Optimal Monetary Policy with Behavioral Consumers

Marco Airaudo[a]   Archil Dvalishvili[b]   Mikheil Dvalishvili[b]

[a]School of Economics, Drexel University
[b]The Graduate Center, CUNY

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Motivation

- The baseline New Keynesian model used for policy analysis yields two strong predictions:
  1. Absent cost push shocks, stabilizing inflation is equivalent to stabilizing the welfare-relevant output gap (**Divine Coincidence**).
  2. Public debt dynamics have neutral effects on households' decisions and their welfare (**Ricardian Equivalence**).
- Weak empirical evidence in their support
  - structural VARs document inflation and output responses to TFP (Gali, '99; Gali and Rabanal, '04)
  - sizable S.D. of residuals from Phillips curve's estimation $\Longrightarrow$ stabilizing inflation does not stabilize output (Blanchard, '16)
  - econometric evidence on aggregate data (Ricciuti, '03; Haug, '20) and incentivized individual responses to current and future tax changes in laboratory experiments (Meissner and Rostam-Afschar, '17) reject Ricardian equivalence
- Both predictions are fragile to reasonable *structural* amendments of baseline NK model

Motivation

- This paper takes a **behavioral approach**: the divine coincidence and Ricardian equivalence do not hold in a NK model with infinitely-lived households characterized by Gul and Pesendorfer (ECTA '01, '04) *temptation with self-control preferences*
- A large body of experimental and field research documents preference reversal in intertemporal choices:
    - if asked today about choosing between a low reward at a future period t and a high reward at $t + 1$, they would act patiently and opt for the latter;
    - if put in front of the same choice problem between today and tomorrow, they would act impatiently and prefer the low reward today.
- Such time-inconsistent behavior cannot be explained by the standard discounted utility framework.

Motivation

- GP-preferences allow to reconcile the evidence on the bias for immediate consumption with a model of dynamic consumption choice which preserves time consistency
- GP provide axioms where decision-maker's utility depends on *choice sets* (not just the choice made)
- In our specific set-up:
    - the representative agent is tempted by *hand-to-mouth* behavior: use entire financial wealth (e.g. government bonds) for immediate consumption;
    - resisting temptation involves cognitive effort (or self-control), and hence some disutility;
    - optimal behavior trades off the temptation for immediate satisfaction (temptation utility) with long-run optimal consumption smoothing (commitment utility).

Motivation

- Let
  - $c^r \equiv$ singleton set of optimal consumption by forward-looking *Ricardian* consumer
  - $c^{htm} \equiv$ singleton set of consumption made by a myopic *non-Ricardian* consumer
- Temptation with self-control requires:

$$\{c^r\} \succeq \left\{c^r, c^{htm}\right\} \succeq \left\{c^{htm}\right\}$$

  - $\{c^r\} \succeq \left\{c^r, c^{htm}\right\} \Longrightarrow c^{htm}$ is a tempting option
  - $\left\{c^r, c^{htm}\right\} \succeq \left\{c^{htm}\right\} \Longrightarrow$ the consumer exerts self-control and chooses c^r.

Our Paper

- We use this *behavioral NK* framework to study the design of optimal (welfare-maximizing) monetary policy
- In particular
  1. We identify of central bank's objective (micro-founded loss)
  2. We derive the optimal responses to shocks to total factor productivity and fiscal variables (fully neutralized in the baseline New Keynesian model)
  3. We compute the consumption equivalent welfare costs of business cycle fluctuations.
- Our analysis builds on the linear-quadratic approach of Benigno and Woodford ('03).

