Pareto Improving Fiscal and Monetary Policies: Samuelson in the New Keynesian Model

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Heterogeneity in Macro

- Fiscal and monetary policy for redistribution
- What is the appropriate mix of policies?
  - Monetary policy can redistribute through inflation or output gap
  - Evaluate winners and losers through a welfare function
- A better alternative: (Robust) Pareto Improvements
- In Aiyagari-Bewely-Hugget models, low hanging fruits (Aguiar-Amador-Arellano 2023)
  - Scope for Pareto Improvements via bond issuances
  - Key insight of Samuelson (1958) when interest rates are low
  - Depends on elasticity on aggregate savings to real rates
- Study this question in a non-Ricardian New Keynesian model

What We Do

- Build a tractable OLG New Keynesian model
- Elasticity of savings to interest rates endogenous to monetary policy
- Analyze the positive and normative consequences of government bond issuances
- Characterize global dynamics without approximations
  - Key tool: Phase diagram
- Analyze interactions of pubic debt and monetary outcomes
  - Abstract from seigniorage revenue (contrast from Sargent and Wallace)
  - Focus on real debt (distinct from FTPL channel)
- Framework to discuss recent papers

Some Insights

- Bond issuances can lead to desirable increases in real interest rates if $r < g + n$
- Monetary policy should respond to bond issuances directly and increase nominal rates
- Pareto improvement possible with a monetary policy that responds to debt
- If follow a standard Taylor Rule:
  - Bond issuances can lead to increases in inflation and fluctuations in consumption
- Bonus
  - Transparent resolution of forward guidance "puzzle"
  - Escaping ZLB via bond issuances

Literature

- Pareto improvements with heterogeneous agents
  Samuelson 1958, Balasko-Shell 1980 (OLG), Aguiar-Amador-Arellano 2023 (Aiyagari)
- OLG and New Keynesian
  Piergallini 2006, Nistico 2016 (optimal monetary policy), Gali 2021, Piergallini 2023 (liquidity trap), DelNegro-Giannoni-Patterson 2023 (forward guidance), Angeletos-Lian-Wolf 2023 (self financing deficits)
- Wealth in the utility and ELB
  Mian-Straub-Sufi 2022, Michau 2023
- HANK with fiscal policy
  Kaplan-Moll-Violante 2018, Auclert-Rognlie-Straub 2018 (fiscal responses key for multipliers), McKay-Nakamura-Steinsson 2016 (forward guidance)

Environment

- Perpetual youth model embedded into New Keynesian paradigm
- Three parties

  Worker – savers in bonds

  Entrepreneurs – price setters

  Government – fiscal: government debt, taxes and monetary: interest rate rule
- Perfect foresight and continuous time

Workers

- Perpetual youth: Die at rate λ, a new cohort $(\lambda + n)e^{nt}$ is born at time t
- Preferences of cohort s at time t over consumption and labor:

$$\int_t^{\infty} e^{-(\rho+\lambda)(\tau-t)} u(c(s,\tau), n(s,\tau)) d\tau$$

- Felicity: $u(c, n) = \ln c + \psi \ln (1 - n)$
- Budget constraint:

$$\dot{a}(s,t) = (r(t) + \lambda)a(s,t) + w(t)z(s,t)n(s,t) - T(s,t) - c(s,t)$$

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- Real bonds and annuity markets
- Perfectly insure survival risk in spot annuities that pay $r + \lambda$

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- Receive real wage $w(t)$ per efficiency unit
- Productivity $z(s,t)$ depends on technological progress g and declines with age α:

$$z(s,t) = z_0 e^{gt} e^{-\alpha(t-s)}$$

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- Pay cohort dependent (non-distortionary) tax $T(s,t) = T(t)z(s,t)$

Workers' Problem

- Optimality conditions for workers problem

$$\text{Euler condition: } \frac{\dot{c}(s,t)}{c(s,t)} = r(t) - \rho$$

$$\text{Labor condition: } \psi c(s,t) = w(t) z(s,t) \left(1 - n(s,t)\right)$$

- c grows at same rate for all cohorts
- Static condition is linear in c and n (can substitute out n in terms of c)

