Determinacy without the Taylor Principle

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Outline

A Perennial Issue

- Important questions (trickier than they look):
  - What determines the price level?
  - Can monetary policy regulate AD and inflation?
  - Does the ZLB trigger a deflationary spiral?

- Basic problem (back to Sargent & Wallace):
  - same path for $R \Rightarrow$ multiple equilibrium paths for π and y
  - need equilibrium selection
  - different selections $\Rightarrow$ different answers to above questions

The (Confusing?) State of the Art

- Two alternatives in the theory:
  - **Taylor principle** (TP)
    - π and y pinned down by interest-rate policy
    - good news for the Fed's role
    - but: TP = an off-eq. threat to blow up the economy? (Cochrane)
  - **Fiscal Theory of the Price Level** (FTPL)
    - π and y pinned down by gov debt and deficits
    - upsets lessons of the NK model (Cochrane)
    - but: FTPL = an off-eq. threat to blow out the gov budget? (Kocherlakota & Phelan, Buiter, etc)
- Debate hard to settle
  - both approaches are equally logical (within the current paradigm)
  - both boil down to off-eq assumptions, which can not be tested
  - choice between the two = a choice of religion! (Kocherlakota & Phelan)

This Paper

- Recast the NK economy as a game among current and future consumers
  - intertemporal Keynesian cross, plus feedbacks via Phillips curve and MP response
- All equilibria but one hinge on strong intertemporal coordination:
  - current consumers respond to sunspots, or payoff-irrelevant histories, only because they expect future consumers to do the same and in a very specific way
  - future consumers do it because expect agents further in the future to do the same; so on.
  - sunspots must have "infinite memory" in the economy

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  - future consumers do it because expect agents further in the future to do the same; so on.
  - sunspots must have "infinite memory" in the economy
- Tiny friction in memory/coordination ⇒ breaks this infinite chain ⇒ ⇒**Unique equilibrium**
  - coincides with what is known as the model's fundamental/MSV solution
  - but does not require Taylor principle
- **No room for FTPL** (at least as currently formulated)
  - non-Ricardian assumption = equil non-existence (logical impossibility, not religious choice)

Outline

A simplified NK economy

- Overlapping generations of consumers, each living two periods:

$$u(C^1_{i,t}) + \beta u(C^2_{i,t+1})e^{-\rho_t}$$

- Budgets:

$$C^1_{i,t} + B_{i,t} = Y_t \quad \text{and} \quad C^2_{i,t+1} = Y_{t+1} + \frac{I_t}{\Pi_{t+1}} B_{i,t}$$

  - Young and old earn the same income Y_t (for simplicity)
  - Young are "strategic": they optimally choose consumption and saving, given expectations of Y and Π, which will map to expectations of the choices of other consumers
  - Old are "robots": their consumption mechanically adjusts to meet budget

Intertemporal Keynesian Cross, or DIS

- Log-linearized optimal consumption for the young:

$$c^1_{i,t} = E_{i,t}\left[\frac{1}{1+\beta}y_t + \frac{\beta}{1+\beta}y_{t+1} - \frac{\beta}{1+\beta}\sigma(i_t - \pi_{t+1} - \rho_t)\right]$$

- Market clearing + old and young earn same income $\Rightarrow$

$$\int c^1_{i,t}di = \int c^2_{i,t}di = c_t = y_t$$

- Combining $\Rightarrow$

$$c_t = \bar{E}_t\left[\frac{1}{1+\beta}c_t + \frac{\beta}{1+\beta}c_{t+1} - \frac{\beta}{1+\beta}\sigma(i_t - \pi_{t+1} - \rho_t)\right]$$

- With FIRE, this reduces to RA's Euler:

$$c_t = \mathbb{E}_t[c_{t+1}] - \sigma(i_t - \mathbb{E}_t[\pi_{t+1}] - \rho_t)$$

- More generally: an example of an "intertemporal Keynesian cross"

Our Three-Equation Model

1. DIS, from above:

$$c_t = \bar{E}_t \left[\frac{1}{1+\beta} c_t + \frac{\beta}{1+\beta} c_{t+1} - \frac{\beta}{1+\beta} \sigma (i_t - \pi_{t+1} - \rho_t) \right] \qquad \text{(DIS)}$$

