Monetary policy along the yield curve: Why can central banks affect long-term real rates?

Paul Beaudry (UBC), Paolo Cavallino (BIS), Tim Willems (BoE)

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Introduction

- What drives long-run real rates of interest?

- Standard view: *real* rate is driven by *real* factors
  - Demographics
  - Productivity growth
  - Safe asset supply/demand

- But: monetary policy decisions have strong effects on long-term rates (Cochrane & Piazzesi, 2002; Hanson & Stein, 2015; Bianchi et al., 2022)
  - Hillenbrand (2023): entire post-80s decline in long-term rates has occurred in narrow windows around FOMC dates
    - ⋆ Fed information effect (Nakamura & Steinsson, 2018)

Alternative hypothesis

- Fed has greater power to affect long-term real rates than usually thought
  - Fed has no such power in standard NKM

- Let output be determined according to:

$$\hat{y}_t = \mathbb{E}_t \sum_{j=0}^{\infty} \psi_j (r_{t+1+j} - r^*)$$

  - NKM has $\psi_j = -1/\sigma \ \forall j$
    - Irrespective of the horizon j, having $r_{t+1+j} < r^*$ has the exact same expansionary effect (and vice versa) in a way that cumulates unboundedly with persistence

Alternative hypothesis (ii)

- When CB follows an interest rate rule with intercept r^L:

$$\hat{y}_t = \sum_{j=0}^{\infty} \psi_j^y \mathbb{E}_t(r_{t+1+j} - r^L) + \Psi^y(1)(r^L - r^*), \;\; \Psi^y(1) \equiv \sum_{j=0}^{\infty} \psi_j$$

  - NKM has $\Psi^y(1) = -\infty \Rightarrow$ crucial for a CB to know r^* with greatest precision
    - Discounted Euler equation has "$\Psi^y(1) = -$*large*"

- This paper: CB may be able to affect long rates b/c persistent rate changes have weak effects on activity ($\Psi(1) \approx 0$)
  - Long-term r^* not a very constraining object for CBs
  - System is "forgiving" to a CB misperceiving r^* (i.e., having an interest rate rule with $r^L \neq r^*$)

Mechanism

- In RANK (solely driven by IS), more persistent rate changes have bigger effects on output and inflation
  - Lower rates are expansionary irrespective of horizon
- No longer true in OLG-setup with retirement state
  - Lower rates (especially if "for long") can *increase* desire to save
    - Ring (2024): wealth tax in Norway ($r \downarrow$) made households save *more*
  - ABP (2019): "*Pensions are becoming increasingly expensive (...) Given the current ambitition and expectating that rates will remain low for a long time, higher premiums will be needed*"
    - Individuals naturally born "short duration" $\rightarrow$hurt by low rates

Model - demographic structure

- FLANK: Finitely-Lived Agent New Keynesian model

- Blanchard-Yaari + retirement state (as in Gertler 1999)
  - Measure 1 of households who work $\rightarrow$ retire $\rightarrow$ die
  - Working households retire with prob δ_1
  - Retired households die with prob δ_2

Model - households

- Households have a CCRA utility function, with working ones experiencing disutility from labor:

$$u_{t,j} = \frac{c_t^{1-\sigma}}{1-\sigma} - \mathbf{1}_{j=wrk} \frac{\ell_t^{1+\varphi}}{1+\varphi}$$

- Retired households only derive income from interest r on accumulated stock of savings, a_t^r

- Working households also have labor income $(w_t \ell_t)$ on top

Model - good-producing firms

- A measure 1 of monopolistically competitive firms produce differentiated goods using technology:

$$y_t(j) = A\ell_t(j)$$

- Maximize profits subject to Rotemberg (1982) cost of price adjustment relative to trend inflation rate $\bar{\pi} = 1$

- Gives rise to the standard NKPC

Model - public sector

- Model features long-term bonds (b, constant in supply): real perpetuity with decaying coupon

$$r_{t+1}^b = \frac{1 + (1 - \mu)\, q_{t+1}}{q_t}$$

- Monetary policy is set according to a Taylor-type rule, hit by AR(1) MP shocks (ε_t^i):

$$i_t = r\bar{\pi} \left(\frac{\mathbb{E}_t \left[\pi_{t+1} \right]}{\bar{\pi}} \right)^{1+\phi} e^{\varepsilon_t^i}$$

