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Optimal monetary policy under bounded rationality[☆]

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ABSTRACT

We develop a behavioral New Keynesian model to analyze optimal monetary policy with heterogeneously myopic households and firms. Five key results are derived. First, our model reflects coherent microeconomic and aggregate myopia due to the consistent transition from subjective to objective expectations. Second, the optimal monetary policy entails implementing inflation targeting in a framework where myopia distorts agents' inflation expectations. Third, price level targeting emerges as the optimal policy under output gap, revenue, or interest rate myopia. Under price level targeting, rational inflation expectations are a minimal condition for optimality under bounded rationality. Fourth, bounded rationality is not necessarily welfare-decreasing and is even associated with welfare gains for extreme cognitive discounting. Finally, our empirical results point to the behavioral model's superiority over the rational model.

1. Introduction

This paper investigates the dependence of optimal monetary policy on specific myopias[1] characterizing households and firms as well as their practical implications for monetary policy conduct. Behavioral monetary policy is an essential concept for central banks that focus on managing gaps (e.g., inflation gap, output gap) and expectations. Economic agents collect prices in supermarkets or on the internet, but observing the output gap is more complicated. The discrepancy in the observability and understanding of prices (inflation) and quantities (output) challenge policymakers. These relative distortions justify the analysis of the optimal monetary policy under different forms of myopia, which is consistent with empirical evidence (Coibion and Gorodnichenko, 2015; Coibion et al., 2018a; Angeletos et al., 2021).

Our findings show that bounded rationality *a la* Gabaix (2020) has essential implications for the conduct of monetary policy and emphasize that both inflation targeting (IT) and price level targeting (PLT) could be optimal under different circumstances and bounded rationality extensions. We find that no definitive answer about the particular targeting policy to adopt in a behavioral setting can be drawn. Neither IT nor PLT is consistently optimal under all states of the world. This is in stark contrast with the literature showing that PLT is the optimal policy resulting from the rational New Keynesian framework, or the rational inattention literature finding minor differences in terms of welfare, which does not alter the policy conclusions (Maćkowiak and Wiederholt, 2015). As surveyed in Eusepi and Preston (2018), learning models assuming inertial interest rate policy conclude that a form of PLT is an adequate proxy for the optimal policy. Also, Milani (2007) finds that adaptive learning generates persistence in the macroeconomic variables, which aligns with our results under commitment. However, Gabaix (2020) finds that PLT is suboptimal with behavioral agents. We challenge these previous results and echo the finding of Gabaix (2020) by showing that PLT is optimal when assuming some forms of bounded rationality, particularly those not involving macroeconomic inattention to inflation, while it is suboptimal in other cases. Under PLT, *bygones are not bygones*, to the extent that any deviation of the price level from its target should be entirely reversed, which

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[1] The terms myopia, inattention, and bounded rationality are used interchangeably in this paper.

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requires attention (rationality) from the public regarding inflation developments. In other words, we show that if agents are rational about inflation expectations, PLT is the optimal policy even if agents are not fully rational about other macroeconomic aggregates. IT is the first best if and only if this condition (rationality about inflation expectations) is not satisfied. We also link the theoretical insight emerging from this model and the practical implementation of optimal monetary policy through a simple rule.

Optimal monetary policy is widely analyzed in the literature through New Keynesian models (Clarida et al., 1999; Woodford, 2003), which assume that agents' expectations about the future are rational. According to Blanchard (2009, 2018), this assumption is exaggerated and quite far from reality, even when considering aggregated representative agents. Despite this caveat, academics and practitioners consider this model as the workhorse of monetary policy analysis, and its conclusions still shape the monetary economics literature.[2]

We derive optimal monetary policy under different forms of myopia that complement[3] Gabaix (2020). However, we deviate from Gabaix (2020) in several ways. Our new Phillips curve results from the consistent transition from subjective to objective expectations, which ensures coherent microeconomic and aggregate myopia dynamics. As a result of decreasing returns to scale in our production function and the appropriate modeling of the flexible-price economy and time-varying output gap, we provide the relevant framework to analyze the trade-off between output and inflation and the central bank response's magnitude to cost-push shocks. Optimal monetary policy is conducted through a welfare-relevant behavioral New Keynesian model, which allows for a model-consistent welfare criterion—second-order approximation of the household's utility. The commitment (first-best) and discretion (second-best) equilibria are examined. The possibility that an optimal simple rule implements the first-best solution is analyzed. All these configurations are explored through variable-specific myopias, i.e., output gap, interest rate, inflation, revenue, general and full myopia.[4]

This paper relates to several strands of the literature. First, it extends the monetary economics literature (Clarida et al., 1999; Woodford, 2003; Galí, 2015) by relaxing the rational expectations hypothesis. Second, compared to the learning (Evans and Honkapohja, 2012, 2013; Woodford, 2013) or the rational inattention (Sims, 2003; Maćkowiak and Wiederholt, 2009, 2015) literature, it is part of a new wave of behavioral models that deviate from the rational expectation hypothesis, while providing richer policy conclusions.

Additionally, we find that bounded rationality is not necessarily associated with decreased welfare. Several forms of economic inattention, especially extreme ones, can increase welfare. By contrast, output gap myopia implies significant welfare losses compared to the rational case.

The remainder of the paper is organized as follows. Section 2 describes the behavioral New Keynesian model, and Section 3 outlines the methodology used to study optimal monetary policy. Sections 4 and 5 present the optimal monetary policy under commitment and discretion, respectively. Section 6 characterizes optimal simple rules and weights within the same model. Section 7 presents empirical results following Bayesian estimations of the rational and behavioral models. Section 8 interprets and discusses our findings to draw some policy implications in Section 9. Section 10 presents the concluding remarks, Appendix A presents our derivations and Appendix B our robustness checks.

2. The model

Our model closely follows Gabaix (2014, 2020), where agents' representations of the economy are sparse, i.e., when they optimize, agents care only about a few variables that they observe with some myopia.

The model derivations are based on a consistent term structure of expectations, quantitatively-relevant assumptions (e.g., decreasing returns to scale,[5] different types of myopia, microfounded flexible economy), and various calibrations allowing for welfare loss' quantification. The household side of the model is identical to Gabaix (2014, 2020), while the Phillips curve is different.

2.1. Households

The infinitely lived rational representative household's utility is

$$U\left(c_t, N_t\right) = \frac{c_t^{1-\gamma} - 1}{1-\gamma} - \frac{N_t^{1+\phi}}{1+\phi}, \tag{1}$$

where c_t is real consumption and N_t is labor supply. γ is the coefficient of the household's relative risk aversion, i.e., the inverse of the intertemporal elasticity of substitution, and ϕ is the inverse of the Frisch elasticity of labor supply, i.e., the inverse of the elasticity of work effort with respect to the real wage.

The household maximizes

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U\left(c_t, N_t\right), \tag{2}$$

where $\mathbb{E}$ is the usual expectation operator and β is the static discount factor, subject to wealth dynamics

$$k_{t+1} = \left(1 + r_t\right)\left(k_t - c_t + y_t\right), \tag{3}$$

and real income

$$y_t = w_t N_t + y_t^f, \tag{4}$$

where k_t is the household's wealth, r_t the real interest rate, y_t the agent's real income, w_t the real hourly wage, N_t the worked hours, and y_t^f the profit income.

The rational household maximizes its lifetime utility (Eq. (2)) given its wealth evolution (Eq. (3)).

The behavioral household maximizes the same lifetime utility (Eq. (2)) but does not pay full attention to all variables in the budget constraints, as correctly processing information entails a cost. The behavioral agent perceives reality with some myopia, which is associated with this information cost.

Let $\hat{r}_t = r_t - \bar{r}$ and $\hat{y}_t = y_t - \bar{y}$ be the deviations of the real interest rate and output from their respective steady-state. Following Gabaix (2020), the behavioral agent's inattention is associated with *perceived* deviations from the steady-state real interest rate, $\hat{r}_t^{BR} = \hat{r}^{BR}\left(S_t\right)$, the function of the current state vector of the economy S_t, and real income, $\hat{y}_t^{BR} = \hat{y}^{BR}\left(N_t, S_t\right)$.

The behavioral agent's budget constraint is

$$k_{t+1} = \left(1 + \bar{r} + \hat{r}^{BR}\left(S_t\right)\right)\left(k_t - c_t + \bar{y} + \hat{y}^{BR}\left(N_t, S_t\right)\right), \tag{5}$$

where $\hat{r}^{BR}\left(S_t\right) = m_r \hat{r}_t\left(S_t\right)$, $\hat{y}^{BR}\left(N_t, S_t\right) = \hat{y}^{BR}\left(S_t\right) + w_t\left(N_t - \overline{N}\right)$, and $\overline{N}$ is the steady-state labor. $\hat{y}^{BR}\left(N_t, S_t\right)$ is the perceived personal

[2] As Stiglitz (2011) notes, one crucial underlying assumption of the traditional models is a rational behavior of the economy; however, the real-world economy seems inconsistent with any model of rationality (Blanchard, 2018; Cole and Milani, 2019).

[3] While Gabaix (2020) derives monetary policy results in a specific setting where only cognitive discounting, or general myopia, is assumed, our monetary policy results are derived in an extended model featuring different forms of myopia in addition to cognitive discounting. Gabaix's insight is that PLT is not desirable when firms (and thus households) are behavioral. In the extended model, this result is reproduced with more emphasis on cases when this could occur.

[4] General myopia refers to the slope of attention (cognitive discounting), and full myopia occurs when agents are affected by all myopia. These concepts are detailed in Section 2.

[5] Our model also allows for increasing returns to scale.

income, while $\hat{y}^{BR}(S_t) = m_y \hat{y}_t(S_t)$ is the aggregate income. The behavioral agent perceives only a fraction of the aggregate income but perfectly perceives his marginal income. The real interest rate myopia (m_r) and the real income myopia (m_y) are parameters[6] in $[0,1]$. For $m_r = m_y = 1$, the rational household's budget constraint is recovered.

The behavioral IS equation[7] resulting from this problem is expressed as

$$\tilde{y}_t = M\mathbb{E}_t\left[\tilde{y}_{t+1}\right] - \sigma\left(i_t - \mathbb{E}_t\left[\pi_{t+1}\right] - r_t^n\right), \tag{6}$$

where $\tilde{y}_t$ is the output gap expressed as deviations of output from its natural level, i_t is the nominal interest which links to r_t by the Fisher equation, r_t^n is the natural level of the real interest rate,[8] $M = \overline{m}/\left(R - m_Y \bar{r}\right)$, $\sigma = m_r/\left(\gamma R\left(R - m_Y \bar{r}\right)\right)$ where $m_Y = \left(\phi m_y + \gamma\right)/(\phi+\gamma)$ and $R = 1 + \bar{r} = 1/\beta$ and $\bar{r}$ is the steady-state of the real interest rate. $\overline{m}$ is the slope of attention (cognitive discounting), also called general myopia.

The first-order condition (FOC) with respect to N_t is

$$w_t = \gamma c_t + \phi n_t, \tag{7}$$

where n_t is the log deviation of employment, N_t, from its steady-state.

The rational IS curve obtained as a particular case, when $m_r = m_y = \bar{m} = 1$, is

$$\tilde{y}_t = \mathbb{E}_t\left[\tilde{y}_{t+1}\right] - \sigma_{re}\left(i_t - \mathbb{E}_t\left[\pi_{t+1}\right] - r_t^n\right), \tag{8}$$

where $\sigma_{re} = 1/(\gamma R)$.

Comparing the behavioral (Eq. (6)) and the rational (Eq. (8)) IS curves[9] reveals that expected future output appears to have less influence on current output in the behavioral equation ($M < 1$). Moreover, the transmission of monetary policy to the real economy is stronger in the rational than in the behavioral case ($\sigma_{re} \geq \sigma$).

2.2. Firms

A continuum of firms populates our economy. Each firm i produces differentiated goods using the same technology described by

$$Y_t(i) = A_t N_t(i)^{1-\alpha}, \tag{9}$$

where A_t is the technological factor (identical across all firms) that evolves such that $a_t = \rho_a a_{t-1} + \varepsilon_t^a$, where $a_t = \ln A_t$ and $\varepsilon_t^a \sim N\left(0;\sigma_a\right)$, *i.i.d.* over time, and $N_t(i)$ are the worked hours at firm i, which aggregates as $N_t = \int_0^1 N_t(i)\,di$.

We follow Basu and Fernald (1997) and Jermann and Quadrini (2007) to assume decreasing returns to scale ($\alpha > 0$), allowing our inflation dynamics to depend on the elasticity of substitution between different goods, ε. We also align our assumptions with the literature on New Keynesian models, such as Galí (2015), to allow for comparability with the established rational literature. Assuming constant returns to scale ($\alpha = 0$) in the production function, as in Gabaix (2020), removes the role of this elasticity of substitution in the Phillips curve.[10]

Following Galí (2015), firms face Calvo (1983) pricing frictions and adjust their prices in each period with probability $1-\theta$. The optimal price setting of the firm, P_t^*, is the price that maximizes the current market value of the profits generated while that price remains effective.

The problem of the behavioral firm is to maximize

$$\sum_{k=0}^{\infty} \theta^k \mathbb{E}_t^{BR}\left[\Lambda_{t,t+k}\left(P_t^* Y_{t+k|t} - \Psi_{t+k}\left(Y_{t+k|t}\right)\right)\right], \tag{10}$$

subject to the sequence of demand constraints

$$Y_{t+k|t} = \left(\frac{P_t^*}{P_{t+k}}\right)^{-\varepsilon} Y_{t+k}, \tag{11}$$

where behavioral agents have a subjective expectation[11] denoted by the operator $\mathbb{E}_t^{BR}[.]$, $\Lambda_{t,t+k} = \beta^k\left(c_{t+k}/c_t\right)^{-\gamma}\left(P_{t+k}/P_t\right)$ is the stochastic discount factor in nominal terms, $\Psi_{t+k}(.)$ is the cost function, $Y_{t+k|t}$ is the output in period $t+k$ for a firm that last reset its price in period t, P_t^* is the optimal price the behavioral firm seeks to determine and P_t is the price level of the overall economy.

Expanding the FOC of the firm's problem around the zero-inflation steady-state[12] yields

$$p_t^* - p_{t-1} = (1-\beta\theta)\sum_{k\geq 0}(\beta\theta)^k\,\mathbb{E}_t^{BR}\left[\widehat{mc}_{t+k|t} + p_{t+k} - p_{t-1}\right], \tag{12}$$

where $\widehat{mc}_{t+k|t}$ is the deviation of the real marginal cost in $t+k$ of a firm that last reset its price at t, $mc_{t+k|t} = \ln\frac{\Psi'_{t+k}\left(Y_{t+k|t}\right)}{P_{t+k}}$, from its steady-state value, $mc = -\ln\frac{\epsilon}{\epsilon-1}$.

The resulting behavioral Phillips curve is[13]

$$\pi_t = \beta M^f \mathbb{E}_t\left[\pi_{t+1}\right] + \kappa\tilde{y}_t, \tag{13}$$

where $M^f = \theta\overline{m}/\left(1-(1-\theta)m_\pi^f\right)$ and $\kappa = \frac{(1-\theta)(1-\beta\theta)m_x^f}{1-(1-\theta)m_\pi^f}\Theta\left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)$, in which $\Theta = (1-\alpha)/(1-\alpha+\alpha\epsilon)$. m_x^f and m_π^f represent the firm's perfect foresight fraction of the future marginal cost[14] and inflation, respectively.

Assuming constant return to scale[15] affects the core optimal monetary policy analysis, which depends on the trade-off between inflation and the output gap captured by κ. In our Phillips curve (Eq. (13)), the coefficient κ depends on α, the return to scale parameter.

Interestingly, κ is decreasing with α, $\frac{\partial\kappa}{\partial\alpha} = m_x^f\boldsymbol{\Phi} < 0$, where $\boldsymbol{\Phi} = \frac{(1-\beta\theta)(1-\theta)(\phi+1-(\gamma+\phi)\epsilon)}{(\alpha\epsilon-\alpha+1)^2}$. α is also related to the output gap weight in the microfounded loss function,[16] ω_x/ω_π. As ω_x/ω_π is a decreasing function of α, $\frac{\partial\omega_x/\omega_\pi}{\partial\alpha} = \frac{1}{\theta\epsilon}\boldsymbol{\Phi} < 0$, the central bank gives less attention to the output gap objective when α increases.

The rational Phillips curve, obtained by assuming $m_x^f = m_\pi^f = \overline{m} = 1$, is

$$\pi_t = \beta\mathbb{E}_t\left[\pi_{t+1}\right] + \kappa_{re}\tilde{y}_t, \tag{14}$$

where $\kappa_{re} = \frac{(1-\theta)(1-\beta\theta)}{\theta}\Theta\left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)$.

The first contrast between the behavioral (Eq. (13)) and the rational (Eq. (14)) Phillips curves is the weight of future inflation in the determination of current inflation. This weight is more attenuated in the behavioral than in the rational equation (as $M^f < 1$). Also, the sensitivity of inflation to the output gap in the rational model is greater than that in the behavioral model (as $\kappa_{re} > \kappa$). Since these necessary ingredients for optimal policy analysis differ from the rational expectations model, we can expect new insights from discretionary and commitment policies.

2.3. Phillips curve

Gabaix (2020) derived a Phillips curve that differs in the magnitude of the feedback from each variable to inflation. These feedback coefficients,

$$M_G^f = \overline{m}\left(\theta + \frac{1-\beta\theta}{1-\beta\theta\overline{m}}m_\pi^f(1-\theta)\right), \tag{15}$$

[6] See Section 3.1 for more details about these parameters.

[7] See Appendix A.1 for a detailed derivation of the IS curve (Eq. (6)).

[8] See Appendix A.3, Eq. (80) for the expression of r_t^n.

[9] The rational IS equation (Eq. (8)) is obtained by expanding Eq. (49) in Appendix A.1.

[10] As presented below, this elasticity plays an essential role in the Phillips curve (Eq. (13)). Decreasing return to scale also allows us to provide comprehensive robustness checks (Appendix B.1).

[11] See Appendix A.1 for the definition of this subjective expectation operator.