   - richer version, with infinitely-lived or OLG, later

2. Phillips curve:

$$\pi_t = \kappa c_t + \xi_t \qquad \text{(PC)}$$

   - ad hoc and static for now, micro-founded and forward-looking later

3. Taylor rule:

$$i_t = z_t + \phi \pi_t \qquad \text{(MP)}$$

   - nests pegs with $\phi = 0$, allows both $\phi < 1$ and $\phi > 1$

From 3 equations to 1, and a game-theoretic prism

- Solving (PC) and (MP) for π_t and i_t, and substituting in (DIS) $\Rightarrow$

$$c_t = \bar{E}_t \left[(1-\delta_0)\theta_t + \delta_0 c_t + \delta_1 c_{t+1} \right]$$

  - θ_t is a transformation of (ρ_t, ξ_t, z_t), $\delta_0 \equiv \frac{1-\beta\sigma\phi\kappa}{1+\beta} < 1$, and $\delta_1 \equiv \frac{\beta+\beta\sigma\kappa}{1+\beta} > 0$
- NK economy = a game among consumers
  - δ_0 and δ_1 measure strategic complementarity within and across time
  - summarize all GE feedbacks: income$\leftrightarrow$spending, output$\leftrightarrow$inflation, MP response

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- NK economy = a game among consumers
  - δ_0 and δ_1 measure strategic complementarity within and across time
  - summarize all GE feedbacks: income$\leftrightarrow$spending, output$\leftrightarrow$inflation, MP response
- With FIRE, this reduces to:

$$c_t = \theta_t + \delta \mathbb{E}_t[c_{t+1}] \qquad \delta \equiv \frac{\delta_1}{1-\delta_0} = \frac{1+\kappa\sigma}{1+\phi\kappa\sigma} > 0$$

- Under this prism, Taylor principle translates as follows:

$$\phi > 1 \quad \Leftrightarrow \quad \delta < 1 \text{ (``forward-stable'')} \quad \Leftrightarrow \quad \delta_0 + \delta_1 < 1 \text{ (``weak complementarity'')}$$

Fundamentals, Sunspots, and Equilibrium Concept

- Fundamentals:

$$\theta_t = \rho \theta_{t-1} + \varepsilon_t, \qquad \varepsilon_t \sim_{\text{i.i.d}} \mathscr{N}(0,1)$$

- Sunspots:

$$\eta_t \sim_{\text{i.i.d}} \mathscr{N}(0,1)$$

- In paper: general stochasticity

- State of nature, or history, at t:

$$h^t = \{\theta_{t-k}, \eta_{t-k}\}_{k=0}^{\infty}$$

- Solution concept: **Rational Expectations Equilibrium (REE)**
  - but, based on potentially limited information about h^t (this will prove crucial)
  - plus, linearity and stationarity (for tractability):

$$c_t = \sum_{k=0}^{\infty} a_k \eta_{t-k} + \sum_{k=0}^{\infty} \gamma_k \theta_{t-k}$$

  - plus, bounded (can be justified by escape clauses)

Outline

The Standard Paradigm

- FIRE / representative-agent benchmark:

$$c_t = \theta_t + \delta \mathbb{E}_t [c_{t+1}]$$

  - $\mathbb{E}_t[\cdot]$ is rational expectation conditional on entire history h^t

- The fundamental or minimum state variable (MSV) solution:
  - equation is only forward looking, plus θ_t is sufficient statistic for the future
  - so guess and verify $c_t = \gamma\theta_t$, to find

$$c_t = c_t^F \equiv \frac{1}{1-\delta\rho}\theta_t$$

- Is MSV the only equilibrium?