Model - simplification

- In principle, share of wealth held by workers (vs retirees) becomes a state variable

- Assumption: upon retiring, household receives a transfer which keeps the distribution of financial wealth between workers and retirees constant at steady state
  - Leads to a compact system that can be analyzed quite easily
  - Checked numerically that this assumption doesn't change results much

Model - log-linear equilibrium

- The log-linearized equilibrium is

$$\begin{aligned}
\hat{q}_t &= -\mathbb{E}_t \hat{r}_{t+1} + \beta(1-\mu)\,\mathbb{E}_t \hat{q}_{t+1} \\
\hat{\Gamma}_t &= \beta(1-\delta_2)^{\frac{1}{\sigma}} \left[\mathbb{E}_t \hat{\Gamma}_{t+1} + \frac{\sigma-1}{\sigma}\mathbb{E}_t \hat{r}_{t+1}\right] \\
\hat{y}_t &= (1-\gamma)\,\hat{c}_t^w + \gamma \hat{c}_t^r \\
\hat{\pi}_t &= \kappa \hat{y}_t + \beta \mathbb{E}_t \hat{\pi}_{t+1} \\
\mathbb{E}_t \hat{r}_{t+1} &= \phi \mathbb{E}_t \hat{\pi}_{t+1} + \varepsilon_t^i \\
\hat{c}_t^r &= \hat{q}_t + \left[\beta(1-\delta_2)^{\frac{1}{\sigma}}\right]^{-1} \hat{\Gamma}_t \\
\hat{c}_t^w &= (1-\delta_1)\left(\mathbb{E}_t \hat{c}_{t+1}^w - \frac{1}{\sigma}\mathbb{E}_t \hat{r}_{t+1}\right) + \delta_1 \left(\hat{q}_t + \left[\beta(1-\delta_2)^{\frac{1}{\sigma}}\right]^{-1} \hat{\Gamma}_t\right)
\end{aligned}$$

Monetary transmission mechanism

- With retirement preoccupations ($\delta_1 > 0$), MTM moves away from intertemporal substitution

$$\hat{c}_t^w = (1 - \delta_1)\left[\mathbb{E}_t \hat{c}_{t+1}^w - \frac{1}{\sigma}\mathbb{E}_t \hat{r}_{t+1}\right] + \delta_1 \left[\hat{q}_t + \left[\beta (1 - \delta_2)^{\frac{1}{\sigma}}\right]^{-1} \hat{\Gamma}_t\right]$$

- MTM has three channels:

1. Intertemporal substitution: $r \uparrow \rightarrow c \downarrow$, as governed by $1/\sigma$
2. Asset valuation channel: $r \uparrow \rightarrow q \downarrow \rightarrow c \downarrow$
3. Asset demand channel (related to interest income that savings are expected to generate going forward): $r \uparrow \rightarrow c \uparrow$
    - Works in the dissonant direction!

Term-structure representation

- Repeated substitution (recognizing q and Γ are functions of r):

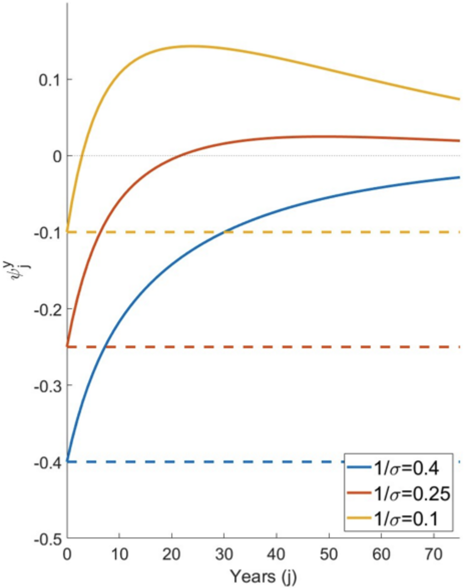
$$\hat{y}_t = \sum_{j=0}^{\infty} \psi_j^y \mathbb{E}_t \hat{r}_{t+1+j}$$

$$\psi_0^y = -\frac{1}{\sigma}$$

$$\psi_j^y = (1-\delta_1)\psi_{j-1}^y + \frac{\sigma-1}{\sigma}\zeta_1\beta^j(1-\delta_2)^{\frac{j}{\sigma}} - \zeta_2\beta^j(1-\mu)^j$$

- Different parts of YC have different effects on activity
  - Potentially even with a different sign!

