Deficits and Inflation: HANK meets FTPL

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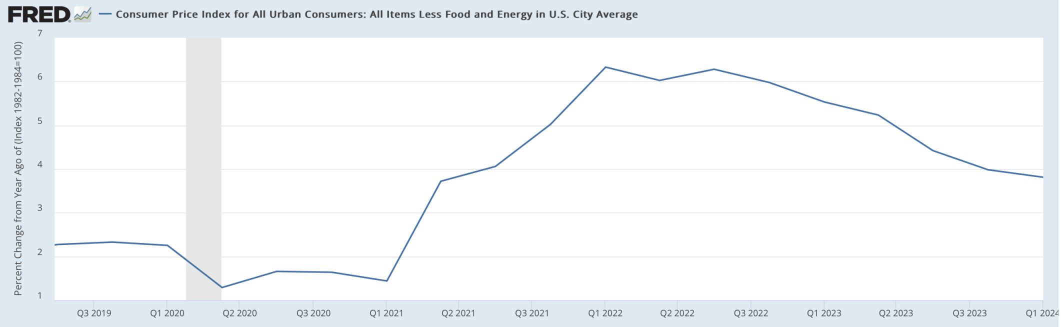
Deficits and Inflation



Two key questions:

1. Quantitative: **How much** inflation can fiscal deficits generate?
2. Mechanism: **How** do fiscal deficits drive inflation?

Deficits and Inflation

FTPL

- **How much**? simple — as much as needed for debt erosion to finance the unfunded deficit

$$\frac{B}{P} = -\text{deficit} + NPV(\text{surpluses}) \quad \Longrightarrow \quad \text{deficit} = 1\%\ \text{GDP} \mapsto \text{price jump} = \left(\frac{B/P}{Y}\right)^{-1}\%$$

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- **HANK** (conventional Keynesian logic)
  - **How**? simple — deficits stimulate y and π because households are non-Ricardian
  - **How much**? subtle — depends on MPCs, slope of PC, MP response...

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This paper: bridge between FTPL & HANK

HANK meets FTPL

1. **HANK** with slow fiscal adjustment = **RANK-FTPL**
   - *Despite* difference in mechanism, HANK predicts same inflation as FTPL
   - *Because* of difference in mechanism, HANK sidesteps FTPL controversies

     robust to (i) active MP & passive FP; (ii) refinements that remove indeterminacy

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2. Deficits **less inflationary** than **simple FTPL arithmetic**
   - Deficits trigger a boom in y and the tax base, substituting for debt erosion

     plus additional effect from front-loaded $\pi \times$ long-term debt
   - This cuts down deficit-driven inflation by $\approx 50\%$ vs. simple FTPL arithmetic

Framework

A Simple New Keynesian Economy

- **AS:** standard, summarized in NKPC

$$\pi_t = \kappa y_t + \beta \mathbb{E}_t \pi_{t+1} = \kappa \sum_{k=0}^{\infty} \beta^k \mathbb{E}_t y_{t+k}$$

  - *crucial implication:* deficits can be inflationary iff Ricardian Equivalence fails

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- **AD:** perpetual youth OLG with survival rate $\omega \in (0,1]$
  - nests PIH / RANK when $\omega = 1$
  - mimics liquidity frictions / HANK when $\omega < 1$
  - later: heterogeneity in MPCs, wealth, and incidence; quantitative HANK

Aggregate Demand

- Optimality + aggregation + log-linearization around flex-price steady state $\Longrightarrow$

$$c_t = \underbrace{(1-\beta\omega)}_{\text{MPC}}\left(\underbrace{a_t}_{\text{assets}} + \underbrace{\mathbb{E}_t\left[\sum_{k=0}^{\infty}(\beta\omega)^k(y_{t+k}-t_{t+k})\right]}_{\text{permament income net of taxes}}\right) - \psi \underbrace{\mathbb{E}_t\left[\sum_{k=0}^{\infty}(\beta\omega)^k r_{t+k}\right]}_{=0 \text{ in a pedagogical benchmark}}$$