The Standard Paradigm

Proposition. FIRE/RA Benchmark

- When $\phi > 1$ (Taylor principle), the MSV solution is the unique equilibrium
- When $\phi < 1$, there exist a continuum of equilibria, given by

$$c_t = (1-b)c_t^F + bc_t^B + ac_t^\eta,$$

where $a, b \in \mathbb{R}$ are arbitrary scalars and where

$$c_t^\eta \equiv \sum_{k=0}^{\infty} \delta^{-k}\eta_{t-k} \qquad \text{and} \qquad c_t^B \equiv -\sum_{k=1}^{\infty} \delta^{-k}\theta_{t-k}$$

- c_t^η is a **sunspot equilibrium**
  - a non-zero solution to $c_t = \delta\mathbb{E}_t[c_{t+1}]$
- c_t^B is a **backward-looking, pseudo-fundamental equilibrium**
  - the product of solving $c_t = \theta_t + \delta c_{t+1}$ backwards

Understanding the Multiplicity

- Equilibrium condition (back-shifted)

$$c_{t-1} = \theta_{t-1} + \delta \mathbb{E}_{t-1}[c_t]$$

- Solving backwards (when $\delta > 1$):

$$\begin{aligned}
\mathbb{E}_{t-1}[c_t] &= \delta^{-1}(c_{t-1} - \theta_{t-1}) \\
c_t &= \delta^{-1}(c_{t-1} - \theta_{t-1}) + \eta_t \\
c_t &= \underbrace{-\sum_{k=1}^{\infty} \delta^{-k}\theta_{t-k}}_{\substack{\text{backward-looking} \\ \text{pseudo-fundamental}}} + \underbrace{\sum_{k=0}^{\infty} \delta^{-k}\eta_{t-k}}_{\text{sunspot}}
\end{aligned}$$

- **Infinite chain based on "thin air":**
  - Current agents ignore current fundamental and respond to payoff-irrelevant histories because they expect to be "rewarded" appropriately by future agents
  - Future agents themselves respond on the basis of a similar expectation

What's Next: Two Perturbations Breaking the Infinite Chain

- Two equivalent representations of non-fundamental equilibria:

(Sequential Form)
$$c_t = -\sum_{k=1}^{\infty} \delta^{-k} \theta_{t-k} + \sum_{k=0}^{\infty} \delta^{-k} \eta_{t-k}$$

(Recursive Form)
$$c_t = \delta^{-1}(c_{t-1} - \theta_{t-1}) + \eta_t$$

- Two takes on infinite chain : c_t needs to respond to payoff-irrelevant distant past
  - directly in Sequential Form
  - indirectly in Recursive Form

- Two perturbations that make infinite chain unravel:
  - Fading social memory about $\eta_{t-k} \Longrightarrow$ determinacy
  - Bounded social memory of what drives $c_{t-1} \Longrightarrow$ determinacy

Outline

The First Perturbation

Assumption. Fading Social Memory

In every t, information set are given by

$$I_{i,t} = \{(\theta_t, \eta_t), \cdots, (\theta_{t-s}, \eta_{t-s})\},$$

where $s \in \{0, 1, \cdots\}$ is drawn from a geometric distribution with $\lambda \in (0,1)$.

- i.e., $s = 0$ with prob λ, $s = 1$ with prob $(1-\lambda)\lambda$, ... $s = k$ with prob $(1-\lambda)^k \lambda$

Interpretation in terms of social transmission of information:

- at every t, the typical young consumer learns current shocks (θ_t, η_t)
- with prob. λ, she learns nothing more;
- with prob. $1-\lambda$, she inherits the info of a random old consumer

The First Perturbation

Social memory:

- $\mu_k \equiv$ mass of agents that knows histories of length k or higher $= (1-\lambda)^k$

RA benchmark, nested by $\lambda = 0$:

- All agents have infinite memory (and this is common knowledge)
- Defines *infinite* social memory, and *perfect* coordination

Key properties for $\lambda > 0$:

- Zero mass has truly *infinite* memory
- But as $\lambda \to 0$, almost all consumers have *arbitrarily long* memory
- No direct knowledge of endogenous outcomes, or of the actions of others
- But as $\lambda \to 0$, arbitrarily well informed about arbitrarily long histories of $\{c_{t-k}, \pi_{t-k}\}$

Main Result: Determinacy without Taylor Principle

- Bottom line: $\lambda > 0$ small enough = nearly infinite social memory = nearly RA
- Still: for any $\lambda > 0$, no matter how small, $\mu_k \to 0$ as $k \to \infty$

Proposition. Determinacy with fading social memory

The MSV solution is the unique equilibrium

- Regardless of ϕ (e.g., even with pegs)
- No matter how slow the memory decay is (how small $\lambda > 0$ is).