Aggregate Euler Equation

- Define: $C(t) \equiv \int_{-\infty}^{t} \phi(s,t)c(s,t)ds$, $\phi(s,t)$ measure of workers
- All surviving cohorts: $\dot{c} = (r - \rho)c$
- Consumption from dying versus newborn cohorts $-\lambda C + (\lambda + n)c(t,t)e^{nt}$

$$\dot{C}(t) = (r(t) - \rho)C(t) - \lambda C(t) + (\lambda + n)c(t,t)e^{nt}$$

- Differences between newborn and old
  - Newborn zero assets, but more productivity and numerous

$$\dot{C}(t) = (r(t) - \rho + \alpha + n)C(t) - \frac{(\rho + \lambda)(\alpha + \lambda + n)}{1 + \psi}A(t)$$

- High A_t lowers growth because lower consumption of newborn relative to dying
- Labor supply already embedded
- Distribution of wealth is irrelevant for aggregate dynamics

Peeking Ahead

$$\frac{\dot{C}(t)}{C(t)} = r(t) - \rho + \alpha + n - \mu\frac{A(t)}{C(t)}$$

- Change in aggregate wealth shifts the Euler Equation
- "Natural" real interest rate increases with government debt
  - Unique to non-Ricardian models
- Worker sector aggregates but CE can be Pareto Inefficient even with zero markup and flex prices (Samuelson, Balasko-Shell)

Entrepreneurs

- There is a measure one continuum of entrepreneurs
- Live forever and discount at rate $\hat{\rho}$ (unimportant)
- Do not save in government bonds (more important)
- Do not pay lump-sum tax (also important)
- Consume profits
- Assume entrepreneurs face effective yield of $\hat{\rho}$ (linear utility)

Entrepreneurs

- Each produce an intermediate variety $j \in [0, 1]$
- Standard NK production sector: $y_j = \ell_j$
- Final good Y CES aggregate over y_j with elasticity η

$$Y(t) = \left(\int_0^1 y_j(t)^{\frac{\eta-1}{\eta}} dj \right)^{\frac{\eta}{\eta-1}}$$

$$P(t) = \left(\int_0^1 p_j(t)^{1-\eta} dj \right)^{\frac{1}{1-\eta}}$$

- Real profits before adjustment costs:

$$\Pi(p, t) = \left(\frac{p}{P(t)} - w(t) \right) \left(\frac{p}{P(t)} \right)^{-\eta} Y(t)$$

Entrepreneurs' Pricing Condition

- Compete monopolistically, choose prices subject to Rotemberg costs of adjusting prices
- For $x = \dot{p}_j / p_j$ costs are $f(x)Y$ where $f(x) = \frac{\varphi}{2}x^2$
- NK Phillips Curve (standard derivation):

$$\dot{\pi}(t) = [\hat{\rho} - g_Y(t)]\, \pi(t) + \hat{\kappa}\, [w^\star - w(t)]$$

- $w^\star = \frac{\eta - 1}{\eta}$ is optimal inverse markup, and $\hat{\kappa} = \frac{\eta}{\varphi}$
- Entrepreneurs' consumptin/profits $C^e(t) = (1 - w(t) - f(\pi(t)))N(t)$
- Allow for nonlinearities

Fiscal Policy

- Real government bonds
- No expenditures other than transfers
- Flow budget constraint:

$$\dot{B}(t) = r(t)B(t) - T(t)$$

- Allow to make "lumpy" sale of B and lump-sum rebate to workers
- Akin to helicopter drop

Monetary Policy

- Interest rate rule
- Nominal interest rate responds to inflation and debt

$$i(t) = \bar{\iota} + \theta_\pi \pi(t) + \theta_b \left(B(t)/Z(t)\right)$$

- $\theta_\pi > 1$, inflation target is zero
- $\bar{\iota}$ is baseline equilibrium real rate
- $\theta_b = 0$ is the standard Taylor rule