MP effects vary along the yield curve in FLANK



Effects of monetary shocks (i)

- MP shock is AR(1): $\varepsilon_t^i = \rho_i \varepsilon_{t-1}^i + \epsilon_t^i$

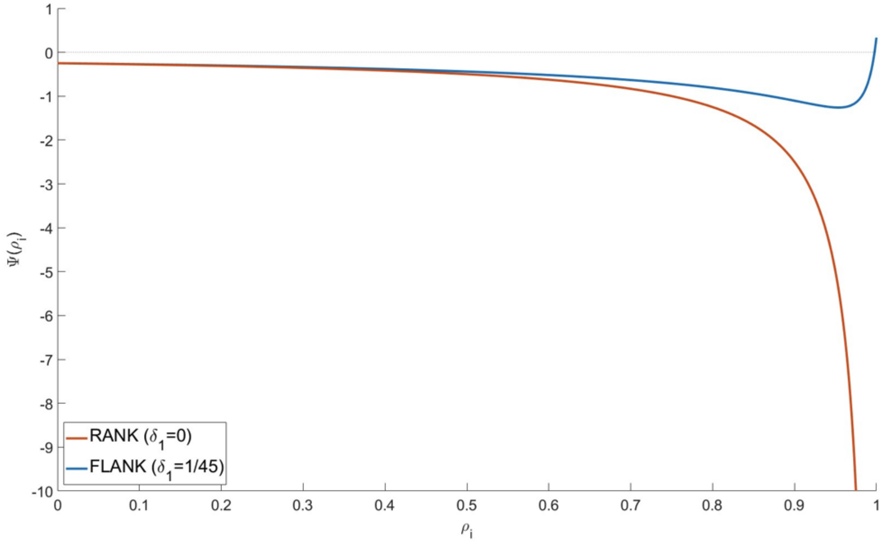
- Impact responses to such MP shock are:

$$\hat{y}_0 = \left(-\frac{1}{\sigma} \frac{(1-\gamma)(1-\delta_1)}{1-\rho_i(1-\delta_1)} + \xi(\delta_1) \left[\frac{\frac{\sigma-1}{\sigma}}{1-\rho_i \beta (1-\delta_2)^{\frac{1}{\sigma}}} - \frac{1}{1-\rho_i \beta (1-\mu)} \right] \right) \epsilon$$
$$\equiv \Psi(\rho_i) \epsilon_0^i$$

- For $\delta_1 = 0$ (RANK):

$$\hat{y}_0 = -\frac{1}{\sigma} \frac{\epsilon_0^i}{1-\rho_i}$$

Total effect: RANK vs FLANK



Total effect of persistent MP shock

- Taking $\rho_i \to 1$, the competing channels become apparent

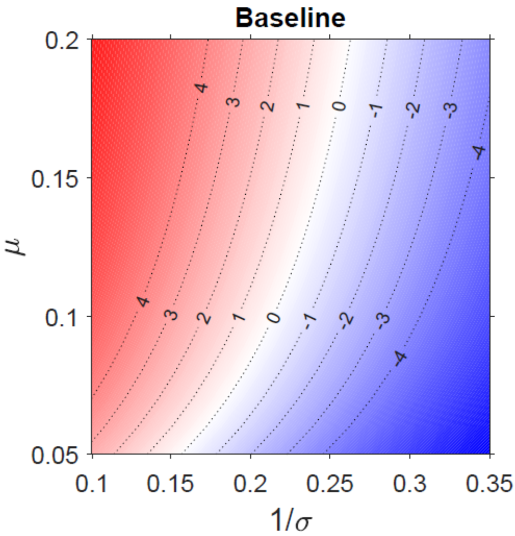
$$\Psi^y(1) = \underbrace{-\frac{1}{\sigma}\left[\frac{(1-\gamma)(1-\delta_1)}{\delta_1} + \frac{1}{1-\beta(1-\delta_2)^{\frac{1}{\sigma}}}\right]}_{\textit{intertemporal substitution}}$$

