Can Deficits Finance Themselves?

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How Are Deficits Financed? [$r > g$]

Question: how are fiscal deficits, e.g., transfers to households, financed?

Basic answer: **Fiscal adjustment**: **raise tax**/cut spending in the future

This paper: **Self-financing** in NK with finite lives/liquidity constraints [break Ricardian Equivalence]

- Deficit $\Rightarrow$ Keynesian boom $\Rightarrow$ **tax base** $\uparrow$ and **debt erosion** ($P_0 \uparrow$)
  - improve budget without tax rate adjustment
- Q: How important is such **self-financing**? Can there ever be **full** self-financing?

How Big Can "Self-financing" Be? [$r > g$]

Environment: finite lives (or liquidity constraints) + nominal rigidities [OLG-NK, HANK...]

Policy: full **delayed fiscal adjustment** promised at future date H + monetary policy "neutral" (fix $\mathbb{E}[r]$) or mildly active

- **Main result**: as **fiscal adjustment** is delayed more, converge to **full self-financing**
  - *Monotonicity*: as H increases, the actual required future tax hike gets smaller and smaller
  - *Limit*: the future tax hike vanishes, i.e., we converge to full self-financing
  - *Split* depends on price rigidities. [All via tax base $\uparrow$ if rigid, all via prices $\uparrow$ if approx. flexible.]

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  - *Split* depends on price rigidities. [All via tax base ↑ if rigid, all via prices ↑ if approx. flexible.]
- **Intuition:** finite-lives/liq. constraints: "**discount**" far-future tax & **front-loaded Keynesian cross**
- **Practical relevance**: holds in many environments & quantitatively powerful

  [general AD (incl. HANK), active monetary policy, investment, distortionary taxation, ...]

Outline

Households and Firms

Continuum of **perpetual youth** consumers with survival rate ω [$\omega = 1$: RANK; $\omega < 1$: proxy for HANK, later]

$$\mathbb{E}_t \left[\sum_{k=0}^{\infty} (\beta \omega)^k \left[u(C_{i,t+k}) - v(L_{i,t+k}) \right] \right],$$

- Invests in actuarially fair annuities

$$A_{i,t+1} = \underbrace{\frac{I_t}{\omega}}_{\text{annuity}} \left(A_{i,t} + P_t \cdot \left(\underbrace{W_t L_{i,t} + Q_{i,t}}_{Y_{i,t}} - C_{i,t} - T_{i,t} + \text{Transfer to Newborns} \right) \right),$$

where transfer to newborns makes sure that all cohorts have the same C in steady state [$r > g$].

- Tax and transfer

$$T_{i,t} = \underbrace{\tau_y Y_{i,t}}_{\text{distonary income tax}} + \underbrace{\mathscr{T}_t}_{\text{lump sum tax/transfer}}$$

Firms as in textbook NK model: **standard NKPC** [in log: $\pi_t = \kappa y_t + \beta \mathbb{E}_t[\pi_{t+1}]$]

Policy, Market Clearing, and Log-Linearization

- Government budget [no G_t, T_t is real tax/transfer]

$$\frac{1}{I_t} B_{t+1} = B_t - P_t T_t \qquad \text{(plus no Ponzi)}$$

and define $D_t = B_t / P_t$ as **real value** of public debt outstanding.

- Market clearing

$$Y_t = \int C_{i,t} di \quad \text{and} \quad \int A_{i,t} di = B_t.$$

- Initial condition

$$A_{i,0} = B_0.$$

- Log-linearization: a lower case capture log-deviations from steady state [with the exception of fiscal variables, e.g., $d_t = \frac{d_t - D^{ss}}{Y^{ss}}$, to accommodate $D^{ss} = 0$]

Monetary Policy

- **Baseline:** **no monetary accommodation** [expected real rate in variant to debt & deficit]

$$r_t \equiv i_t - E_t[\pi_{t+1}] = 0$$

- **Extension:** different degrees of monetary accommodation

$$r_t = \phi y_t$$

  - $\phi < 0$: an "accommodative" monetary authority
  - $\phi > 0$: leans against the wind [Taylor principle holds]

- Baseline ($\phi \approx 0$) consistent with IRFs to identified fiscal shocks [Ramey; Caldara & Kamps; Wolf]

Fiscal Policy

- **Baseline:** Markovian Fiscal Policy [extension of Leeper (1991)]

$$T_{i,t} = \underbrace{\tau_y Y_{i,t}}_{\text{distonary income tax}} + \underbrace{\bar{T} + \tau_d \left(D_t + \mathscr{E}_t\right) - \mathscr{E}_t}_{\text{lump sum}},$$

  or after (log-)linearization and aggregation

$$t_t = \underbrace{\tau_y y_t}_{\text{tax base adjustment}} + \underbrace{\tau_d \cdot (d_t + \varepsilon_t)}_{\text{fiscal adjustment}} - \underbrace{\varepsilon_t}_{\text{i.i.d. deficit shock}} \quad (1)$$

  - $\tau_y > 0$: self financing through endogenous **adjustment in tax base**
  - $\tau_d \in [0,1]$: a lower τ_d captures **delay in fiscal adjustment** (lump sum)

- **Variant:** a Non-Markovian FP with **delayed full fiscal adjustment**

$$t_t = \begin{cases} \tau_y y_t - \varepsilon_t & t < H \quad \text{initially no fiscal adjustment} \\ d_t & t \geq H \quad \text{eventually full fiscal adjustment (lump sum)} \end{cases} \quad (2)$$

  - High H, similar to low τ_d, captures **delay in fiscal adjustment**

Outline

Aggregate Demand

- Optimal consumption + aggregation + $r_t = 0$

$$c_t = \underbrace{(1-\beta\omega)}_{\text{MPC}} \times \left(\underbrace{a_t}_{\text{wealth}} + \underbrace{\mathbb{E}_t \left[\sum_{k=0}^{\infty} (\beta\omega)^k (y_{t+k} - t_{t+k}) \right]}_{\text{post-tax income}} \right),$$

  - $\omega < 1$: (i) elevated MPC; (ii) discounting future y & t, breaking Ricardian Equiv.