Equilibrium

- Workers' optimize given paths of r, w, and T
- Entrepreneurs' optimize given w, P, and Y
- Government budget constraint and monetary rule
- Market clearing:

$$A(t) = B(t)$$
$$C(t) + C^e(t) = (1 - f(\pi))Y$$

Equilibrium: Output

- Because of preferences and segmentation of bonds markets and taxation

$$N(t) = \int_{-\infty}^{t} \phi(s,t) z(s,t) n(s,t) ds = \frac{Z(t)}{1+\psi}$$

- Aggregate productivity $Z(t) \int_{-\infty}^{t} \phi(s,t) z(s,t) ds = e^{(g+n)t}$
- Workers labor is constant and output growth exogenous

$$Y(t) = N(t)$$

- Monetary and fiscal policy affect division but not size

$$Y(t) = w(t)N(t) + \text{Profits} + \text{Adjustment Costs}$$

Equilibrium Dynamics

- Normalize variables by aggregate productivity $c(t) = C(t)/Z(t)$ and $b(t) = B(t)/Z(t)$

$$
\begin{aligned}
\dot{c}(t) =& (r(t) - \rho - g + \alpha)c(t) - \mu\, b(t) \\
\dot{\pi}(t) =& \hat{\rho}\pi(t) + \kappa[c^* - c(t)] \\
\dot{b}(t) =& (r(t) - g - n)b(t) - T(t)
\end{aligned}
$$

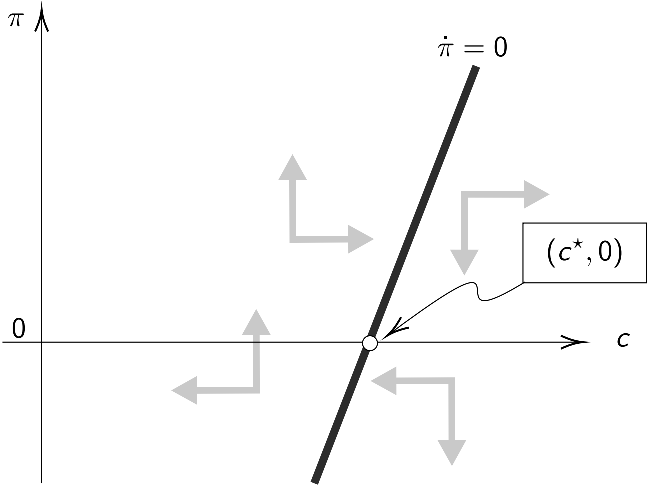
$\hat{\rho} = \tilde{\rho} - (g + n)$, $\kappa = (1 + \psi)\tilde{\kappa}$; $c^* = w^*/(1 + \psi)$

- Goal: Characterize equilibrium in simple phase diagram
- Constant b and do comparative statics
- Reduce to system of two ODEs in π and c
  - NK Phillips Curve
  - Aggregate Euler Equation+ monetary policy

Phase Diagram

$$\dot{\pi}(t) = \hat{\rho}\pi(t) + \kappa\left[c^{\star} - c(t)\right]$$

- The "$\dot{\pi} = 0$" locus: $\pi = \frac{\kappa}{\hat{\rho}}(c - c^{\star})$
- Steady state π increasing in c
- For a given c, as $\pi \uparrow \rightarrow \dot{\pi} > 0$



Dynamics for c

- Aggregate Euler Equation:

$$\frac{\dot{c}(t)}{c(t)} = r(t) - \rho - g + \alpha - \mu \frac{b(t)}{c(t)}$$

- Stationary real rate

$$r = \rho + g - \alpha + \mu \frac{b}{c}$$

- Monotonic positive relationship between r and b/c
- To map $r(t)$ to $(\pi(t), c(t))$ use MP rule and Fisher Equation

$$i(t) = \bar{\imath} + \theta_\pi \pi(t) + \theta_b b(t)$$

$$r(t) = \bar{\imath} + (\theta_\pi - 1)\pi(t) + \theta_b b(t)$$

Dynamicsf for c

- Combine Euler Equation and monetary rule

$$\frac{\dot{c}(t)}{c(t)} = \bar{\iota} + (\theta_\pi - 1)\pi(t) + \theta_b b(t) - \rho - g + \alpha - \mu \frac{b(t)}{c(t)}$$

- The "$\dot{c} = 0$" locus is:

$$\pi = \frac{\rho + g - \alpha - \bar{\iota}}{\theta_\pi - 1} + \frac{\mu b / c - \theta_b b}{\theta_\pi - 1}$$