[12] See Eq. (58) in Appendix A.2 for further details.

[13] See Appendix A.2 for detailed derivations.

[14] As it proportionally enters κ, we recall this marginal cost the output gap myopia.

[15] $\alpha = 0$ in the production function (Eq. (9)).

[16] The formal definitions of ω_x and ω_π are available in Section 3.3.

$$\kappa_G = m_x^f \frac{(1-\theta)(1-\beta\theta)}{\theta}(\gamma+\phi), \tag{16}$$

highlight two substantial differences from our model.

First, the main difference between M^f (Eq. (13)) and M_G^f (Eq. (15)) consists of the use of the term structure of expectations. Our consistent approach to formulate M^f uses the term structure of expectation starting from Eq. (66) (See Appendix A.2), while Gabaix (2020) used the same formula but starting from Eq. (65) to obtain M_G^f. Unlike Gabaix (2020), our formulation is consistent with the term structure of expectations stipulated in Lemma 5 in Gabaix (2020). Consequently, Gabaix (2020) consider the *level* of the variable, while we consider the *deviation from the steady-state* as the argument for the term structure of the expectations. This correct transition from subjective to objective expectations explains why the Phillips curve in Gabaix (2020) is not nested in our formulation.[17]

This contribution is important not only for theoretical purposes but also for empirical ones. Indeed, $M_G^f < M^f$ confers a lower discounting power to the consistent transition from subjective to objective expectations[18] than Gabaix (2020).

Second, the difference between κ (Eq. (13)) and κ_G (Eq. (16)) is related to our assumption of decreasing returns to scale in the production function (Basu and Fernald, 1997), in addition to the term structure of expectations. Gabaix (2020) assumes constant return to scale, $\alpha = 0$, which simplifies to κ_G. κ is a function of α in our formulation and, more importantly, κ is decreasing with α ($\frac{\partial\kappa}{\partial\alpha} < 0$). Therefore, the decreasing return to scale assumption might lengthen the feedback from real to nominal variables.

When κ is decreasing with α in the general case ($\alpha \neq 0$), the feedback from output to inflation is lessened, and the central bank gives less weight to the output gap objective, compared to the constant return to scale ($\alpha = 0$) case. Then monetary policy should be more aggressive in bringing down inflation. This intuition will be clear from the robustness check Appendix B when comparing the general case to the constant return to scale ($\alpha = 0$) calibration.

Our microfounded Phillips curve (Eq. (13)) reflects the importance of both general myopia ($\overline{m}$) and inflation myopia (m_π^f) in the weight of inflation expectations in the determination of current inflation, which is also the case in Gabaix (2020). However, our Phillips curve gives a role to inflation myopia (m_π^f) in the weight of the output gap in the determination of current inflation, which is not the case in Gabaix (2020).

2.4. Myopia coherence

In this section, we demonstrate how the composition and properties of our firms' aggregate-level attention parameter M^f differ from M_G^f with regard to consistency between aggregate and microeconomic myopia intuitions.

The firm aggregate attention (Eq. (13)) presents the following relations

$$\frac{\partial M^f}{\partial \overline{m}} = \frac{\theta}{1-(1-\theta)\,m_\pi^f} > 0, \tag{17}$$

$$\frac{\partial M^f}{\partial m_\pi^f} = \theta\overline{m}\frac{1-\theta}{\left(1-(1-\theta)\,m_\pi^f\right)^2} > 0, \tag{18}$$

while the ones presented in Gabaix (2020) are

$$\frac{\partial M_G^f}{\partial \overline{m}} = \frac{\theta-\theta^2\beta\overline{m}(2-a\theta\beta)-m_\pi^f(1-\theta)(1-\theta\beta)}{(1-\theta\beta\overline{m})^2}, \tag{19}$$

$$\frac{\partial M_G^f}{\partial m_\pi^f} = \overline{m}(1-\theta)\frac{1-\theta\beta}{1-a\theta\beta} > 0, \tag{20}$$

The relations of aggregate myopia with microfounded myopias are consistent. M^f is an increasing function of $\overline{m}$ and m_π^f (Eqs. (17) and (18)), suggesting that when micro myopia increases, aggregated myopia increases as well. However, M_G^f may be a decreasing function of $\overline{m}$ (Eq. (19)), which is counterintuitive because micro and aggregated myopia should have similar directions. Assuming a standard model's calibration (Galí, 2008), $\partial M_G^f/\partial\overline{m}$ becomes negative for $\overline{m} \gtrsim 0.89$. In other words, M_G^f is coherent (increasing function of $\overline{m}$ and m_π^f) only for $\overline{m}$ below 0.89. Consequently, the consistency of M_G^f depends on the calibration of both $\overline{m}$ and the model's parameters, while this is not the case for M^f.

In addition, M_G^f dynamics depend only on the cognitive discounting $\overline{m}$. The aggregate-level attention parameter of firms should depend on the attention to prices (m_π^f) rather than only cognitive discounting ($\overline{m}$). This result also questions micro and aggregated myopia relationships.

Furthermore, κ is an increasing function[19] of m_π^f while κ_G does not depend on m_π^f. As inflation myopia is expected to influence the weight of the output gap in the Phillips curve, this additional difference is also substantial. For instance, when firms are more attentive to inflation (i.e., higher m_π^f), they tend to be more attentive to the production side, which suggests a positive relationship between m_π^f and κ as in our model.

2.5. Welfare-relevant model

In the presence of nominal rigidities alongside real imperfections, the flexible price equilibrium is inefficient (Galí, 2015). Consequently, it is not optimal for the central bank to target this allocation. Our model has to be expressed in terms of deviations with respect to the efficient aggregates so that the resulting variables become *welfare-relevant*.

Let us define the welfare-relevant output gap such that $x_t = y_t - y_t^e$, where y_t is the (log) output, y_t^e is the efficient output and y_t^n is the natural output (flexible-price output). Since $\tilde{y}_t = y_t - y_t^n$, linking the output gap and the welfare-relevant output gap gives $\tilde{y}_t = x_t + \left(y_t^e - y_t^n\right)$.

By exploiting this relationship, the behavioral IS curve in welfare-relevant output gap terms is

$$x_t = M\mathbb{E}_t x_{t+1} - \sigma\left(i_t - \mathbb{E}_t\left[\pi_{t+1}\right] - r_t^e\right), \tag{21}$$

where $r_t^e = r_t^n + (1/\sigma)\left(M\mathbb{E}_t\left[y_{t+1}^e - y_{t+1}^n\right] - \left(y_t^e - y_t^n\right)\right)$ is the efficient interest rate perceived by households.[20]

The behavioral Phillips curve in welfare-relevant output gap terms is

$$\pi_t = \beta M^f \mathbb{E}_t\left[\pi_{t+1}\right] + \kappa x_t + u_t, \tag{22}$$

where $M^f = \frac{\theta\overline{m}}{1-(1-\theta)m_\pi^f}$ and $\kappa = \frac{(1-\theta)(1-\beta\theta)\Theta m_x^f}{1-(1-\theta)m_\pi^f}\left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)$, and $u_t = \kappa\left(y_t^e - y_t^n\right)$ is a cost-push shock evolving according to an $AR(1)$ process[21] such that $u_t = \rho_u u_{t-1} + \varepsilon_t^u$ and $\varepsilon_t^u \sim N\left(0;\sigma_u\right)$, *i.i.d.* over time.

The expectations in Eqs. (21) and (22) are augmented by M and M^f, respectively, thus reducing the exaggerated weight given to expectations in the rational New Keynesian model (Blanchard, 2009).

[17] Subjective expectations refer to boundedly rational expectations, while objective expectations refer to rational expectations.

[18] For standard calibration (Table 2) and full myopia (Table 1), $M^f = 0.806$ and $M_G^f = 0.762$.

[19] Formally, $\frac{\partial\kappa}{\partial m_\pi^f} = \Theta\overline{m}(1-\theta)^2\frac{1-\theta\beta}{\left(\theta m_\pi^f - m_\pi^f + 1\right)^2} > 0$.

[20] See Appendix A.4 for technical details.

[21] Appendices A.3 and A.5 define the natural output y_t^n and efficient output y_t^e as a function of only the technology shock (a_t), respectively. As long as the technology shock is defined as an AR(1) process, the difference between the efficient and natural output, $y_t^e - y_t^n$, also follows an exogenous AR(1) process.

3. Methodology

3.1. Myopia parameters

Since optimal monetary policy is fully microfounded, our research question is independent of the determination of the myopia parameters. They are hereafter considered exogenous but in the interval $[0, 1]$ as in Gabaix (2020). Assuming differentiated myopias concerning macroeconomic variables is conceptually and empirically justified since consumers and firms have different perceptions of each macroeconomic aggregate. For instance, consumers may pay more attention to income than interest rates. On the other hand, firms could be more myopic to the output gap than the prices they set. Measurement could be dealt with survey data (Coibion et al., 2018a) or estimating medium-scale models (Coibion et al., 2018b).

Most papers in the optimal monetary policy literature consider small or moderate variances in their calibration and find small or moderate variances for their technology or monetary policy shocks in standard frameworks like ours. According to Fig. 5 in Gabaix (2020), this allows us to set myopia parameters exogenously, each at their calibrated mean. Although the endogenous case may be obtained by specifying agents' cost functions and may disappear with linearization, we leave the myopia endogenization specification for further research as long as our research question does not consider unusual variances.[22] In addition, no feedback between optimal monetary policy and myopia levels can be assumed as long as small or moderate variances are considered,[23] making our results for optimal policy robust to endogenizing myopia.

Gabaix (2014) argues that inattention is derived from minimizing the cost of information, which yields to myopia parameters in the interval $[0, 1]$. New Keynesian models have to obey some conditions, like convergence and stability, implying that the framework may not support all forms of irrationality, such as over-attention, which is behaviorally plausible. Knowing these limitations, this type of model is preferred because of its tractability.

Although our model only focuses on under-reaction, it is also able to generate over-reaction (indirectly). As raised in Gabaix (2014), neglecting mitigating factors (i.e., negatively correlated additional effects) leads to overreaction. In other words, a consumer overreacts to an income shock if too little attention is paid to the fact that this shock is very transitory.

An essential feature of our theoretical framework allows for differentiated myopias—agents can be myopic about different economic variables to varying degrees. Wagner (1976) and Oates (1991) documented the revenue myopia as a consequence of the complexity of the tax structure, the renter illusion with respect to property taxation, the income elasticity of the tax structure, the debt illusion, and the flypaper effect. Modigliani and Cohn (1979) have shown that because agents do not understand the real effect of raising prices on interest rates, the market's response to inflation is not rational. Bachmann et al. (2015) have found that spending attitudes are influenced by nominal interest rate myopia. These examples justify the use of different myopias in our framework.

3.2. Calibration

Our main experiment uses calibrated values at 15% myopia, corresponding to setting myopia parameters at 0.85. The detailed calibration for each model is described in Table 1. A robustness analysis using higher and extreme values for myopia parameters to demonstrate that our conclusions hold is available in Appendix B.

Table 1
Myopia parameters: Calibration.

	Models						
	No myopia	Myopia					
	Rational	Interest rate	Output gap	Inflation	Revenue	General	Full
m_r	1	0.85	1	1	1	1	0.85
m_x^f	1	1	0.85	1	1	1	0.85
m_π^f	1	1	1	0.85	1	1	0.85
m_y	1	1	1	1	0.85	1	0.85
$\overline{m}$	1	1	1	1	1	0.85	0.85

Source: Gabaix (2020).

Table 2
Model parameters: Calibration.

Parameter	Calibration	Description
β	0.996	Static discount factor
γ	2	Household's relative risk aversion
ϵ	9	Elasticity of substitution between goods
α	1/3	Return to scale
ϕ	5	Frisch elasticity of labor supply
θ	0.75	Probability of firms not adjusting prices
ρ_a	0.75	Technology shock persistence
ρ_u	0.75	Cost-push shock persistence

Source: Galí (2015).

Evidence from the information rigidity literature provides empirical ground for the calibrations extracted from Gabaix (2020) presented in Table 1. Indeed, most myopia values extracted from Coibion and Gorodnichenko (2015) and Bordalo et al. (2020) fall into the $[-0.15; +0.15]$ interval, including error margins, justifying the calibration presented in Table 1, while their remaining myopia values are partially caught by our robustness calibration presented in Appendix B.2.

Table 2 summarizes the calibration used to simulate our regimes taken from Galí (2015). Several robustness checks using various calibrations from the New Keynesian literature and extreme myopia are presented in Appendix B.

The calibration provided in Table 2 and Appendix B.1 aligns with the moments found in most theoretical DSGE models based on the standard New Keynesian models' calibration of Galí (2008, 2015).

3.3. Optimal policy

The optimal monetary policy question discussed in this paper requires an evaluation of the household's utility as the criterion that the central bank maximizes subject to the economy's constraints. The microfounded welfare loss measure

$$\mathbb{W} = \frac{1}{2}\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\pi_t^2 + \frac{w_x}{w_\pi} x_t^2 \right), \tag{23}$$

where $w_\pi = \frac{\epsilon}{\Theta} \frac{\theta}{(1-\beta\theta)(1-\theta)}$ and $w_x = \gamma + \frac{\phi+\alpha}{1-\alpha}$ are derived from the second-order approximation of the behavioral household's utility as usual.[24]

4. Commitment

The central bank is assumed to be able to commit to a policy plan that stabilizes the economy credibly. It chooses a path for the output gap and inflation over the infinitely lived horizon to minimize a policy objective function, the welfare loss (Eq. (23)).

[22] Any potential endogenized myopia would be calibrated according to exogenous myopia means presented in Section 3.2.
[23] Standard deviation shock of 25 basis points, i.e., one percentage point annualized.

[24] See Appendix A.5 for derivations. According to the calibration presented in Table 2, $\frac{w_x}{w_\pi} \simeq 0.02$. The optimal policy results for alternative calibrations are presented in Appendix B.1.

4.1. Analytical solution

The central bank problem solution under commitment yields the following FOCs

$$\pi_t + \varphi_t - M^f \varphi_{t-1} = 0, \tag{24}$$

$$\frac{w_x}{w_\pi} x_t - \kappa \varphi_t = 0, \tag{25}$$

where φ_t is the Lagrange multiplier associated with the problem constraints.

Proposition 1. *PLT is the optimal monetary policy when agents are fully attentive to inflation and the state evolution. Otherwise, IT is the optimal monetary policy.*[25]

Proof. The Lagrangian of the central bank's problem is

$$L_t = \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{2} \left(\pi_t^2 + \frac{w_x}{w_\pi} x_t^2 \right) + \varphi_t \left(\pi_t - \kappa x_t - M^f \pi_{t+1} \right) \right]. \tag{26}$$

Deriving the Lagrangian with respect to π_t yields the first FOC (Eq. (24)). Deriving the latter with respect to x_t yields the second FOC (Eq. (25)). Consequently, we can write Eq. (24) in terms of the price level

$$p_t + \varphi_t = p_{t-1} + M^f \varphi_{t-1}. \tag{27}$$

Two cases can be distinguished: (i) The case where the price level is stationary, i.e., $M^f = 1$. Such a case prevails when $\overline{m} = 1$ and $m_\pi^f = 1$, and a form of PLT is optimal. (ii) Otherwise, a form of IT is optimal.

On non-explosivity of Lagrange multiplier φ_t. The characteristic equation of the difference Eq. (27) is $r - M^f = 0$ and $M^f \leq 1$, with the solution of φ_t is an additive function of $\left(M^f\right)^t$ and π_t, which are both non-explosive. ■

By combining Eqs. (24) and (25) we obtain the following central bank targeting rule

$$\pi_t = -\frac{w_x}{\kappa w_\pi} \left(x_t - M^f x_{t-1} \right), \tag{28}$$

which has to be satisfied at every period to obtain optimal outcomes. Rewriting Eq. (28) in price levels leads to

$$p_t = -\frac{w_x}{\kappa w_\pi} \left(x_t + \left(1 - M^f\right) \sum_{j=0}^{t-1} x_j \right). \tag{29}$$

Applying Proposition 1 to Eq. (29), and considering the case of optimal PLT where $\overline{m} = 1$ and $m_\pi^f = 1$, yields the following targeting rule

$$p_t = -\frac{w_x}{\kappa w_\pi} x_t,$$

which satisfies the fact that the price level is stationary, as the output gap tends to zero in the long term. The PLT is an optimal outcome for monetary policymaking even in the presence of other forms of myopia such as interest rate, revenue, or output gap myopias. The only requirement for this form of targeting to be optimal is full attentiveness to inflation developments. Indeed, a central bank under this regime sets a target for the price level and adjusts its decisions accordingly. In case of a positive cost-push shock, the price level jumps to a new level and the output gap widens. To achieve its target, the central bank has to engineer a deflation. Consider the case where economic agents are myopic to inflation ($m_\pi^f \neq 1$), the recessionary effect of monetary policy on output does not transmit completely to the price level (through Eq. (29)). Consequently, the central bank has to engineer a second deflationary round to stabilize the price level, and so on until the target is achieved at the expense of depressing economic activity. Thus, for PLT to be socially optimal, a minimal condition of full attentiveness to inflation has to be satisfied even in the presence of other forms of myopia.

Contrary to this result, Gabaix (2020) concluded that PLT is not optimal with behavioral agents. Proposition 1 indicates the optimality of PLT in many behavioral cases. Referring to the cases described in Table 1, the cases of interest rate, output gap, and revenue myopia satisfy Proposition 1, all exhibiting a form of PLT.

Importantly, the aggregated myopia, M^f, is a sufficient statistics for the optimality of PLT. Indeed, developing Eq. (29), we obtain

$$p_t = -\frac{1-(1-\theta)\, m_\pi^f}{\epsilon \theta m_x^f} \left(x_t + \left(1 - M^f\right) \sum_{j=0}^{t-1} x_j \right), \tag{30}$$

while Gabaix (2020) obtain

$$p_t^G = -\frac{1}{\epsilon m_x^f} \left(x_t + \left(1 - M_G^f\right) \sum_{j=0}^{t-1} x_j \right). \tag{31}$$

Clearly, $p_t = p_t^G = -\frac{1}{\epsilon} x_t$ if and only if agents are fully rational ($M^f = M_G^f = 1$). However, once agents are not attentive to inflation ($m_\pi^f < 1$), the output gap ($m_x^f < 1$), or their cognitive discounting deviates from one (slope of attention, $\overline{m} < 1$), Eqs. (30) and (31) derive different theoretical optimal monetary policy conclusions. This is confirmed by the fact that aggregate myopia (M^f or M_G^f) is a sufficient statistics for optimal monetary policy, and depends differently on microeconomic myopia (Section 4.2).