- Using fiscal policy (1) and market clearing

$$y_t = \mathscr{F}_1 \cdot (d_t + \varepsilon_t) + \mathscr{F}_2 \cdot E_t \left[\sum_{k=0}^{+\infty} (\beta\omega)^k y_{t+k} \right], \tag{3}$$

with $\mathscr{F}_1 = \frac{(1-\beta\omega)(1-\omega)(1-\tau_d)}{1-\omega(1-\tau_d)}$ and $\mathscr{F}_2 = (1-\beta\omega)\left(1 - \tau_y \frac{1-\omega}{1-\omega(1-\tau_d)}\right)$.

  - $\mathscr{F}_1$ captures **PE effect** of debt/deficits on AD
    - ⋆ $\mathscr{F}_1 > 0$ iff $\omega < 1$ (failure of Ricardian Equiv)
    - ⋆ deficits are transfer from future generations to current generations
  - $\mathscr{F}_2$ captures **GE effect** through **intertemporal Keynesian cross**
    - ⋆ jointly governed by FP (τ_d and τ_y), and MPC (ω)

The economy in 3 equations

1. **AD:**

$$y_t = \mathscr{F}_1 \cdot (d_t + \varepsilon_t) + \mathscr{F}_2 \cdot \mathbb{E}_t \left[\sum_{k=0}^{+\infty} (\beta\omega)^k \, y_{t+k} \right],$$

2. **AS:**

$$\pi_t = \kappa y_t + \beta \mathbb{E}_t [\pi_{t+1}]$$

3. **Evolution of real value of public debt:**

$$d_{t+1} = \beta^{-1} (d_t - t_t) - \underbrace{\frac{D^{ss}}{Y^{ss}} (\pi_{t+1} - \mathbb{E}_t [\pi_{t+1}])}_{\text{self financing: debt erosion}}$$

with $$t_t = \underbrace{\tau_d \cdot (d_t + \varepsilon_t)}_{\text{fiscal adjustment}} + \underbrace{\tau_y y_t}_{\text{self financing: tax base}} - \varepsilon_t$$

Equilibrium Existence and Uniqueness

Theorem

Let $\omega < 1$ *and* $\tau_y > 0$. *There exists* ***unique bounded eq'm*** *taking the form:*

$$y_t = \chi\,(d_t + \varepsilon_t)\,, \quad E_t\,[d_{t+1}] = \rho_d\,(d_t + \varepsilon_t)\,. \tag{4}$$

Moreover, $\chi > 0$ *(deficits trigger boom) and* $0 < \rho_d < 1$ *(debt converges to steady state).*

- Finding the equilibrium: fixed-point relation $\rho_d \longleftrightarrow \chi$
  - $\chi \to \rho_d$ follows from the evolution of real value of public debt:

$$\rho_d = \frac{1}{\beta}\,(1 - \tau_d - \tau_y \chi)$$

  - $\rho_d \to \chi$ follows from the aggregate demand/IKC

$$\chi = \mathscr{F}_1 / (1 - \mathscr{F}_2 / (1 - \beta\omega\rho_d))$$

Outline

Channels of Self Financing

- Start with steady state and consider $\varepsilon_0 > 0$ (one-time unexpected positive deficit shock)
- Gov's intertemporal budget constraint $\Rightarrow$

$$\underbrace{\varepsilon_0}_{\text{deficit}} = \underbrace{\tau_d \left(\varepsilon_0 + \sum_{k=0}^{+\infty} \beta^k E_0 [d_k] \right)}_{\substack{\text{fiscal adjustment} \\ \equiv (1-\nu)\varepsilon_0}} + \underbrace{\overbrace{\frac{D^{ss}}{Y^{ss}} (\pi_0 - E_{-1}[\pi_0])}^{\text{debt erosion} \equiv \nu_p \varepsilon_0} + \overbrace{\sum_{k=0}^{+\infty} \tau_y \beta^k E_0 [y_k]}^{\text{tax base} \equiv \nu_y \varepsilon_0}}_{\substack{\text{self-financing} \\ \equiv \nu \varepsilon_0}}$$

where $\nu \equiv$ fraction of deficit that is **self-financed**, contrast with **fiscal adjustment**.

- RANK benchmark ($\omega = 1$): **zero self financing, $\nu = 0$** [standard eq'm ($\phi \to 0^+$)]
- Now ($\omega < 1$): **full self financing $\nu \to 1$** with **delayed fiscal adjustment** [$\tau_d \to 0$ or $H \to +\infty$]

The Self Financing Result

Theorem

*Suppose that $\omega < 1$ and $\tau_y > 0$. The **self-financing share ν** has the following properties.*

1. ***[Monotonicity]** ν increases in the **delay of fiscal adjustment** (i.e., it is increasing in H and decreasing in τ_d).*
2. ***[Limit]** As fiscal financing is **delayed further** (i.e., as $H \to \infty$ or $\tau_d \to 0$), there is **complete self financing**: ν converges to 1.*
   - *In this limit, self-financing is strong enough to return d to the steady state.*
     [$\tau_d \to 0 : \lim_{k\to\infty} \mathbb{E}_t [d_{t+k}] \to 0$; $H \to \infty : \lim_{H\to\infty} \mathbb{E}_0 [d_H] \to 0$]

