Life-cycle forces make monetary policy transmission wealth-centric

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

The views expressed in this paper are those of the authors, and not necessarily those of the Bank of England or its committees.

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Introduction

- Standard New Keynesian model has intertemporal substitution at its core
  - But empirical estimates suggest EIS=small (Best et al., 2020)
- Much recent progress in NK-style models featuring other transmission channels
  - Financial frictions
  - Informational frictions
  - Liquidity constraints
- This paper: how do life-cycle forces affect the MTM?
  - Interest changes not only affect the intertemporal price of consumption, but also the desire to hold assets (as well as their value)

Core idea

- Standard logic: lower interest rates stimulate spending (IS)
- But does it, if working agents need to save for their retirement?
  - Rajan (2013): "*Persistently-low rates may not be expansionary as savers put more money aside (...) in order to meet the savings they think to need when they retire*"
  - 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*"
- Link between interest rates and consumption now affected by:
  - Intertemporal substitution: $r \uparrow$ is contractionary
  - Asset valuation: $r \uparrow$ lowers asset prices $\rightarrow$ contractionary
  - Asset demand: $r \uparrow$ raises income flow $\rightarrow$ expansionary

Key findings

- Financial wealth emerges as a key variable to the MTM
  - Rate changes need to have a sufficiently strong effect on asset prices for MTM to work in conventional direction
- Potency of conventional MP is affected by CB's balance sheet composition
  - QE reduces interest-rate sensitivity of household assets $\rightarrow$ weakens "asset valuation channel"
- Rath path starts to matter
  - "High for long" or "low for long" policies may be less effective
- CB may need to stabilize asset prices following financial shocks $\Rightarrow$ "Greenspan put"

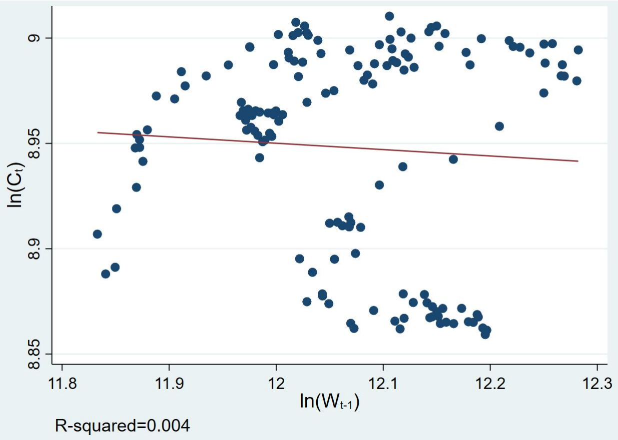
Empirical motivation (i)

- Life-cycle forces create a "target" level for asset holdings (Modigliani)
- Not wealth *per se* that drives consumption, but wealth relative to targeted wealth ("excess wealth")
  - Lower r tends to boost asset valuation $\rightarrow$ expansionary
  - Lower r may also increase asset demand $\rightarrow$ contractionary
- Important to control for the level of interest rates
  - Having \$100k is very different between $r = 1\%$ and $r = 5\%$
- Model tells us *how* to control for different values of r:

$$\mathcal{A}_t(r_t) = (\rho + \delta_2 + (\sigma - 1)r_t)\,(\rho + \delta_1 + \sigma g - r_t)^{1/\sigma}$$

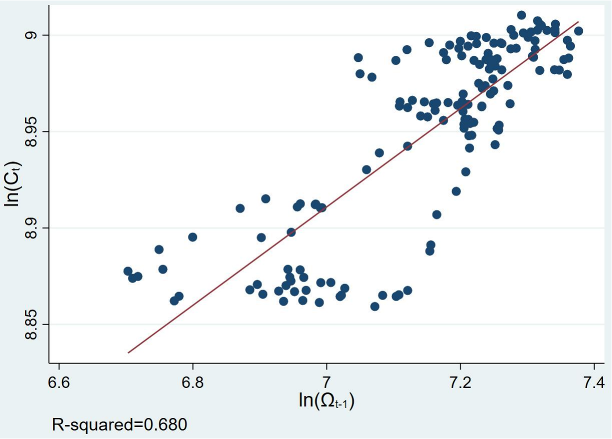
Empirical motivation (ii)

- "Raw" US household wealth levels are ∼uncorrelated with US consumption: $corr(\ln C_t, \ln W_{t-1}) = -0.064$