$$+ \underbrace{\frac{1}{1-\beta(1-\delta_2)^{\frac{1}{\sigma}}}}_{\textit{asset demand}} - \underbrace{\frac{1}{1-\beta(1-\mu)}}_{\textit{asset valuation}}$$

$$= \underbrace{\frac{1-1/\sigma}{1-\beta(1-\delta_2)^{\frac{1}{\sigma}}} - \frac{(1-\gamma)(1-\delta_1)}{\sigma\delta_1}}_{\textit{MPC out of wealth}} - \underbrace{\frac{1}{1-\beta(1-\mu)}}_{\textit{asset valuation}}$$

- Whenever MPC out of wealth $\uparrow$ as $r \uparrow$ permanently, $\Psi^y(1) \approx 0$ is possible

Total effect of persistent MP shock (ii)



On the (ir)relevance of r*

- Euler equation can be rewritten as:

$$\hat{y}_t = \sum_{j=0}^{\infty} \psi_j^y \mathbb{E}_t(r_{t+1+j} - r^L) + \Psi^y(1)(r^L - r^*), \; \Psi(1) \equiv \sum_{i=1}^{\infty} \psi_i^y$$

- RANK has $\Psi^y(1) = -\infty$
  - Crucial that CB knows r^* with the greatest precision

- When $\Psi^y(1) \approx 0$, as in FLANK, pull from true r^* is weak
  - CB can easily steer towards some other terminal rate $r^L \neq r^*$
  - Private sector's best guess of long-term rates is whatever the CB thinks about r*, $E_t^{CB}\{r_t^*\}$
    - CB's belief gets a self-fulfilling aspect to it

Laubach-Williams estimation of r*

- Start from canonical Euler equation + RW assumption on r*:

$$c_t = \mathbb{E}_t c_{t+1} - \frac{1}{\sigma}(r_t - r_t^*) + v_t, \; v_t \sim iid$$
$$r_t^* = r_{t-1}^* + w_t, \; w_t \sim iid$$

- Can define $z_t \equiv \sigma(c_t - E_t c_{t+1} - \frac{1}{\sigma} r_t)$
  - Implies $z_t = r_t^* + \sigma v_t$
- Then, long-run variation in z_t will be driven by r_t^* and Kalman filter will recover it
- Core of Laubach-Williams approach to estimating r_t^*

Laubach-Williams estimation of r* (ii)

- Question: what if there is model misspecification? In particular, what if data are generated by FLANK-style Euler equation?

$$c_t = -\sum_{j=1}^{\infty} \psi_j^y \mathbb{E}_t r_{t+j} + \Psi(1) r_t^* + v_t$$

- Say that CB sets monetary policy according to:

$$r_t = \mathbb{E}_t^{CB}\{r_t^*\} + \theta v_t$$

  - $\mathbb{E}_t^{CB}\{r_t^*\}$ = CB's r* belief; θ = response to demand shocks "v_t"
- Then, $z_t \equiv \sigma(c_t - \mathbb{E}_t c_{t+1} - \frac{1}{\sigma} r_t)$ in part reflects $\mathbb{E}_t^{CB}\{r_t^*\}$:

$$z_t = \mathbb{E}_t^{CB}\{r_t^*\} + ((\sigma - 1) + \theta) v_t$$

- CB mainly ends up recovering its own prior beliefs + its own actions "θ" in response to shocks v_t

Conclusions

- Taking life-cycle forces seriously matters for monetary policy!
  - Monetary policy can have qualitatively different effects across the yield curve
    - Effect of persistent monetary policy shocks is weaker (close to 0), possibly unconventional
  - Long-term real rates not firmly pinned down, meaning that the central bank may have significant control over them (without creating massive boom/recession)
- Implications:
  - Smoother monetary policy ("high/low for long") less powerful
    - Monetary policy faces a "persistence-potency trade-off"
  - Laubach-Williams style estimation of r* likely biased
  - Exact location of r* is ultimately an object of limited practical relevance in setting policy; there will be distributional implications