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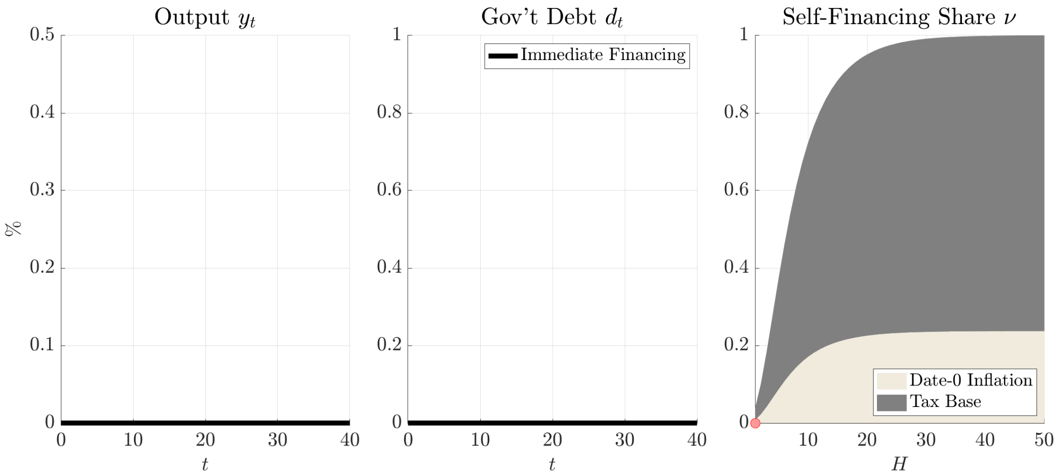
3. ***[Split]****. With rigid price ($\kappa = 0$), all self-financing occurs through tax base ($\nu_y = \nu$); as prices become more flexible (a higher κ), more self-financing occurs through debt erosion*

A Graphical Illustration [$t_t = \tau_y y_t - \varepsilon_t$ for $t < H$ and $t_t = d_t$ for $t \geq H$]



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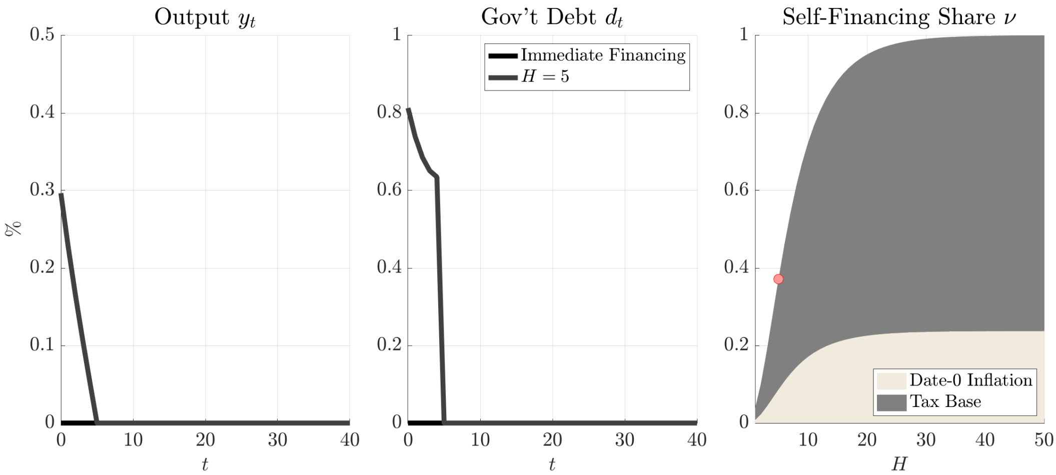

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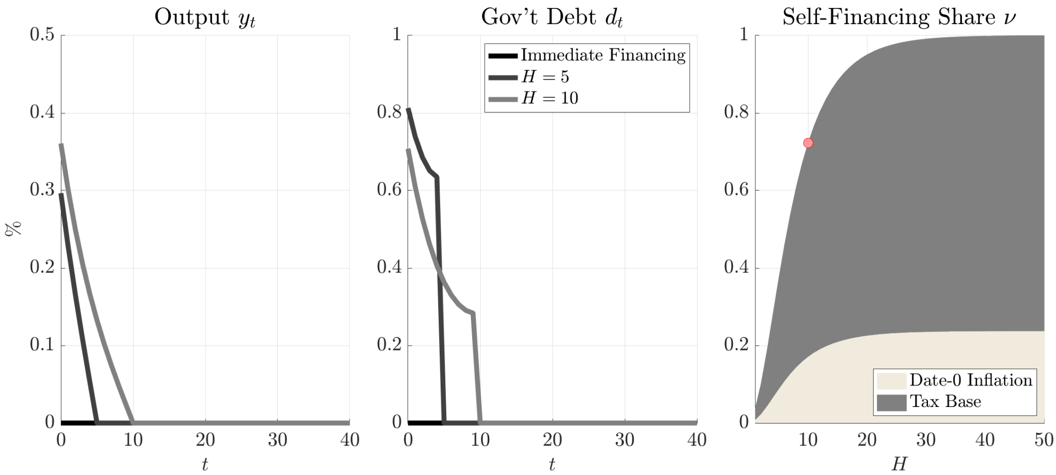

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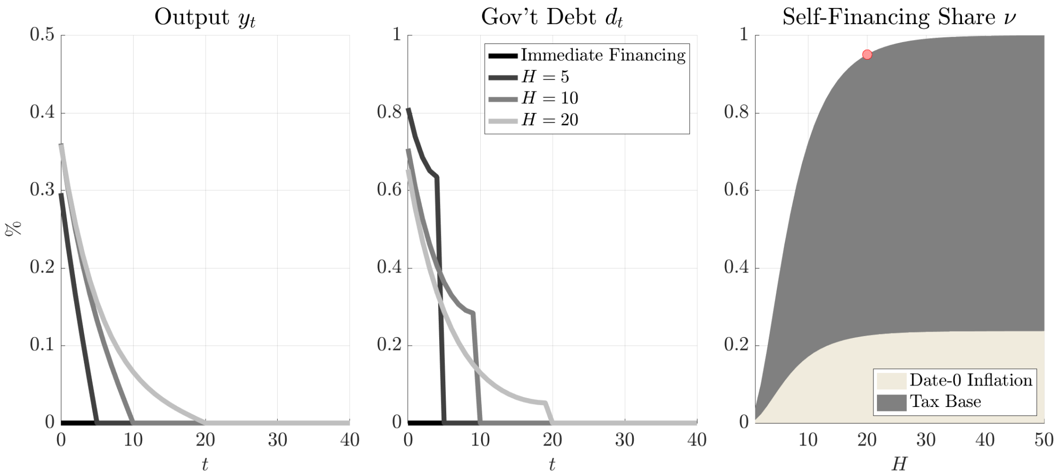

