rules, which results in a mildly contractionary force that affects the model's responses to a given shock. In response to a positive demand shock, this contractionary force slightly tempers the equilibrium responses to an expansionary shock. In response to a negative shock, this contractionary force amplifies the downturn leading to a larger decline in inflation and bigger increase in unemployment. On net, we see that the contractionary force is a bit larger in response to a positive shock (since firms expect the expansion to be persistent), which helps explain why we see a slightly lower volatility of a shortfalls rule under rational expectations when compared with perfect foresight.

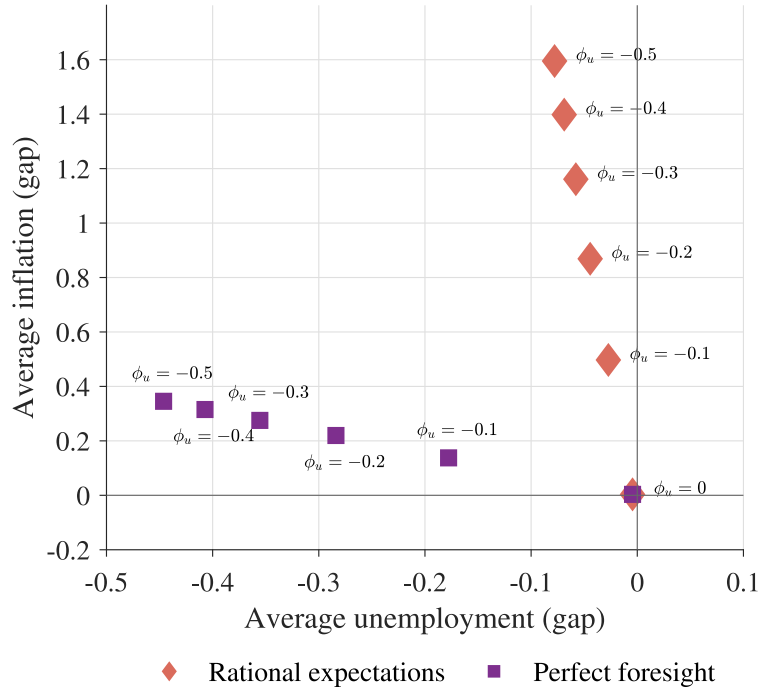
5 Further Discussion

This section discusses some additional considerations and some additional robustness exercises regarding our main conclusions.

5.1 Longer-Run Tradeoffs

Past work by Benigno and Ricci (2011), Daly and Hobijn (2014), and others highlights that downward nominal wage rigidities (a type of macroeconomic asymmetry) can generate longer-run tradeoffs between unemployment and inflation. However, a key insight from our work is that the exact quantitative tradeoff generated by a particular asymmetry could depend on assumptions regarding household and firm expectations. To illustrate this idea, we re-solve the model with the asymmetric Shortfalls rule from Section 4 under various parameterizations of the weight on unemployment gap ϕ_u, ranging from -0.5 to 0, while keeping all other parameters fixed. The results are shown in Figure 4 which plots the longer-run average outcomes for unemployment and inflation under each calibration for both rational expectations (red diamonds) and perfect foresight (purple squares). Under perfect foresight, the simulations suggest that policymakers may face a relatively benign tradeoff under a shortfalls rule. As ϕ_u increases, we see that policymakers can achieve lower unemployment at a relatively mild cost of higher inflation. Under rational expectations, however, the shortfalls policy does not generate any real benefits for unemployment and simply results in higher

Figure 4: Long Run Phillips Curve under a Shortfalls Approach



Note: Moments calculated on 3000 simulations each of 1000 period length. Unemployment gap reported in percentage points. Inflation gap reported in annualized percentage points.

inflation. Consistent with our earlier results, longer-run tradeoffs implied by macroeconomic or policy asymmetries may be less favorable under the assumption rational expectations.

