# Optimal Monetary Policy Under Bounded Rationality

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# Empirical Motivation

- Essential concepts for CBs:
  - Managing **gaps** (e.g., inflation, output).
    Do agents measure/model/understand these gaps accurately ?
  - Managing **expectations**.
    Do agents measure/model/understand these expectations accurately ?
- Collecting prices:
  - **More or less easy** supermarket/internet.
- Collecting values of the output gap:
  - **Less easy**.
- Myopia(s) to inflation and output
  $\Rightarrow$ Relative distortion between prices and quantities
  $\Rightarrow$ (Optimal) monetary policy?

# Theoretical Motivation

- Optimal monetary policy: **rational NK** models (Clarida et al., 1999 and Woodford, 2003).
  - Agents' expectations are **exaggerated** in New Keynesian models (Blanchard, 2009).
  - The economy is **inconsistent** with any model of rationality (Stiglitz, 2011).
- What is the optimal monetary policy when relaxing the rational expectations hypothesis?

# Literature

- **Information stickiness**
  Flexible or strict PLT is optimal (Ball, Mankiw, and Reis, 2005).
- **Rational inattention**
  Small differences in terms of welfare compared to the rational case (Mackowiak and Wiederholt, 2015).
- **Learning**
  A form of PLT could be an adequate proxy of the optimal policy (Eusepi and Preston, 2018).
- **Behavioral New Keynesian**
  PLT is not desirable when firms are behavioral (Gabaix, 2020).

# Intuition

- How agents' **perceptions** are key to monetary policy conduct?
  - Bounded rationality **types** influence monetary policy reactions and households' welfare differently.
  - Inflation expectations are pivotal to most targeting policies.
- Does the behavioral agent's **welfare** is necessarily lower than the rational agent's one?
  - *Ignoring some aspects of reality might be welfare increasing.*
- Why should **mechanical rules** hold whatever the state of the world ?
  - Behavioral states.

# Model

- Building on the workhorse NK model and its behavioral version (Gabaix, 2020).
  - Agents are myopic to future disturbances: interest rate, output-gap, inflation, real income, general and full myopia.
  - Boundedly rational **households** and **firms**, and rational **CB**.
  - Encompasses the rational model and its policy recommendations as a particular case.
- Contributions:
  - **Consistent term structure of attention**
    $\Rightarrow$ Original Phillips curve.
  - **Variable-specific myopias**
    $\Rightarrow$ Bounded rationality tractability.
  - **Decreasing return to scale**
    $\Rightarrow$ Realistic pass-through between real and nominal variables.
  - **Flexible-price economy**
    $\Rightarrow$ Microfounded output-gap and natural interest rate.
  - **Welfare-relevant model**
    $\Rightarrow$ Consistent optimal monetary policy evaluation.

# Findings

- Optimal monetary policy is **myopia-dependent**.
- If myopia distorts agents' inflation expectations, the optimal policy entails an IT.
- Otherwise, the optimal policy is a PLT.
- Rational inflation expectations are a **minimal condition** for PLT optimality in a behavioral world.
  - To the extent that bygones are not bygones under PLT.
- No feasible instrument rules for implementing the optimal monetary policy: casting **doubt** on the ability of simple Taylor rules to be useful in guiding monetary policy.
- Bounded rationality may be associated with **welfare gains**.

# Environment

- Boundedly rational **households** maximize their life-time utility subject to their budget constraint and a non-Ponzi scheme condition.

| | |
|---|---|
| $\bar{m}$ | General myopia |
| $m_r$ | Interest rate myopia |
| $m_y$ | Real income myopia |

- Boundedly rational **firms** maximize their perceived profit subject to production technology.

| | |
|---|---|
| $\bar{m}$ | General myopia |
| $m_\pi^f$ | Inflation myopia |
| $m_x^f$ | Output-gap myopia |

- Sticky-price economy: Calvo pricing mechanism.