Under interest rate, output gap, and revenue myopia, PLT is optimal as there is no inflation myopia. Since the central bank corrects upside (inflation) and downside (deflation) deviations and monitors inflation expectations, PLT can be implemented appropriately, delivering the first-best solution.

In response to a cost-push shock, the central bank's commitment to engineering a deflation in the future has implications for the current inflation to the extent that behavioral agents – households and firms – are forward-looking in terms of inflation while myopic to other macroeconomic variables. The conclusion that bounded rationality implies the suboptimality of PLT is shortsighted. Digging into different forms of bounded rationality shows that PLT might be optimal in the cases highlighted earlier and that IT is optimal in the remaining cases (Proposition 1).

The takeaway from this analysis is that, contrary to the literature, there is no definitive answer regarding the optimal conduct of monetary policy. A central bank must choose the corresponding targeting policy depending on which myopia characterizes households and firms.

4.2. Sufficient statistics coherence

M^f is a sufficient statistics for the optimality of PLT (Eq. (29)). This result is related to the coherent aggregated myopia parameter developed in this study (Section 2.4). The dynamics of this sufficient statistics structurally differ from Gabaix (2020).

Consequently, as shown in Section 2.4, the sensitivity of M^f and M_G^f (Eqs. (30) and (31)) to $\overline{m}$ and m_π^f are structurally different. Our result shows that this sufficient statistics is central to determining optimal monetary policy. Hence, for each unit of $\overline{m}$ and m_π^f deviating from one (rational), optimal monetary policy implications for M^f provide different policy recommendations than M_G^f.

4.3. Simulation and welfare

Fig. 1 presents the responses of the economy to a 1 percent cost-push shock. The cost-push shock implies a trade-off between the output gap and inflation. The intensity of this trade-off differs depending on the form of myopia.

[25] In other words, a form of PLT is optimal when $\overline{m} = 1$ and $m_\pi^f = 1$, and a form of IT is optimal when this condition is not satisfied.

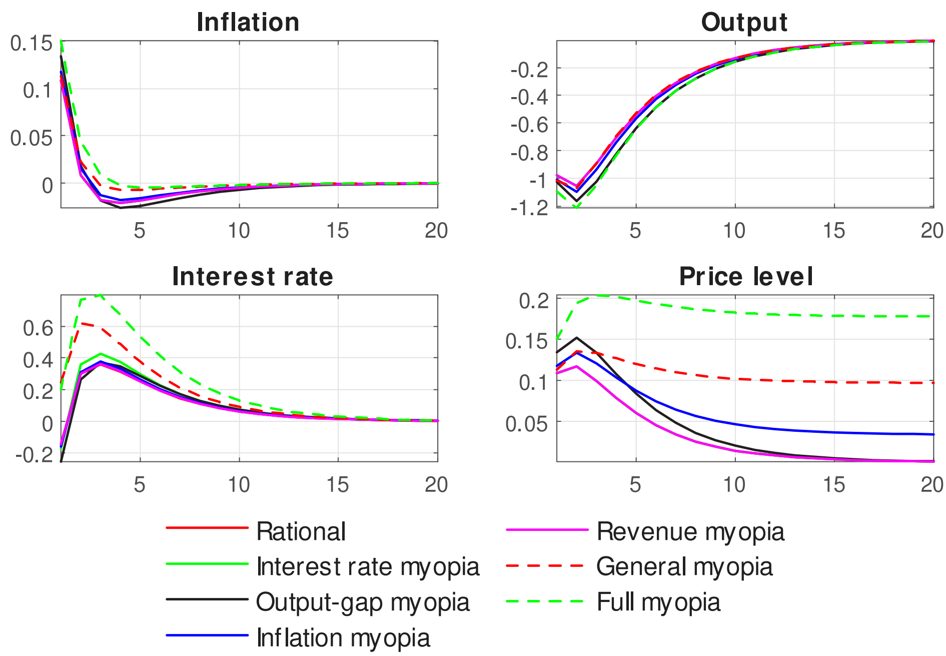

Fig. 1. Commitment: Impulse response functions.
Notes: Responses to a 1% cost-push shock. Tables 1 and 2 provide myopia and model calibrations, respectively.

Table 3
Commitment: Welfare losses.

No myopia	Myopia					
Rational	Interest rate	Output gap	Inflation	Revenue	General	Full
0.174	0.174	0.227	0.190	0.174	0.176	0.248

Full myopia entails a substantial increase in inflation with a significant drop in output. Such deviations require a strong reaction from the central bank. Furthermore, in this (full) myopia case, we notice that the price level never returns to its steady-state after a cost-push shock, corroborating the analytical result about the suboptimality of PLT.

Fig. 1 shows that whenever agents are myopic to inflation or exhibit cognitive discounting (general myopia), PLT is suboptimal while IT is optimal due to the welfare cost induced by the central bank's decisions to stabilize the price level.

Concerning output gap, revenue, and interest rate myopia, we notice that, following a cost-push shock, inflation rises on impact but decreases to deflation after some periods. In both cases, the price level reaches its steady-state value, which makes these types of myopia entail a form of PLT as optimal monetary policy.

Regarding the central bank's reactions, it is worth noting that the impulse response function amplitudes in the cases of the output gap, inflation, and revenue myopia are very close to the rational case. The only cases where a strong central bank reaction is required are the interest rate myopia, general myopia and full myopia. In these cases, the optimal policy is set in a way to sharply offset the shock, and converge to a persistently higher price level—new steady-state value. However, in the remaining cases, the optimal required action is more smooth, and the central bank improves the policy trade-off in a way that allows deflation to operate and then the price level to be stationary.

To sum up, the impulse response results confirm our analytical result (Section 4.1) and emphasize that the optimal responses of the central bank, in the presence of behavioral agents, are not always different from the rational benchmark. These results are robust to various model and myopia calibrations reported in Appendix B.

Table 3 presents the welfare losses for each bounded rationality case.

Although the rational case generates the lowest welfare loss, which is intuitive given the perfect foresight assumption, interest rate and revenue myopia provide the same welfare losses as the rational benchmark. The reason is simple. The central bank loss does not penalize deviations of interest rate or revenue, while in these two myopia cases, agents are well-informed about output and inflation. Moreover, the general myopia is very close to these cases. As a result, bounded rationality is not necessarily welfare decreasing.

According to Giannoni (2014), the welfare depends on the persistence of the autoregressive shock processes. The welfare values computed according to different values of autoregressive shock persistence change, but the welfare ordering according to myopia does not change.

5. Discretion

In this section, the central bank makes whatever decision is optimal in each period without committing itself to any future actions.[26] Also, we characterize the second-best solutions of the central bank's optimization problem following a cost-push shock.

5.1. Analytical solution

In this regime, the central bank minimizes the welfare loss related to the decision period, considering that expectations are given, which yields the following proposition.

Proposition 2. *Discretionary central bank has to obey the following targeting criterion when setting its optimal policy:*

$$\pi_t = -\frac{w_x}{\kappa w_\pi} x_t. \tag{32}$$

Proof. It is sufficient to write the Lagrangian and derive with respect to both endogenous variables to obtain FOCs. Once combined, we end up with the targeting rule for the central bank in this case. ■

[26] According to Plosser (2007), monetary policy is called *discretionary* when the central bank is "not bound by previous actions or plans and thus is free to make an independent decision every period".

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Table 4
Discretion: Welfare losses.

No myopia	Myopia					
Rational	Interest rate	Output gap	Inflation	Revenue	General	Full
0.270	0.270	0.386	0.287	0.270	0.236	0.341

After a cost-push shock, a discretionary central bank has to keep this proposition satisfied to minimize the welfare loss. When inflationary pressures arise, the policymaker is incentivized to drive output below its efficient level to accommodate the cost-push shock. While this proposition is silent about the influence of bounded rationality on a discretionary policy, the size of both output and inflation deviations due to the cost-push shock depends on myopia. We replace Eq. (32) in the Phillips curve and solve forward, which yields the following expression for inflation

$$\pi_t = \frac{\frac{w_x}{w_\pi}}{\frac{w_x}{w_\pi} + \kappa^2 - \frac{w_x}{w_\pi} M^f \rho_u} u_t, \quad (33)$$

and by using the targeting rule Eq. (32), we obtain an expression for the output gap

$$x_t = \frac{-\kappa}{\frac{w_x}{w_\pi} + \kappa^2 - \frac{w_x}{w_\pi} M^f \rho_u} u_t. \quad (34)$$

These expressions state that the central bank has to let the output gap and inflation deviate proportionally to the cost-push shock (u_t). Bounded rationality influences the magnitudes of these deviations through κ, which depends on output gap and inflation myopias, m_x^f and m_π^f respectively, and through M^f, which depends on the general and inflation myopia, $\overline{m}$ and m_π^f respectively.

The optimal policy response entails an indeterminate price level but determinate inflation, which suggests a form of IT as the preferred regime for a central bank under discretion.

Although different types of myopia could impact the magnitudes of the reactions to a particular shock, bounded rationality under discretion does not impact the choice of the policy regime. The rationale of this proposition is that, in this case, monetary policy takes expectations as exogenous and seek to only accommodate the shock in the current period. However, bounded rationality influences the expected reaction of macro variables to this shock, as highlighted in Eqs. (33) and (34) and shown by the impulse response functions presented in the following section.

5.2. Simulation and welfare

A cost-push shock captures the resulting optimal equilibrium (Eqs. (33) and (34)) by examining inflation and output gap reactions under different myopia scenarios. Fig. 2 presents the impulse response functions to a 1 percent cost-push shock under an optimal discretionary monetary policy.

As discussed in Section 5.1, we can assess the deviation of both the output gap and inflation in response to a cost-push shock. Differences arising in each type of myopia reflect the way myopia interacts with the solution for inflation (Eq. (33)) and the output gap (Eq. (34)).

Two remarks are worth noting here. First, the optimal monetary policy reaction seeks to increase the policy rate to accommodate the inflation increase albeit more aggressively than the rational benchmark—except for the case of revenue myopia. Second, as mentioned previously, the price level is not stationary in any case, which suggests an IT regime as the desirable monetary policy.

As reported in Table 4, the evaluation of welfare losses reveals that the optimal policy is better under general myopia than under the rational benchmark.

Although this result could seem counterintuitive, one should remember that this form of myopia (general myopia) impacts the level of expectations of all macroeconomic variables of the model. In this case, people's expectations are distorted, which is consistent with a discretionary policymaker.

Table 5
Optimal simple rules: Description.

Name	Targeting regime	Instrument-rule
F1	Flexible inflation	$i_t = \phi_\pi \pi_t + \phi_y \tilde{y}_t$
F2	Flexible price level	$i_t = \phi_p p_t + \phi_y \tilde{y}_t$
F3	Flexible NGDP growth	$i_t = \phi_g \left(\pi_t + \Delta\tilde{y}_t\right) + \phi_y \tilde{y}_t$
F4	Flexible NGDP level	$i_t = \phi_n \left(p_t + \tilde{y}_t\right) + \phi_y \tilde{y}_t$
S1	Strict inflation	$i_t = \phi_\pi \pi_t$
S2	Strict price level	$i_t = \phi_p p_t$
S3	Strict NGDP growth	$i_t = \phi_g \left(\pi_t + \Delta\tilde{y}_t\right)$
S4	Strict NGDP level	$i_t = \phi_n \left(p_t + \tilde{y}_t\right)$

6. Optimal simple rules

In this section, we determine the optimal coefficient values that minimize the central bank loss function of the various simple rules described in Table 5.

The instrument rules described in Table 5 reproduce the central bank's instrument rules when reacting only to the targeted variable (strict targeting, rules S1 to S4), and when also reacting to real fluctuations in addition to the primary target (flexible targeting, rules F1 to F4).

6.1. Optimal weights

Table 6 reports the optimal values[27] of ϕ_π, the weight on inflation; ϕ_y, the weight on the output gap; ϕ_p, the weight on the price level; ϕ_g the weight on NGDP growth; and ϕ_n the weight on the NGDP level for different monetary policy rules.

As shown in Table 6, the inflation coefficients under the flexible and strict IT regimes (F1 and S1) are greater than one for all myopia cases, in line with the Taylor principle. As the results show, myopia does impact the coefficients of the optimal simple rules. Consequently, people's perceptions of future macroeconomic dynamics lead the central bank to react differently under each regime for each type of myopia.

Compared to the rational case, interest rate myopia appears to increase the sensitivity of the policy instrument to the central bank target. Monetary policy is transmitted to the output gap and inflation through the IS and Phillips curve equations, conditional on the model coefficients, which are influenced by myopia parameters. Agents' myopia over the future interest rate weakens the transmission of monetary policy to the output gap. To control its target, the central bank must react strongly to send the appropriate signal. For each targeting case, the policymaker has to strongly signal its control over its target when people misperceive the interest rate.

For all considered rules, the output gap myopia decreases the weight on the primary target compared to the rational case. However, the reaction to the output gap becomes stronger compared to the rational case under the flexible IT rule. The reason for this shift is related to the fact that the output gap myopia implies that the transmission from the output gap to inflation becomes weak, while the other channel from the interest rate to the output gap remains unaffected by this myopia. To have the desired impact on inflation, the central bank reacts strongly to the output gap but softly to inflation in F1. The pass-through from the output gap to the nominal variables, which are the targeted variables for the central bank, is altered by output gap myopia. Thus, the central bank reaction function is less sensitive to its nominal target compared to the rational case.

[27] Optimizations are based on the calibration presented in Section 3.2.

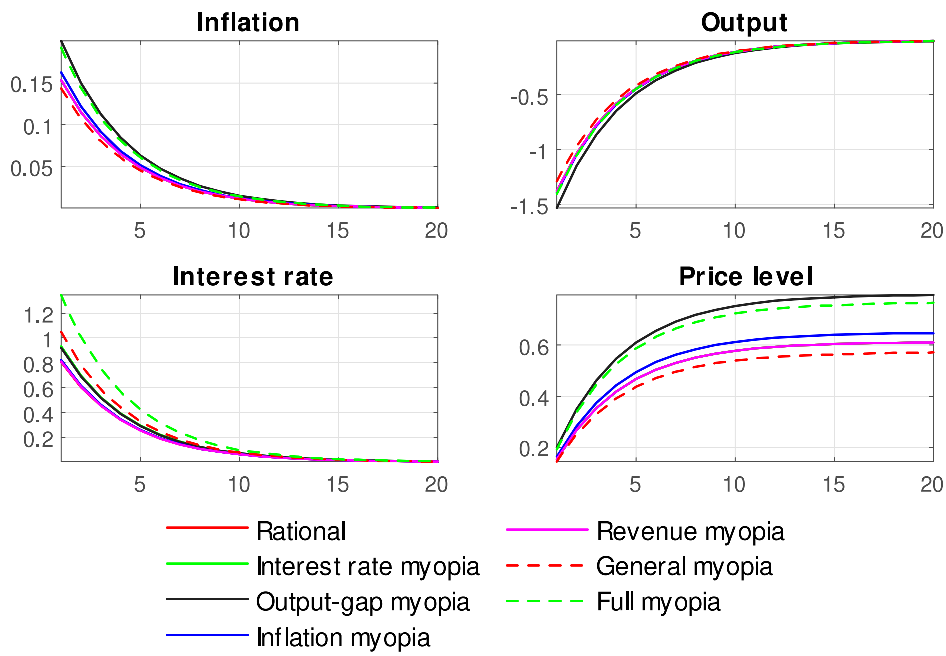

Fig. 2. Discretion: Impulse response functions.
Notes: Responses to a 1% cost-push shock. Tables 1 and 2 provide myopia and model calibrations, respectively.

Table 6
Optimal simple rules: Coefficients.

	F1		F2		F3		F4		S1	S2	S3	S4
	ϕ_π	ϕ_y	ϕ_p	ϕ_y	ϕ_g	ϕ_y	ϕ_n	ϕ_y	ϕ_π	ϕ_p	ϕ_g	ϕ_n
No (rational)	1.96	0.25	0.33	0.0	2.62	0.5	0.17	0.0	2.37	0.34	3.90	0.17
Interest rate	2.44	0.20	0.39	0.0	3.32	0.5	0.20	0.0	3.11	0.40	4.00	0.20
Output gap	1.39	0.32	0.26	0.0	1.81	0.5	0.13	0.0	2.02	0.27	3.43	0.13
Inflation	1.43	0.27	0.30	0.0	1.55	0.5	0.15	0.0	1.99	0.31	3.26	0.15
Revenue	2.03	0.21	0.33	0.0	2.63	0.5	0.17	0.0	2.37	0.34	3.91	0.17
General	2.05	0.14	0.56	0.0	1.61	0.5	0.25	0.0	2.38	0.58	3.34	0.25
Full	1.54	0.18	0.49	0.0	1.10	0.5	0.21	0.0	2.10	0.50	2.82	0.21

Regarding inflation myopia, the sensitivity to targeted variables is smaller than the rational case due to the higher transmission from inflation expectations and the output gap to inflation. The case for revenue myopia is quite similar, given that this myopia increases the feedback from output gap expectations and the interest rate to the output gap, which then feeds to inflation, while the transmission from the output gap to inflation remains constant. That is why we see similar coefficients in reaction to the targeted variable compared to the rational case.

The central bank should react aggressively to curb expectations and impact the desired variables under general and full myopia.

Another set of results is derived when comparing the different targeting regimes. The optimal rule weights vary under different myopia cases. The central bank is more sensitive to its target when operating under strict targeting than flexible targeting.