Theoretical Models

- Gul-Pesendorfer (ECTA '01, '04), lay out baseline framework with *linear costs* in static and dynamic contexts
- Extensions of GP framework to *convex* and *menu-dependent* costs of self-control by Noor and Takeoka (JMathE '10; TE '15)
- Dual-self model of Fudenberg and Levine(AER '06; AEJMicro '11)

Empirical Evidence

- Convincing experimental evidence on GP-preferences by Toussaert (ECTA '18, WP '19) and Houser et al. (GEB '18)
- General overview in Frederick et al. (JEL '02)

Related Literature

Applications to Macroeconomics

Positive and normative implications of GP-preferences in dynamic macroeconomic models

- Social security (Kumru and Thanopoulos, JPubE '11)
- Optimal capital taxation (Krusell et al., ECTA '10)
- Asset pricing (DeJong and Ripoll, JME '07)
- Welfare cost of business cycle fluctuations (Huang et al., JMCB '15)
- Forward guidance puzzle (Airaudo, JET '20)
- Housing and hand-to-mouth behavior (Attanasio et al., NBER '21; Kovacs, IER '21)
- Monetary-fiscal policy coordination and determinacy (Airaudo, '23)

Preview of Results

We find that, under GP-preferences

1. Euler equation is distorted by public debt fluctuations;
2. public debt volatility enters as an additional term in the central bank's objective;
3. divine coincidence breaks even in the absence of cost-push shocks;
4. welfare costs of fluctuations are declining in temptation

The Model

Overview

- The backbone of our model economy is identical to the baseline New Keynesian model used for monetary policy analysis:
  - A continuum of identical infinitely-lived households who consume and save (demand side).
  - A continuum of sticky price monopolistically competitive good producing firms (supply side).
  - A unified monetary/fiscal authority.
- Standard supply side: Calvo price setting problem with monoplistically competitive firms
- **Key innovation**: GP-preferences for households, as developed in Airaudo ('20).

Household chooses commitment plan $a = \{c_t, h_t, b_t\}_{t=0}^{\infty}$ and temptation plan $\tilde{a} = \{\tilde{c}_t, \tilde{h}_t, \tilde{b}_t\}_{t=0}^{\infty}$ to solve a dynamic program:

$$\mathcal{U}_t = \max_a \{u(c_t, h_t) + \nu(c_t, h_t) + \beta E_t \mathcal{U}_{t+1}\} - \max_{\tilde{a}} \nu(\tilde{c}_t, \tilde{h}_t)$$

$$c_t + b_t = R_{t-1}\frac{b_{t-1}}{\pi_t} + w_t h_t + d_t - \tau_t, \qquad b_t \geq 0$$

- **Self-control cost**: utility difference between most tempting option (consume all wealth, $\tilde{b}_t = 0$) and optimal long-run plan

$$SCC = \max_{\{\tilde{c}_t, \tilde{h}_t\}} \nu(\tilde{c}_t, \tilde{h}_t) - \nu(c_t, h_t) > 0$$

- **Temptation parameter**: $\xi \geq 0$

$$\underbrace{u_t = \ln x_t}_{\text{commit. utility}}, \qquad x_t \equiv c_t - \frac{h_t^{1+\chi}}{1+\chi} \text{ (GHH utility)}, \qquad \underbrace{v_t = \xi u_t}_{\text{tempt. utility}}$$

- Household's problem gives a **Generalized Euler Equation**

$$x_t^{-1}(1+\xi) = \beta R_t E_t\left[\frac{x_{t+1}^{-1}+\xi(x_{t+1}^{-1}-\tilde{x}_{t+1}^{-1})}{\pi_{t+1}}\right] \quad (1)$$
$$\tilde{x}_t = x_t + b_t$$

- Temptation introduces two key changes
  1. It affects the **consumption-saving trade-off**
     - MB of current consumption (LHS of (1)) accrued by factor $(1+\xi)$
     - MB of saving (RHS of (1)) augmented by (marginal) disutility cost of self-control, $\xi(x_{t+1}^{-1}-\tilde{x}_{t+1}^{-1})>0$ (as $\tilde{x}_{t+1}=x_{t+1}+b_{t+1}>x_{t+1}$)
  2. It introduces **negative real wealth effects** from bond holdings in Euler equation (Ricardian Equivalence breaks)
     - by increasing $\tilde{x}_{t+1}$, higher b_{t+1} lowers the future marginal costs of self-control
     - forward-looking households have an additional incentive to save