# Households

Infinitely-lived household maximizes

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U\left(c_t, N_t\right) \tag{1}$$

subject to

$$k_{t+1} = \left(1 + \overline{r}_t + \widehat{r}_t^{BR}\right)\left(k_t - c_t + \overline{y}_t + \widehat{y}_t^{BR}\right) \tag{2}$$

$$S_{t+1} = \bar{m} f\left(S_t, \epsilon_{t+1}\right) \tag{3}$$

where the following *behavioral term structure of expectations* (BTSE) is assumed

$$\mathbb{E}_t^{BR}[\widehat{X}_{t+k}] = m_X \overline{m}^k \mathbb{E}_t[\widehat{X}_{t+k}] \tag{4}$$

$m_X$ : level (intercept) of attention (contemporaneous attention).

$\overline{m}$ : slope of attention (cognitive discounting) as a function of the horizon ($k$).

# IS Curve

- **Behavioral** IS curve

$$\widetilde{y}_t = M\mathbb{E}_t\left[\widetilde{y}_{t+1}\right] - \sigma\left(i_t - \mathbb{E}_t\left[\pi_{t+1}\right] - r_t^n\right) \tag{5}$$

  - $\tilde{y}_t$ is the output gap
  - $M = M_G = \overline{m}/\left(R - m_Y \bar{r}\right)$ where
    - $R = 1 + \bar{r} = 1/\beta$.
    - $m_Y = \left(\phi m_y + \gamma\right)/\left(\phi + \gamma\right)$.
  - $\sigma = \sigma_G = m_r/\left(\gamma R\left(R - m_Y \bar{r}\right)\right)$.

- **Rational** IS curve $\left(m_r = m_y = \bar{m} = 1\right)$

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

  - $\sigma_{re} = 1/\left(\gamma R\right)$.

# Firms

- Continuum of firms produces differentiated goods using the technology
$$Y_t = A_t N_t^{1-\alpha} \tag{7}$$
- Behavioral firm maximizes
$$\sum_{k=0}^{\infty} \theta_p^k \mathbb{E}_t^{BR} \left[ \Lambda_{t,t+k} \left( P_t^* Y_{t+k|t} - \Psi_{t+k} \left( Y_{t+k|t} \right) \right) \right] \tag{8}$$
subject to the sequence of demand constraints.
  - $\Lambda_{t,t+k}$ : stochastic discount factor in nominal terms.
  - $\Psi_{t+k}(.)$ : cost function.
  - $Y_{t+k|t}$ : output in $t+k$ for a firm that last reset its price in $t$.
- FOC:
$$\begin{aligned} p_t^* - p_{t-1} &= (1-\beta\theta)\,\Theta \sum_{k=0}^{\infty} (\beta\theta)^k \,\mathbb{E}_t^{BR} \left[ \widehat{mc}_{t+k} \right] \\ &\quad + \sum_{k=0}^{\infty} (\beta\theta)^k \,\mathbb{E}_t^{BR} \left[ \pi_{t+k} \right] \end{aligned} \tag{9}$$

# Phillips Curve

- **Behavioral** Phillips curve

$$\pi_t = \beta M^f \mathbb{E}_t \left[\pi_{t+1}\right] + \kappa \tilde{y}_t \tag{10}$$

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

- **Rational** Phillips curve ($m_x^f = m_\pi^f = \overline{m} = 1$)

$$\pi_t = \beta \mathbb{E}_t \left[\pi_{t+1}\right] + \kappa_{re} \tilde{y}_t \tag{11}$$

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

# Phillips Curve: Comparison

- Our **behavioral** Phillips curve
  - $M^f = \frac{\theta \overline{m}}{1-(1-\theta) m_\pi^f}$
  - $\kappa = m_x^f \frac{(1-\theta)(1-\beta\theta)}{1-(1-\theta) m_\pi^f} \Theta \left(\gamma + \frac{\phi+\alpha}{1-\alpha}\right)$
- Gabaix (2020) **behavioral** Phillips curve
  - $M_G^f = \overline{m} \left(\theta + \frac{1-\beta\theta}{1-\beta\theta\overline{m}} m_\pi^f (1-\theta)\right)$
  - $\kappa_G = m_x^f \frac{(1-\theta)(1-\beta\theta)}{\theta} (\gamma + \phi)$
- Compared to Gabaix (2020), our **fully** microfounded Phillips curve reflects a **stronger role** of $\overline{m}$ and the importance of both, **decreasing return to scale** and **inflation myopia** in $\kappa$.