The nominal income coefficients associated with strict NGDP growth targeting (S3) are higher than the flexible NGDP growth targeting coefficients (F3) across all types of myopia, which is consistent with the literature (Rudebusch, 2002; Benchimol and Fourçans, 2019). As these coefficients are also larger than one, they satisfy the Taylor principle. Table 6 shows that when the central bank targets the NGDP level (F4 and S4) or the price level (F2 and S2), both in the strict and flexible senses, the coefficients are positive but lower than one, a result in line with Rudebusch (2002).

Zeroed optimal coefficients in Table 6 show that the output gap objective is undesirable when the central bank targets a form of price level or NGDP objective. This result relies on the *divine coincidence* between stabilizing the price level and the output gap. Indeed, a form of PLT leads to self-stabilizing dynamics for the output gap. If the price level decreases (increases) from its target, the central bank takes corrective measures to increase (decrease) inflation in the future, decreasing the real interest rate, which increases the output gap.

All the optimal coefficients depend on agent myopia, and it is clear that interest rate myopia delivers the most substantial amplitude compared to other types of myopia under IT and NGDP growth targeting. Under price level and NGDP level targeting regimes, it is general myopia that delivers the highest coefficients.

For the optimal values of ϕ_p in rules F2 and S2, the sensitivity of the policymaker's instrument to the price level does not vary significantly between the flexible and strict regimes, regardless of whether the central bank targets the price level flexibly or strictly. This is also the case for rules F4 and S4.

The coefficient of the output gap varies across the different types of myopia and rules considered. The rules reflecting flexible PLT (F2) and NGDP level targeting (F4) show zero optimal values for the output gap, which suggests that the central bank does not have to care about real fluctuations under these regimes. Furthermore, the coefficient on the output gap in the flexible IT rule (F1) displays a slight sensitivity to myopia.

6.2. *First best solution*

The performance of policy rules is compared using the same micro-founded welfare criterion as in Sections 5 and 4. The welfare losses for

Table 7
Optimal simple rules: Welfare losses.

Myopia	F1	F2	F3	F4	S1	S2	S3	S4
Rational	0.2093	0.1766	0.2161	0.1855	0.2093	0.1762	0.2167	0.1852
Interest rate	0.2093	0.1766	0.2162	0.1857	0.2094	0.1763	0.2168	0.1854
Output gap	0.2848	0.2317	0.2976	0.2456	0.2848	0.2310	0.2993	0.2450
Inflation	0.2264	0.1923	0.2361	0.2016	0.2264	0.1919	0.2378	0.2013
Revenue	0.2093	0.1766	0.2161	0.1855	0.2093	0.1762	0.2167	0.1853
General	0.1997	0.1773	0.2110	0.1840	0.1997	0.1772	0.2134	0.1838
Full	0.2849	0.2518	0.3091	0.2612	0.2849	0.2517	0.3205	0.2609

Regimes

Notes: The shading scheme is defined separately in relation to each column. The lighter the shading is, the smaller the welfare loss. Tables 1 and 2 provide myopia and model calibrations, respectively. Table 5 details monetary policy regimes.

each rule are reported in Table 7 to determine which rule best reflects the first-best solution.

Flexible targeting rules do not necessarily induce welfare losses compared to strict rules. Most flexible targeting rules generate similar welfare losses compared to their corresponding strict targeting rules. For instance, welfare losses are identical between F1 and S1.

Strict PLT delivers the lowest welfare among the considered rules. The welfare losses associated with this rule are similar to the flexible PLT rule through different myopia cases. The reason behind this equivalence lies in the optimal value of the feedback from the output gap to the interest rate in rule F2, which is zero, a case of divine coincidence when the central bank is pursuing a price level objective.

Moreover, the rational case delivers similar welfare losses to interest rate and revenue myopia cases as in the previously reported results (Tables 3 and 4).

Regarding other bounded rationality cases, it is clear that across those targeting rules, output gap and full myopia imply the most significant welfare losses. However, general myopia, combined with appropriate central bank action, sometimes yields to smaller welfare losses compared to the rational case as in the discretion case (Table 4).

As the welfare analysis shows (Table 7), the best monetary policy rule (that delivers the lowest welfare loss) is the strict PLT rule, regardless of the type of myopia considered. While this result is interesting, it demonstrates the inability of these simple rules to replicate the first-best solution under commitment, which emphasizes that the optimal policy depends on the type of myopia characterizing agents.

Our findings complement (Vestin, 2006), which demonstrates the superiority of PLT over IT regarding the central bank loss function. We extend this result by demonstrating that PLT consistently outperforms IT across all bounded rationality configurations.

7. Empirical results

Following Smets and Wouters (2003, 2007) and An and Schorfheide (2007), we apply Bayesian techniques to estimate the rational and behavioral models.

7.1. Data

In this section, we provide an overview of the data sources from the Organisation for Economic Co-operation and Development (OECD) that we use in our estimation exercise on the US economy from 1996:Q1 to 2019:Q4.

For the quarterly real Gross Domestic Product (GDP) data for the United States, we use the expenditure approach, with values expressed in US dollars, volume estimates, fixed purchasing power parity, annual levels, and seasonally adjusted. Additionally, we estimate the GDP deflator data using the OECD expenditure approach, with values denominated in the national reference year and seasonally adjusted. Furthermore, we collect data on the number of employed persons in the United States, employee average annual hours worked, and population. These data are obtained from the OECD's Quarterly National Accounts.

To gather information on short-term (3-month) interest rates, we extract data from the OECD's Monthly Monetary and Financial Statistics (MEI).

7.2. Observable equations

The data transformations to construct the observable equation are presented in this section, and follow Smets and Wouters (2007). We demean the first difference of each of the following transformations of the raw data:

$$y_{obs} = 100\log\left(\frac{RealGDP_t}{POPIndex_t}\right) + \bar{y}, \tag{35}$$

where $POPIndex_t = \frac{POP_t}{POP_{1996}}$.

$$n_{obs} = 100\log\left(\frac{HOURSIndex_t \times EMPLOYMENTIndex_t \times 100}{POPIndex_t}\right) + \bar{n}, \tag{36}$$

where $HOURSIndex_t = \frac{Hours_t}{Hours_{1996}}$ and $EMPLOYMENTIndex_t = \frac{EMPLOYMENT_t}{EMPLOYMENT_{1996}} \times 100$.

$$\pi_{obs} = 100\log\left(\frac{GDPDeflator_t}{GDPDeflator_{t-1}}\right) + \bar{\pi}, \tag{37}$$

$$i_{obs} = \frac{INTEREST_t}{4} + \bar{\imath}, \tag{38}$$

where $\bar{y}$ is the trend growth rate in real GDP, $\bar{\pi}$ is the steady-state inflation rate, $\bar{\imath}$ is the steady-state nominal interest rate, and $\bar{n}$ is the steady-state hours worked.

The prior calibration for these estimated values is zero, since all of our data are demeaned. Thus, we assume that any deviation from zero is attributed to measurement errors.

7.3. Calibration

Following standard conventions, we calibrate beta distributions for parameters that fall between zero and one, inverted gamma distributions for parameters that need to be constrained to be greater than zero, and normal distributions in other cases. We adopt the same priors in the two models. The standard errors of the innovations are assumed to follow inverse gamma distributions and we choose a beta distribution for shock persistence parameters (as well as for the backward component of the monetary policy rule, ρ_i) that should be lesser than one.

The calibration of γ and α to two and 1/3 is inspired by Galí (2015), as in Appendix B.1. To observe the behavior of the central bank, we assign a higher standard error (0.2 and 0.1, respectively) and a Normal prior distribution for the monetary policy rule parameters ϕ_π, and ϕ_y, while we restrict to be positive and below one (Beta distribution) the smoothing parameter, ρ_i.

The calibration of the shock persistence parameters and the standard errors of the innovations follows Smets and Wouters (2007) and Benchimol and Fourçans (2019). All the standard errors of shocks are assumed to be distributed according to inverted Gamma distributions, with prior means of 0.01. The latter ensures that these parameters have positive support. The autoregressive parameters ρ_u, ρ_a, ρ_z, and

Table 8
Bayesian estimation of structural parameters.

	Priors			Posteriors					
				Rational			Behavioral		
	Law	Mean	Std.	Mean	Inf.	Sup.	Mean	Inf.	Sup.
γ	normal	2.00	0.20	3.060	2.879	3.272	2.997	2.785	3.262
α	beta	0.33	0.10	0.482	0.356	0.609	0.115	0.033	0.197
m_x^f	uniform	1.00	0.20				0.801	0.654	0.948
m_π^f	uniform	1.00	0.20				0.810	0.654	0.955
$\overline{m}$	uniform	1.00	0.20				0.660	0.654	0.669
m_r	uniform	1.00	0.20				0.662	0.654	0.673
ρ_i	beta	0.80	0.10	0.905	0.878	0.933	0.819	0.781	0.856
ϕ_π	normal	2.50	0.20	2.538	2.211	2.858	2.695	2.401	2.989
ϕ_y	normal	0.25	0.10	0.309	0.147	0.468	0.403	0.247	0.562
ρ_u	beta	0.50	0.10	0.395	0.299	0.488	0.618	0.509	0.730
ρ_a	beta	0.80	0.10	0.989	0.982	0.997	0.991	0.984	0.997
ρ_z	beta	0.70	0.10	0.950	0.926	0.975	0.939	0.914	0.965
ρ_m	beta	0.10	0.10	0.141	0.000	0.244	0.155	0.036	0.264
$\bar{y}$	normal	0.00	0.01	−0.001	−0.018	0.015	−0.001	−0.017	0.016
$\bar{\pi}$	normal	0.00	0.01	0.002	−0.014	0.017	0.001	−0.015	0.017
$\bar{i}$	normal	0.00	0.01	−0.001	−0.017	0.016	0.001	−0.017	0.016
$\bar{n}$	normal	0.00	0.01	0.001	−0.017	0.016	−0.001	−0.017	0.016
σ_u	invgamma	0.01	2.00	0.155	0.133	0.177	0.119	0.098	0.141
σ_a	invgamma	0.01	2.00	0.017	0.012	0.021	0.028	0.024	0.033
σ_z	invgamma	0.01	2.00	0.024	0.020	0.028	0.029	0.024	0.035
σ_m	invgamma	0.01	2.00	0.108	0.091	0.124	0.133	0.110	0.156

Notes: Mean is the posterior mean distribution. Inf. and Sup. denote the lower and upper bounds of the 90% highest posterior density interval, respectively. The log marginal data density of the rational and behavioral models is −575.2 and −527.2, respectively.

ρ_m, are all assumed to follow Beta distributions centered around 0.5, 0.8, 0.7, and 0.1, respectively, with a common standard error of 0.1, as in Smets and Wouters (2003) and Benchimol and Fourçans (2019).

Importantly, the behavioral parameters m_x^f, m_π^f, $\overline{m}$, and m_r, are all calibrated to one, corresponding to the rational model, with an uninformative distribution (Uniform) and a common standard error of 0.2.

The calibration of priors is summarized in Table 8.

7.4. Estimation results

The model is estimated with 96 observations for each observable from 1996:Q1 to 2019:Q4 in order to avoid high volatility periods before 1980 and the COVID-19 pandemic.

The estimation of the implied posterior distribution of the parameters is done using the Monte Carlo Markov Chain (MCMC) algorithm, which involves simulating multiple sequences of random samples from a target probability distribution to generate 1 million draws from 3 distinct parallel chains, with the first 500,000 draws being used for burn-in. The average acceptance ratio per chain is about 0.33. The parameters are identified according to the Jacobian of the steady-state and reduced-form solution matrices, the steady-state and minimal system matrices (Komunjer and Ng, 2011), the mean and spectrum matrices (Qu and Tkachenko, 2012), and the first two moments (Iskrev, 2010). To assess the model validation, we ensure convergence of the proposed distribution to the target distribution.

The calibration of priors and estimated results are summarized in Table 8.

The log marginal data density is a fundamental measure of model fit in the Bayesian estimation literature, reflecting the degree to which a given model accounts for the observed data. The log marginal data density of the rational and behavioral models is −575.23 and −527.3, respectively. These values indicate that the behavioral model exhibits a superior fit to the data relative to the rational model.

The Bayesian framework provides a natural means for model comparison by assessing the relative evidence provided by competing models. In this case, the evidence favoring the behavioral model over the rational model is reflected in the difference in their log marginal data densities, which could be quantified using Bayes factors or posterior model probabilities.

Overall, these findings support the conclusion that the behavioral model is more desirable for explaining the observed data than the rational model.

8. Discussion

Analyzing optimal monetary policy through the lens of a behavioral perspective leads to a richer set of results compared to rational frameworks. Some results corroborate the findings in the rational expectations literature about optimal monetary policy–as in Section 4 when setting myopia parameters to 1. Other results question the views of the behavioral macroeconomic literature—when myopia parameters are different from one. Our results shed light on an old debate about the shortcomings of simple rules to constitute a guideline for monetary policy when agents are boundedly rational.

Relaxing the rational agent hypothesis contributes, in the case of commitment, to addressing one of the critiques of the New Keynesian model, namely, the persistence of macroeconomic variables with respect to monetary policy shocks (Walsh, 2017; Fuhrer and Moore, 1995). We come to the same conclusion as Woodford (2010), in which near-rational expectations are used, about the history dependence of the targeting rule under commitment. One can infer that assuming more *realistic* agents in the New Keynesian model would provide a more accurate replication of the impact of monetary policy.

Our result on the optimality of a form of PLT in the cases of interest rate, output gap or revenue myopia and the optimality of a form of IT in the remaining cases departs from the existing monetary economics literature and echoes in detail Gabaix (2020)'s brief insight about optimal monetary policy. Bounded rationality gives support to both the proponent of PLT and IT, by setting the borders between the appropriate use of each targeting regime depending on the agents' myopia. While this departure from rationality complicates expectation management, it offers a rich set of policy regimes–IT and PLT–for the policymaker to choose given the state of the world–myopia.

The baseline rational New Keynesian framework recommends a form of PLT as the optimal policy (Galí and Gertler, 1999; Woodford, 2003). This recommendation is nested in our results by shutting down myopia parameters (in Section 4). Deviations from this policy benchmark like in the rational inattention framework (Maćkowiak and Wiederholt, 2009, 2015) find small differences in terms of welfare compared to the rational case, which does not alter the policy conclusions of the rational expectations model.

Learning models, as surveyed in Eusepi and Preston (2018), conclude that a form of PLT could be a proxy for the optimal policy.

By deviating from the rational agent hypothesis and using price setters' information stickiness, Ball et al. (2005) find that flexible PLT is optimal. Honkapohja and Mitra (2020) employs a nonlinear New Keynesian model under learning to show that PLT performs well depending on the credibility of the central bank. Using different deviations from rationality, namely bounded rationality, supports the finding of PLT optimality. Gabaix (2020) dismisses the latter result and concludes that PLT is suboptimal.

By exploring different forms of myopia, we emphasize the optimality of PLT in some cases, as the existing literature does, while validating the results of Gabaix (2020) only under some specific bounded rationality configurations. PLT is the desirable monetary policy since the experiment led by Amano et al. (2011) has shown its suitability to *real* agents' beliefs, who are presumably boundedly rational.

Our robustness analysis (Appendix B) shows that our results are robust to the model's calibration of the structural parameters. It also shows that high general myopia always improves welfare under commitment, discretion, and optimal simple rule regimes. Hence, bounded rationality is not necessarily associated with decreased welfare. Extreme general myopia can increase welfare under any monetary policy regime.

Regarding our results under commitment, one could expect that optimal simple rules would allow us to replicate the first-best solution emphasizing IT in some cases (small welfare losses) and PLT in the remaining cases. However, under these instrument rules, the welfare loss evaluation points to the desirability of strict PLT as a proxy for the optimal monetary policy, regardless of the bounded rationality type. Such a result is in sharp contrast with the policy prescription under commitment.

This result recalls the old debate regarding the instrument rules versus targeting rules, as emphasized in Svensson (2003). Mechanical instrument rules, as a guideline for monetary policy, are likely inadequate for optimizing and forward-looking central banks. Svensson (2003) argues that the concept of targeting rules is more appropriate to the forward-looking nature of monetary policy. In the same vein, the inability of simple rules to replicate the commitment solution is a clear case of the shortcomings related to this kind of monetary policy conception. Managing expectations in a behavioral world needs to deviate from a mechanical rule and enlarge the scope to a targeting rule that provides more room for adjusting policies as people's perceptions change. Indeed, this suggestion requires central bankers to measure inflation misperceptions (e.g., through regular surveys) to adjust policies if specific myopia levels change.

9. Policy implications

Following the Global Financial Crisis, central bank and policy institution members called for an in-depth revision of the IT framework, which shaped the policy decisions of major central banks over several decades (Blanchard and Summers, 2019; Bernanke, 2020). Some policymakers advocate the appropriateness of PLT as a measure to overcome the challenges brought by the Zero Lower Bound (Bernanke, 2020). Others want to retain the current IT framework and make some adjustments to its parameters, such as raising the inflation target (Blanchard and Summers, 2019) or setting negative interest rates. Even before the crisis, the debate between IT and PLT was characteristic of the modern monetary policy era (Svensson, 1999).

Our result bridges the gap between these two competing views about which kind of monetary policy targeting is optimal. Both forms of targeting, namely PLT and IT, could be optimal but in different circumstances. Our findings show that assessing bounded rationality is a crucial indicator for the central bank when deciding whether to pursue IT or PLT.

The evaluation of the instrument rules indicates the desirability of strict PLT over the other monetary policy targeting regimes, which aligns with the literature surveyed by Hatcher and Minford (2016) in the rational case. However, this homogeneity of the choice of the targeting rule leaves us with much concern about the inability of these simple instrument rules to replicate the optimal policy as a first-best solution when rationality is bounded.

The inability of simple rules to stabilize the economy and replicate the first-best solution under bounded rationality calls for reconsidering their roles in the conduct of monetary policy. Furthermore, their mechanical nature is inappropriate to the changing nature of inattention experienced by agents. We join Svensson (2003) in calling for the inclusion of *targeting rules* (as derived in Proposition 1) in the central banking toolkit in setting monetary policy decisions.