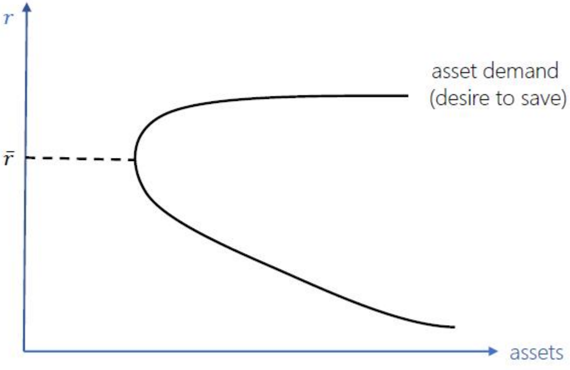
Empirical motivation (iii)

- Remarkable increase once one looks at $\Omega_t \equiv \mathcal{A}(r_t) W_t$: $corr(\ln C_t, \ln \Omega_{t-1}) = +0.825$



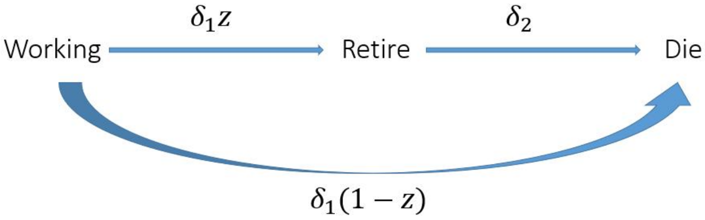
Empirical motivation (iv)

- When $\sigma > 1$ ($EIS < 1$), $\mathcal{A}_t(r_t)$ is C-shaped:



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 $\delta_1 z$; die immediately with prob $\delta_1 (1 - z)$
  - Retired households die with prob δ_2



Model - retired households

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

$$V^r\left(\tilde{a}_t^r\right) = \max_{c_t^r} \left\{ \frac{\left(c_t^r\right)^{1-\sigma}}{1-\sigma} + \beta \mathbb{E}_t\left[\left(1-\delta_2\right) V^r\left(\tilde{a}_{t+1}^r\right)\right] \right\}$$

$$s.t.\ \tilde{a}_{t+1}^r = r_{t+1}^d\left(\tilde{a}_t^r - c_t^r\right) + bond\ revaluation$$

- Optimality conditions yield $V^r\left(\tilde{a}_t^r, \Gamma_t\right) = \frac{\left(\tilde{a}_t^r\right)^{1-\sigma}}{1-\sigma}\Gamma_t$ and

$$c_t^r = \tilde{a}_t^r \Gamma_t^{-\frac{1}{\sigma}}$$

$$\left(\Gamma_t^{\frac{1}{\sigma}} - 1\right)^{\sigma} = \left(1-\delta_2\right)\beta \mathbb{E}_t\left[\left(r_{t+1}^d\right)^{1-\sigma}\Gamma_{t+1}\right]$$

  - Γ captures expected future rate path, working over $\tilde{a}^r$

Model - working households

- Households work and own firms:

$$V^{w}\left(\tilde{a}_{t}^{w}\right)=\max_{c_t^w,a_t^w}\left\{\frac{\left(c_{t}^{w}\right)^{1-\sigma}}{1-\sigma}-\chi\frac{\left(\ell_{t}\right)^{1+\varphi}}{1+\varphi}+\beta\mathbb{E}_{t}\left[\begin{array}{c}\left(1-\delta_{1}\right)V^{w}\left(\tilde{a}_{t+1}^{w}\right)+\\ \delta_{1}z_{s}V^{r}\left(\tilde{a}_{t+1}^{r},\Gamma_{t+1}\right)\end{array}\right]\right\}$$

$$s.t.\ \tilde{a}_{t+1}^{w}=r_{t+1}^{d}(\tilde{a}_{t}^{w}-c_{t}^{w}+w_{t}\ell_{t}+\tau_{t})+bond\ revaluation$$