5.2 Model Extensions

We highlight the robustness of our conclusions across several additional macroeconomic environments. First, within the context of the Shortfalls policy rule, we consider an extension where agents are boundedly rational and another extension where cost push shocks–instead of natural rate shocks–are the drivers of macroeconomic fluctuations. Finally, we revisit the case of a kinked Phillips curve which steepens when the labor market is tight in the context of our macroeconomic model under a Deviations monetary policy rule. Our main conclusions, summarized in Table 3, still apply in these additional cases: Assumptions about household and firm expectations matter in macroeconomic models when either asymmetries or nonlinearities are present.

Table 3: Model-Implied Moments for Additional Cases

	Means			Standard deviations		
	u	π	i	u	π	i
A: Baseline results						
Deviations rule*	0.00	0.00	0.01	1.00	0.77	2.16
Shortfalls rule, RE	-0.05	1.02	1.03	1.33	1.03	2.14
Shortfalls rule, PF	-0.32	0.25	-0.03	1.42	1.10	2.12
B: Extensions						
B.1: Bounded rationality						
Shortfalls rule, RE	-0.26	0.62	0.54	1.28	0.78	1.67
B.2: Cost-push shocks						
Deviations rule*	0.00	0.01	0.01	1.00	3.00	3.50
Shortfalls rule, RE	-0.04	1.03	1.03	1.33	2.75	3.54
Shortfalls rule, PF	-0.32	0.25	-0.02	1.41	2.70	3.54
B.3: Nonlinear Phillips curve						
Deviations rule**, RE	0.63	0.01	0.01	1.46	1.85	2.77
Deviations rule**, PF	0.30	0.41	0.62	1.43	1.92	2.88

Notes: Moments calculated on 3000 simulations each of 1000 period length. Unemployment gap (u) reported in percentage points. Inflation gap (π) and nominal interest rate (i) reported in annualized percentage points. RE: rational expectations. PF: perfect foresight. *: Moments for the model with a deviations rule are identical under RE and PF solutions and not reported separately. **: We set $\phi_u = 0$ to better align with the simple example for a nonlinear Phillips curve in Section 2.

Bounded Rationality

One concern may be that the model of Section 2 under RE assumes too much forward-looking behavior. This is addressed by considering an extension with bounded rationality. Limiting the response of current outcomes to expectations far in the future could reduce the differences between RE and PF equilibrium outcomes. This extension follows Gabaix (2020) and introduces an additional discounting parameter m^{br} in both the intertemporal saving equations, as well as in the Phillips curve, as follows:

$$u_t = \mathbb{E}_t^j m^{br} u_{t+1} + \frac{1}{c}\Big(i_t - \mathbb{E}_t^j \pi_{t+1} - rn_t\Big), \tag{12}$$

$$\pi_t = \beta\, \mathbb{E}_t^j\, m^{br} \pi_{t+1} - \kappa\, c\, u_t. \tag{13}$$

where, once again, where $j = RE$ or PF. The parameter m^{br} controls the sensitivity of current outcomes to future expectations. In this extension all parameters retain the values described in Table 1 and we set $m^{br} = 0.97$, following McKay, Nakamura and Steinsson (2017).

Panel B.1 of Table 3 shows the macroeconomic effects of a shortfalls rule under rational expectations but with bounded rationality. As expected, the bounded rationality framework yields outcomes more akin to the perfect foresight case, exhibiting a more favorable trade-off between unemployment and inflation than the rational expectations case. That is, the adoption of the shortfalls rule results in lower average unemployment than under RE, with a more muted increase in the inflation rate.[8] These results show that limiting the response of current outcomes to expectations about future shocks, either via bounded rationality or perfect foresight, can lead to different conclusions regarding the implications of adopting a shortfalls rule. Thus, while assuming bounded rationality could change exact quantitative values of a macroeconomic asymmetry, our main point remains: The assumptions on expectations formation are crucial in determining the effect of a macroeconomic asymmetry. [9]