We acknowledge that myopia could be endogenous, a function of the volatility of macroeconomic variables behavioral agents might be attentive. Although the rational central bank interacts with boundedly rational agents in our model, we acknowledge that the central bank could also be behavioral, as behavioral agents run it. We leave these two extensions for future research.

Overall, agents' expectations matter for monetary policy conduct. A concrete illustration is policymakers' desire to *educate* the public through intensive communication. Central banks have, for several decades, educated agents in economics to increase public understanding and trust of their monetary policies, among other objectives. These programs may be perceived as an effort to attenuate myopia, thus guiding agents to rationality. Bounded rationality is intrinsic to human functioning, and improves welfare in certain situations. This should motivate central banks to use appropriate tools by considering agents' myopia to improve welfare. Convincing central bank staffs to explore, monitor and analyze agents' myopia constitutes a relevant policy recommendation of this paper. Assessing the degree to which economic agents are myopic is one of the areas that central banks should invest in more. Borrowing an analogy from Thaler (2016), the central bank should invest in studying the degree to which *Homo sapiens* are myopic and act consistently rather than educate people and attempt to transform humans into *Homo economicus*.

10. Conclusion

Optimal monetary policy is assessed through a consistently microfounded behavioral New Keynesian framework to show that the first-best solution depends on the type of myopia that characterizes agents. While a form of PLT is optimal in some myopia cases, IT is more appropriate in others. Our new Phillips curve consistently reflects the microeconomic and aggregate dynamics of myopia as a result of the consistent transition from subjective to objective expectations, giving rise to inflation myopia in the Phillips curve.

No definitive answer about the targeting policy to adopt in a behavioral setting can be drawn. Neither IT nor PLT is consistently optimal across all types of bounded rationality.

Bounded rationality matters for the conduct of monetary policy. In an attempt to implement the commitment result through an instrument rule, we find that optimal simple rules favor strict PLT in all bounded rationality cases we consider. Such a result leaves us with a puzzling observation about the lack of replication of the first-best solution.

The inability of simple rules to replicate the first-best solution calls for reconsidering their roles in the conduct of monetary policy. Our finding opens a new reflection about instrument rules in an economy with behavioral agents. While these types of rules provide policymakers with a simple monetary policy tool, it is unclear what role these rules could play in a behavioral world. Bounded rationality is not necessarily associated with decreased welfare. Several forms of economic inattention, especially extreme ones, can increase welfare. By contrast, output gap myopia implies significant welfare losses compared to the rational case. The central bank has to assess and monitor different types of myopia to optimally conduct monetary policy.

Data availability

The replication files of this paper are available upon request and online at JonathanBenchimol.com/Research.

Appendix A. Derivations

A.1. IS curve

In this section, we use the Feynman–Kac methodology to derive the Taylor expansion of the consumption deviations.

The Lagrangian of the optimization problem is

$$L = \sum_{t=0}^{\infty} \beta^t u\left(c_t, N_t\right) + \sum_{t=0}^{\infty} \beta^t \lambda_t^k \left(k_t - \left(1+r_t\right)\left(k_{t-1} - c_{t-1} + y_{t-1}\right)\right), \tag{39}$$

where $r_t = \bar{r} + m_r \hat{r}_t$, $y_t = \bar{y} + m_y \hat{y}_t$, and λ_t is the Lagrange multiplier, which is equal to $\partial V\left(k_t\right)/\partial k_t$, the derivative of the value function with respect to k.

The value function is defined as[28] $V(k_t) = \max_c \{u(c) + \beta V(k_{t+1})\}$

At the optimum, the agent solves the following problem: $V(k) = \max_{c,k}\{L\}$. The envelope theorem implies that

$$\frac{\partial V}{\partial r_t} = \frac{\partial L}{\partial r_t} = \beta^t \left[\frac{\partial u(c_t)}{\partial r_t} + \beta\lambda_t^k (k_t - c_t + y_t)\right]. \tag{40}$$

By deriving this expression with respect to k_0, we find that

$$\frac{\partial}{\partial k_0}\left(\frac{\partial V}{\partial r_t}\right) = \beta^t \frac{\partial k_t}{\partial k_0}\frac{\partial}{\partial k_t}\left[\frac{\partial u(c_t)}{\partial r_t} + \beta\lambda_t^k (k_t - c_t + y_t)\right]. \tag{41}$$

By applying this formula to the problem at hand and taking into account the derivative of the value function in the default case, $\lambda_t^k = \frac{\partial V}{\partial k_t} = \left(\bar{y} + \frac{r}{R}\frac{\phi}{\phi+\gamma}k\right)^{-\gamma}$, we obtain

$$V_{r,k} = \beta^t \frac{\partial}{\partial k_t}\left[\beta\left(\frac{\bar{r}}{R}\frac{\phi}{\phi+\gamma}k_t + \bar{y}\right)^{-\gamma}\frac{k_t}{R}\right], \tag{42}$$

where $V_{r,k} = \frac{\partial}{\partial k_0}\left(\frac{\partial V}{\partial r_t}\right)$.

By deriving and simplifying the expression above, we obtain

$$V_{r,k} = \frac{1}{R^{t+2}} c_0^{-\gamma-1}\left(-\gamma\frac{\bar{r}}{R}\frac{\phi}{\phi+\gamma}k_0 + c_0\right). \tag{43}$$

Since $u_{c_0} = V_{k_0}$, we have $u_{cc}\partial_{\hat{r}}c_0 = \partial_{\hat{r}}V_{k_0}$, which implies

$$\partial_{\hat{r}}c_0 = \frac{\partial_{\hat{r}}\left(\frac{\partial V}{\partial k_t}\right)}{u_{cc}} = \frac{1}{R^{t+2}}\left(\frac{\bar{r}}{R}\frac{\phi}{\phi+\gamma}k_0 - \frac{1}{\gamma}c_0\right), \tag{44}$$

which gives the expression for $b_r(k_t) = \frac{1}{R^{t+2}}\left(\frac{\bar{r}}{R}\frac{\phi}{\phi+\gamma}k_0 - \frac{1}{\gamma}c_0\right)$.

We take the derivative of the value function with respect to y_t. Applying the envelope theorem yields

$$\frac{\partial V}{\partial y_t} = \frac{\partial L}{\partial y_t} = \beta^t\left(\frac{\partial u(c_t)}{\partial y_t} + \beta\lambda_t^k(1 + r_t)\right). \tag{45}$$

By deriving this expression with respect to k_0, we find the following expression

$$\frac{\partial}{\partial k_0}\left(\frac{\partial V}{\partial y_t}\right) = \beta^t \frac{\partial k_t}{\partial k_0}\frac{\partial}{\partial k_t}\left[\frac{\partial u(c_t)}{\partial y_t} + \beta\lambda_t^k(1 + r_t)\right]. \tag{46}$$

Eq. (46) can be simplified as

$$\frac{\partial}{\partial k_0}\left(\frac{\partial V}{\partial y_t}\right) = \frac{1}{R^t}\left(-\gamma\frac{\bar{r}}{R}c_0^{-\gamma-1}\right). \tag{47}$$

Since $u_{c_0} = V_{k_0}$, we have $u_{cc}\partial_{\hat{y}}c_0 = \partial_{\hat{y}}V_{k_0}$, which implies

$$\partial_{\hat{y}}c_0 = \frac{\partial_{\hat{y}}\left(\frac{\partial V}{\partial k_0}\right)}{u_{cc}} = \frac{\bar{r}}{R^{t+1}}. \tag{48}$$

Once we obtain Eqs. (44) and (48), the Taylor expansion of $\hat{c}$ can be expressed as

$$\hat{c}_t = \mathbb{E}_t \sum_{\tau\geq t}\frac{b_{r|k=0}\hat{r}_\tau + b_y\hat{y}_\tau}{R^{\tau-t+1}}, \tag{49}$$

where $b_r = \frac{1}{R}\left(\frac{\bar{r}}{R}k_0 - \frac{1}{\gamma}c_0\right)$ and $b_y = \bar{r}$.

For the behavioral agent expression, Eq. (49) becomes

$$\hat{c}_t = \mathbb{E}_t^{BR} \sum_{\tau\geq t}\frac{b_{r|k=0}\hat{r}_\tau + b_y\hat{y}_\tau}{R^{\tau-t+1}}. \tag{50}$$

Recall from Gabaix (2020) the term structure of attention: $\mathbb{E}_t^{BR}[\hat{r}_{t+k}] = m_r\overline{m}^k\mathbb{E}_t[\hat{r}_{t+k}]$ and $\mathbb{E}_t^{BR}[\hat{y}_{t+k}] = m_y\overline{m}^k\mathbb{E}_t[\hat{y}_{t+k}]$, where $\overline{m}$, m_r and m_y are general, interest rate and revenue myopia, respectively. By replacing those expressions in Eq. (50), we obtain

$$\hat{c}_t = \mathbb{E}_t \sum_{\tau\geq t}\frac{\overline{m}^{\tau-t}}{R^{\tau-t+1}}\left(b_{r|k=0}m_r\hat{r}_\tau + b_y m_y\hat{y}_\tau\right). \tag{51}$$

[28] In this section, the labor supply (N_t) is omitted because only FOCs with respect to consumption are considered.

Dividing Eq. (51) by $\bar{c}$, we find

$$\frac{\hat{c}_t}{\bar{c}} = \mathbb{E}_t \sum_{\tau\geq t}\frac{\overline{m}^{\tau-t}}{R^{\tau-t+1}}\left(\frac{b_{r|k=0}}{\bar{c}}m_r\hat{r}_\tau + b_y m_y\frac{\hat{y}_\tau}{\bar{c}}\right). \tag{52}$$

The market clearing condition is $y_t = c_t$, and thus $\frac{\hat{c}_t}{\bar{c}} = \frac{\hat{y}_\tau}{\bar{c}} = \tilde{y}_t$ is the output gap. Moreover, $\frac{b_{r|k=0}}{\bar{c}} = \frac{1}{\bar{c}}\frac{1}{R}\left(-\frac{1}{\gamma}c_0\right) = -\frac{1}{\gamma R}$.

Then, Eq. (52) becomes

$$\tilde{y}_t = \mathbb{E}_t \sum_{\tau\geq t}\frac{\overline{m}^{\tau-t}}{R^{\tau-t+1}}\left(-\frac{1}{\gamma R}m_r\hat{r}_\tau + \bar{r}m_y\tilde{y}_\tau\right). \tag{53}$$

Expanding this expression yields

$$\tilde{y}_t = -\frac{1}{\gamma R^2}m_r\hat{r}_t + \frac{\bar{r}}{R}m_y\tilde{y}_t + \frac{\overline{m}}{R}\mathbb{E}_t\tilde{y}_{t+1}, \tag{54}$$

which can be simplified to

$$\tilde{y}_t = M\mathbb{E}_t[\tilde{y}_{t+1}] - \sigma\hat{r}_t, \tag{55}$$

where $M = \frac{\overline{m}}{R-\bar{r}m_y}$, $\sigma = \frac{m_r}{\gamma R(R-rm_y)}$ and $R = 1/\beta$.

A.2. Phillips curve

The problem of the behavioral firm is then to maximize

$$\sum_{k=0}^{\infty}\theta^k\mathbb{E}_t^{BR}\left[\Lambda_{t,t+k}\left(P_t^*Y_{t+k|t} - \Psi_{t+k}\left(Y_{t+k|t}\right)\right)\right], \tag{56}$$

subject to the sequence of demand constraints

$$Y_{t+k|t} = \left(\frac{P_t^*}{P_{t+k}}\right)^{-\varepsilon}Y_{t+k}, \tag{57}$$

where $\Lambda_{t,t+k} = \beta^k(C_{t+k}/C_t)^{-\gamma}(P_{t+k}/P_t)$ is the stochastic discount factor in nominal terms, $\Psi_{t+k}(.)$ is the cost function, and $Y_{t+k|t}$ denotes the output in period $t+k$ for a firm that last reset its price in period t.

The FOC of the problem is the following

$$\sum_{k=0}^{\infty}\theta^k\mathbb{E}_t^{BR}\left[\Lambda_{t,t+k}Y_{t+k|t}\left(P_t^* - \mathcal{M}\psi_{t+k|t}\right)\right] = 0, \tag{58}$$

where $\mathcal{M} = \frac{\varepsilon}{\varepsilon-1}$ is the desired or frictionless markup.

By dividing Eq. (58) by P_{t-1} and defining $\Pi_{t,t+k} = \frac{P_{t+k}}{P_t}$ and $MC_{t+k|t} = \frac{\psi_{t+k|t}}{P_{t+k}}$, we obtain the following

$$\sum_{k=0}^{\infty}\theta^k\mathbb{E}_t^{BR}\left[\Lambda_{t,t+k}Y_{t+k|t}\left(\frac{P_t^*}{P_{t-1}} - \mathcal{M}MC_{t+k|t}\Pi_{t-1,t+k}\right)\right] = 0. \tag{59}$$

We define the steady-state of $\Lambda_{t,t+k}$ as β^k, $Y_{t+k|t}$ as Y, $\frac{P_t^*}{P_{t-1}}$ as 1, $MC_{t+k|t}$ as $\frac{1}{\mathcal{M}}$, and $\Pi_{t-1,t+k}$ as 1. These defined steady-states allow us to expand the FOC (Eq. (59)) as follows

$$\sum_{k=0}^{\infty}(\beta\theta)^k\mathbb{E}_t^{BR}\left[p_t^* - p_{t-1} - \left(\widehat{mc}_{t+k|t} + p_{t+k} - p_{t-1}\right)\right] = 0, \tag{60}$$

with small letters denoting the logarithm of capital letters $p_t = \ln P_t$ and hat indicating the deviation with respect to the steady-state $\widehat{mc}_{t+k|t} = mc_{t+k|t} - mc$, where $mc_{t+k|t} = \ln MC_{t+k|t}$, and $mc = -\ln\mathcal{M}$.

By simplifying Eq. (60) we obtain

$$p_t^* - p_{t-1} = (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k\mathbb{E}_t^{BR}\left[\widehat{mc}_{t+k|t} + p_{t+k} - p_{t-1}\right]. \tag{61}$$

By rearranging the terms of Eq. (61), we obtain

$$p_t^* = -mc + (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k\mathbb{E}_t^{BR}\left[mc_{t+k|t} + p_{t+k}\right]. \tag{62}$$

The (log) marginal cost can be expressed as

$$mc_{t+k|t} = mc_{t+k} - \frac{\alpha\epsilon}{1-\alpha}\left(p_t^* - p_{t+k}\right). \tag{63}$$

We replace Eq. (63) in Eq. (61) and find

$$p_t^* - p_{t-1} = (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k\,\mathbb{E}_t^{BR} \times \left[\widehat{mc}_{t+k} - \frac{\alpha\epsilon}{1-\alpha}\left(p_t^* - p_{t+k}\right) + p_{t+k} - p_{t-1}\right]. \tag{64}$$

Rearranging terms leads to the following expression

$$p_t^* - p_{t-1} = (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k\,\mathbb{E}_t^{BR}\left[\Theta\widehat{mc}_{t+k} + p_{t+k} - p_{t-1}\right]. \tag{65}$$

where $\Theta = \frac{1-\alpha}{1-\alpha+\alpha\epsilon}$.

Eq. (65) can be expressed as

$$p_t^* - p_{t-1} = (1-\beta\theta)\,\Theta\sum_{k=0}^{\infty}(\beta\theta)^k\,\mathbb{E}_t^{BR}\left[\widehat{mc}_{t+k}\right] + \sum_{k=0}^{\infty}(\beta\theta)^k\,\mathbb{E}_t^{BR}\left[\pi_{t+k}\right]. \tag{66}$$

We recall the term structure of expectations from Gabaix (2020): $\mathbb{E}_t^{BR}\left[\pi_{t+k}\right] = m_\pi^f \overline{m}^k \mathbb{E}_t\left[\pi_{t+k}\right]$ and $\mathbb{E}_t^{BR}\left[\widehat{mc}_{t+k}\right] = m_x^f \overline{m}^k \mathbb{E}_t\left[\widehat{mc}_{t+k}\right]$, where $\overline{m}$ is the general myopia to the evolution of the economy's state, m_π^f is the myopia to prices, and m_x^f is the myopia related to output. Hence, Eq. (66) can be rewritten as

$$p_t^* - p_{t-1} = (1-\beta\theta)\,\Theta\sum_{k=0}^{\infty}(\beta\theta)^k\, m_x^f \overline{m}^k \mathbb{E}_t\left[\widehat{mc}_{t+k}\right] + \sum_{k=0}^{\infty}(\beta\theta)^k\, m_\pi^f \overline{m}^k \mathbb{E}_t\left[\pi_{t+k}\right]. \tag{67}$$

By writing this equation as a difference equation, we find

$$p_t^* - p_{t-1} = \beta\theta\overline{m}\mathbb{E}_t\left[p_{t+1}^* - p_t\right] + (1-\beta\theta)\,\Theta m_x^f \widehat{mc}_t + m_\pi^f \pi_t. \tag{68}$$

We combine Eq. (68) with $\pi_t = (1-\theta)\left(p_t^* - p_{t-1}\right)$ and obtain

$$\pi_t = \frac{\beta\theta\overline{m}}{1-(1-\theta)\,m_\pi^f}\mathbb{E}_t\left[\pi_{t+1}\right] + \frac{(1-\theta)(1-\beta\theta)\,\Theta m_x^f}{1-(1-\theta)\,m_\pi^f}\widehat{mc}_t. \tag{69}$$

We express the real marginal cost of a firm, mc_t, as a function of the output gap, $\tilde{y}_t$. Notice that the real marginal cost is defined in terms of the real wage and marginal productivity of labor

$$mc_t = w_t - mpn_t, \tag{70}$$

where mpn_t is the marginal productivity of labor.