Proof Sketch

- Abstract from fundamentals, let only shock be η_0 (effectively, focus on IRF of c_t to η_0):

$$c_t = \alpha_t \eta_0 \qquad \text{for some coefficient } \alpha_t \equiv \frac{\partial c_t}{\partial \eta_0}$$

- Use this to rewrite key equilibrium equation as

$$c_t = \delta_0 \underbrace{\alpha_t \bar{E}_t[\eta_0]}_{\bar{E}_t[c_t]} + \delta_1 \underbrace{\alpha_{t+1} \bar{E}_t[\eta_0]}_{\bar{E}_t[c_{t+1}]}$$

- Next, use $\bar{E}_t[\eta_0] = \mu_t \eta_0$ to get

$$c_t = \delta_0 \mu_t \underbrace{\alpha_t \eta_0}_{c_t} + \delta_1 \mu_t \underbrace{\alpha_{t+1} \eta_0}_{\mathbb{E}_t[c_{t+1}]}$$

  where $\mu_t = (1-\lambda)^t$ is mass remembering η_0 at t.
- Maps to "twin" economy with infinite memory ($\lambda = 0$) but modified best response:

$$c_t = (\mu_t \delta_0) c_t + (\mu_t \delta_1) \mathbb{E}[c_{t+1}]$$

Proof Sketch

- Maps to "twin" economy with infinite memory ($\lambda = 0$) but modified best response:

$$c_t = (\mu_t \delta_0) c_t + (\mu_t \delta_1) \mathbb{E}[c_{t+1}]$$

  - $\lim_{t \to \infty} \mu_t = 0 \Rightarrow \mu_\tau \delta_0 + \mu_\tau \delta_1 < 1$ for τ large enough
  - perceived strategic complementarity eventually fades $\Longrightarrow$ determinacy

Proof Sketch

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  - perceived strategic complementarity eventually fades $\Longrightarrow$ determinacy

- Equivalently, RA economy with modified eigenvalue:

$$c_t = \tilde{\delta}_t \mathbb{E}[c_{t+1}] \qquad \text{with} \qquad \tilde{\delta}_t \equiv \frac{\mu_t \delta_1}{1 - \mu_t \delta_0}$$

  - $\lim_{t\to\infty} \mu_t = 0 \Rightarrow \tilde{\delta}_\tau < 1$ for τ large enough $\Longrightarrow c_t = 0$ is unique outcome for $t \geq \tau$
  - by backward induction starting at $\tau \Longrightarrow c_t = 0$ is unique outcome for $t < \tau$ as well

Logic

- I can see the current sunspot very clearly
- It would make sense to react if all future agents will keep responding to it **in perpetuity**
- But I worry that agents **far in the future will fail to do so**
  - either because they will have forgotten it
  - or because they may worry that agents further into the future will not react to it
- It therefore makes sense to ignore the sunspot

Outline

The Full NK Model: AD Side

- Let consumers be long lived but imperfectly informed or inattentive
- Consumer optimality (basically, PIH):

$$c_{i,t} = E_{i,t}\left[(1-\beta)a_{i,t} - \beta\sigma\sum_{k=0}^{+\infty}\beta^k(i_{t+k}-\pi_{t+k+1}) + (1-\beta)\sum_{k=0}^{+\infty}\beta^k(y_{t+k}-\tau_{t+k})\right]$$

- Gov's intertemporal budget:

$$b_t - p_{t-1} = \sum_{k=0}^{+\infty}\beta^k(\tau_{t+k}-g_{t+k})$$

- Market clearing:

$$\int a_{i,t}di = b_t - p_{t-1} \quad \text{and} \quad y_t = c_t \equiv \int c_{i,t}di$$

- Put together $\Longrightarrow$ intertemporal Keynesian cross:

$$c_t = -\beta\sigma\left\{\sum_{k=0}^{+\infty}\beta^k\bar{E}_t[i_{t+k}-\pi_{t+k+1}]\right\} + (1-\beta)\left\{\sum_{k=0}^{+\infty}\beta^k\bar{E}_t[c_{t+k}]\right\}$$