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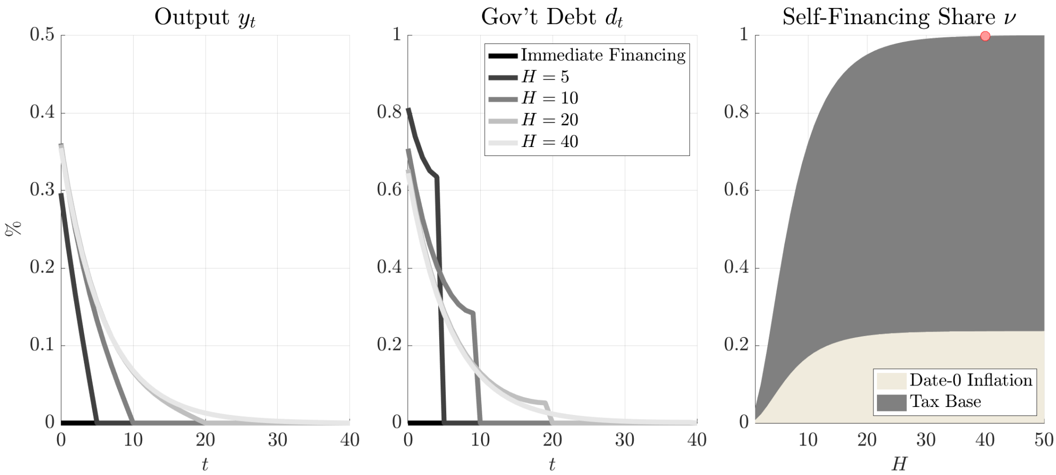
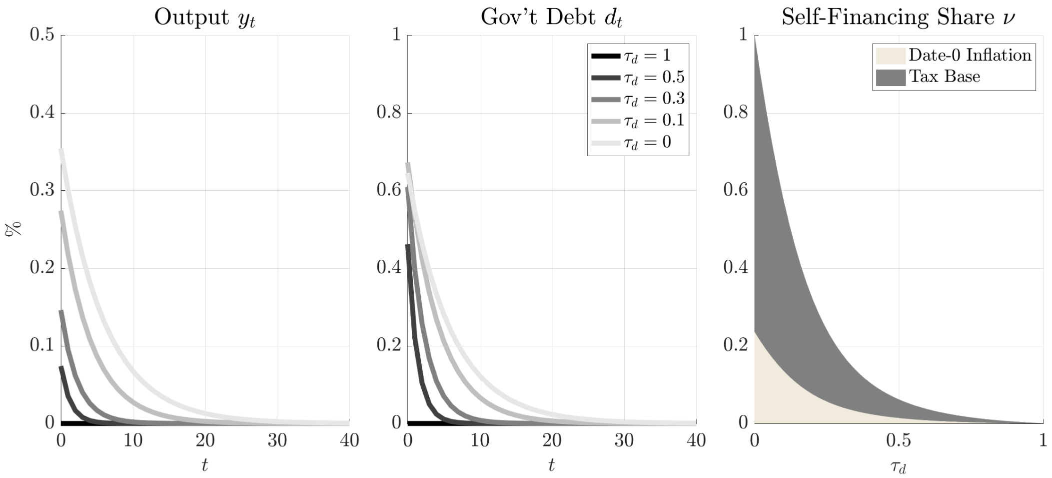


A Graphical Illustration $[t_t = \tau_d(d_t + \varepsilon_t) + \tau_y y_t - \varepsilon_t]$



Economic Intuition [Fully Rigid Price, $\kappa = 0$]

- To illustrate, consider the **total adj. of tax base** from an ad-hoc **static Keynesian cross**
  - Transfer ε at $t = 0$, static Keynesian cross at $t = 0$, tax (if needed) at $t = 1$.

$$y = \text{MPC} \cdot y_{\text{disp}} \quad \text{and} \quad y_{\text{disp}} = (1 - \tau_y)y + \varepsilon \Longrightarrow y = \frac{\text{MPC}}{1 - (1 - \tau_y)\text{MPC}} \times \varepsilon$$

  - \$1 increase in transfer leads to \$MPC increase in AD
  - \$1 increase in AD leads to $\$(1 - \tau_y)$ GE increase in post-tax income
  - $\$(1 - \tau_y)$ increase in post-tax income lead to $\$\text{MPC} \times (1 - \tau_y)$ increase in AD

- **Self-financing** through tax base adjustment: $\nu \equiv \frac{\tau_y y}{\varepsilon} = \frac{\tau_y \text{MPC}}{1 - (1 - \tau_y)\text{MPC}}$ is increasing in the MPC
  - $t = 1$ tax hike needed: $R(1 - \nu)\varepsilon$

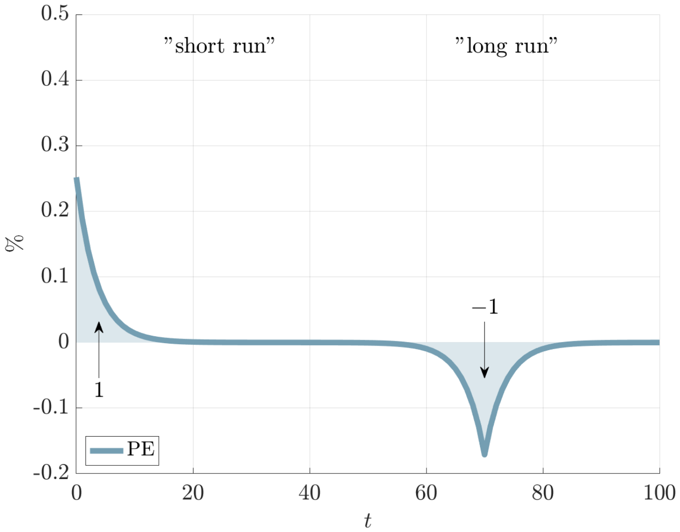
- **Full self-financing** would require $\text{MPC} = 1$, giving $y = \frac{1}{\tau_y} \times \varepsilon$.
  [Hint: Dynamic: cumulative $\text{MPC} = 1$]