# Phillips Curve: Contributions (1)

- Gabaix (2020) apply the BTSE to

$$p_t^* - p_{t-1} = (1-\beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k \, \mathbb{E}_t^{BR} \left[ \pi_{t+1} + \ldots + \pi_{t+k} - \mu_{t+k} \right]$$

  where $-\mu_{t+k} = mc_{t+k}$ is the **level** of real marginal cost.
- However, the BTSE should be applied to the **deviation from the steady state** of the variable (Lemma 2.4).
- We apply the BTSE to

$$\begin{aligned} p_t^* - p_{t-1} &= (1-\beta\theta)\, \Theta \sum_{k=0}^{\infty} (\beta\theta)^k \, \mathbb{E}_t^{BR} \left[ \widehat{mc}_{t+k} \right] \\ &\quad + \sum_{k=0}^{\infty} (\beta\theta)^k \, \mathbb{E}_t^{BR} \left[ \pi_{t+k} \right] \end{aligned} \tag{12}$$

- Correct transition from **subjective** to **objective** expectations
  $\Rightarrow$ Our Phillips Curve is **not nested** in Gabaix (2020).

# Phillips Curve: Contributions (2)

- $\kappa \neq \kappa_G$ is related to our assumption of decreasing returns to scale in the production function.
  - Gabaix (2020): constant return to scale $\Rightarrow \kappa_G$.
  - Our formulation: $\kappa$ is a function of $\alpha$ ($\frac{\partial \kappa}{\partial \alpha} < 0$) $\Rightarrow$ lengthens the feedback from **real** to **nominal** variables.
- Decreasing return to scale
  - More realistic (Basu and Fernald, 1997; Jermann and Quadrini, 2007)
  - More realistic role for inflation myopia in $\kappa$.
- $\kappa$ is decreasing with $\alpha$ in the general case ($\alpha \neq 0$):
  - **Incomplete feedback** from output to inflation.
  - Central bank gives less weight to the output gap objective compared to the constant return to scale case.
  - Monetary policy should be more **aggressive** in bringing down inflation. Intuition confirmed by the robustness checks (cf. decreasing vs. constant return to scale calibrations).

# Summary

- Behavioral IS curve

$$\widetilde{y}_t = M\mathbb{E}_t\left[\widetilde{y}_{t+1}\right] - \sigma\left(i_t - \mathbb{E}_t\left[\pi_{t+1}\right] - r_t^n\right) \qquad (13)$$

- Behavioral Phillips curve

$$\pi_t = \beta M^f \mathbb{E}_t\left[\pi_{t+1}\right] + \kappa\tilde{y}_t \qquad (14)$$

- $M$ and $M^f$ augment both equations by reducing the excessive **weight** given to rational expectations (Blanchard, 2009).

# Welfare-Relevant Definitions

- Nominal rigidities alongside real imperfections
  $\Rightarrow$ Inefficient flexible price equilibrium
- Optimal for the central bank to target **efficient allocation**
  $\Rightarrow$ *Welfare-relevant* variables.
  $\Rightarrow$ Model in terms of deviations wrt. efficient aggregates
- Welfare-relevant output: $x_t = y_t - y_t^e$
  - $y_t^e$ is the efficient output
- Welfare-relevant output gap: $\tilde{y}_t = x_t + (y_t^e - y_t^n)$.
  - $y_t^n$ is the natural output (flexible-price output).

# Welfare-Relevant Model

- Welfare-relevant behavioral IS curve

$$x_t = M\mathbb{E}_t x_{t+1} - \sigma \left( i_t - \mathbb{E}_t \left[ \pi_{t+1} \right] - r_t^e \right) \tag{15}$$

  - Efficient interest rate perceived by households:

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

- Welfare-relevant behavioral Phillips curve

$$\pi_t = \beta M^f \mathbb{E}_t \left[ \pi_{t+1} \right] + \kappa x_t + u_t \tag{16}$$

  - $u_t = \kappa \left( y_t^e - y_t^n \right)$ is an $AR(1)$ cost-push shock (Galí, 2015)
    $u_t = \rho_u u_{t-1} + \varepsilon_t^u$ and $\varepsilon_t^u \sim N(0; \sigma_u)$, *i.i.d.* over time.