Cost-Push Shocks

We now introduce a cost-push shock ν_t to the environment of Section 2 as a shifter to the Phillips curve:

$$u_t = \mathbb{E}_t^j u_{t+1} + \frac{1}{c}\Big(i_t - \mathbb{E}_t^j \pi_{t+1}\Big), \tag{14}$$

$$\pi_t = \beta \mathbb{E}_t^j \pi_{t+1} - \kappa c u_t + \nu_t, \tag{15}$$

noting that for this example the natural rate shock is absent for simplicity. Cost-push shocks tend to move the unemployment and inflation gaps in the same direction. The stochastic process for ν_t is given by: $\nu_t = \rho_\nu \nu_{t-1} + \epsilon_t^\nu$ where $\rho_\nu < 1$, and $\epsilon_t^\nu \sim N(0, \sigma_\nu^2)$. All parameters retain the values described in Table 1 and we set $\rho_\nu = 0.9$ and $\sigma_\nu = 0.00043$ so as to match the standard deviation of the unemployment rate gap in our baseline case with a deviations monetary policy rule and natural rate shocks only.

Panel B.2 of Table 3 shows the model-implied moments under cost-push shocks. Two results stand out. First, as discussed previously, given that the model is linear under a symmetric policy rule (such as the Deviations rule considered in the model), the model-implied moments are the same under PF and RE regardless of the nature of business cycle shocks.

[8] Figure C.3 in the Appendix illustrate these results across different values of the policy parameter ϕ_u, holding other parameters fixed.

[9] Given that the assumed natural rate shocks are persistent, the results under perfect foresight with bounded rationality will also differ from our baseline results under perfect foresight, resulting in a even more favorable tradeoff between unemployment and inflation when $m^{br} = 0.97$ than when $m^{br} = 1$.

Second, as was the case for the natural rate shocks, the macroeconomic effects of a Shortfalls rule (versus a Deviations rule) under cost-push shocks also differ across the two alternative approaches to expectations formation. Importantly though, the differences between the RE and PF effects of a Shortfalls rule are broadly similar to those found under natural rate shocks.[10] Thus, our conclusions about the differences in macroeconomic outcomes depending on the assumptions on expectations formation are robust to different types of macroeconomic shocks.

Nonlinear Phillips Curve

Finally, we consider a nonlinear Phillips curve in which inflationary pressures accelerate at low and falling unemployment gaps. Our reduced-form approach to capturing such dynamics is to modify the Phillips curve equation, leaving the IS curve unchanged from the baseline Equation (1), as follows:

$$\pi_t = \beta\, \mathbb{E}_t^j\, \pi_{t+1} - \tilde{\kappa}_t\, c\, u_t. \tag{16}$$

where the slope of the Phillips curve is state-contingent and depends on the current unemployment gap. That is, consistent with the empirical evidence in Smith, Timmermann and Wright (2025), the slope increases by a factor of 3 when the unemployment is negative:

$$\tilde{\kappa}_t = \begin{cases} \kappa & \text{if } u_t \geq 0 \\ 3 \times \kappa & \text{if } u_t < 0. \end{cases} \tag{17}$$

In order to line up with the simple example of a nonlinear Phillips curve in Section 3, we assume that the central bank follows a deviations-type monetary policy rule that responds to the inflation gap only, with no response to the unemployment rate gap (i.e., with $\phi_u = 0$). The rest of the parameters retain the values described in Table 1.

The results are presented in Panel B.3 of Table 3.[11] As was the case in our simple example in Section 3, we find that, if the Phillips curve steepens when the labor market is tight, the average effects on inflation and unemployment can significantly differ depending on the assumptions about household and firm's expectations about future shocks. Under rational expectations, an increase in future inflation due to the nonlinearity in the Phillips curve possibly binding in the future causes firms to set higher prices today. This increase in

[10] Note that the volatility of inflation is larger under cost-push shocks than under the natural-rate shocks, regardless of the assumption on expectations. This is expected given the direct impact on the Phillips curve in Equation (15).

[11] Unemployment and inflation gap policy functions under RE and PF are shown in appendix Figure C.4.

current in inflation leads the central bank to set higher policy rates, which leads to higher unemployment. This interaction between an inflation-stabilizing central bank and forward-looking price setters is absent in the case of PF. As a result, the model-implied moments will differ depending on the assumption of expectations formation. In the example shown in Panel B.3 of Table 3, the inflation gap is closed under RE while it averages 0.4 percentage points under PF, and the average unemployment gap is higher under RE than under PF (0.6 compared to 0.3 in this example).