- Higher mortality (lower ω) mimics tighter liquidity
  - higher MPC out of current income and assets $\Rightarrow$ spend fast any transfers
  - higher discounting of future disposable income $\Rightarrow$ respond less to future taxes

- RANK imposes $\omega = 1$ vs Micro evidence requires $\omega \ll 1$

Government

- Gov must satisfy flow budget constraint plus no-Ponzi condition ($\lim_{k\to\infty} \beta^t \mathbb{E}_t d_{t+k} = 0$)
- Together, these imply

$$d_t = \mathbb{E}_t \left[\sum_{k=0}^{\infty} \beta^k \left(t_t - \beta \frac{D^{ss}}{Y^{ss}} r_t \right) \right]$$

- Baseline model: one-period nominal debt $\Rightarrow$

$$\underbrace{d_t - \mathbb{E}_{t-1}[d_t]}_{\text{innovation in real value of public debt}} = - \underbrace{\frac{D^{ss}}{Y^{ss}} (\pi_t - \mathbb{E}_{t-1}[\pi_t])}_{\text{erosion due to inflation surprise}}$$

- Extension and quantitative: long-term nominal debt

Policy Rules

- **Fiscal policy:** set taxes according to

$$t_t = \underbrace{-\varepsilon_t}_{\text{i.i.d. deficit shock}} + \underbrace{\tau_y y_t}_{\text{tax base channel}} + \underbrace{\tau_d (d_t + \varepsilon_t)}_{\text{fiscal adjustment}}$$

  - think of ε_t as a transfer to hhs (stimulus checks), $\tau_y > 0$ as the steady-state rate of taxation, and $\tau_d \geq 0$ as speed of fiscal adjustment (future tax hikes)
  - no-Ponzi satisfied for <u>all</u> y, π iff $\tau_d > 0$ ("passive FP") but not if $\tau_d = 0$ ("active FP")

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- **Monetary Policy:** set nominal rate i_t according to

$$\underbrace{i_t - \mathbb{E}_t[\pi_{t+1}]}_{\equiv r_t} = \phi y_t$$

  - allow both $\phi > 0$ ("active MP") and $\phi \leq 0$ (passive MP).

Equilibrium Definition

Definition. A stochastic path for y_t, π_t, d_t, r_t, etc such that

- π_t obeys NKPC (firm and worker optimality)
- c_t obeys aggregate consumption function (consumer optimality)
- $y_t = c_t$ and $a_t = d_t$ (goods and asset market clearing)
- d_t obeys gov's flow budget and no-Ponzi
- t_t and r_t obey assumed policy rules

* Slight departure from Leeper: { drop boundedness of d_t, for consistency with FTPL; address boundedness of y_t and π_t in due course }

RANK ($\omega = 1$)

RANK: Equilibrium Characterization

Proposition

Suppose $\omega = 1$.

1. *Conventional solution: If* $\phi > 0$ & $\tau_d > 0$ *("active MP and passive FP"),* $\exists$ *a unique equil with bounded* y_t *and is such that* $y_t = \pi_t = 0$.

2. *FTPL solution: If* $\phi \leq 0$ & $\tau_d = 0$ *("passive MP and active FP"),* $\exists$ *a different unique equil and is such that*

$$\pi_\varepsilon^{FTPL} \equiv \frac{\text{price jump}}{\text{deficit shock}} = \frac{\kappa}{\tau_y + (\kappa - \beta\phi)\frac{D^{ss}}{Y^{ss}}} \underbrace{= \left(\frac{D_{ss}}{Y_{ss}}\right)^{-1} \text{ when } \phi = \tau_y = \tau_d = 0}_{\text{simple FTPL arithmetic}}$$

Other regimes: multiple bounded equilibria for $\phi \leq 0$ & $\tau_d > 0$; non-existence for $\phi > 0$ & $\tau_d = 0$.