Economic Intuition [Fully Rigid Price, $\kappa = 0$]

Our th'm: features of static model have **analogues in dynamic economy**

1. Static: expected "future" tax hike does not affect "current" spending behavior
   $\Longrightarrow$ Dynamic: **discount** $(\omega < 1) \Longrightarrow$ **far future** H-tax's impact on short-run consumption **vanishes**
   [IKC matrix: income change at $t+\ell$ has a vanishing effect on t consumption: $\lim_{\ell \to \infty} \beta^{-\ell} \mathscr{M}_{t,t+\ell} = 0$]

Economic Intuition [$\kappa = 0$, PE effect of transfer-and-tax vector $\mathscr{M} \cdot \boldsymbol{t}^{PE}$, with $\boldsymbol{t}^{PE} = (-1, \cdots, \beta^{-H})$]



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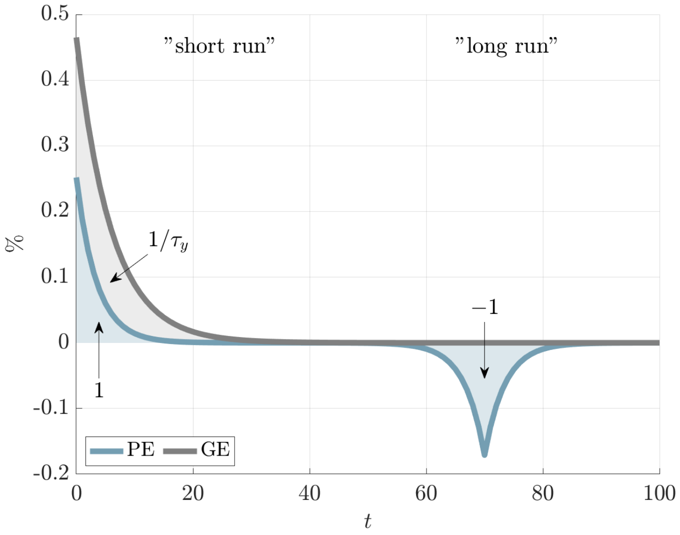
2. Static: "current" transfer & additional GE income are fully spent currently (MPC $\to 1$)
   $\Longrightarrow$ Dynamic: **front-loaded MPCs** $(\omega < 1) \Longrightarrow$ **cumulative short-run MPCs** approach 1 far before H
   [IKC matrix: income change at $t+\ell$ has a vanishing effect on t consumption: $\lim_{\ell\to\infty} \beta^{-\ell} \mathscr{M}_{t,t+\ell} = 0$]
   $\Longrightarrow$ Transfer receipt (and higher-order GE income) is fully spent before the tax hike at H
   $\Longrightarrow$ Thus debt stabilizes on its own before H, and tax hike at H is not needed.

Economic Intuition [$\kappa = 0$, PE and GE effect of tax-and-transfer vector]



The Role of Nominal Rigidities, $\kappa > 0$

A simple **rescaling** of the perfect rigid price case $\kappa = 0$

- From NKPC, self financing through debt erosion **proportional** to tax base expansion

$$\pi_0 - E_{-1}[\pi_0] = \kappa \cdot \text{NPV}(y) = \kappa \cdot \sum_{k=0}^{+\infty} \beta^k E_0[y_k]$$

- Split between sources of self financing:

$$\text{tax base: } \nu_y = \frac{\tau_y}{\tau_y + \kappa \frac{D^{ss}}{Y^{ss}}} \nu \quad \& \quad \text{debt erosion: } \nu_p = \frac{\kappa \frac{D^{ss}}{Y^{ss}}}{\tau_y + \kappa \frac{D^{ss}}{Y^{ss}}} \nu$$

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- When price is appr. flexible ($\kappa \to +\infty$), **full self financing through debt erosion** ($\nu_p \to 1$)
  - Infinitesimal boom leads to large enough adjustment in P_0 to finance ε_0
- The $\kappa \to +\infty$ case akin to FTPL, but with important differences
  - Consistent with promised fiscal adjustment to return public debt back to SS
  - Consistent with (mildly) active MP & Taylor principle [soon]
  - Avoid controversy regarding FTPL eq'm selection [Kocherlakota & Phelan; Buiter; Angeletos & Lian]
  - Attention away from **prices/debt erosion** to **tax base** (realistic κ)

Outline

Extensions & Generality

- Fiscal policy
  - full self-financing result unaffected if far-ahead fiscal adjustment is **distortionary**
  - result applies with little change to **gov't purchases** instead of transfers
- **Monetary policy** [coming up]
  - Full self-financing remains to hold under the Taylor principle, unless real rates very procyclical
- More **general aggregate demand** [coming up]
  - Discounting + front-loaded MPCs
- Allow for **investment**, limit result unaffected [same IKC among consumers]

Different Degrees of Monetary Accommodation

Leeper Regions

- **Extension:** OLG + a Real Taylor Rule

$$r_t = \phi y_t$$

[baseline $\phi = 0$; $\phi < 0$ accelerates the deficit-driven boom; $\phi > 0$ delays it]

Proposition

There exists $\bar{\phi} > 0$, such that, iff $\phi < \bar{\phi}$, **full self financing** obtains as fiscal adjustment is **infinitely delayed** (i.e., $H \to \infty$ or $\tau_d \to 0$).

- **Complete self-financing** if MP does not lean against the boom "too aggressively."
  - Consistent with IRFs to identified fiscal shocks [Ramey; Caldara & Kamps; Wolf]

- What happens if $\phi > \bar{\phi}$?
  - No bounded *full* self financing eq'm as in (4) exists (with $\tau_d \to 0$)
  - If fiscal adjustment is fast enough (with $\tau_d > \bar{\tau}_d(\bar{\phi})$), there is bounded *partial* self financing eq'm.