Optimal Monetary Policy

Objective of the Analysis

- We study the consequences of GP-preferences for the design of optimal monetary policy, both under discretion and commitment.
- For this purpose, we pursue a 2nd order approximation to household's welfare
- Not straightforward
  - a linear debt term appears in loss function
  - to guarantee accuracy of solution, we eliminate that by 2nd order approximation to household's intertemporal budget constraint

Proposition 1

Maximization of representative household's welfare is equivalent to the minimization of following intertemporal loss

$$\mathcal{L}_0 \equiv \frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \left[\alpha_y \left(\hat{y}_t - \hat{y}_t^* \right)^2 + \alpha_\pi \hat{\pi}_t^2 + \alpha_b (\hat{b}_t - \hat{b}_t^*)^2 \right]$$

with

$$\begin{aligned} \text{Debt Target:} \quad & \hat{b}_t^* = \text{ lin. comb. of demand shocks} \\ \text{Welfare Weights} \quad : \quad & \alpha_\pi, \alpha_y > 0 \qquad \alpha_b < 0 \\ & |\alpha_\pi| >> |\alpha_b| \end{aligned}$$

REMARK: Groll and Monacelli ('20) show loss depends (negatively) on terms-of-trade volatility in 2-country model

Optimal Monetary Policy under Discretion

Markov Perfect Equilibrium

- Optimal monetary policy is found by solving

$$\min_{\{\hat{y}_t,\hat{\pi}_t,\hat{b}_t,\hat{R}_t\}} \frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \left[\alpha_y(\hat{y}_t - \hat{y}_t^*)^2 + \alpha_\pi \hat{\pi}_t^2 + \alpha_b(\hat{b}_t - \hat{b}_t^*)^2\right] \quad \text{s.t.}$$

$$\begin{aligned}
\hat{\pi}_t &= \tilde{\beta} E_t \hat{\pi}_{t+1} + \kappa_y(\hat{y}_t - \hat{y}_t^*) + \hat{e}_t \\
\hat{R}_t &= E_t \hat{\pi}_{t+1} + \gamma_b(\hat{b}_t - \hat{b}_t^*) + \underbrace{\mathcal{M}_t}_{\text{lin. comb. of demand shocks}} \\
\hat{b}_t - \hat{b}_t^* &= \rho_b(\hat{b}_{t-1} - \hat{b}_{t-1}^* + \hat{R}_{t-1} - \hat{\pi}_t) + \underbrace{\mathcal{N}_t}_{\text{lin. comb. of demand shocks}}
\end{aligned}$$

- With $\alpha_b, \gamma_b \neq 0$, optimal monetary policy is also dynamic under discretion
  $\Longrightarrow$ we solve for a Markov-Perfect-Equilibrium (MPE)

Optimal targeting rule under discretion

$$\alpha_\pi \kappa_y \hat{\pi}_t + \alpha_y \hat{y}_t^{GAP} \underbrace{- \alpha_b \rho_b \kappa_y \hat{b}_t^{GAP}}_{\text{debt targeting}} = \underbrace{\eta}_{\in(0,1)} E_t \left(\alpha_\pi \kappa_y \hat{\pi}_{t+1} + \alpha_y \hat{y}_{t+1}^{GAP} \right) \quad (2)$$

- **Without temptation**: $\xi = 0 \implies \alpha_b = 0$, solving forward

$$\alpha_\pi \kappa_y \hat{\pi}_t + \alpha_y \hat{y}_t^{GAP} = 0$$

$\implies$ combined with equilibrium conditions, *divine coincidence* holds

- **With temptation**, targeting rule modified along two dimensions
  1. A dynamic trade-off between stabilizing current versus expected next period inflation and output (RHS of (2))
  2. Additional static component related to deviations of debt from target (on LHS of (2)).