Understanding RANK-FTPL

- When $\omega = 1$, aggregate consumption is

$$c_t = (1-\beta)\, z_t + (1-\beta) \sum_{k=0}^{\infty} \beta^k \mathbb{E}_t [y_{t+k}] - \sigma\beta \sum_{k=0}^{\infty} \beta^k \mathbb{E}_t [r_{t+k}]$$

$$z_t \equiv a_t - \sum_{k=0}^{\infty} \beta^k \mathbb{E}_t \left[t_{t+k} - \beta \frac{A^{ss}}{Y^{ss}} r_{t+k} \right]$$

- For <u>any</u> policy mix and <u>any</u> equilibrium,

$$a_t = d_t = NPV(\text{surpluses}) \quad \Rightarrow \quad z_t = 0$$

- Combining with $c_t = y_t$ and $r_t = \phi y_t$, yields

$$y_t = (1 - \beta - \sigma\beta\phi) \left(y_t + \sum_{k=1}^{\infty} \beta^k \mathbb{E}_t [y_{t+k}] \right) \qquad \textbf{(IKC)}$$

Note: IKC $\Longleftrightarrow$ DIS : $y_t = -\sigma\phi y_t + \mathbb{E}_t y_{t+1}$

Understanding RANK-FTPL

- Two key properties:
  1. **fiscal policy has dropped out**:
     gov debt is not net wealth in equil—and consumers *understand* this because they are rational
  2. **the IKC admits multiple fixed points** due to GE feedback between c and y:
     consumers willing to spend more when they expect others to do the same

- Conventional approach: naturally preserve Ricardian Equivalence
  - impose $\phi > 0$ & rule out unbounded solutions $\Rightarrow$ select $y_t = 0$ (and hence $\pi_t = 0$)
  - satisfy no-Ponzi by letting $\tau_d > 0$ ("passive FP")

- RANK-FTPL: break Ricardian Equivalence by force of equilibrium selection
  - let $\tau_d = 0$ ("active FP") $\Rightarrow$ select unique solution that avoids Ponzi
  - consumers coordinate on spending more (and triggering inflation) when deficits are high

HANK $(\omega < 1)$

A different mechanism: classical non-Ricardian effects

- Same aggregate consumption function and same definition for z_t, modulo $\beta \mapsto \beta\omega$
- In equilibrium, we still have $a_t = d_t = NPV(\text{surpluses})$, but no more $z_t = 0$. Instead,

$$z_t = \mathbb{E}_t \left[\underbrace{\sum_{k=0}^{\infty} \beta^k \tilde{t}_{t+k}}_{a_t} - \sum_{k=0}^{\infty} (\beta\omega)^k \tilde{t}_{t+k} \right] \qquad \text{with } \tilde{t}_t \equiv t_t - \beta \frac{D^{ss}}{Y^{ss}} r_t$$

  - Essence: FP stimulates AD by shifting tax burden to future (or easing borrowing constraints)

- The **IKC** becomes

$$y_t = \underbrace{(1-\beta\omega) z_t}_{\text{non-Ricardian effect}} + \underbrace{(1-\beta\omega-\beta\omega\sigma\phi) \left\{ y_t + \sum_{k=1}^{\infty} (\beta\omega)^k \mathbb{E}_t [y_{t+k}] \right\}}_{\text{permament income and intertemporal substitution}}.$$

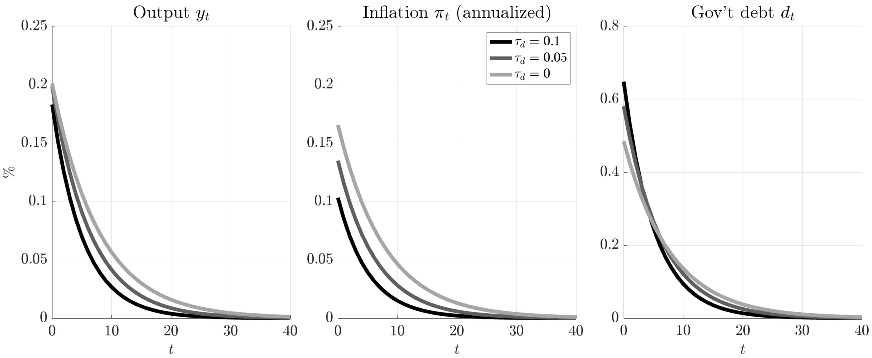
  - "Bug" inherited from RANK: IKC may still admit multiple fixed points
  - Later: verify FP operates only via z_t in our HANK equilibrium