- Negative relationship between c and π

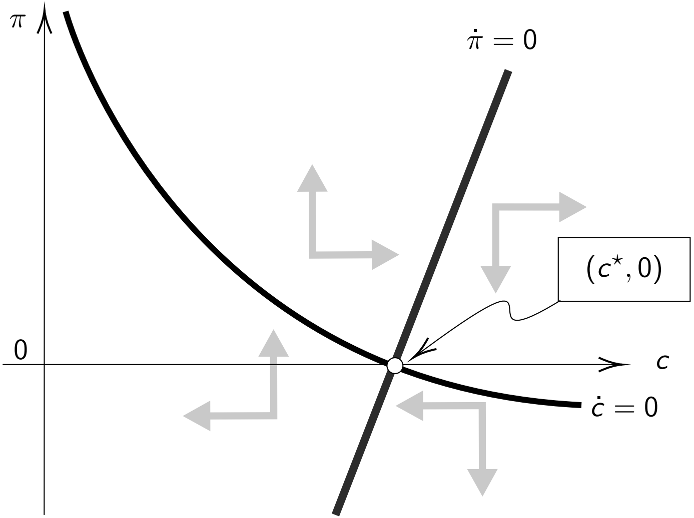
- As $c \uparrow \rightarrow \dot{c} > 0$

Phase Diagram for (constant b^o)

$$\dot{\pi}(t) = \hat{\rho}\pi(t) + \kappa\left[c^\star - c(t)\right]$$

$$\frac{\dot{c}(t)}{c(t)} = \bar{\imath} + (\theta_\pi - 1)\pi(t) + \theta_b b^o - \mu\frac{b^o}{c(t)}$$

- Fiscal policy B matters for (π, c)
- Alive households hold B, and will be paid by taxes on generations not yet alive
- Key for breaking Ricardian Equivalence



Anticipated Fiscal Expansion

- Announcement of a future tax cut to be enacted at $t' > t$
  - At time t', b increases from b^o to b'
  - Proceeds are lump-sum rebated
  - After t', b constant at b'

Anticipated Fiscal Expansion

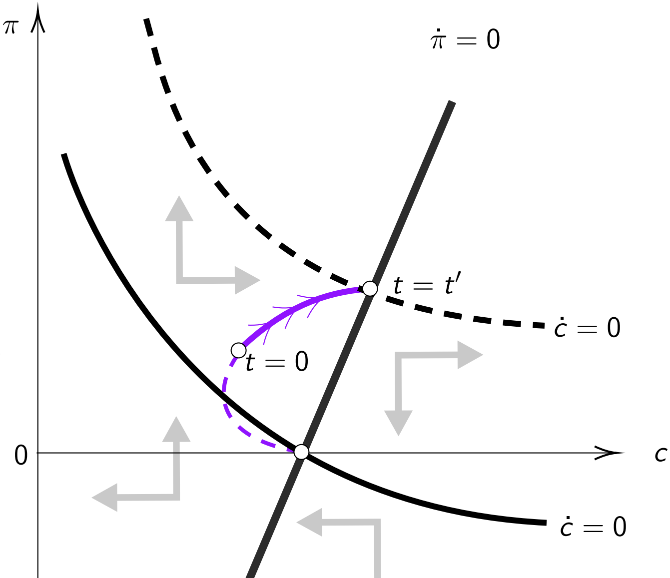
Standard Taylor Rule $\theta_b = 0$

$$\dot{\pi}(t) = \hat{\rho}\pi(t) + \kappa\left[c^\star - c(t)\right]$$

$$\frac{\dot{c}(t)}{c(t)} = \bar{\bar{\imath}} + (\theta_\pi - 1)\pi(t) - \mu\frac{b'}{c(t)}$$

- Long run: π, c, and r higher
- Initial impact:
  - Increase in π and $\dot{\pi}$ (unless we have cycles)
  - Real rate moves with π:

$$r = \bar{\imath} + (\theta_\pi - 1)\pi$$



Anticipated Fiscal Expansion

- Following standard Taylor rule prescription may be counter-productive
- Fiscal announcements lead to inflation which leads to MP reaction
- MP appears to be cleaning up the fiscal mess by immediately $i \uparrow$
  - Actually inducing unnecessary fluctuations
- But following standard Taylor rule could be beneficial for some agents
  - Increases real wages (increase c)
  - Prevents sharper increase taxes due to higher real rates