A Generalized Aggregate Demand Relation

- Our results are *not* tied to the particular OLG microfoundations
- Consider the following **generalized AD relation**:

$$c_t = M_d d_t + M_y \left(y_t - t_t + \delta \mathbb{E}_t \left[\sum_{k=0}^{\infty} (\beta\omega)^k (y_{t+k} - t_{t+k}) \right] \right)$$

[Rich enough to nest PIH, OLG, spender-saver, spender-OLG, behavioral discounting, . . .]

- Complete self-financing with two empirically plausible features of consumer demand
  1. ***Discounting***: far future tax hike's impact on current consumption **vanishes**

$$\omega < 1. \tag{5}$$

  2. ***Front-loaded MPCs***: transfer receipt (and higher-order GE income) is **spent quickly**

$$M_d + \frac{1-\beta}{\tau_y}(1-\tau_y) M_y \left(1 + \delta \sum_{k=1}^{\infty} (\beta\omega)^k \right) > \frac{1-\beta}{\tau_y}. \tag{6}$$

[Deficit-driven Keynesian boom is front-loaded enough to deliver $\rho_d < 1$.]

A Generalized Aggregate Demand Relation

Theorem

Under (5) and (6).

- ***Full self financing*** *obtains (i.e., $\nu \to 1$) as fiscal adjustment is* ***infinitely delayed*** *(i.e., $H \to \infty$ or $\tau_d \to 0$).*
- *In this limit, self-financing is strong enough to return d to the steady state.*
  [$\tau_d \to 0 : \lim_{k\to\infty} \mathbb{E}_t [d_{t+k}] \to 0$; $H \to \infty : \lim_{H\to\infty} \mathbb{E}_0 [d_H] \to 0$]

Outline

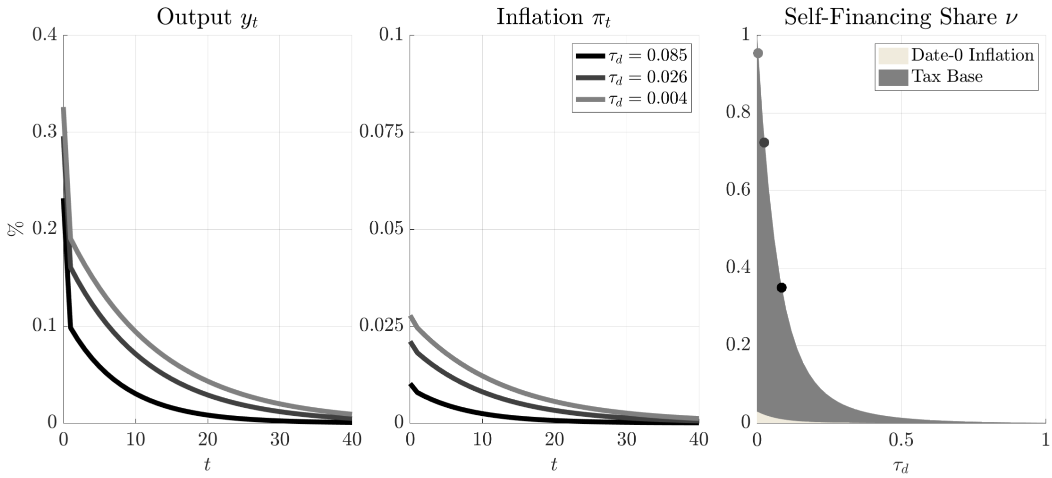
Model & Calibration Strategy

Key targets: (i) consumer spending behavior [iMPCs] & (ii) fiscal adjustment speed

- **Model**: generalize demand block to OLG-spender hybrid
  [Why? disentangles level & slope of dynamic MPC profile, consistent with evidence.]

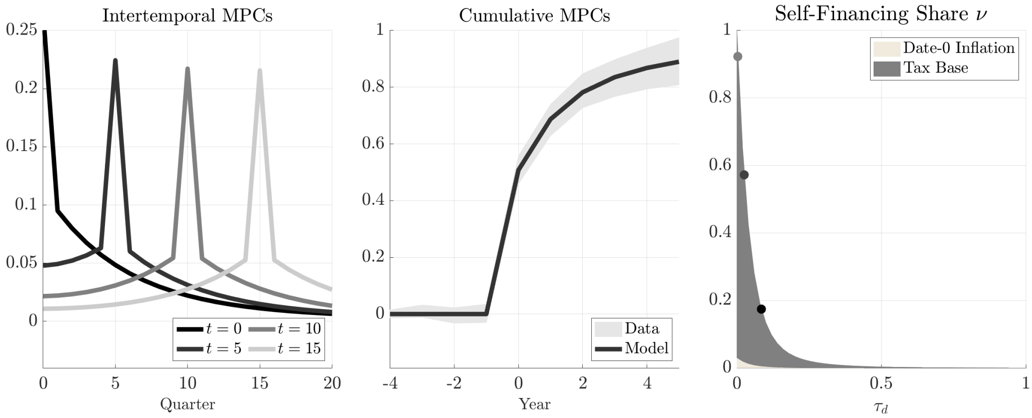
- **Calibration strategy**
  - Match evidence on iMPCs to lump-sum income receipt in Fagereng-Holm-Natvik
    [Later: other calibration targets, behavioral models, and a full-blown HANK model...]
  - Consider range of τ_d consistent with literature on fiscal adjustment estimation
    [Galí-López-Salido-Vallés, Bianchi-Melosi, Auclert-Rognlie, ...]
  - Flat NKPC [Hazell-Herreno-Nakamura-Steinsson]; steeper NKPC [later]