The HANK equilibrium

Proposition

Suppose $\omega < 1$ and $\phi < \bar{\phi}$ (for appropriate $\bar{\phi} > 0$). $\exists$ a unique bounded equilibrium, henceforth referred to as the HANK equilibrium, and it has the following properties:

- *continuous in τ_d and ϕ (including at $\tau_d = 0$ and $\phi = 0$)*
- *pushing tax hikes to future (lower τ_d) $\Rightarrow$ bigger and more persistent boom*



HANK meets FTPL (with $\phi = 0$)

Proposition

Suppose $\omega < 1$ and $\phi = 0$. Let π_ε^{HANK} be the price jump normalized by the deficit shock. This increases as fiscal adjustment gets slower ($\tau_d \downarrow$), converging eventually to its FTPL counterpart:

$$\lim_{\tau_d \to 0^+} \pi_\varepsilon^{HANK} = \pi_\varepsilon^{HANK}\Big|_{\tau_d = 0} = \pi_\varepsilon^{FTPL}$$

- **Different "how", but same "how much"!**
  - without a discontinuity at $\tau_d = 0$ or $\phi = 0$
  - without other fragilities (shown shortly)
- Result holds regardless of how strong the tax-base channel is
  - but as $\tau_y \to 0$ (or $\kappa \to \infty$), replicate simple FTPL arithmetic: $\pi_\varepsilon^{HANK}\big|_{\tau_d=0} \to \left(\frac{D^{ss}}{Y^{ss}}\right)^{-1}$
- Result extends to $\phi \neq 0$, provided same IRF for real rates

Why?

- When $\phi = \tau_d = 0$, Gov's intertemporal budget becomes

$$\underbrace{\varepsilon_t}_{\text{deficit shock}} = \underbrace{\tau_y \sum \beta^t \left(y_t - \mathbb{E}_{t-1} y_t\right)}_{\text{tax base bonanza}} + \underbrace{\frac{D_{ss}}{Y_{ss}} \left(\pi_t - \mathbb{E}_{t-1} \pi_t\right)}_{\text{debt erosion}}$$

- By NKPC,

$$\frac{\text{debt erosion}}{\text{tax base bonanza}} = \frac{\kappa}{Y} \frac{D_{ss}}{Y_{ss}}$$

- Both the sum and the ratio are the same in HANK and in RANK-FTPL
  $\Longrightarrow$ each component has to be the same $\Longrightarrow$ same price jump

- Remark: our HANK-FTPL equivalence is not *just* this arithmetic
  - result hinges on existence and continuity of HANK equilibrium at $\tau_d = 0$

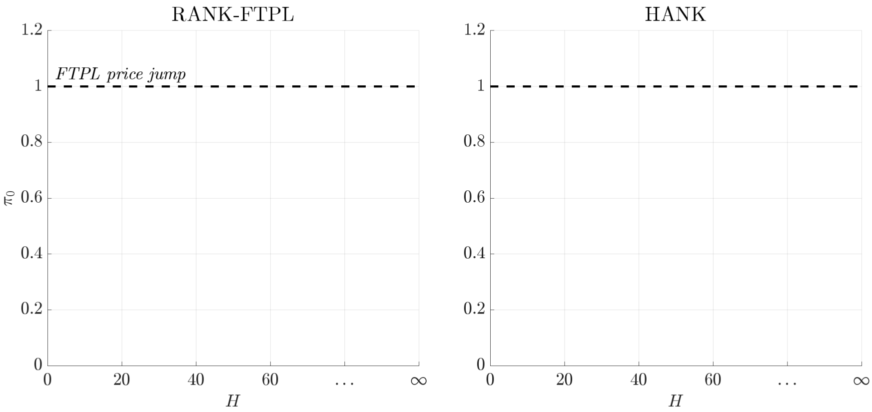
Does the difference in mechanism matter?