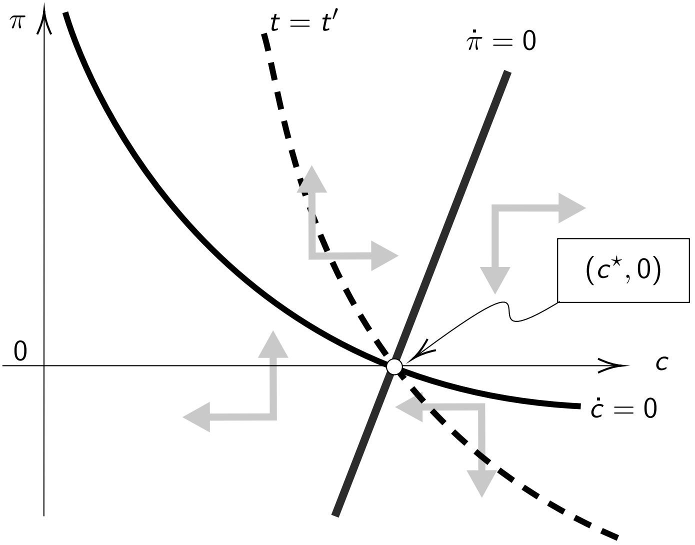
Anticipated Fiscal Expansion

Interest rule with $\theta_b = \theta_b^\star = \mu/c^\star$

$$\dot{\pi}(t) = \hat{\rho}\pi(t) + \kappa\left[c^\star - c(t)\right]$$

$$\frac{\dot{c}(t)}{c(t)} = \bar{\bar{\imath}} + (\theta_\pi - 1)\pi(t) + \theta_b b' - \mu \frac{b'}{c(t)}$$

- Monetary policy expected to react to expansion t'
- For $t \in [0, t')$ nothing changes
  - Individuals anticipate an increase in wealth and r at t'
  - No anticipation effects in eqm: anticipated windfall is saved due to higher future r



Inefficiency

$$\frac{\dot{c}(t)}{c(t)} = r(t) - \rho - g + \alpha - \mu\frac{b(t)}{c(t)}$$

stationary real rate:

$$r = \rho + g - \alpha + \mu\frac{b}{c}$$

- CE may be Pareto inefficient (Samuelson 58)
- Guide is whether $r < g + n$
  - If $r < g + n$, individuals are saving at a rate that is lower than technologically feasible
  - Note, it's not the total output that is inefficient, just the allocation across cohorts
- Issuance of government bonds can be Pareto improving in a real model $T < 0$

Robust Pareto Improvements

- Simple policies that expand budget sets
  - Debt, transfers, monetary policy rule
  - Sufficient for Pareto improvement
- In our environment
  - Workers:
$$(r+\lambda)a + wz(s,t)n - z(s,t)T$$
  - Entrepreneurs:
$$\Pi - f(\pi) = (1 - w - f(\pi))\,Y = Q$$
- Let original eq $(r^o, T^o, w^o, Q^o) \to$ new eq (r', T', w', Q')
- RPI if
$$r' \geq r^o, \quad T' \leq T^o, \quad w' \geq w, \quad Q' \geq Q$$

RPI with strict inflation targeting

- Suppose monetary policy delivers $\pi' = 0$, which implies $w' = w^\star$, $c = c^\star$, $Q' = Q$
- Suppose start from BGP, $b(0) = b^o$
- Government issues new debt $b' - b^o$ and transfers proceeds to workers
- No further changes $\to$ jump to new BGP, with r', T': RPI if $r' \geq r^o, \quad T' \leq T^o$
- For interest rates to increase, $r' > r^o$, need $b' > b^o$

$$\underbrace{\dot{c}(t)}_{=0} = (\underbrace{r(t)}_{r'} - \rho - g + \alpha)\underbrace{c(t)}_{c^\star} - \mu \underbrace{b(t)}_{b'}$$