6 Conclusion

This paper demonstrates that assumptions about household and firm expectations play a crucial role in determining the effects of macroeconomic asymmetries and nonlinearities on economic outcomes, particularly longer-run averages and the distribution of business-cycle outcomes. We show that for standard New Keynesian models, the implied averages of unemployment and inflation can differ significantly in magnitude and potentially even in sign depending on whether agents account for the possibility of future shocks. We show the differences between rational expectations and perfect foresight solutions through both analytical examples and numerical simulations, focusing on two key scenarios: an asymmetric monetary policy rule and a nonlinear Phillips curve.

Our findings reveal that under perfect foresight, where agents do not account for future shocks, the model can suggest favorable longer-run tradeoffs between inflation and unemployment that disappear under rational expectations. The key mechanism driving differences in these results is the interaction between forward-looking price-setters and an inflation-stabilizing central bank. Under rational expectations, anticipated future asymmetries affect current pricing decisions, leading to changes in inflation expectations that the central bank must counteract, even in the absence of realized shocks. Our numerical results demonstrate that these differences can be quantitatively significant.

Our findings have important implications for macroeconomic modeling and policy analysis. While perfect-foresight solutions can be computationally advantageous, especially for larger models, our results caution that they may lead to misleading conclusions about both the short-run dynamic and longer-run average effects of macroeconomic asymmetries. We suggest that researchers using perfect foresight techniques verify their conclusions about longer-run averages using simplified models solved under both perfect foresight and rational expectations.

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Appendix

A Related Literature

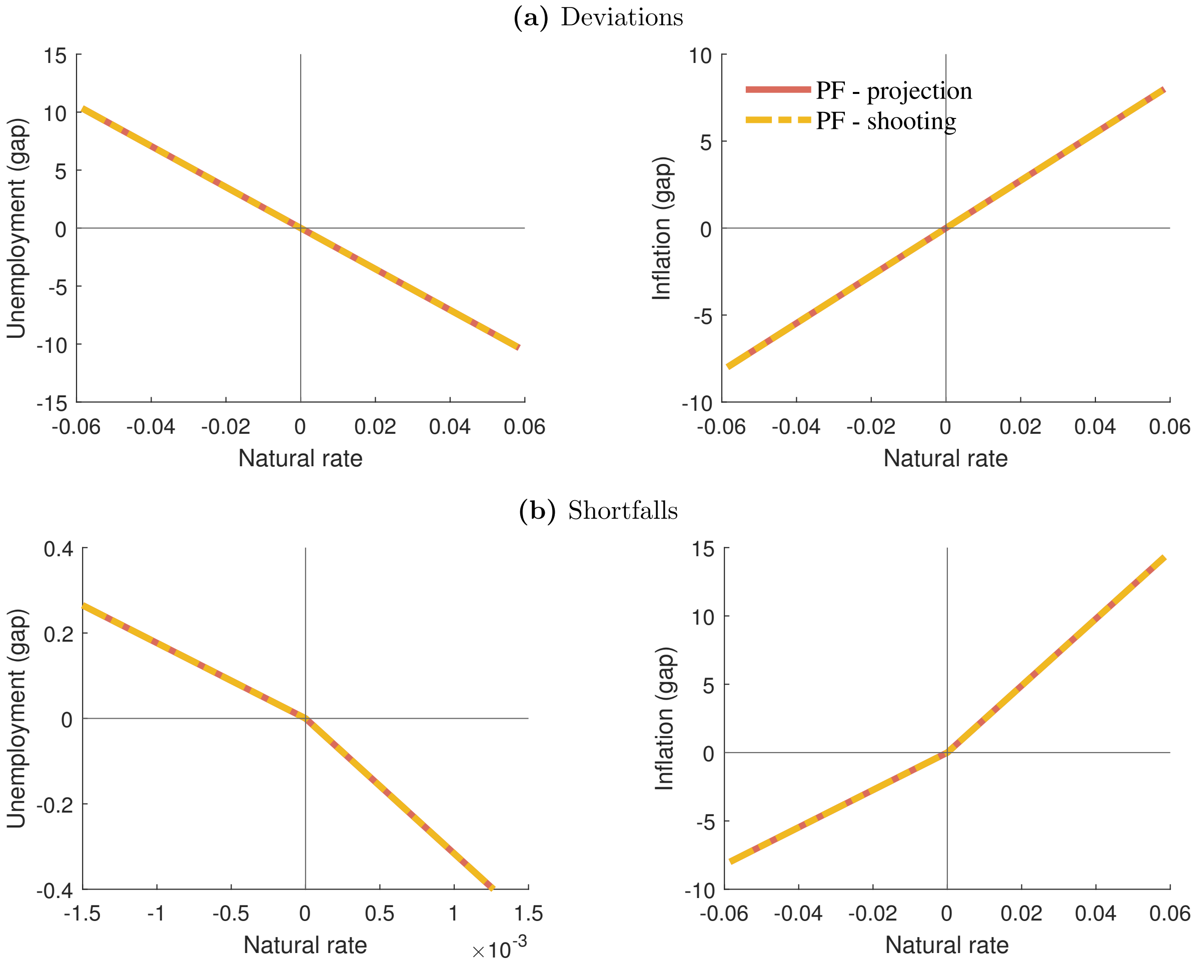
Table A.1: Expectations in Previous Literature on Macroeconomic Asymmetries