Same predictions about debt erosion, but two differences:

1. **Front-loading:** HANK predicts less persistence in y and π
   - because non-Ricardian households are relatively impatient (spend fast)
2. **Robustness:** unlike RANK-FTPL, HANK is robust to
   - active-monetary passive-fiscal ($\phi > 0, \tau_d > 0$)
   - fiscal adjustment at long horizons
   - mild belief refinement that removes NK indeterminacy

Robustness to full fiscal adjustment at long horizons

- Modification: at $t \geq H$, FP adjusts taxes s.t. $\mathbb{E}_t d_{t+1} = 0$ and MP switches to active
- Selects conventional solution in RANK,



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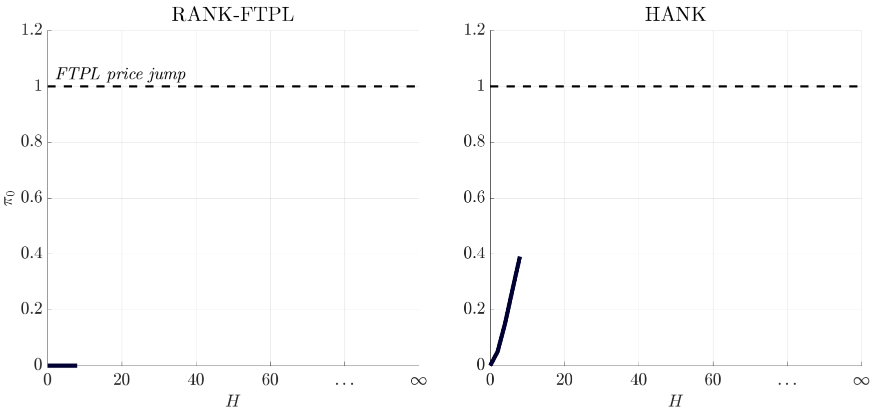

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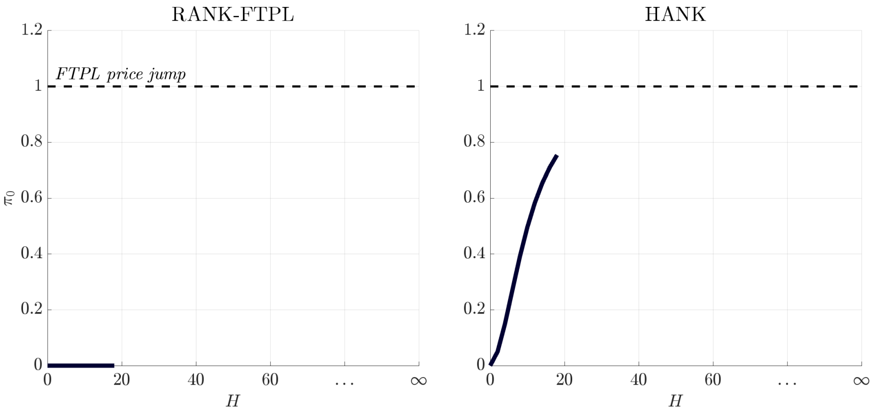

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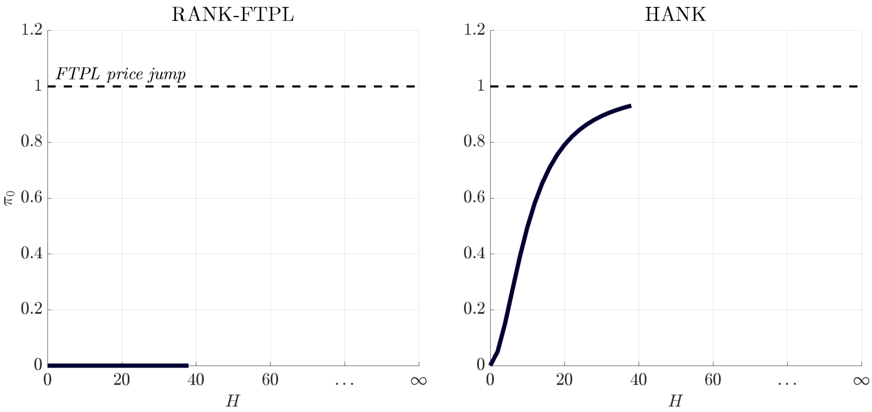