  - $z_s = z + \varpi$ is *subjective* prob of surviving retirement shock
- Optimality conditions:

$$w_{t}=\chi\left(c_{t}^{w}\right)^{\sigma}\left(\ell_{t}\right)^{\varphi}$$

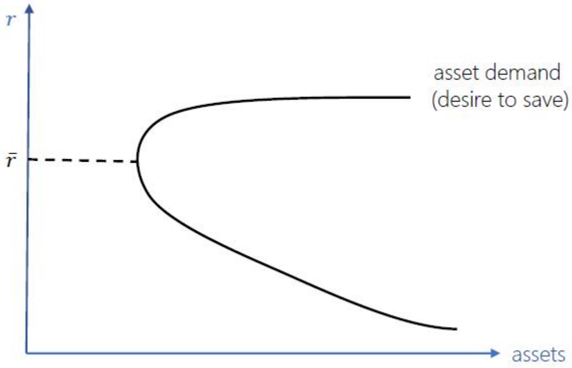
$$\left(c_{t}^{w}\right)^{-\sigma}=\beta\mathbb{E}_{t}\left\{\begin{array}{c}\left(1-\delta_{1}\right)\left[\left(c_{t+1}^{w}\right)^{-\sigma}r_{t+1}\right]+\\ z_{s}\delta_{1}\left(a_{t+1}^{w}\right)^{-\sigma}\Gamma_{t+1}r_{t+1}\end{array}\right\}$$

Model - asset demand

- Steady-state asset demand:

$$y\left[\frac{\delta_1\varpi\beta}{1-\beta r\left(1-\delta_1\right)}\right]^{\frac{1}{\sigma}}\left\{r^{\frac{\sigma-1}{\sigma}}-\left[\left(1-\delta_2\right)\beta\right]^{\frac{1}{\sigma}}\right\}^{-1}$$

- If $\sigma > 1$, then:



Model - good-producing firms

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

$$y_t = A\ell_t$$

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

$$(\pi_t - 1)\,\pi_t = \kappa\,(mc_t - 1) + \mathbb{E}_t\left[\Lambda_{t,t+1}\,(\pi_{t+1} - 1)\,\pi_{t+1}\frac{y_{t+1}}{y_t}\right]$$

Model - financial firms

- Collect deposits and invest in short- and long-term bonds:

$$q_t b_t + s_t = a_t$$

- s are central banks reserves (paying $r_{t+1} = i_t / \pi_{t+1}$) and b is a real perpetuity with decaying coupon:

$$r^b_{t+1} = \frac{1 + (1-\rho)\, q_{t+1}}{q_t}$$

Model - public sector

- Government issues short- and long-term bonds, in constant supply:

$$s_t = s$$
$$b_t = b$$

- Let $\eta \equiv qb/(s + qb)$ denote the share of long-term bonds
  - $\eta \approx$ duration

- Monetary policy is set according to a Taylor-type rule:

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

Model - simplification

- Role played by retirees is relatively clear: lower r contracts their consumption possibilities

- Focus on the impact of life-cycle forces on working households

- "Prudent perpetual youth (PPY)" assumption
  - No household actually makes it to the retired state, yet they all *think* they will
    - ★ No household survives the retirement shock: $z = 0$
    - ★ Subjective survival probability is $z_s = \varpi > 0$ (ϖ is degree of over-estimation)
  - All retirement savings are "prudent"

Model - log-linear PPY equilibrium

- Under the PPY-structure, the log-linearized equilibrium is:

$$\hat{y}_t = (1-\delta_1)\left[\mathbb{E}_t \hat{y}_{t+1} - \frac{1}{\sigma}\mathbb{E}_t \hat{r}_{t+1}\right] + \delta_1\left[\eta\left(\hat{q}_t + \zeta_t\right) + \frac{\sigma-1}{\sigma}\mathbb{E}_t \hat{r}_{t+1} - \frac{1}{\sigma}\mathbb{E}_t \hat{\Gamma}_{t+1}\right]$$

$$\hat{\Gamma}_t = \beta\left[\mathbb{E}_t \hat{\Gamma}_{t+1} - (\sigma-1)\,\mathbb{E}_t \hat{r}_{t+1}\right]$$

$$\hat{\pi}_t = \beta \mathbb{E}_t \hat{\pi}_{t+1} + \kappa\,(1+\varphi)\,\hat{y}_t$$

$$\hat{q}_t = -\mathbb{E}_t \hat{r}_{t+1} + \beta\,(1-\rho)\,\mathbb{E}_t \hat{q}_{t+1} - \zeta_t$$

$$\mathbb{E}_t \hat{r}_{t+1} = \phi \mathbb{E}_t \hat{\pi}_{t+1} + \varepsilon_t$$