# Model Calibration

| Parameter | Calibration | Description |
|---|---|---|
| $\beta$ | 0.996 | Static discount factor |
| $\gamma$ | 2 | Household's relative risk aversion |
| $\varepsilon$ | 9 | Elasticity of substitution between goods |
| $\alpha$ | 1/3 | Return to scale |
| $\phi$ | 5 | Frisch elasticity of labor supply |
| $\theta$ | 0.75 | Probability of firms not adjusting prices |
| $\rho_a$ | 0.75 | Technology shock persistence |
| $\rho_u$ | 0.75 | Cost-push shock persistence |

Table 1: Model parameters: Calibration.
Source: Galí (2015).

# Myopia 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 |
| $m_\pi^f$ | 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 |

Table 2: Myopia parameters: Calibration.
Source: Gabaix (2020).

# Optimal Policy

- Microfounded welfare loss measure derived from the second order approximation of the behavioral household's utility

$$\mathbb{W} = \frac{1}{2}\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left( \pi_t^2 + \frac{w_x}{w_\pi} x_t^2 \right) \tag{17}$$

  - $w_\pi = \frac{\epsilon}{\Theta} \frac{\theta}{(1-\beta\theta)(1-\theta)}$,
  - $w_x = \gamma + \frac{\phi+\alpha}{1-\alpha}$.

# Commitment: Analytical Solution

- Central bank:
  - **Credible** + Able to **commit** to a policy plan ⇒ stabilization.
  - Chooses a path for the output gap and inflation over the **infinitely lived horizon** to minimize the welfare loss.
- CB problem FOCs (Lagrange multiplier: $\varphi_t$)

$$\pi_t + \varphi_t - M^f \varphi_{t-1} = 0 \tag{18}$$

$$\frac{w_x}{w_\pi} x_t - \kappa \varphi_t = 0 \tag{19}$$

- Solution:

$$p_t = -\frac{w_x}{\kappa w_\pi} \left( x_t + \left(1 - M^f\right) \sum_{j=0}^{t-1} x_j \right) \tag{20}$$

- A form of PLT is optimal when $\overline{m} = 1$ and $m_\pi^f = 1$.
- A form of IT is optimal when this condition is not satisfied.

# Commitment: Simulation

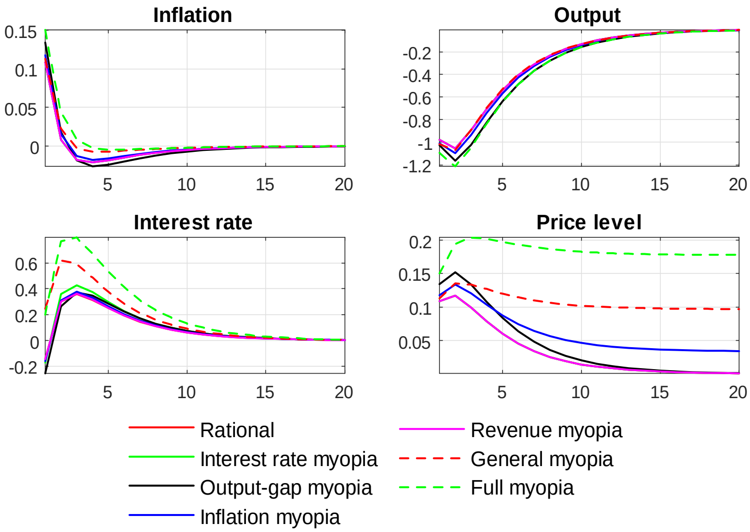


Figure 1: Commitment: Impulse response functions.
Note: responses to a 1% cost-push shock.

# Commitment: Analysis

- **Suboptimality of PLT** under inflation, full and general myopia.
- IT is optimal due to the **welfare cost** induced by CB's decisions to stabilize the price level in a world where people are boundedly rational regarding inflation.
- **Optimality of PLT** under output gap, revenue, and interest rate myopia.
- CB's reactions: output gap, inflation, and revenue myopia are very close to the **rational** case.
- Strong central bank reaction: **interest rate**, **general** and **full** myopia.
- Remaining cases: optimal required action is smoother, and the central bank improves the policy trade-off in a way that allows a deflation to operate and then the price level to be stationary.