We consider $\xi \in [0, 0.3]$
Kovacs et al. (IER, '21), Attanasio et al. (NBER, '21), Airaudo et al. '23

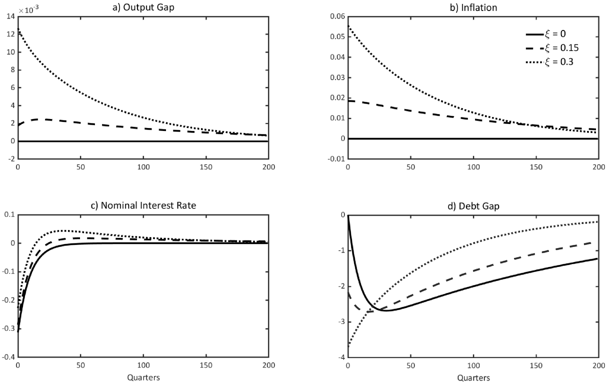
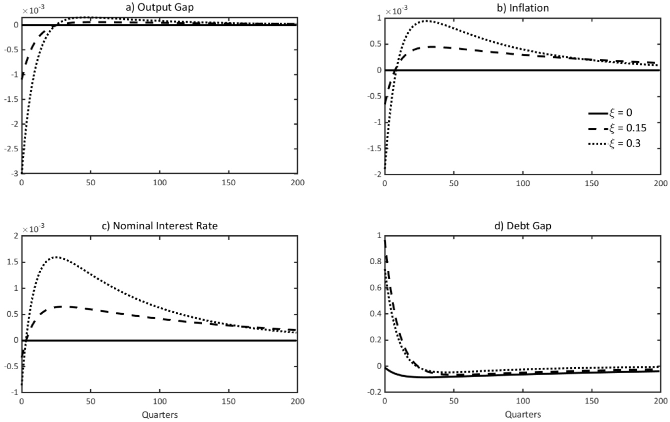


Figure:

Optimal Monetary Policy under Discretion

Impulse Responses to 1% Fiscal Shock



- For simplicity, suppose $\alpha_y = 0$
  $\Longrightarrow$ targeting rule under discretion

$$
\begin{aligned}
\hat{\pi}_t &= \eta E_t \hat{\pi}_{t+1} + \alpha \rho_b (\hat{b}_t - \hat{b}_t^*) \\
\alpha &\equiv \alpha_b / \alpha_\pi < 0, \qquad \eta \in (0,1)
\end{aligned}
$$

- By forward iteration

$$
\hat{\pi}_t = \alpha \rho_b E_t \sum_{j=0}^{\infty} \eta^j (\hat{b}_{t+j} - \hat{b}_{t+j}^*)
$$

- Expected cumulative debt gaps are NEGATIVE (for TFP shock) and POSITIVE (for fiscal shock)

Optimal Monetary Policy under Discretion

Some Remarks

- In baseline NK model, inflation
  - does not respond to TFP under OMP (divine coincidence)
  - responds negatively to TFP under Taylor rule (b/c lower marginal costs)
- Here, the inflation response is positive
  - as in HANK models (driven by counter-cyclical earning risk channel and incomplete markets)
  - as in empirical work by Ravn and Sterk (2021)

- Define L_J, the unconditional welfare-based loss under policy J

$$\mathcal{L}_J = \alpha_y Var(\hat{y}_{J,t} - \hat{y}_t^*) + \alpha_\pi Var(\hat{\pi}_{J,t}) + \alpha_b Var(\hat{b}_{J,t} - \hat{b}_t^*)$$