Macroeconomic Asymmetry	**Rational Expectations**	**Perfect Foresight**	**Consider Both**
Zero Lower Bound on Nominal Interest Rates	Adam and Billi (2006)	Eggertsson and Woodford (2003), Jung, Teranishi and Watanabe (2005),	Adam and Billi (2007), Nakov (2008), Guerrieri and Iacoviello (2015), Nakata (2017)
Collateral Constraints		Guerrieri and Iacoviello (2017)	Dou et al. (2023)
Downward Nominal Wage Rigidites	Elsby (2009), Benigno and Ricci (2011), Kim and Ruge-Murcia (2009)	Daly and Hobijn (2014)	
Nonlinear Phillips Curve	Blanco et al. (2025)	Benigno and Eggertsson (2023)	
Asymmetric Policy Rules	Davig and Leeper (2008); Gust, López-Salido and Meyer (2017)	Alves and Violante (2025)	

B Solution Methods

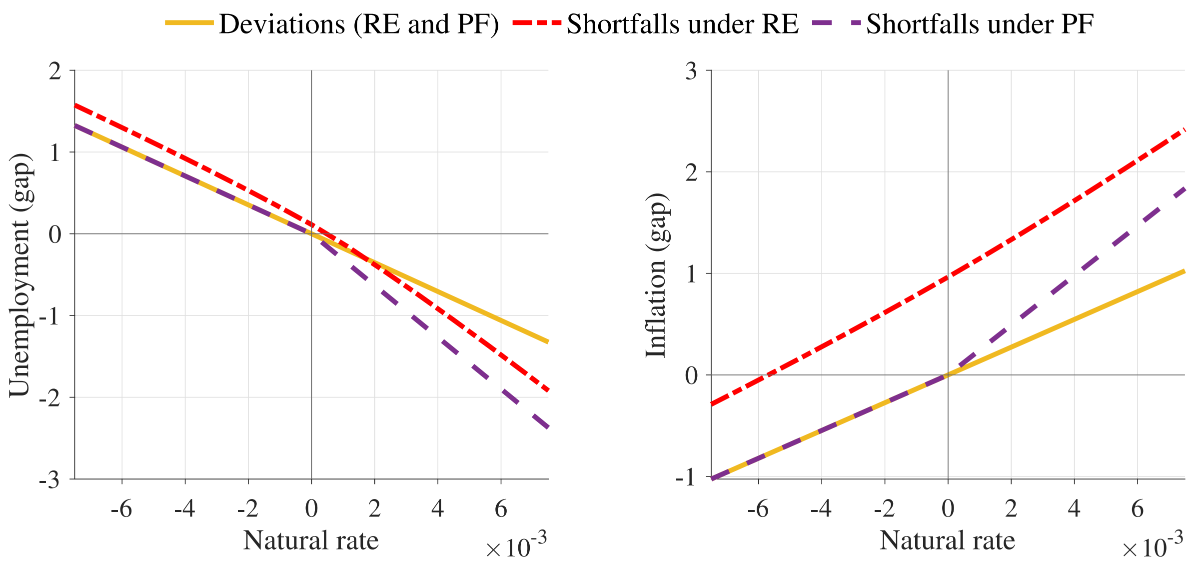
We compare the solution to the perfect foresight equilibrium using our parameterized expectations global approach to the more common shooting algorithm (see Miranda and Fackler for an example of this latter approach). Figure B.1 plots the equilibrium policy functions for the unemployment and inflation gaps when a central bank follows a symmetric deviations rule (panel (a)) or a shortfalls approach (panel (b)). The policy rules are identical across solution methods. However, in terms of computation time the gains from using a parameterized expectations are substantial. By way of example with 105 grid points for the natural rate the parameterized expectations approach takes 0.04 seconds to solve the model under both the dev and sf monetary policy rules. This contrasts with the 10.8 seconds needed to solve both models over the same number of grid points following a shooting algorithm.