# Commitment: Welfare

| 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 |

Table 3: Commitment: Welfare losses.

- Intuitive: rational case generates the lowest welfare loss.
- Interest rate and revenue myopia: same welfare losses as the **rational** benchmark.
  - The CB loss does not penalize deviations of interest rate or revenue: agents are **well-informed** about output and inflation in these two cases.
- General myopia: close to these cases.
- Bounded rationality: **not necessarily welfare decreasing**.

# Discretion: Analytical Solution

- CB "not bound by previous actions or plans and thus is free to make an independent decision every period" (Plosser, 2007)
  - Makes whatever decision is optimal in each period without committing itself to any future actions.
  - Minimizes the welfare loss related to the **decision period**, taking into account that expectations are given.
- Optimal discretionary CB should follow this targeting criterion:

$$\pi_t = -\frac{w_x}{\kappa w_\pi} x_t \tag{21}$$

- 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 has an incentive to drive output below its efficient level to accommodate the cost-push shock.
- Proposition **silent** about the influence of bounded rationality.

# Discretion: Myopia

- Combining and solving forward:

$$\pi_t = \frac{\frac{w_x}{w_\pi}}{\frac{w_x}{w_\pi} + \kappa^2 - \frac{w_x}{w_\pi}\beta M^f \rho_u} u_t \tag{22}$$

$$x_t = \frac{-\kappa}{\frac{w_x}{w_\pi} + \kappa^2 - \frac{w_x}{w_\pi}\beta M^f \rho_u} u_t \tag{23}$$

- CB 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 $\kappa$ $(m_x^f, m_\pi^f)$ and $M^f$ $(\overline{m}, m_\pi^f)$.
- Optimal policy response $\Rightarrow$ **indeterminate** price level but **determinate** inflation $\Rightarrow$ a form of IT is the preferred regime.
- Bounded rationality under discretion influences magnitudes of the reactions to a shock but does not impact the **choice** of the policy regime.

# Discretion: Simulation

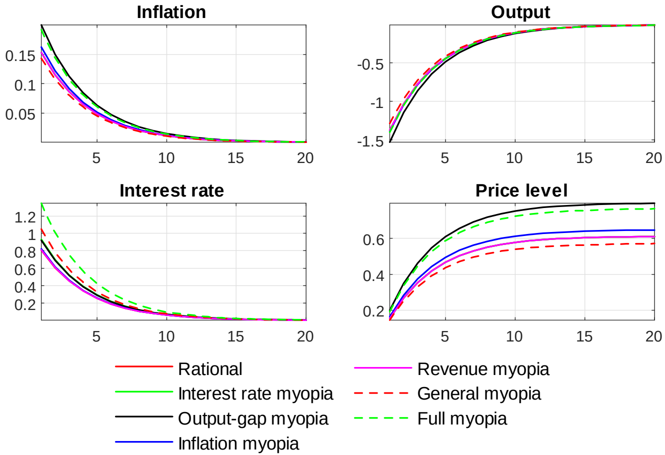


Figure 2: Discretion: Impulse response functions.
Note: responses to a 1% cost-push shock.

# Discretion: Welfare

- IT regime is always the desirable monetary policy.

| **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 |

Table 4: Discretion: Welfare losses.

- Although this result could seem counterintuitive, **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.

# Optimal Simple Rules

| 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 | $i_t = \phi_n \left(p_t + \tilde{y}_t\right)$ |

Table 5: Optimal simple rules: Description

# Optimal Simple Rules: Coefficients

| | F1 | | F2 | | F3 | | F4 | | S1 | S2 | S3 | S4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\phi_\pi$ | $\phi_y$ | $\phi_p$ | $\phi_y$ | $\phi_g$ | $\phi_y$ | $\phi_n$ | $\phi_y$ | $\phi_\pi$ | $\phi_p$ | $\phi_g$ | $\phi_n$ |
| 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 |

Table 6: Optimal simple rules: Coefficients.