Quantitative Relevance of Self-financing



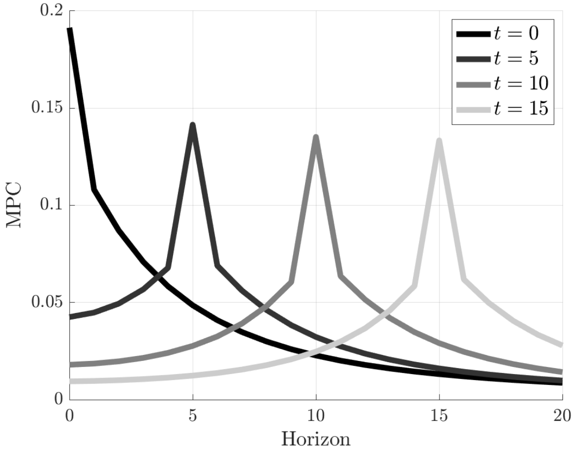
Alternative Calibration Strategies ‣ behavioral ‣ active

Variant: three-type OLG + spender model to match cumulative MPC time profile



An One-Asset HANK Model ▸ hank

One-Asset HANK: iMPCs similar to OLG-spender (Wolf, 2023; Auclert, Rognlie, Straub, 2023)



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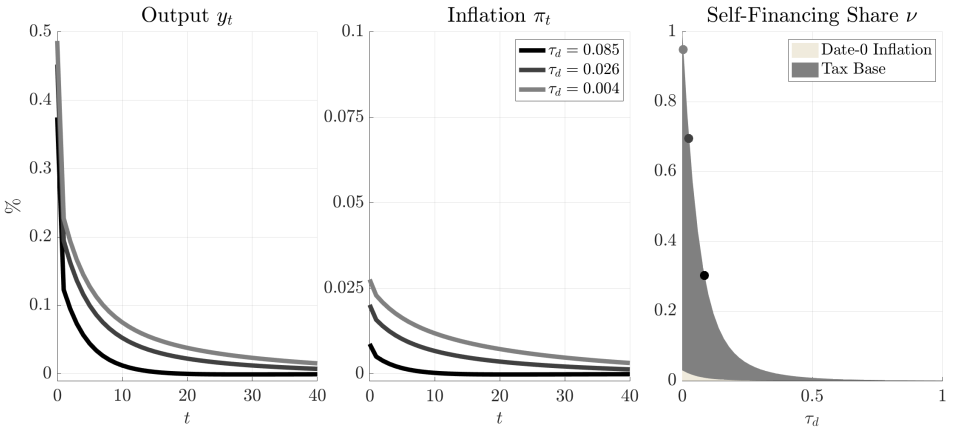
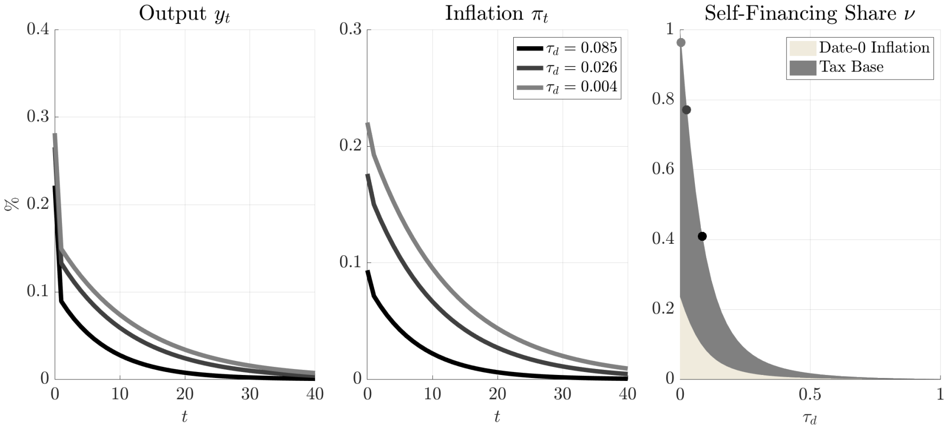
hank



Steeper Phillips Curve

Steeper NKPC: (i) change ν_y/ν_p split & (ii) faster convergence to self-financing limit



Outline

Conclusion

- **Key**: delayed **fiscal adjustment** $\Rightarrow$ strong **self-financing** (esp. from tax base adjust.)
- **Implications:**
  1. Theory: grounded in a failure of Ricardian equivalence + nominal rigidities
     [consistent with Taylor principle & promise to return d to SS]
  2. Practice: self-sustaining stimulus may be less implausible than commonly believed
- Our analysis here is entirely positive, **not normative**.
  - If start at an efficient SS, self-financing stimulus never optimal
  - If output is inefficiently low, self-financing stimulus can be a benefitial stabilization tool

Future Work: Deficits and Inflation

- Two alternative perspectives on deficits $\Longrightarrow$ inflation nexus: **OLG-NK/HANK** vs **FTPL**

- Different mechanisms:
  - FTPL: break Ric. Equiv. by force of **eq'm selection** [PIH households]
  - OLG-NK/HANK: deficits $\Rightarrow$ boom $\Rightarrow$ inflation, breaking Ric. Equiv. by **finite lives/liq. constraints**

- Different impulse responses:
  1. **Dampening**:
     - ★ In principle, OLG-NK/HANK can generate as large cumulative inflation responses as FTPL
     - ★ In practice, cumulative inflation responses dampened i) flat NKPC ii) alternative to finance deficits (τ_y)
  2. **Front-loading**:
     - ★ OLG-NK/HANK generate more front-loaded inflation responses than FTPL