Monetary transmission mechanism

- When introducing retirement preoccupations ($\delta_1 > 0$), MTM moves away from intertemporal substitution
- Log-linearized Euler equation:

$$\hat{y}_t = (1-\delta_1)\left[\mathbb{E}_t\hat{y}_{t+1} - \frac{1}{\sigma}\mathbb{E}_t\hat{r}_{t+1}\right] + \delta_1\left[\eta\hat{q}_t + \frac{\sigma-1}{\sigma}\mathbb{E}_t\hat{r}_{t+1} - \frac{1}{\sigma}\mathbb{E}_t\hat{\Gamma}_{t+1}\right]$$

- Additional effects from $r \uparrow$
  1. Higher current income flow on asset stock $\Rightarrow \hat{y}_t \uparrow$
  2. Higher future income flow on asset stock $\Rightarrow \hat{y}_t \uparrow$
  3. Lower asset prices ($q_t \downarrow$) $\Rightarrow \hat{y}_t \downarrow$
- These factors become more important as $\delta_1 \uparrow$
  - For $\delta_1 < \bar{\delta_1} \equiv (1-\beta)/(\sigma-\beta)$, IS > asset flow effect
  - For $\delta_1 > \bar{\delta_1}$, asset flow effect > IS
    - ★ Asset valuation channel becomes *necessary* to obtain conventional signs

Effects of monetary shocks (i)

- We work with $\phi = 0$ (constant real rate) $\Rightarrow$ determinacy
- Defining $\overline{\varepsilon} \equiv \sum_{t=0}^{\infty} \rho_{\varepsilon}^{t} v_0 = v_0/(1-\rho_{\varepsilon})$, impact responses are:

$$\hat{y}_0 = -\frac{1-\rho_{\varepsilon}}{\sigma} \frac{1-\delta_1 \frac{\sigma(1-\eta)-\rho_{\varepsilon}\beta}{1-\rho_{\varepsilon}\beta}}{1-\rho_{\varepsilon}(1-\delta_1)} \overline{\varepsilon}$$

$$\hat{\pi}_0 = \kappa \frac{1+\varphi}{1-\rho_{\varepsilon}\beta} \hat{y}_0$$

- For $\delta_1 = 0$ (standard NKM):

$$\hat{y}_0 = -\frac{\overline{\varepsilon}}{\sigma}$$

Effects of monetary shocks (ii)

- **Proposition 1.** *The ability of a surprise interest rate cut* $\bar{\varepsilon} < 0$ *(hike,* $\bar{\varepsilon} > 0$*) to boost (contract) output and inflation is decreasing in retirement preoccupations* δ_1.

- Defining $\hat{y}_0 = -\frac{1-\rho_\varepsilon}{\sigma} \frac{1-\delta_1 \frac{\sigma(1-\eta)-\rho_\varepsilon \beta}{1-\rho_\varepsilon \beta}}{1-\rho_\varepsilon(1-\delta_1)} \bar{\varepsilon} \equiv -\frac{1-\rho_\varepsilon}{\sigma} \Psi \bar{\varepsilon}$, we get:

$$\frac{\partial \Psi}{\partial \delta_1} = -\frac{(1-\beta)\rho_\varepsilon + (1-\rho_\varepsilon)\sigma\,(1-\eta)}{(1-\rho_\varepsilon \beta)\,[1-\rho_\varepsilon\,(1-\delta_1)]^2} < 0$$

  - Pushing $\delta_1 \uparrow$ (i) decreases role of IS, while (ii) increasing asset flow effect

- Proofs of other propositions are similar

Effects of monetary shocks (iii)

- **Proposition 2.** *With $\delta_1 > 0$, the ability of an interest rate cut ($\overline{\varepsilon} < 0$) to boost output and inflation is increasing in the duration of assets held by the public (η).*

- When assets held by households are of lower duration, the asset valuation effect is weaker
  - On the lower arm of the C-shape, this is the crucial channel working in the conventional direction!

- QE can be seen as the central bank $\downarrow \eta \Rightarrow$ conventional MP less potent
  - In a post-QE world, rates may need to move *by more* to achieve a given effect
    - Implications for financial stability

Effects of monetary shocks (iv)

- **Proposition 3.** *If* $\eta < (\sigma - 1)/\sigma$, *then there exists a* $\delta_1^* \in \left(\bar{\delta}_1, 1\right)$ *such that an interest rate hike becomes expansionary for all* $\delta_1 > \delta_1^*$.