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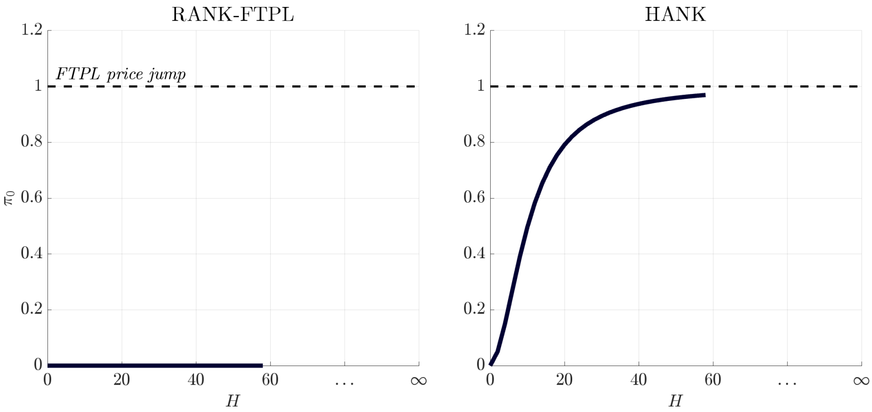
- Modification: at $t \geq H$, FP adjusts taxes s.t. $\mathbb{E}_t d_{t+1} = 0$ and MP switches to active
- Selects conventional solution in RANK, but has a small effect on our HANK equilibrium



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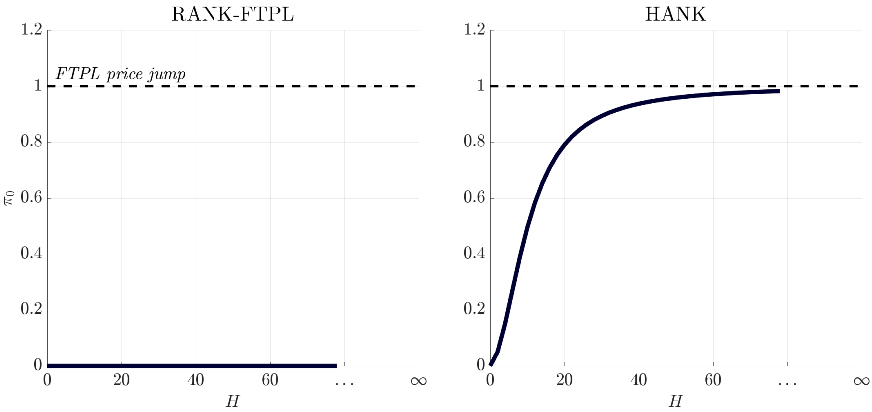

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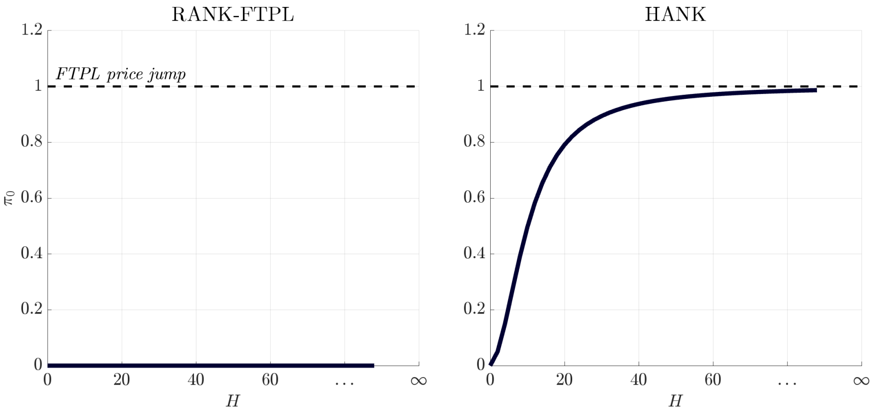