Figure B.1: Perfect Foresight Policy Functions - Comparing Two Solution Methods



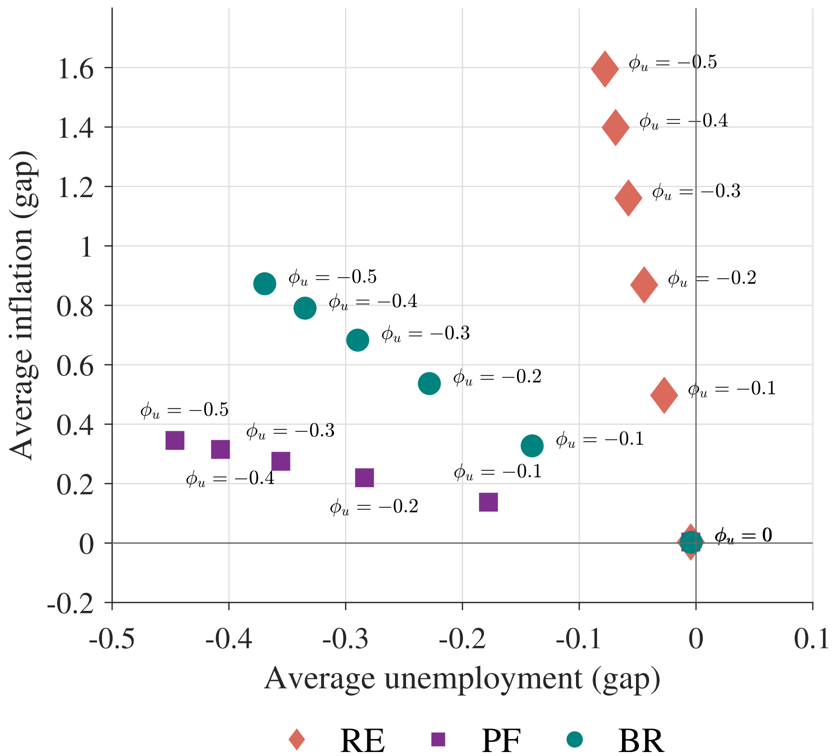
C Additional Results

Figure C.2: Unemployment and Inflation Gap Policy Functions over 3 standard deviations of the Natural Rate



Note: Unemployment and inflation gap policy functions are shown over a limited range of the of the natural rate, between ± 3 of σ_{rn}.

Figure C.3: Long Run Phillips Curve under a Shortfalls Approach



Note: Moments calculated on 3000 simulations each of 1000 period length. Unemployment gap reported in percentage points. Inflation gap reported in annualized percentage points. BR corresponds to the model outcomes under rational expectations and bounded rationality with $m^{br} = 0.97$.

Figure C.4: Policy Functions in the Presence of a Nonlinear Phillips curve and a Symmetric Deviations Monetary Policy Rule