Using the facts that the real wage equals the marginal rate of substitution between consumption and labor and that the marginal productivity can be derived from Eq. (9), expression Eq. (70) can be written as

$$mc_t = \left(\gamma y_t + \phi n_t\right) - \left(y_t - n_t\right) - \ln(1-\alpha). \tag{71}$$

We use the production function Eq. (9) to eliminate n_t from Eq. (71), and we obtain

$$mc_t = \left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)y_t - \frac{1+\phi}{1-\alpha}a_t - \ln(1-\alpha). \tag{72}$$

Writing Eq. (72) in the flexible price economy yields

$$mc = \left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)y_t^n - \frac{1+\phi}{1-\alpha}a_t - \ln(1-\alpha), \tag{73}$$

where mc is the marginal cost prevailing under flexible prices (Eq. (60)) and y_t^n is the natural output. Finally, by subtracting Eq. (73) from Eq. (72), we obtain

$$\widehat{mc}_t = \left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)\left(y_t - y_t^n\right) = \left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)\tilde{y}_t. \tag{74}$$

Finally, by replacing Eq. (74) in the price setting Eq. (69), we obtain

$$\pi_t = \frac{\beta\theta\overline{m}}{1-(1-\theta)\,m_\pi^f}\mathbb{E}_t\left[\pi_{t+1}\right] + \frac{(1-\theta)(1-\beta\theta)\,\Theta m_x^f}{1-(1-\theta)\,m_\pi^f}\left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)\tilde{y}_t. \tag{75}$$

The resulting behavioral Phillips curve is

$$\pi_t = \beta M^f \mathbb{E}_t\left[\pi_{t+1}\right] + \kappa\tilde{y}_t, \tag{76}$$

where $M^f = \frac{\theta\overline{m}}{1-(1-\theta)m_\pi^f}$ and $\kappa = \frac{(1-\theta)(1-\beta\theta)\Theta m_x^f}{1-(1-\theta)m_\pi^f}\left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)$.

Note that if we consider the rational case, where $m_x^f = m_\pi^f = \overline{m} = 1$, we end up with the usual Phillips curve as in Galí (2015).

A.3. Natural output and rate

The marginal rate of substitution between labor and consumption equals the real wage, which can be expressed as

$$-\frac{U_{n,t}}{U_{c,t}} = \frac{W_t}{P_t}. \tag{77}$$

Taking logs, we obtain $w_t = \phi n_t + \gamma c_t$.

For the marginal productivity of labor in logs, we have

$$mpn_t = a - \alpha n_t + \ln(1-\alpha), \tag{78}$$

and because the production function takes the form $y_t = a_t + (1-\alpha)\,n_t$, we can express the marginal cost formula in terms of output and a technological factor (Eq. (72)). By expressing Eq. (72) in the flexible price economy, we obtain Eq. (73).

By solving for y_t^n, we obtain the expression for natural output as

$$y_t^n = \frac{1+\phi}{\phi+\alpha+\gamma(1-\alpha)}a_t + \frac{(1-\alpha)(mc + \ln(1-\alpha))}{\phi+\alpha+\gamma(1-\alpha)}. \tag{79}$$

Following the behavioral IS equation (Eq. (6)), we obtain the expression for the natural interest rate

$$r_t^n = -\frac{1}{\sigma}\frac{1+\phi}{\phi+\alpha+\gamma(1-\alpha)}\left(1-\rho_a\right)a_t, \tag{80}$$

A.4. Efficient interest rate

The IS curve Eq. (81) is written as

$$\hat{y}_t = M\mathbb{E}_t\left[\hat{y}_{t+1}\right] - \sigma\left(i_t - \mathbb{E}_t\left[\pi_{t+1}\right] - r_t^n\right). \tag{81}$$

The definitions of the output gap, $\hat{y}_t$, and the relevant output gap, x_t, are

$$\hat{y}_t = y_t - y_t^n, \tag{82}$$

$$x_t = y_t - y_t^e, \tag{83}$$

where y_t^n is the natural output and y_t^e is the efficient output.

By employing those definitions, we can write the IS curve Eq. (21) as

$$y_t - y_t^n = M\mathbb{E}_t\left[y_{t+1} - y_{t+1}^n\right] - \sigma\left(i_t - \mathbb{E}_t\left[\pi_{t+1}\right] - r_t^n\right), \tag{84}$$

which is equivalent to

$$y_t - y_t^e + y_t^e - y_t^n = M\mathbb{E}_t\left[y_{t+1} - y_{t+1}^e + y_{t+1}^e - y_{t+1}^n\right] - \sigma\left(i_t - \mathbb{E}_t\left[\pi_{t+1}\right] - r_t^n\right). \tag{85}$$

The welfare-relevant output gap is

$$x_t + y_t^e - y_t^n = M\mathbb{E}_t\left[x_{t+1} + y_{t+1}^e - y_{t+1}^n\right] - \sigma\left(i_t - \mathbb{E}_t\left[\pi_{t+1}\right] - r_t^n\right), \tag{86}$$

which leads to the following expression

$$x_t = M\mathbb{E}_t\left[x_{t+1}\right] + M\mathbb{E}_t\left[y_{t+1}^e - y_{t+1}^n\right] - \left(y_t^e - y_t^n\right) - \sigma\left(i_t - \mathbb{E}_t\left[\pi_{t+1}\right] - r_t^n\right). \tag{87}$$

Hence, we obtain

$$x_t = M\mathbb{E}_t\left[x_{t+1}\right] - \sigma\left(i_t - \mathbb{E}_t\left[\pi_{t+1}\right] - r_t^e\right), \tag{88}$$

where

$$r_t^e = r_t^n + \frac{1}{\sigma}\left(M\mathbb{E}_t\left[y_{t+1}^e - y_{t+1}^n\right] - \left(y_t^e - y_t^n\right)\right). \tag{89}$$

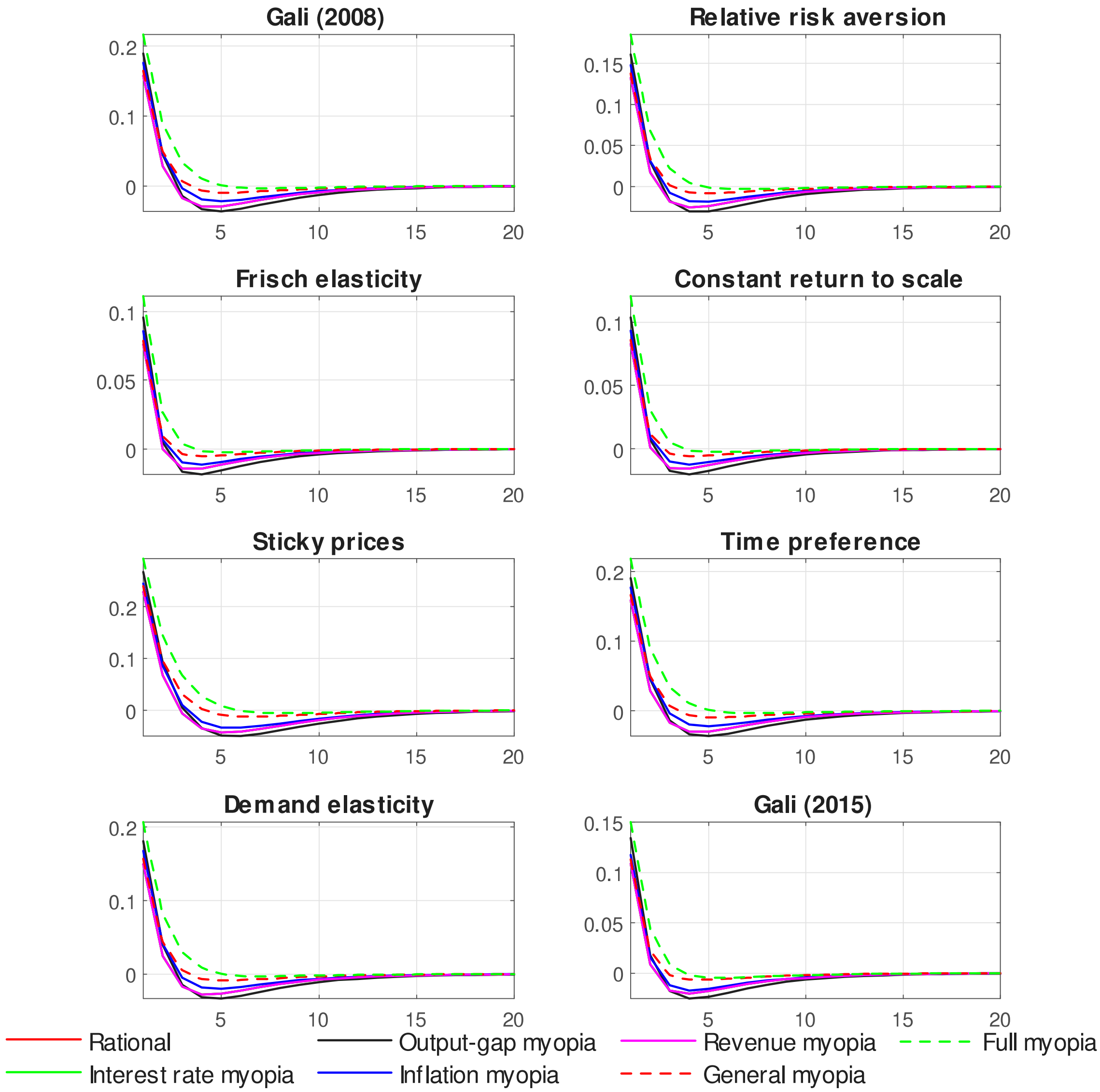

Fig. 3. Commitment: Inflation.
Notes: Impulse response functions to a 1% cost-push shock. Model calibration: Table 9. Myopia calibration: Table 1.

By taking Eq. (89) in deviation from its flexible price economy counterpart, we obtain an expression for the efficient interest rate in deviation form such as

$$r_t^e - r_t^n = \left[r_t^n + \frac{1}{\sigma}\left(M\mathbb{E}_t\left[y_{t+1}^e - y_{t+1}^n \right] - \left(y_t^e - y_t^n \right) \right) \right] - \left[r_t^n + \frac{1}{\sigma}\left(M\mathbb{E}_t\left[y_{t+1}^n - y_{t+1}^n \right] - \left(y_t^n - y_t^n \right) \right) \right]. \quad (90)$$

Considering the notation $\hat{v} = v - v^n$, Eq. (90) can be simplified to

$$\hat{r}_t^e = \frac{1}{\sigma}\left(M\mathbb{E}_t\left[\hat{y}_{t+1}^e \right] - \hat{y}_t^e \right). \quad (91)$$

A.5. Endogenous welfare loss

The Taylor expansion of the utility function U_t defined in Eq. (1) is the following

$$U_t - U = U_c c\left(\frac{c_t - c}{c} \right) + \frac{1}{2} U_{cc} c^2 \left(\frac{c_t - c}{c} \right)^2 + U_n N\left(\frac{N_t - N}{N} \right) + \frac{1}{2} U_{nn} N^2 \left(\frac{N_t - N}{N} \right)^2 + \Theta\left(Z^3 \right), \quad (92)$$

where $\Theta\left(Z^3\right)$ represents the terms up to the power of 3 and null cross variables derivatives due to the separability of our utility function.

To further develop the Eq. (92), we use the fact that $U_{cc} = -\gamma \frac{1}{c} U_c$ and $U_{nn} = -\phi \frac{1}{N} U_n$. Moreover, for any variable z_t, we have $\frac{z_t - z}{z} = \hat{z}_t + \frac{1}{2}\hat{z}_t^2$.

Taking into account all of this, Eq. (92) becomes

$$U_t - U = U_c c\left(\hat{c}_t + \frac{1-\gamma}{2}\hat{c}_t^2 \right) + U_n N\left(\hat{n}_t + \frac{1+\phi}{2}\hat{n}_t^2 \right) + \Theta\left(Z^3 \right). \quad (93)$$

We express $\hat{n}_t$ in terms of $\tilde{y}_t$ (remember that $\tilde{y}_t$ is our notation for the output gap from Section 2.1). Using $Y_t(i) = \left(\frac{P_t(i)}{P_t} \right)^{-\epsilon} Y_t$ and $P_t = \left(\int_0^1 P_t(i)^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}}$, we have

$$N_t = \int_0^1 N_t(i)\, di = \int_0^1 \left(\frac{Y_t(i)}{A_t} \right)^{\frac{1}{1-\alpha}} di$$

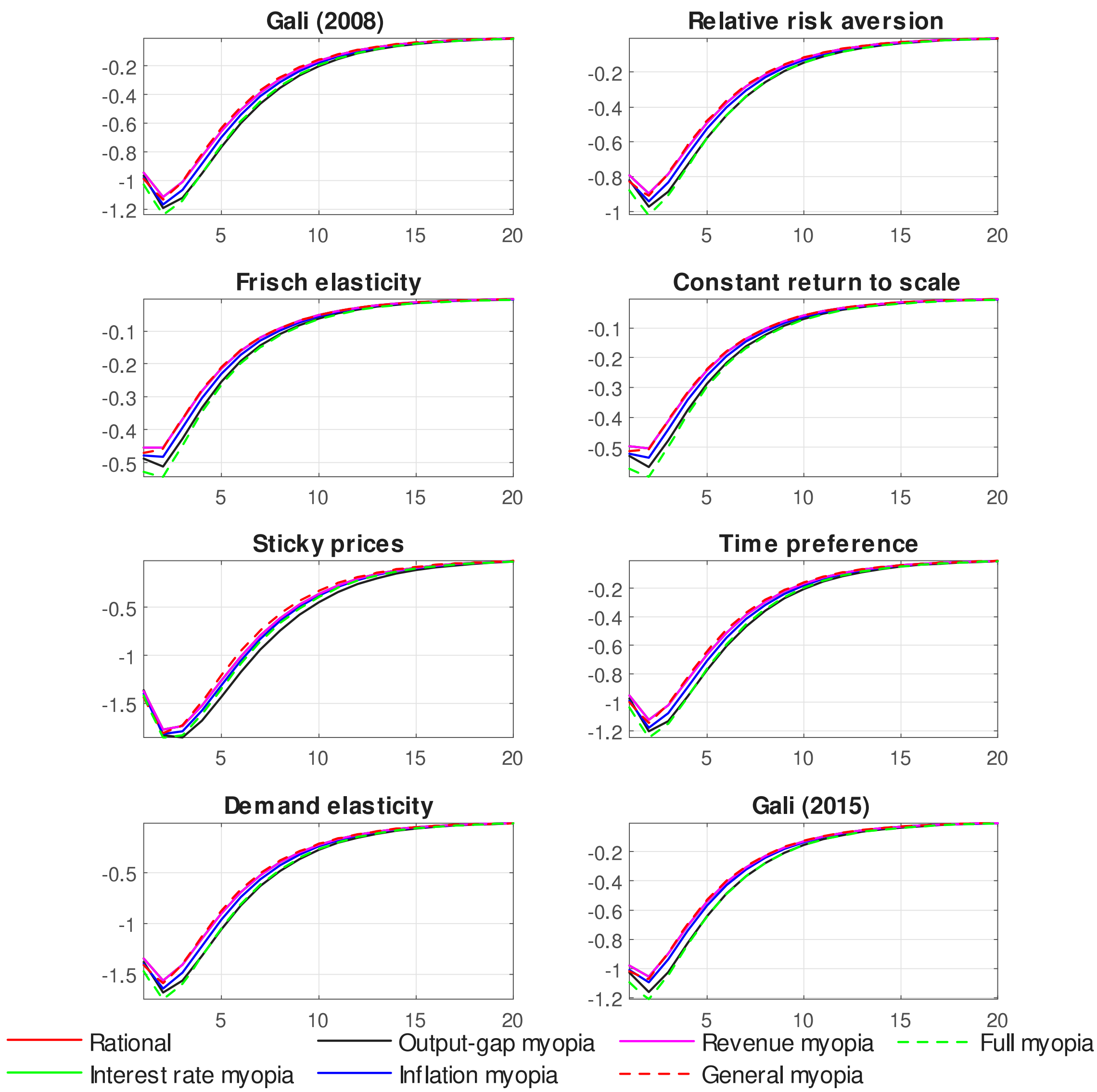

Fig. 4. Commitment: Output.
Notes: Impulse response functions to a 1% cost-push shock. Model calibration: Table 9. Myopia calibration: Table 1.

$$= \left(\frac{Y_t}{A_t}\right)^{\frac{1}{1-\alpha}} \int_0^1 \left(\frac{P_t(i)}{P_t}\right)^{-\frac{\epsilon}{1-\alpha}} di.$$

In terms of log deviations, this expression can be written as

$$(1-\alpha)\hat{n}_t = \tilde{y}_t - a_t + d_t,$$

where $d_t = (1-\alpha)\ln\int_0^1 \left(\frac{P_t(i)}{P_t}\right)^{-\frac{\epsilon}{1-\alpha}} di$. It follows from Lemma 1 (Galí, 2015, chapter 4) that

$$d_t = \frac{\epsilon}{2\Theta} var_i \{p_t(i)\}.$$

Returning to our Taylor expansion Eq. (93) and using the fact that $\hat{c}_t = \tilde{y}_t$, we obtain

$$\begin{aligned} U_t - U &= U_c c \left(\tilde{y}_t + \frac{1-\gamma}{2}\tilde{y}_t^2\right) \\ &+ \frac{U_n N}{1-\alpha}\left(\tilde{y}_t + \frac{\epsilon}{2\Theta} var_i\{p_t(i)\} + \frac{1+\phi}{2(1-\alpha)}(\tilde{y}_t - a_t)^2\right). \end{aligned} \tag{94}$$

The efficiency of the steady-state implies

$$-\frac{U_n}{U_c} = MPN = (1-\alpha)\frac{Y}{N}.$$

By combining the previous two equations, we find that

$$\frac{U_t - U}{U_c c} = \tilde{y}_t + \frac{1-\gamma}{2}\tilde{y}_t^2 - \left(\tilde{y}_t + \frac{\epsilon}{2\Theta} var_i\{p_t(i)\} + \frac{1+\phi}{2(1-\alpha)}(\tilde{y}_t - a_t)^2\right). \tag{95}$$