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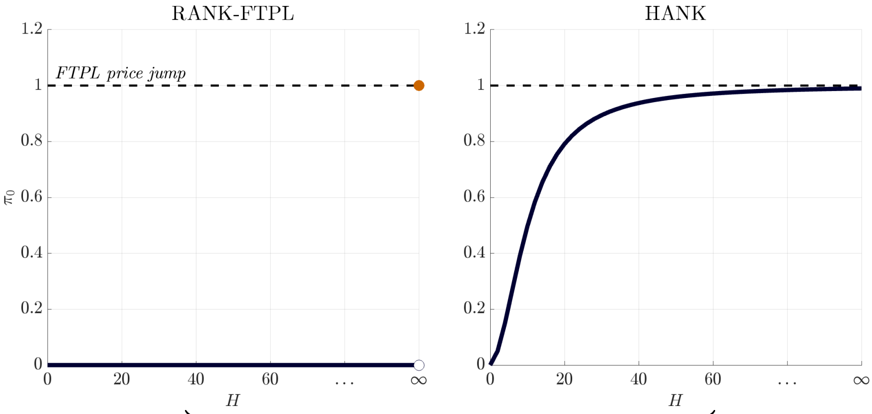


HANK replicates key FTPL prediction, but sidesteps controversy

Robustness to belief refinement (echoes Angeletos & Lian, 2023)

Proposition

Suppose consumers ***expect economy to return to steady state at some far-ahead but finite date*** H*. Then:*

1. In ***RANK****,* $\exists$ *a unique equilibrium and it has* $y_t = \pi_t = 0 \ \forall t$*.*

- In RANK, any equilibrium has to solve

$$y_t = -\sigma\phi y_t + \mathbb{E}_t y_{t+1}.$$

  Setting $y_H = 0$ and solving backwards $\Rightarrow$ $y_t = 0$ for all t.

- This fragility is "hidden" behind asymptotic convergence of FTPL equilibrium.
- Similar fragility to small noise in info/coordination (Angeletos & Lian, 2023)

Robustness to belief refinement (echoes Angeletos & Lian, 2023)

Proposition

Suppose consumers ***expect economy to return to steady state at some far-ahead but finite date*** *H (instead of asymptotically). Then:*

1. *In* ***RANK***, *$\exists$ a unique equilibrium and it has $y_t = \pi_t = 0 \ \forall t$.*
2. *In* ***HANK***, *$\exists$ a unique equilibrium and it converges to our HANK equilibrium as $H \to \infty$.*

- Repeat previous RANK argument after addition of discount-rate shock ξ_t.
- Unique equilibrium again converges to conventional one, which now has y_t move with ξ_t.
- Same logic explains robustness of our HANK equilibrium, with z_t in place of ξ_t.

Extensions

Additional Results

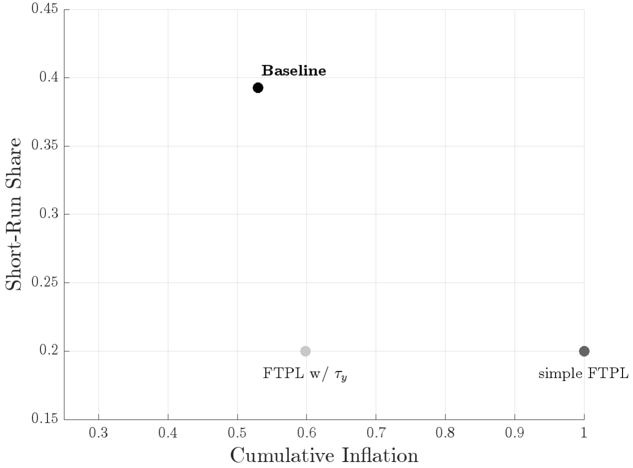
- **Heterogeneity in MPC and incidence** (a bridge to richer HANK)
  - this gives more front-loading, but preserves $\pi^{HANK} = \pi^{FTPL}$
- **Long-term debt**
  - debt erosion becomes larger in both HANK and RANK
  - now $\pi^{HANK} < \pi^{FTPL}$, because HANK has more front-loaded inflation response
  - but the distance vanishes when $\tau_y \to 0$, $\kappa \to \infty$ or $\omega \to 1$ (and it's small quantitatively)
- **Hybrid NKPC:**
  - this allows $\pi^{HANK} > \pi^{FTPL}$ in principle (with short-term debt)
  - but does not matter in practice (with long-term debt)