# Optimal Simple Rules: Myopia

- The CB **reacts differently** under each regime for each myopia.
- Myopia influences the
  - **sensitivity** of the policy instrument to the CB target.
  - transmission of monetary policy to the output gap.
  - transmission from the output gap to nominal variables.
  - transmission from expectations to inflation.
  - CB **behavior** (to control its target).
- Under general and full myopia, the CB should react **aggressively** to:
  - curb expectations.
  - impact the desired variables.

# Optimal Simple Rules: Regimes

- CB **more sensitive** to its target when operating under strict targeting compared to flexible targeting.
- In line with Rudebusch (2002) and Benchimol and Fourçans (2019):
  - The strict NGDP growth targeting coefficients (S3) are **higher** than for the flexible NGDP growth targeting coefficients (F3) across all myopia types.
  - When the central bank targets the NGDP level (F4 and S4) or the price level (F2 and S2), the coefficients are positive but **lower than one**.
- *Divine coincidence* between stabilizing the price level and the output gap $\Rightarrow$ a form of PLT leads to **self-stabilizing** dynamics for the output gap.

# Optimal Simple Rules: Welfare

| Myopia \ Regimes | 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 |

Figure 3: Optimal simple rules: Welfare losses.
Note: the shading scheme is defined separately in relation to each column. The lighter the shading is, the smaller the welfare loss.

# Optimal Simple Rules: Welfare

- 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.
- **Strict PLT** delivers the lowest welfare among the considered rules, similar to the flexible PLT rule through different myopia cases (divine coincidence when PLT CB).
- Rational case delivers similar welfare losses to interest rate and revenue myopia cases as in commitment and discretion cases.
- The best monetary policy rule is the **strict PLT rule**, whatever types of myopia considered.
- **Inability** of these simple rules to replicate the first best solution (commitment) $\Rightarrow$ optimal policy **depends** on the type of myopia characterizing agents.

# Robustness: Model Parameters

| **Calibration name** | $\beta$ | $\gamma$ | $\phi$ | $\epsilon$ | $\alpha$ | $\theta$ |
|---:|---|---|---|---|---|---|
| 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 |

Table 7: Calibration of the model parameters used for the robustness checks.

# Robustness: 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 |

Table 8: Commitment: Welfare losses.

# Robustness: 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 |

Table 9: Discretion: Welfare losses.

# Robustness: Myopia Parameters

| | 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 |
| $m_\pi^f$ | 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 10: Calibration of the myopia parameters used for the robustness checks.

# Robustness: Commitment

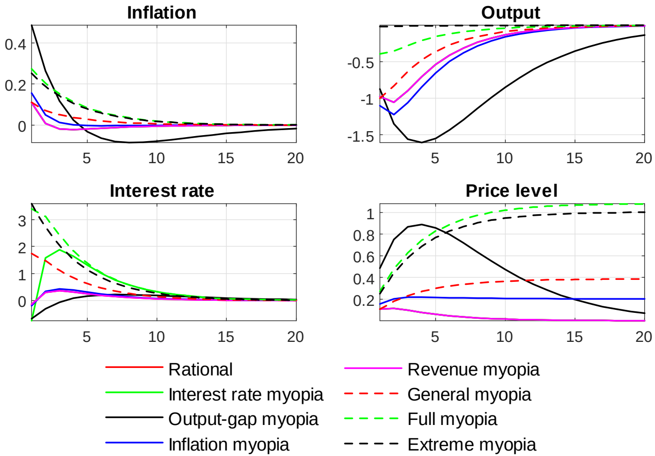


Figure 4: Commitment: Robustness.

Note: Impulse response functions to a 1% cost-push shock.