- For taxes to decrease, $T' \leq T^o$, need govt expenses to fall,

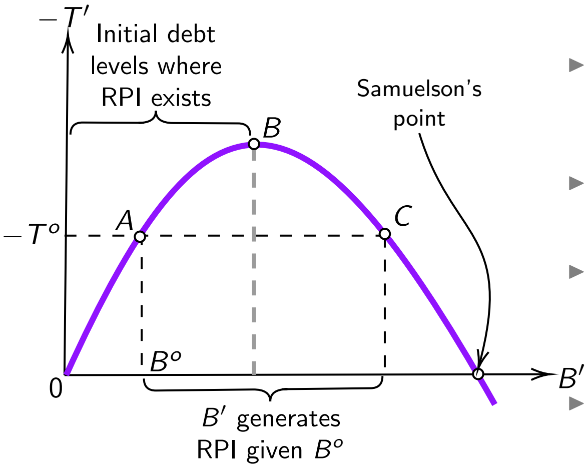
$$T' = (r' - g - n)b' \leq (r^o - g - n)b^o = T^o$$

- Need that $\partial T / \partial b < 0$

$$-\frac{r - (g+n)}{b}\frac{\partial b}{\partial r} > 1$$

- Elasticity of aggregate savings $b^*(r)$ must be high enough

RPI with strict inflation targeting



- Samuelson's point not RPI

  Suppose HH heavily relies on T, doesn't gain

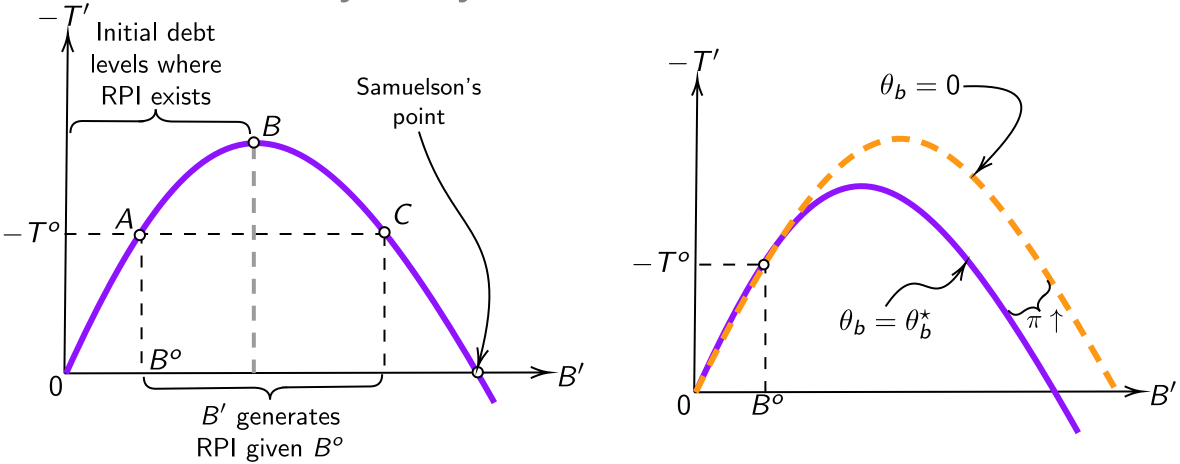
- Advantege of debt over tax-redistribution is Samuelson's "social contrivance"

- Aggregate savings function with strict inflation targeting

$$b^*(r') = (r' - \rho - g + \alpha)\frac{c^\star}{\mu}$$

- In general it aggregate elasticity depends on the monetary policy rule

RPIs and Monetary Policy



- Monetary policy can increase the elasticity of savings, at the cost of inflation (not RPI)
- The monetary control of the real rate does not create additional space for RPIs

Implementing an RPI

- Fiscal authority issues b'
- Monetary authority keeps $\pi' = 0$
  - Can be implemented with rule that responds to debt $\theta_b = \theta_b^*$

Existence of an RPI

Given an initial stationary equilibrium with $\pi^o = 0$, there exists a debt issuance at $t = 0$ that generates an RPI if and only if $r^o - g - n < (\rho - \alpha - n)/2 < 0$ and monetary policy follows a debt-sensitive interest rate rule with $\theta_b = \theta_b^\star$

Other Applications

- Phase diagram helpful to address other questions in monetary economics
  - Escaping the ELB
  - Forward Guidance Puzzle

Forward Guidance Puzzle

- Announcements to reduce rates in the future have effects that increase with the announcement horizon

  Del Negro, Giannoni, Patterson (2023)

- Revisit with our framework

- Consider the following announcement:
  - The real interest rate will decline between $[t_0, t_1]$
  - Then return to the long-run level after t_1
  - How does the announcement effect depend on horizon t_0?