As in Galí (2015), we can consider that the product of Φ with second-order terms is null under the assumption of small distortions. We obtain

$$\begin{aligned} \frac{U_t - U}{U_c c} &= -\frac{1}{2}\left[\frac{\epsilon}{\Theta} var_i\{p_t(i)\} - (1-\gamma)\tilde{y}_t^2 + \frac{1+\phi}{1-\alpha}(\tilde{y}_t - a_t)^2\right] \\ &= -\frac{1}{2}\left[\frac{\epsilon}{\Theta} var_i\{p_t(i)\} + \left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)\tilde{y}_t^2 \right. \\ &\left. -2\left(\frac{1+\phi}{1-\alpha}\right)\tilde{y}_t a_t\right]. \end{aligned} \tag{96}$$

Using the fact that $\hat{y}_t^e = \frac{1+\phi}{\gamma(1-\alpha)+\phi+\alpha} a_t$, we obtain

$$\frac{U_t - U}{U_c c} = -\frac{1}{2}\left[\frac{\epsilon}{\Theta} var_i\{p_t(i)\} + \left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)(\tilde{y}_t - \hat{y}_t^e)^2\right].$$

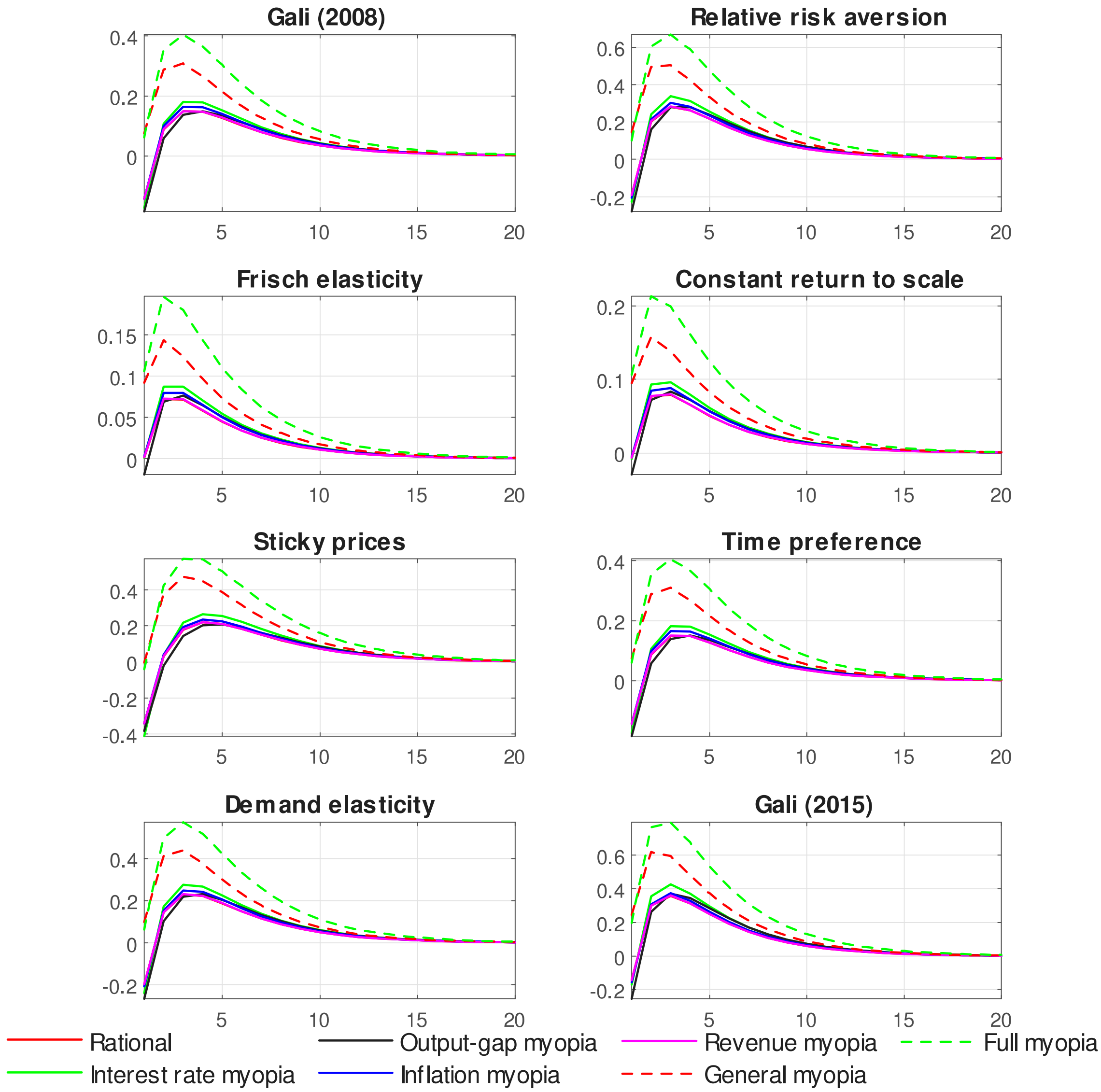

Fig. 5. Commitment: Interest rate.
Notes: Impulse response functions to a 1% cost-push shock. Model calibration: Table 9. Myopia calibration: Table 1.

The welfare loss is expressed as a fraction of the steady-state consumption

$$\mathbb{W} = -\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{U_t - U}{U_c c} \right)$$
$$= -\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[-\frac{1}{2} \left(\frac{\epsilon}{\Theta} var_i \left\{ p_t(i) \right\} + \left(\gamma + \frac{\phi + \alpha}{1-\alpha} \right) \left(\tilde{y}_t - \hat{y}_t^e \right)^2 \right) \right]. \quad (97)$$

Assuming that $x_t = y_t - y_t^e = \tilde{y}_t - \hat{y}_t^e$ and by applying Lemma 2 (Galí, 2015, chapter 4), we find the welfare loss expression

$$\mathbb{W} = -\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[-\frac{1}{2} \left(\frac{\epsilon}{\Theta} \frac{\theta}{(1-\beta\theta)(1-\theta)} \pi_t^2 + \left(\gamma + \frac{\phi + \alpha}{1-\alpha} \right) x_t^2 \right) \right]. \quad (98)$$

Appendix B. Robustness check

This section presents our results under the alternative model and myopia calibrations.

Table 9
Calibration of the model parameters used for the robustness checks.

Calibration name	β	γ	ϕ	ϵ	α	θ
Galí (2008)	0.99	1	1	6	1/3	0.66
Relative risk aversion	0.99	2	1	6	1/3	0.66
Frisch elasticity	0.99	1	5	6	1/3	0.66
Constant return to scale	0.99	1	1	6	0	0.66
Sticky prices	0.99	1	1	6	1/3	3/4
Time preferences	0.996	1	1	6	1/3	0.66
Demand elasticity	0.99	1	1	9	1/3	0.66
Galí (2015)	0.996	2	5	9	1/3	3/4

B.1. Model calibrations

Table 9 presents the different model calibrations considered in the following robustness analysis.

Figs. 3 to 6 present the impulse response of inflation, output, interest rate and price level under commitment, respectively, over the different calibrations presented in Table 9. Figs. 7 to 10 present the

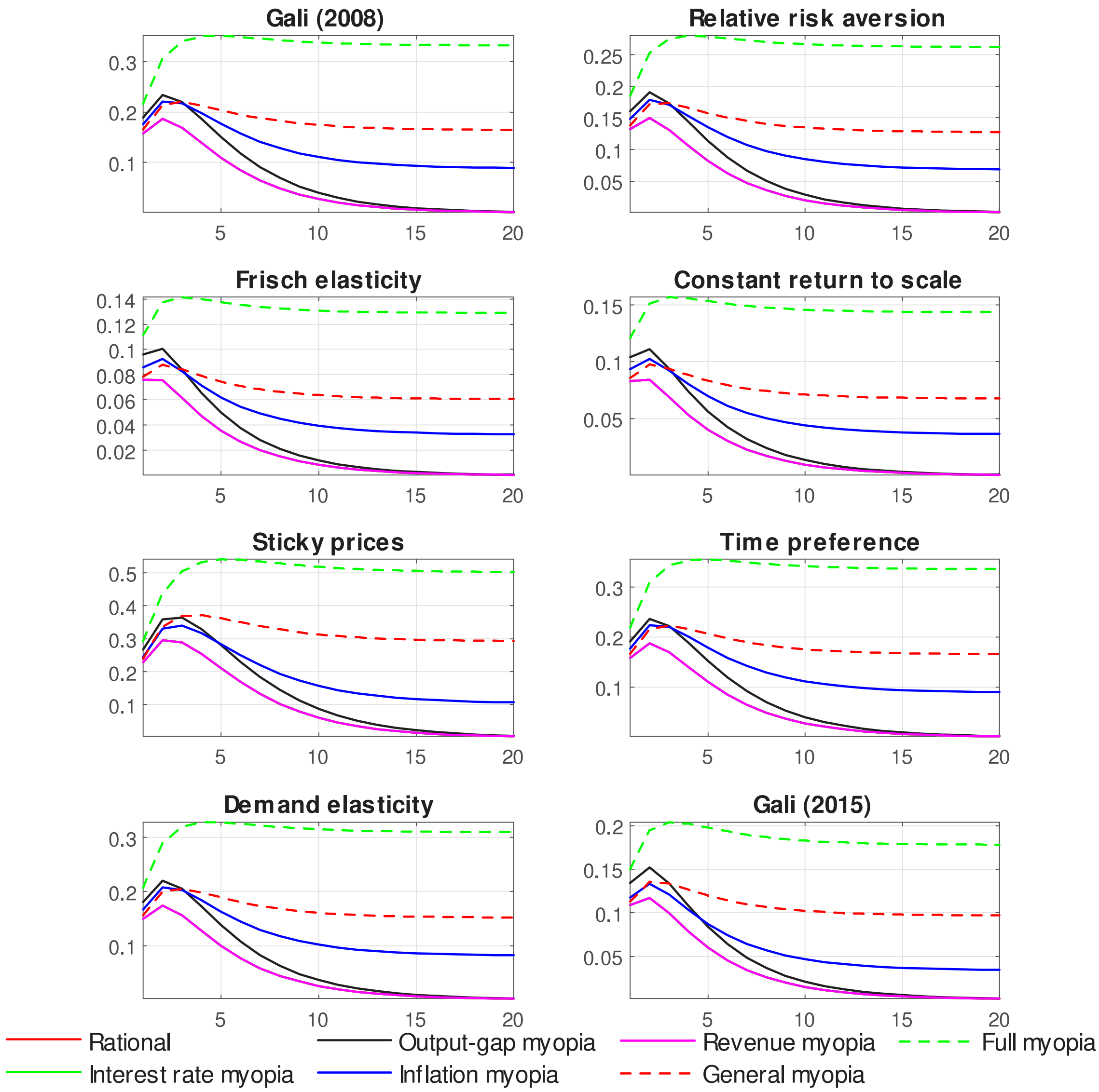

Fig. 6. Commitment: Price level.
Notes: Impulse response functions to a 1% cost-push shock. Model calibration: Table 9. Myopia calibration: Table 1.

impulse response of inflation, output, interest rate and price level under commitment, respectively, over the different calibrations presented in Table 9.

Impulse response functions for optimal simple rules under each calibration are available upon request. Welfare heatmaps for commitment and discretion under the different model calibrations (Table 9) are presented in Table 10. Welfare heatmaps of optimal simple rules under different model calibrations are available upon request.

The impulse response functions lead to similar conclusions as in Sections 4.3 and 5.2, whatever the model calibration chosen.

Recall from Section 2.2 the discussion about the effect of constant returns to scale; it is worth noting that when $\alpha \neq 0$, the trade-off between inflation and output worsens, and the central bank acts aggressively in order to accommodate the cost-push shock as it is clear from the Figures below when comparing the baseline calibration to the constant returns to scale calibration $\alpha = 0$.

Table 10 reveals that under different model calibrations, myopia does not necessarily increase welfare losses. Interestingly, our previous results hold. Increasing the Frisch elasticity or assuming a constant return to scale improves welfare, whatever the type of myopia. Under discretion and optimal simple rules, the welfare-improving abilities of the general myopia are clear and robust. This result is not clear under commitment for such myopia levels (85%), but extreme myopia values demonstrate the robustness of this result (Appendix B.2).

B.2. Myopia calibrations

The different myopia cases considered in this section are presented in Table 11.

Table 11 presents more pronounced myopic agents with approximately 80% myopia and an extreme case with an almost fully myopic agent (99%). The impulse response functions resulting from the calibration presented in Table 11 are presented in the case of commitment (Fig. 11) and discretion (Fig. 12). The optimal simple rule cases are available upon request.

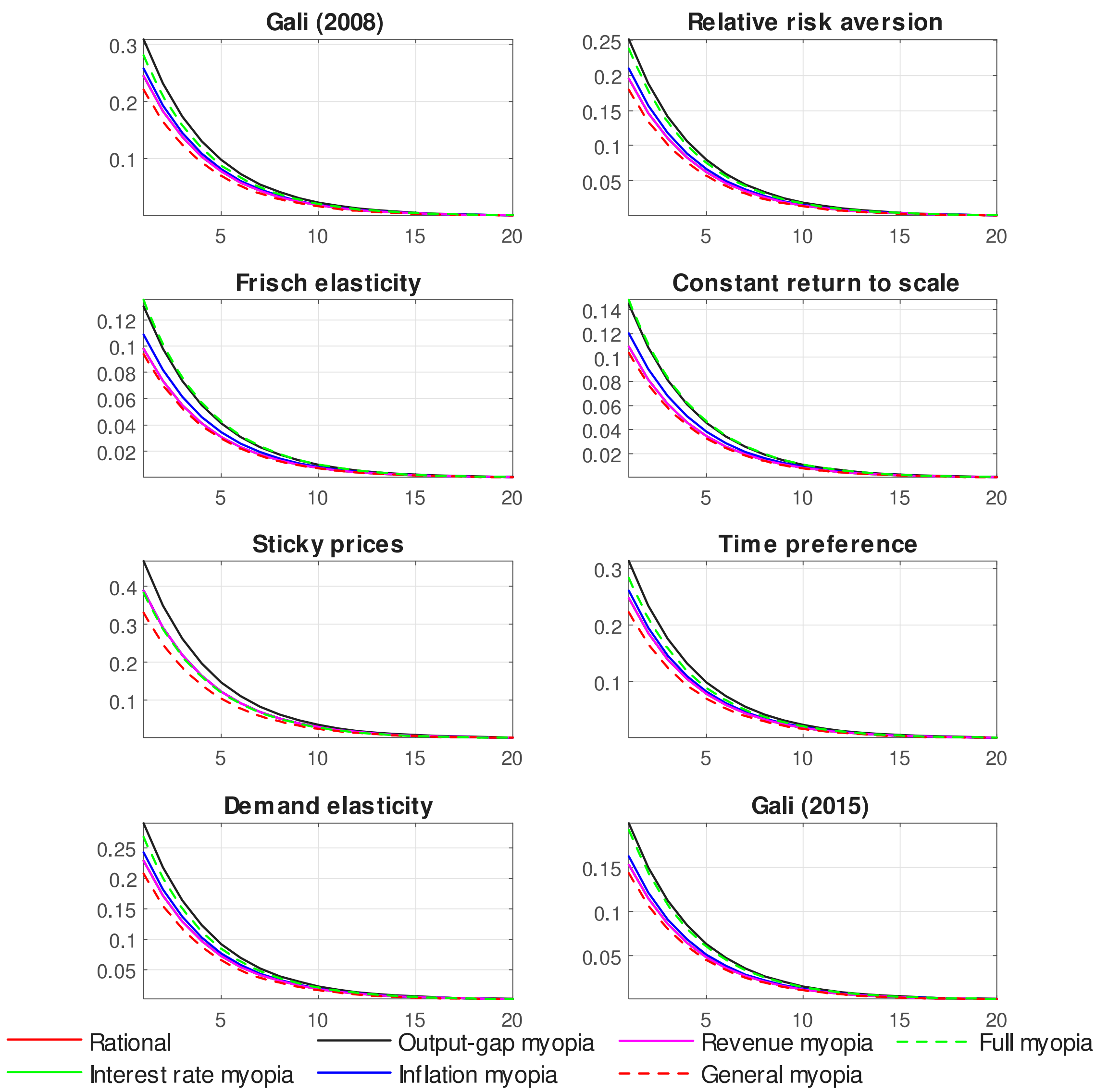

Fig. 7. Discretion: Inflation.
Notes: Impulse response functions to a 1% cost-push shock. Model calibration: Table 9. Myopia calibration: Table 1.