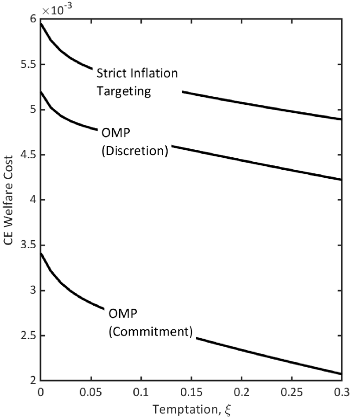
for

$$J = SIT, \ OMP^{disc}, \ OMP^{comm}, \ TR$$

- The **consumption equivalent (CE)** welfare cost of policy J is the steady state share δ_J of consumption to be given up to make households as well off in the stochastic equilibrium under policy J as in the non-stochastic efficient steady state (Schmitt-Grohe and Uribe, '07)

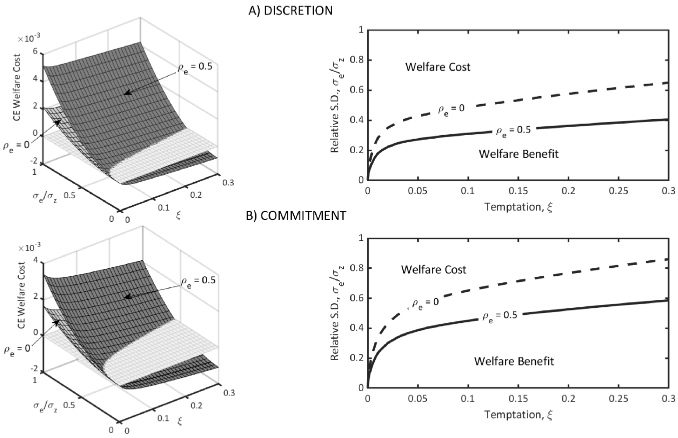
Welfare Analysis

Welfare Costs under Alternative Policies



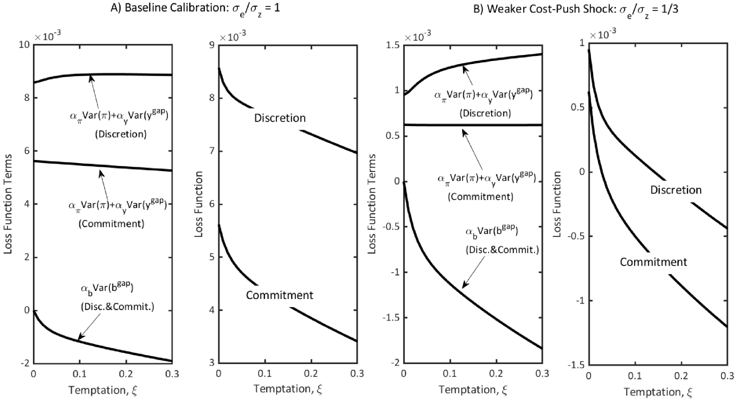
Welfare Analysis

Demand-driven Volatility and Welfare Benefits



Welfare Analysis

Temptation and Unconditional Loss



Welfare Analysis

Some Intuition

With temptation, higher wealth volatility may increase household's welfare. This can be explained in two steps:

1. Loss L_J is strictly decreasing in ξ.
   - Main driver is the new term $\alpha_b Var(\hat{b}_t^{GAP})$
   - As $\alpha_b < 0$ and strictly decreasing in ξ, stronger temptation amplifies the negative effect of wealth volatility on the loss.
2. Higher wealth volatility lowers cognitive costs of self-control
   - Self-control costs are strictly concave in debt-to-income ratio
   - Higher debt-to-income variation lowers (unconditional) expectation of self-control costs.

Conclusions

- We study the design of optimal monetary policy in a NK model where agents are subject to temptation with self-control issues in intertemporal decisions, à-la Gul and Pesendorfer ('01, '04).
- GP-preferences break the *Divine Coincidence* and *Ricardian Equivalence*
  - CB can no longer neutralize demand-side shocks
  - Debt volatility (around welfare-relevant target) enters CB's objective
- Welfare costs of economic fluctuations are decreasing in extent of temptation as wealth volatility has negative impact on (expected) cognitive costs of self-control.