- Can show that $\delta_1^* \in \left[\bar{\delta}_1, 1\right] \Rightarrow$ perverse effects can only occur on lower arm of C-shape

- On lower arm, asset flow effect $>$ IS $\Rightarrow$ valuation effect *needed* to deliver conventionally-signed responses
  - Valuation effect is weak when η is low (assets are interest-rate insensitive)

Effects of monetary shocks (v)

- **Proposition 4.** *With $\delta_1 > 0$, the ability of a surprise rate cut ($\overline{\varepsilon} < 0$) to boost output is decreasing in its persistence ρ_ε.*

- Remember that standard NKM has
$\hat{y}_0 = -\overline{\varepsilon}/\sigma \Rightarrow \partial^2 \hat{y}_0 / \partial\overline{\varepsilon}\partial\rho_\varepsilon = 0$

- With $\delta_1 > 0$, more persistent changes affect output and inflation by less
  - Persistent rate changes do less to IS

Effects of monetary shocks (vi)

- Effect of time-T MP shock pre-annoucned at time-0 in FLANK:

$$\hat{y}_0 = \hat{y}_T + \left[1 - (1-\delta_1)^T\right](1-\delta_1)(1-\eta)\,\varepsilon_{T;0}$$

  - Standard NKM ($\delta_1 = 0$) has:

$$\hat{y}_0 = \hat{y}_T$$

- **Proposition 5.** *When $\eta < 1$, the effect that pre-announced monetary policy shocks have on current output is decreasing in δ_1 and the announcement horizon T.*
  - FLANK mitigates FG puzzle by weakening IS
  - NKM has FG puzzle increase in the length of the pre-announcement horizon T
  - FLANK captures notion that pre-announced shocks far into the future ($T \to \infty$) do less today

Optimal policy following financial shocks (i)

- What are the implications of life-cycle forces for optimal policy?
  - Focus on financial shock: location on the C-shape matters
  - Adverse AR(1) shock: $\zeta_t = \rho_\zeta \zeta_{t-1} + u_t$
  - $\hat{q}_t = -\mathbb{E}_t \hat{r}_{t+1} + \beta(1-\rho)\mathbb{E}_t \hat{q}_{t+1} - \zeta_t$
- Consider flex-price eqm and ask: how can MP replicate this?

$$\hat{q}_t = -\left\{1 - \frac{\eta\sigma\beta\rho_\zeta\delta_1}{\delta_1\left[\beta\rho_\zeta - (1-\eta)\sigma\right] + 1 - \beta\rho_\zeta}\right\}\frac{\lambda}{1-\beta\rho_\zeta}\zeta_t.$$

- For $\delta_1 = 0$ (standard NKM, without retirement preoccupations):

$$\hat{q}_t = -\frac{\lambda}{1-\beta\rho_\zeta}\zeta_t$$

  - Optimal policy requires *no* intervention from the CB

Optimal policy following financial shocks (ii)

- **Proposition 6.** *If* $\delta_1 < \bar{\delta}_1$*, a "Greenspan put" is never required to reproduce the flex-price equilibrium. If* $\delta_1 > \bar{\delta}_1$ *and* $\eta > (1 - \beta/\sigma)(1 - \bar{\delta}_1/\delta_1)$*, then a Greenspan put is required to reproduce the flex-price outcome whenever:*

$$\rho_\zeta \geq \frac{1}{\beta}\frac{1 - \delta_1\sigma + \delta_1\eta\sigma}{1 - \delta_1 + \delta_1\eta\sigma}.$$

- Greenspan put never needed on the upper arm of the C-shape

- May be needed on the lower arm, if the shock is sufficiently persistent

Conclusions

- Retirement preoccupations matter for monetary policy!
  - Moves MTM away from intertemporal substitution, becomes "wealth-centric"
  - Financial channel reflects impact of $\triangle r$ on both asset supply and asset demand
    - Asset demand (flow): $r \uparrow \Rightarrow$ asset demand $\downarrow \Rightarrow$ expansionary
    - Asset supply (price): $r \uparrow \Rightarrow q \downarrow \Rightarrow$contractionary

- Implications:
  - Valuation effect becomes *crucial* on lower arm of C-shape
  - Potency of MP is decreasing in retirement preoccupations
  - Conventional MP less powerful in a post-QE world
  - "Smoother" MP less powerful
  - Financial shocks may require a "Greenspan put"