Quantitative Evaluation and Post-Covid Application

Assumptions

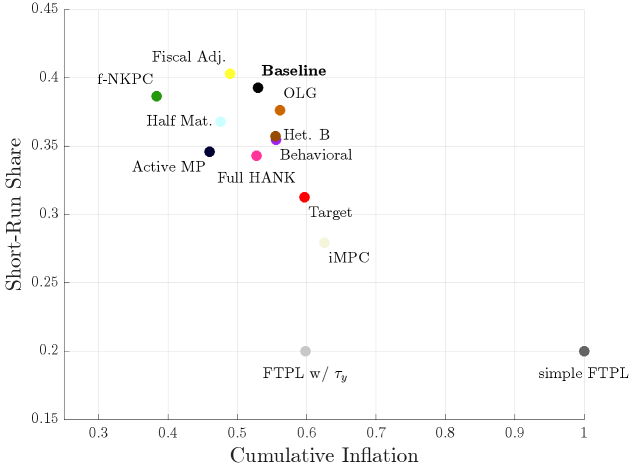
- **AD:** realistic heterogeneity
  - three types of OLG consumers
  - heterogeneity in MPCs, wealth, and incidence
  - calibrated to corresponding evidence
- **AS:** Hybrid NKPC
  - κ similar to Cerraro & Gitti (2023) for post-covid
  - or 3×baseline in Hazell, Herreño, Nakamura & Steinsson (2022)
  - inertia as in Barnichon & Mesters (2022) update to Gali & Gertler (2000)
- **Policy:**
  - $\tau_d \approx 0$ (upper bound, "unfunded" stimulus checks), $\phi = 0$ (isolate fiscal effects)
  - realistic values for τ_y, maturity structure, and D_{ss}/Y_{ss}

Cumulative Inflation and Front-Loading



*Short-Run Share = cumulative π in year 1 relative to cumulative π in years 1-5

Cumulative Inflation and Front-Loading



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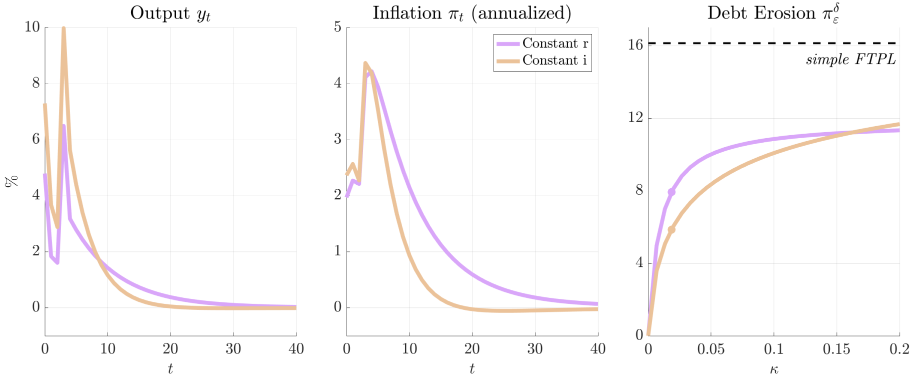
Application: Stimulus Checks



Shocks = household components of **CARES** and **ARP**

Cumulative inflation = **6 to 8%** in our baseline vs **16%** in simple FTPL arithmetic

Conclusion

This paper: bridge between **FTPL** & **HANK** theories of deficits and inflation

Take-home messages:

1. **HANK** replicates **FTPL** predictions about π and debt erosion, w/o the controversies

   Key to robustness: Ricardian Equivalence fails because of classical reasons, not equilibrium selection.

2. Unfunded deficits are quite inflationary, but much less than **simple FTPL arithmetic**

   Why? meaningful tax base self-financing + interaction of front-loading w/ long-term debt.

Thank You!