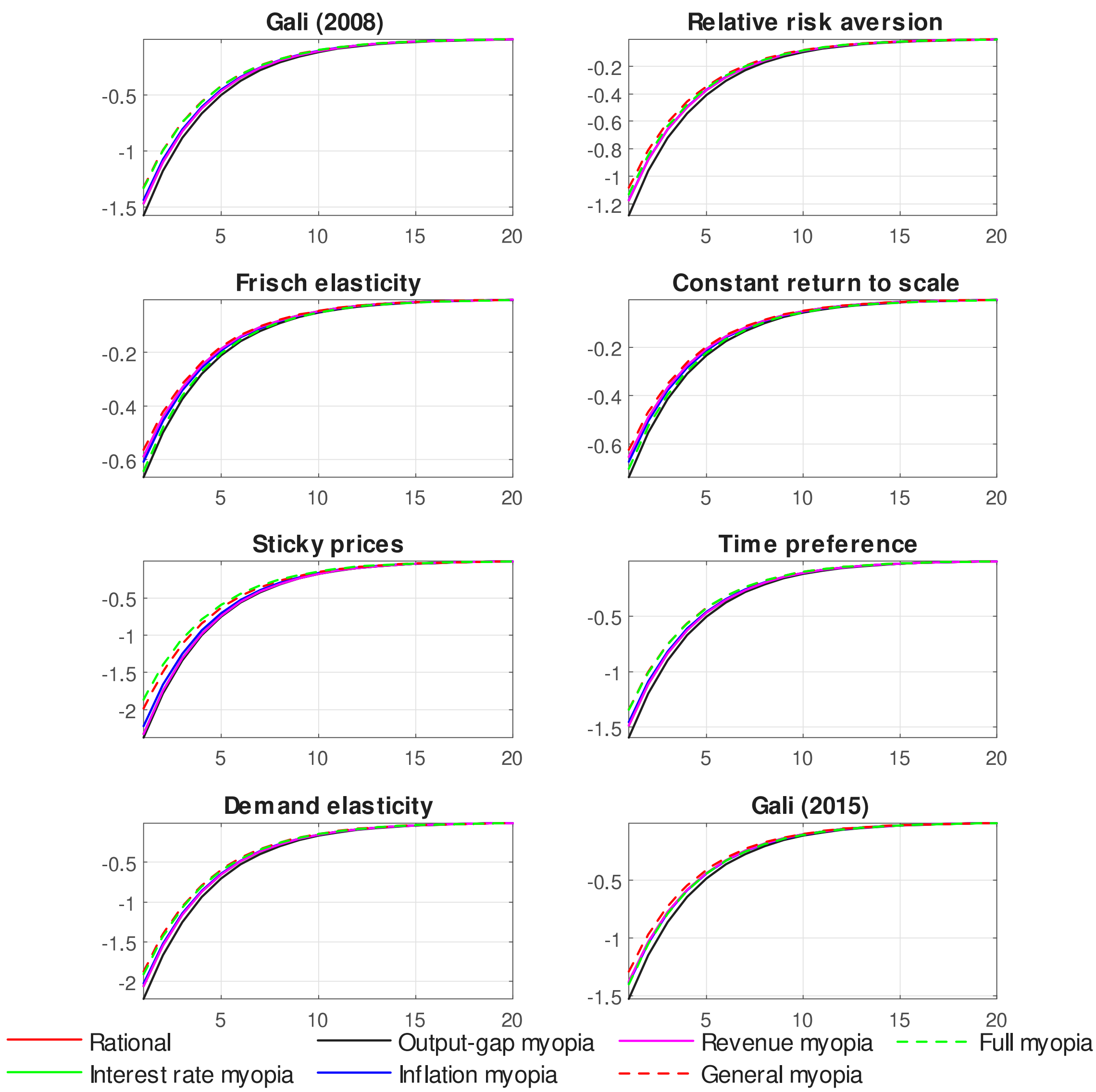

Fig. 8. Discretion: Output.
Notes: Impulse response functions to a 1% cost-push shock. Model calibration: Table 9. Myopia calibration: Table 1.

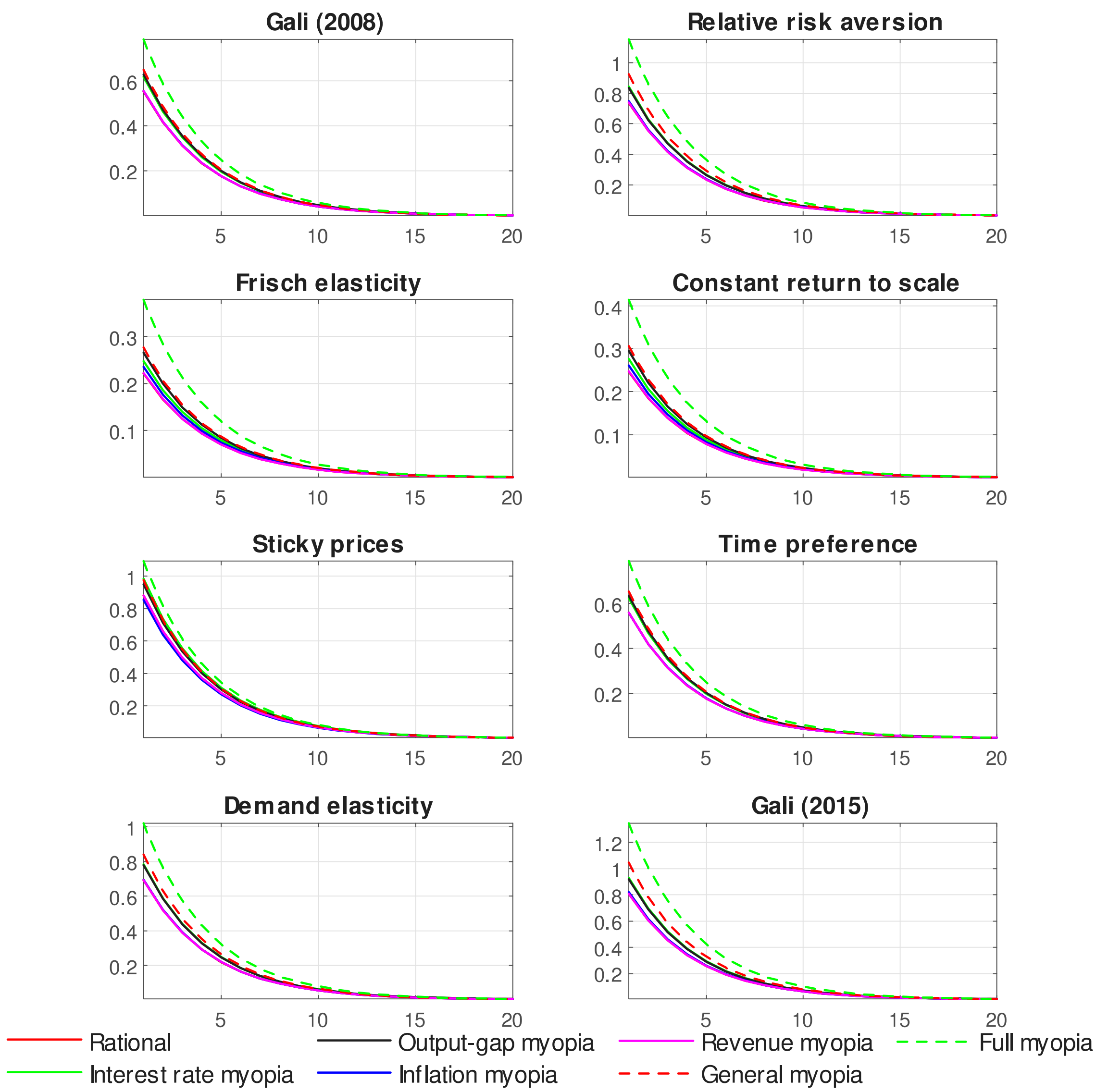

Fig. 9. Discretion: Interest rate.
Notes: Impulse response functions to a 1% cost-push shock. Model calibration: Table 9. Myopia calibration: Table 1.

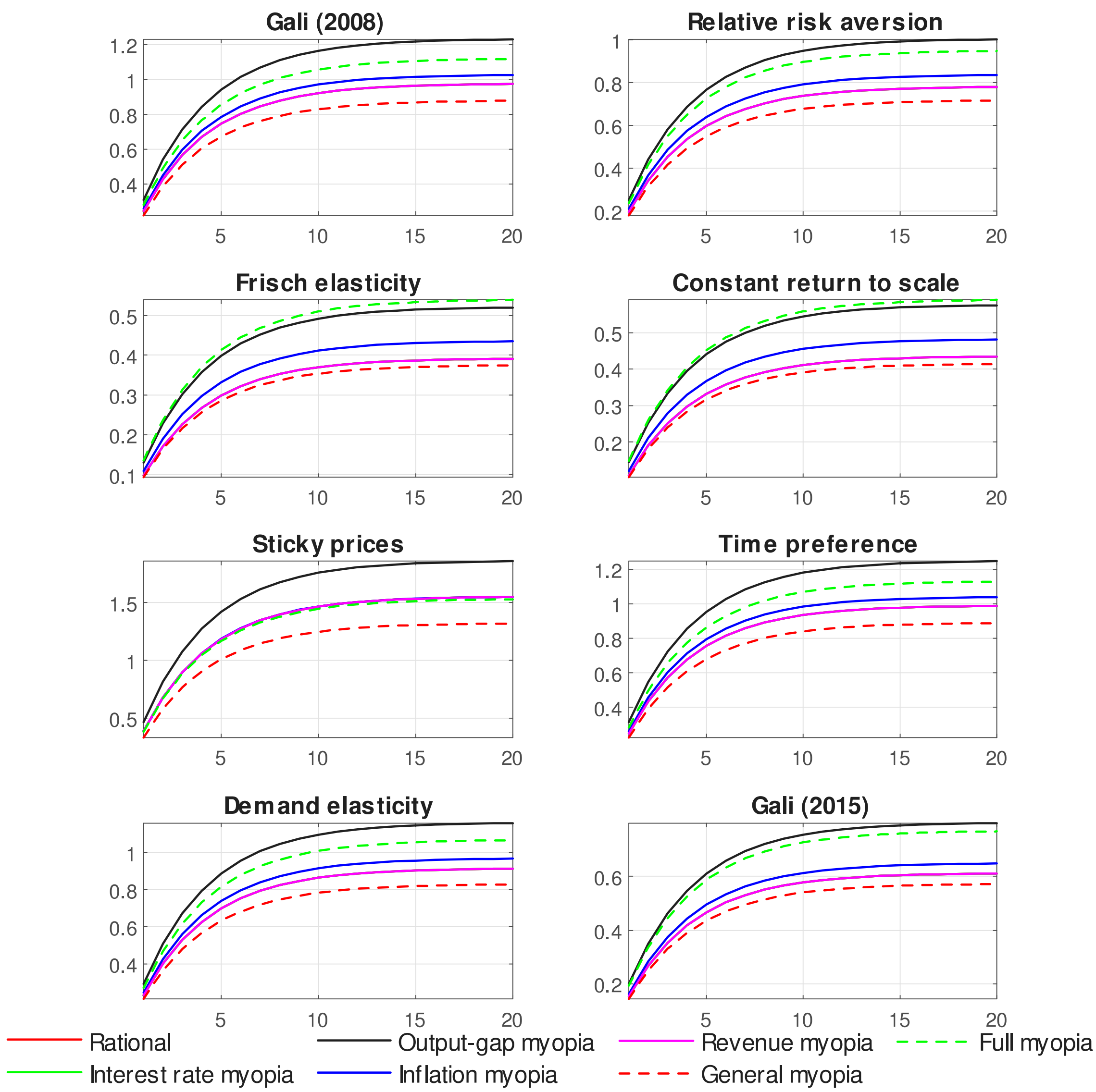

Fig. 10. Discretion: Price level.
Notes: Impulse response functions to a 1% cost-push shock. Model calibration: Table 9. Myopia calibration: Table 1.

Table 10
Commitment (top) and Discretion (bottom): Welfare losses.

Commitment:

Myopia	Gali (2008)	Relative risk aversion	Frisch elasticity	Constant return to scale	Sticky prices	Time preference	Demand elasticity	Gali (2015)
Rational	0.2809	0.2235	0.1126	0.1248	0.4667	0.2832	0.2624	0.1741
Interest rate	0.2809	0.2235	0.1126	0.1248	0.4667	0.2832	0.2624	0.1741
Output-gap	0.3599	0.2892	0.1492	0.1649	0.5830	0.3627	0.3372	0.2274
Inflation	0.3171	0.2533	0.1286	0.1424	0.5039	0.3199	0.2966	0.1901
Revenue	0.2809	0.2235	0.1126	0.1248	0.4667	0.2832	0.2624	0.1741
General	0.2834	0.2257	0.1136	0.1260	0.4672	0.2861	0.2648	0.1760
Full	0.3962	0.3223	0.1699	0.1873	0.6043	0.4001	0.3727	0.2478

Discretion:

Myopia	Gali (2008)	Relative risk aversion	Frisch elasticity	Constant return to scale	Sticky prices	Time preference	Demand elasticity	Gali (2015)
Rational	0.5102	0.3740	0.1528	0.1740	1.0109	0.5212	0.4649	0.2697
Interest rate	0.5102	0.3740	0.1528	0.1740	1.0109	0.5212	0.4649	0.2697
Output-gap	0.7148	0.5308	0.2189	0.2494	1.3426	0.7315	0.6543	0.3862
Inflation	0.5324	0.4005	0.1713	0.1942	0.9864	0.5432	0.4892	0.2868
Revenue	0.5102	0.3740	0.1528	0.1740	1.0109	0.5212	0.4649	0.2697
General	0.4149	0.3165	0.1403	0.1583	0.7347	0.4222	0.3828	0.2362
Full	0.5625	0.4484	0.2155	0.2412	0.8907	0.5721	0.5264	0.3407

Notes: The shading scheme is defined separately in relation to each column. The lighter the shading is, the smaller the welfare loss. Tables 1 and 9 provide myopia and model calibrations, respectively.

Table 11
Calibration of the myopia parameters used for the robustness checks.

	Models							
	No myopia	Myopia						
	Rational	Interest rate	Output gap	Inflation	Revenue	General	Full	Extreme
m_r	1	0.2	1	1	1	1	0.2	0.01
m_x^f	1	1	0.2	1	1	1	0.2	0.01
m_π^f	1	1	1	0.2	1	1	0.2	0.01
m_y	1	1	1	1	0.2	1	0.2	0.01
$\overline{m}$	1	1	1	1	1	0.2	0.2	0.01

Table 12
Welfare losses: Robustness.

	Myopia						
	Interest rate	Output gap	Inflation	Revenue	General	Full	Extreme
Commitment	0.174	1.446	0.257	0.174	0.143	0.372	0.302
Discretion	0.270	3.357	0.348	0.270	0.145	0.372	0.302

Notes: Tables 2 and 11 provide model and myopia calibrations, respectively.

Table 12 presents the welfare losses under the standard calibration (Galí, 2015) for commitment and discretion. Here again the results for the optimal simple rule cases are available upon request. The results under the different calibrations presented in Table 11 are also available upon request.

Table 12 shows that the welfare losses under discretion are always higher than under commitment, except under full and extreme myopia. Interestingly, the general myopia case leads to the best welfare losses under commitment and discretion, confirming our result that myopia can also improve welfare losses.

From these robustness analyses, one can conclude that there exists a general myopia level that improves the welfare losses whatever the chosen commitment, discretion or optimal simple rule regime.

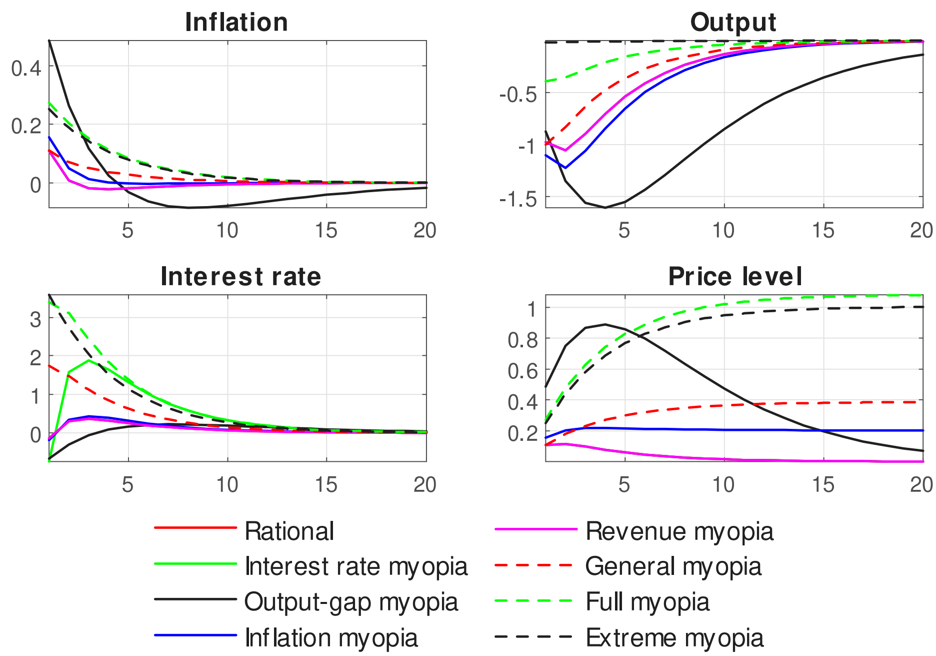

Fig. 11. Commitment: Robustness.
Notes: Impulse response functions to a 1% cost-push shock. Model calibration: Table 2. Myopia calibration: Table 11.

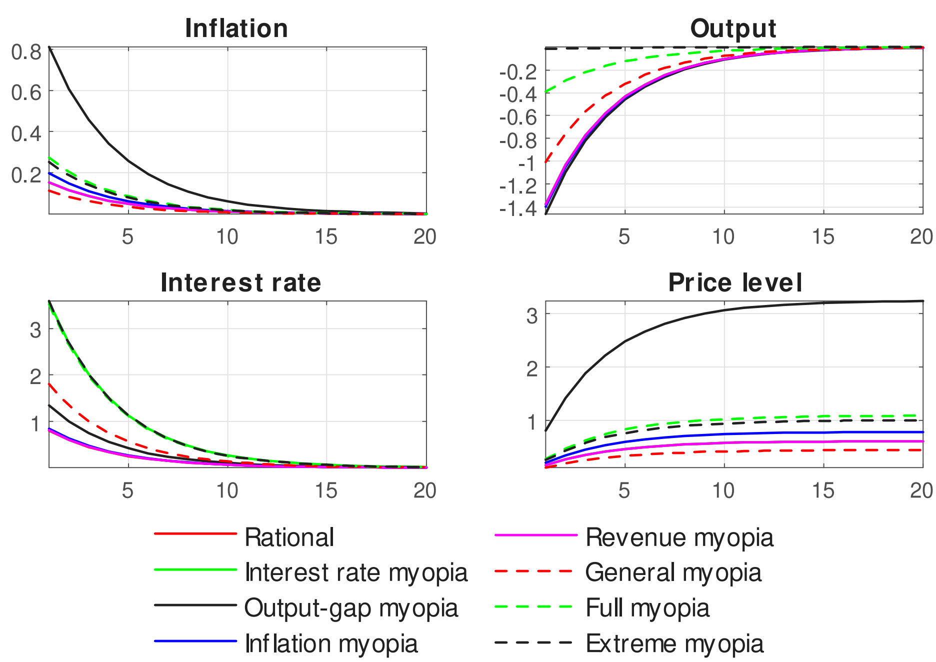

Fig. 12. Discretion: Robustness.
Notes: Impulse response functions to a 1% cost-push shock. Model calibration: Table 2. Myopia calibration: Table 11.

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