The Full NK Model: its three equations

- Intertemporal Keynesian cross (proper DIS):

$$c_t = -\beta\sigma \left\{ \sum_{k=0}^{+\infty} \beta^k \bar{E}_t \left[i_{t+k} - \pi_{t+k+1} \right] \right\} + (1-\beta) \left\{ \sum_{k=0}^{+\infty} \beta^k \bar{E}_t \left[c_{t+k} \right] \right\}$$

  - reduces to RA's Euler (plus transversality) under full information
  - summarizes consumer optimality and market clearing more generally (think HANK)
  - in paper: robust to idiosyncratic shocks as long as there are no "misperceptions"

- Standard forward-looking NKPC:

$$\pi_t = \kappa c_t + \beta E_t \left[\pi_{t+1} \right] + \xi_t$$

  - unlike consumers, firms are perfectly informed (can be relaxed)

- Monetary policy:

$$i_t = z_t + \phi_c c_t + \phi_\pi \pi_t$$

  - for arbitrary $\phi_c, \phi_\pi \geq 0$ (nests pegs with $\phi_c = \phi_\pi = 0$)

The Generalized Result

- From three equations to one:
  - solve NKPC and MP for (π_t, i_t) as a function of $\{c_{t+k}\}_{k=0}^{\infty}$
  - replace in DIS to get an equation of the form

$$c_t = \theta_t + \bar{E}_t \left[\sum_{k=0}^{+\infty} \delta_k c_{t+k} \right]$$

  for some coefficients $\{\delta_k\}_{k=0}^{\infty}$ that encapsulate all the GE feedbacks

- Once again: a game among the consumers, albeit with more complicated best response
  - math is more complicated, but basic logic is same.
  - precise values of δ_k don't matter, result extends as long as $\delta_0 < 1$ and $\sum_{k=0}^{\infty} |\delta_k| < \infty$

Proposition. Determinacy with fading social memory

Maintain our assumption about information, for any $\lambda > 0$.
Then, the MSV solution is again the unique equilibrium

Fiscal Theory of Price Level

- Conventional approach:
  - assume Taylor principle $\Longrightarrow$ select MSV solution
  - debt and deficits do not appear in DIS+NKPC+MP $\Longrightarrow$
    - Ricardian equivalence
    - fiscal regime does not enter MSV

- Known as "monetary-active regime" (Leeper) or "Ricardian regime" (Woodford)

Fiscal Theory of Price Level

- Alternative approach: FTPL
  - suppose the MSV solution is such that

$$\frac{B_{t-1}}{P_t^{(\mathrm{MSV})}} \neq PVS_t$$

  - then MSV cannot be a "full" equilibrium
  - but if drop Taylor principle, another solution to DIS+NKPC+MP such that

$$\frac{B_{t-1}}{P_t^{(\mathrm{FTPL})}} = PVS_t$$

    and this is the "right" equilibrium
  - pins $\{P_t\}$ and hence also $\{c_t, \pi_t, i_t\}$ as a function of debt and deficits

- Known as "fiscal-active regime" (Leeper) or "nonRicardian regime" (Woodford)

- Breaks Ricardian equivalence
  - not by liquidity constraints, finite lives etc
  - but rather by force of equilibrium selection ("threat of equil non-existence")

Our Take on the FTPL

- Our result $\Rightarrow$ **no room for "non-Ricardian" regime**
  - even if Taylor principle does not hold ($\phi_\pi < 1$)
  - $\{c_t, \pi_t, i_t\}$ necessarily pinned down by MSV solution to DIS+NKPC+MP
  - Ricardian equivalence *has* to hold
  - fiscal policy *has* to adjust to make sure

$$\frac{B_{t-1}}{P_t^{(MSV)}} = PVS_t$$

- Non-Ricardian assumption = actual equil non-existence
  - to paraphrase Kocherlakota & Phelan:
  - "rejecting the non-Ricardian assumption is a logical necessity, not a religious choice"

- But of course: fiscal policy may still matter if MP internalizes fiscal conditions
  - perhaps this is what the FTPL *should* be about?