# Robustness: Discretion

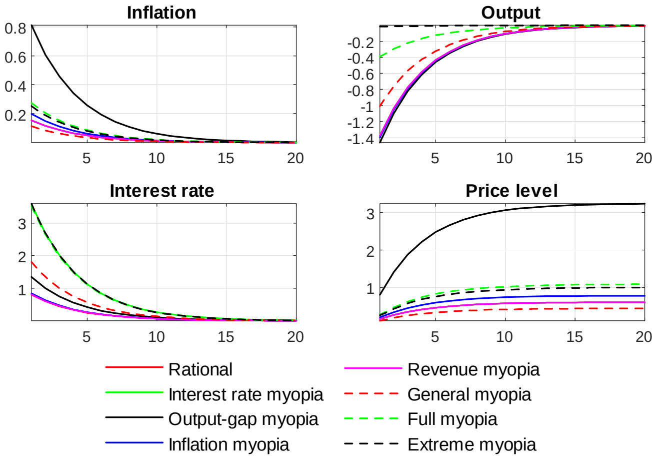


Figure 5: Discretion: Robustness.

Note: Impulse response functions to a 1% cost-push shock.

# Robustness: Welfare

| | 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 |

Table 11: Welfare losses: Robustness.

Note: Model calibration: Table 1. Myopia calibration: Table 10.

- Welfare losses under discretion are always **higher** than under commitment, except under full and extreme myopia.
- General myopia leads to the best welfare losses under commitment and discretion $\Rightarrow$ **myopia may improve welfare**.

# Discussion

- The rational expectations literature results about optimal monetary policy are nested in our model (Fuhrer and Moore, 1995; Galí and Gertler, 1999; Walsh, 2017; Woodford, 2003, 2010).
- Optimal policy is **myopia-dependent**.
- Optimality of a form of **PLT** (interest rate, output gap or revenue myopia) and **IT** (remaining cases) $\neq$ literature
  - Information stickiness (Ball, Mankiw and Reis, 2005),
  - Rational Inattention (Mackowiak and Wiederholt, 2009, 2015),
  - Learning (Eusepi and Preston, 2018),
  - Behavioral NK (Gabaix, 2020).
- **Inability** of simple rules to replicate the first best solution: casting doubt on their usefulness in the CB toolkit.
  - Svensson (2003): the concept of targeting rules is more appropriate to the forward-looking nature of monetary policy.
- Bounded rationality is **not necessarily** associated with welfare losses.

# Bridging the gap

- Revision of the IT framework after the GFC (Bernanke, 2017; Evans, 2018;Blanchard and Summers, 2019).
- PLT overcome the challenges brought by the Zero Lower Bound (Bernanke, 2017).
- Current IT + some adjustments to its parameters: raising the inflation target (Blanchard and Summers, 2019) or allowing interest rates to be negative.
- Before the crisis, debate between IT and PLT (Svensson, 1999).
- We bridge the gap between these competing views:
  - Both forms of targeting (PLT and IT) could be optimal but in different **circumstances**.
  - Assessing bounded rationality is a crucial **indicator** for the CB targeting policy.

# Policy implications (1)

- Agents' expectations **matter** for monetary policy conduct.
- Managing expectations in a behavioral world
  $\Rightarrow$ deviate from a mechanical rule
  $\Rightarrow$ more room for **adapting policies** according to people's perceptions.
- Policymakers' *educate* the public through intensive **communication**
  $\Rightarrow$ increase public **understanding** and **trust** of their monetary policies, among other objectives
  $\Rightarrow$ attenuate myopia
  $\Rightarrow$ may increase welfare.

# Policy implications (2)

- Central banks have to **explore**, **monitor**, and **analyze** agents' myopia.
- 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
  - act consistently rather than educate people and attempt to transform humans into *Homo economicus*.
- Call for *targeting rules*, considering myopia, in the **central banking apparatus** in setting monetary policy decisions.

# Summary

- No definitive answer: neither IT nor PLT is **consistently** optimal under all states of the world.
- Bounded rationality **matters** for the conduct of monetary policy.
- Optimal simple rules: strict PLT in all bounded rationality cases $\Rightarrow$ puzzling observation about replicating the first-best solution.
  - Inability of simple rules to replicate the first best solution calls for a **reconsideration** of their roles in the conduct of monetary policy.
  - New reflection about the **instrument rules** in an economy with behavioral agents.
- Bounded rationality is not necessarily associated with decreased welfare.
- The central bank has to **identify**, **assess** and **monitor** different myopia types to conduct monetary policy optimally.

# Thanks

*Thank you for your attention*

- Comments
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