- To implement this:

$$i(t) = \begin{cases} r^o + \pi(t) & \text{for } t \notin [t_0, t_1) \\ r^o - \Delta + \pi(t) & \text{for } t \in [t_0, t_1). \end{cases}$$

- Note: $\theta_\pi = 1, \theta_b = 0$ in this case

Forward Guidance Puzzle

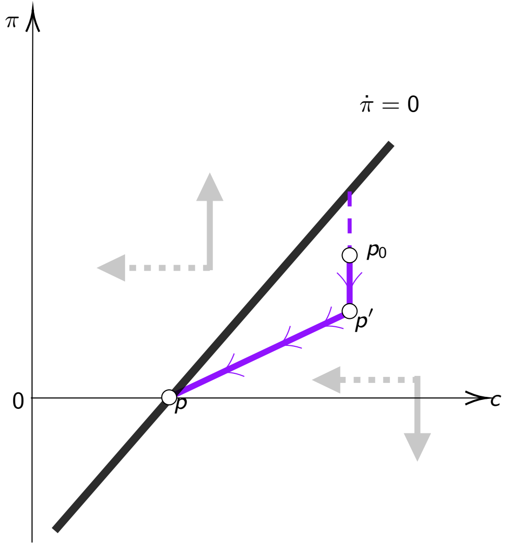
- Representative agent model (maps into $b = 0$)

$$\dot{c} = (r(t) - \rho - g + \alpha)c(t)$$

For $t \in [t_0, t_1)$, $\dot{c} < 0$

For $t \notin [t_0, t_1)$, $\dot{c} = 0$

- Solve backward:
  - At t_1 back at steady state (point p)
  - At t_0 on path with $r(t) = r_0 - \Delta$ (point p')
  - At $t = 0$ on path to reach p' at t_0 (point p_0)
- As $t_0 \to \infty$, effect on π is stronger



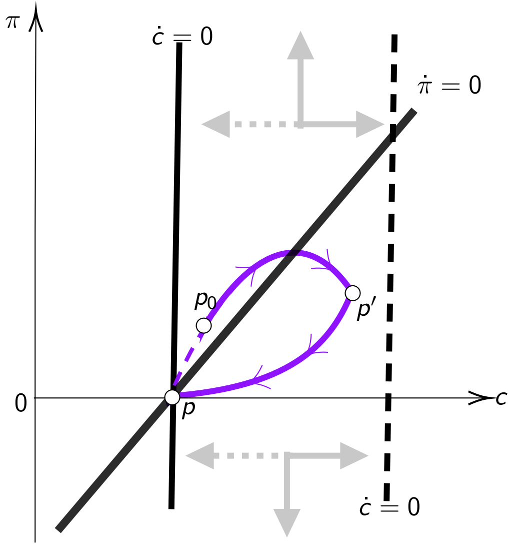
Forward Guidance Puzzle

- With $b^o > 0$ the $\dot{c} = 0$ line is:

$$\dot{c} = (r(t) - \rho - g + \alpha)c(t) - \mu b^o$$

$$c = \frac{\mu b^o}{r - \rho - g + \alpha}.$$

- Vertical and shifts with r_0
- No puzzle: t_0 increase brings smaller initial adjustment
- Difference: a unique b/c given stationary r



Escaping ZLB

- There are paths that take the economy to ZLB (Benhabib-SchmittGrohe-Uribe 2001)
- It could be that $\pi = 0$ outcome is unfeasible
- We can use diagram to analyze these cases away from Ricardian Equivalence
- Find role for fiscal policy:

  Debt raises the natural rate

  May be sufficient to take economy away from ZLB

Conclusion

- Analytical framework to understand impact of government borrowing on economy
- And interactions with monetary policy
- Robust pareto improvements possible when interest rates are low and high elasticity of savings
    - Require expansion of government debt and monetary adjustment
- Lessons applicable to other non-Ricardian frameworks