Outline

Observation of Past Outcomes

- So far:
  - preclude *direct* knowledge of past outcomes, such as c_{t-1} or π_{t-1}
  - but as $\lambda \to 0$, *almost perfect but private and indirect* knowledge of past outcomes
- But what about *direct* knowledge of past outcomes?
- Shut down fundamentals (tentatively) and consider recursive representation of pure sunspot equilibrium:

$$c_t = \delta^{-1} c_{t-1} + \eta_t$$

- This can be supported by

$$I_{i,t} = \{\eta_t, c_{t-1}\} \quad \text{instead of} \quad I_{i,t} = \{\eta_t, \eta_{t-1}, \eta_{t-2}, \ldots\}$$

  - c_{t-1} alone serves as a sufficient statistic ("storage device") for infinite memory
- Is our take on "infinite memory" misleading?
- No! It's the simple recursive logic that is misleading!

Illustrative Example

- **Private signals** of the past aggregate outcome (turn off θ_t tentatively)

$$I_{i,t} = \{\eta_t, s_{i,t}\}, \qquad s_{it} = c_{t-1} + \varepsilon_{i,t}$$

where $\varepsilon_{i,t} \sim \mathcal{N}(0,\sigma)$ is i.i.d. and independent of η_t

Proposition. Noisy Recursive Equilibria

- When $\sigma = 0$, there exist multiple sunspot equilibria.
- When instead $\sigma > 0$, not matter how small, **sunspot equilibria cease to exist**, and the MSV solution is the unique equilibrium.

- Illustrates fragility of *simplest* recursive equilibria
- But what about more complicated cases, with more info about past outcomes?

The Second Perturbation

- Let's even insist on *perfect* and *public* knowledge of $\{c_{t-1}, ..., c_{t-K}\}$ for K finite but arbitrarily large
- But accommodate uncertainty (and no revelation) about a small driver of past outcomes
- Formally, add small fundamental shock that is known at t but unknown at $\tau \geq t+1$.
  - best responses:

$$c_t = (1-\delta_0)(\theta_t + \zeta_t) + \delta_0 \bar{E}_t[c_t] + \delta_1 \bar{E}_t[c_{t+1}]$$

  - payoff perturbation: $\zeta_t \sim_{\text{i.i.d.}} U[-\varepsilon, +\varepsilon]$, for $\varepsilon > 0$ but arbitrarily small
  - information: for all t and all i,

$$I_{i,t} = I_t = \{\zeta_t\} \cup \{\theta_t ..., \theta_{t-K}\} \cup \{\eta_t ..., \eta_{t-K}\} \cup \{\cdots, c_{t-K}\}$$

- Equivalently: representative but "forgetful" agent in each period ($I_t \not\subseteq I_{t+1}$)

The Second Perturbation

Proposition. Determinacy even with CK of past outcomes

For any $\varepsilon > 0$, not matter how small, there is a **unique equilibrium** and is given by $c_t = c_t^F + \zeta_t$, where c_t^F is the same **MSV solution** as before.

- Intuition:
  - to support infinite chain, the agents at $t+1$ must know how to "reward" the agents at t
  - in particular, they must be able to play

$$c_{t+1} = \delta^{-1}(c_t - \theta_t - \zeta_t) + \eta_{t+1}$$

  - but if they don't know ζ_t, they don't know the "preferences" of the agents at t, and they can't reward them in the needed way
  - and because the agents at t understand this, the chain breaks at t (and before)

Outline

Feedback Rules and Ramsey Implementation

- Consider the **Ramsey optimum**. How can monetary policy uniquely implement it?

- If the monetary authority **observes the underlying shocks**, uniquely implemented with:

$$i_t = i_t^o + \phi(\pi_t - \pi_t^o),$$

  where i_t^o and π_t^o are rates and inflation in the optimum and $\phi > 1$.

- What if the monetary authority **does not observe the underlying shocks?**
  - implemented through feedback rules?

$$i_t = \phi \pi_t$$

- Two conflicting roles
  - **Stabilization** ($\phi < 1$ possible in the Ramsey optimum)
  - **Eq. selection** ($\phi > 1$ necessary in the standard paradigm)

- Here: Liberates the **stabilization role** of monetary policy from **its eq. selection role**

Alternative Boundedly-Rational Solution Concepts

1. **Relax REE but maintain a "fixed point" between expectations & actual**
   - e.g., Cognitive discounting in Gabaix (20); Diagnostic expectations in Bordalo et. al (20)
   - may change the parameter region ϕ for which there is indeterminacy
   - but the indeterminacy problem remains, and so does the "war" with the FTPL
   - also: a version of our logic extends to such solutions concepts as well
2. Completely **shut down the "fixed point"**
   - e.g. Level-k thinking (Garcia-Schmidt & Woodford, 19; Farhi & Werning, 19)
   - produces a unique solution but opens a new issue
   - whenever $\phi < 1$, Level-k solution becomes infinitely sensitive to Level-0 behavior
   - so doesn't really resolve the issue, but complements our approach in solidifying the logical foundations of the conventional solution

Outline

Conclusion (1)

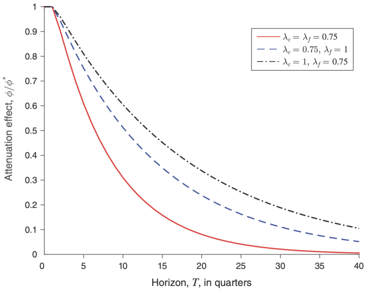
- NK indeterminacy/FTPL hinge on **strong info assumptions**
- **A small friction in memory & intertemporal coordination** can result in **determinacy**
  - equilibrium same as conventional, but not equi selection conondrum
- Taylor principle perhaps less consequential than previously thought
  - more crucial: boundedness (commitment to rule out large deviations)
  - and: stabilization role of high ϕ
- **No room for FTPL** as currently formulated
  - non-Ricardian assumption = equil non-existence even if MP is passive
  - but **fiscal considerations can matter if internalized by MP**
  - model MP-FP interaction as a game of between monetary & fiscal authority?

Bonus: Revisiting the MSV Solution

- So far: θ_t is perfectly and commonly known $\Rightarrow$ MSV solution unaffected by friction
- How does c_t^F change if θ_t is not perfectly and commonly known?
- That's the question studied by existing literature
  - Woodford, Mankiw-Reis, Mackowiac-Wiederholt
  - my earlier work with Chen and Zhen
  - that is, this literature assumes away the determinacy issue by imposing TP and focuses on "noising up" the fundamental solution
- Key difference: noise has to be <u>large</u> to affect MSV
- But common theme:
  - info friction attenuates strategic complementarity/GE feedback
  - here: lower them enough to kill self-fulfilling equilibria
  - earlier work: reduce GE multipliers for forward guidance, monetary shocks etc

Illustration 1: Angeletos & Lian (AER 2018)

- Liquidity trap of length T, forward guidance about i_t after T
  - akin to a news shock at $t = 0$ for θ_{T+1}
- Add idios noise in observation of this news (higher-order uncertainty)
- Study how effect varies with T



- Why? Because higher T maps to a large GE multiplier in the standard model, which is greatly attenuated by the noise/higher-order uncertainty

Illustration 2: Angeletos & Huo (AER 2021)

- Normal times (away from ZLB), stationary environment
- Main result: adding noise to MSV is *as if* adding two behavioral distortions:

$$c_t = \theta_t + \omega_f \delta E_t[c_{t+1}] + \omega_b c_{t-1}$$

  with $\omega_f < 1$ ("myopia") and $\omega_b > 0$ ("anchoring")
- Also: both distortions increase with GE params such as MPC/slope of Keynesian cross
  - HANK meets HOB

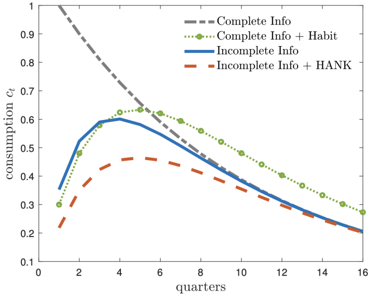


Figure 4. Response of Consumption to Lower Interest Rates

Conclusion (2): Two Birds with One Stone

- This paper:
  - resolve classic indeterminacy issue
  - reinforce logical foundations of conventional solution
  - mute FTPL critique
- Complementary previous work:
  - improve empirical properties of standard solution
  - reduce forward-guidance puzzle etc
  - interaction with HANK etc