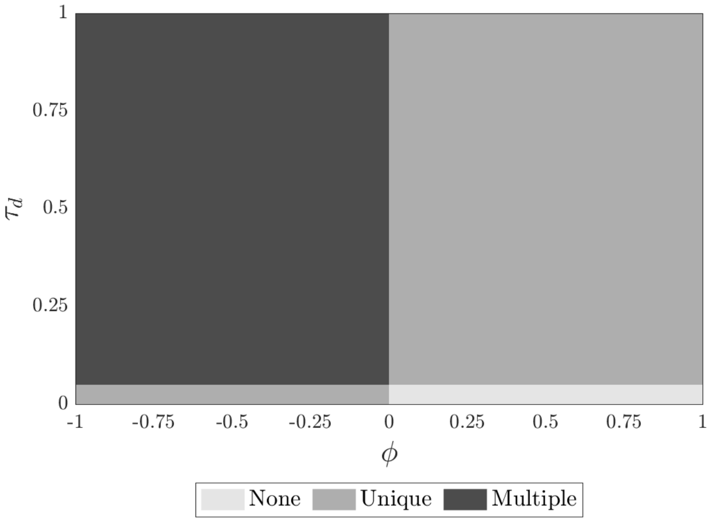
Labor Supply ▸ back

- **Unions** equalize post-tax wage and average consumption-labor MRS. This gives

$$(1-\tau_y)W_t = \frac{\chi L_t^{\frac{1}{\varphi}}}{\int_0^1 C_{i,t}^{-1/\sigma}\,di} \quad \text{and} \quad L_{i,t} = L_t.$$

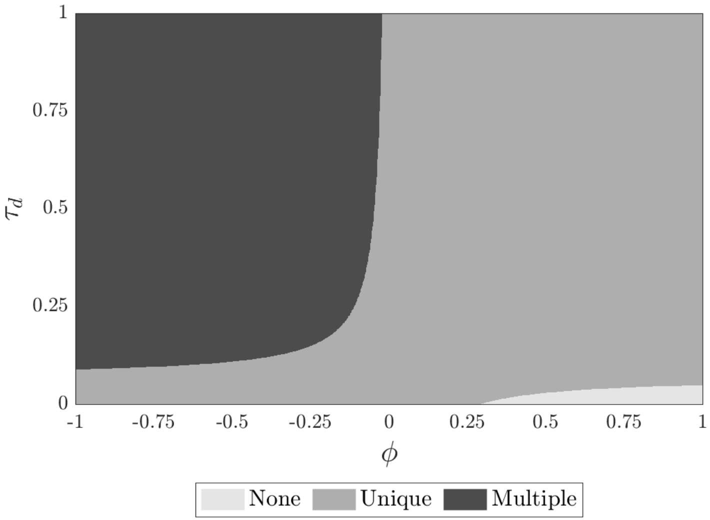
Leeper Regions

▸ back



Leeper Regions

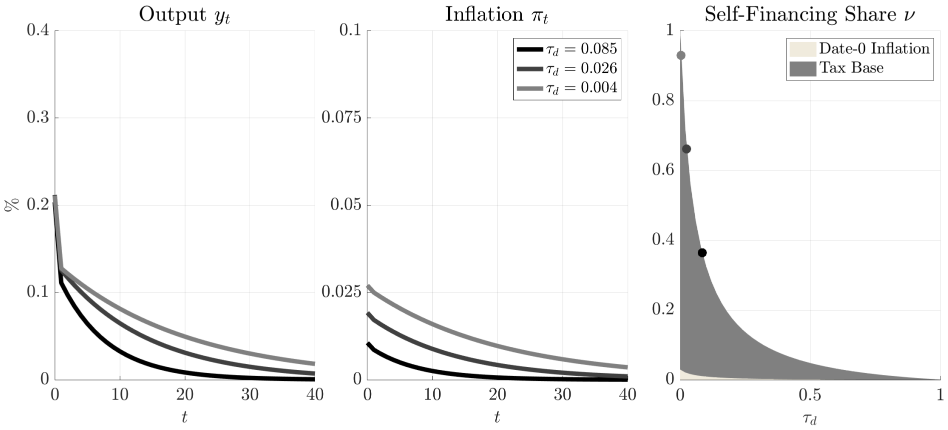
back



Behavioral Households (Cognitive Discounting)

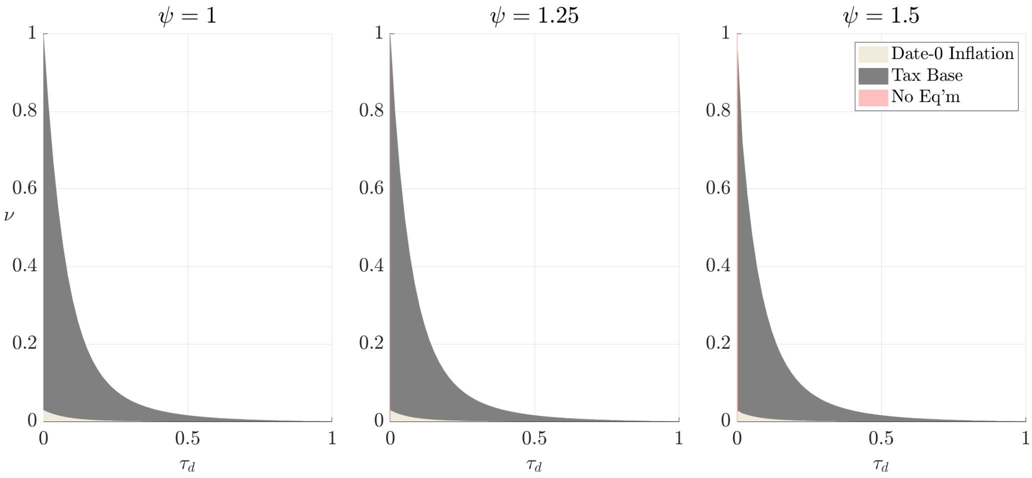
main

Main result: large initial boom [bigger PE] but slower convergence [dampen GE]



Active Monetary Policy ▸ main

MP: $i_t = \psi \pi_t$. (i) slower convergence (ii) no bounded full self-financing eq'm for high ψ & $\tau_d = 0$



A Simple Hank Model ▸ main

- **Environment**: standard one-asset HANK model
  [As in McKay-Nakamurs-Steinsson (2016), Auclert-Rognlie-Straub (2018), Wolf (2022): self-insure against idiosyncratic earnings risk through savings in a single risk-free asset.]

- **Calibration**

  1. Income risk process: taken straight from Kaplan-Moll-Violante (2018)
  2. Tax-and-transfer system: $\tau_y = 0.3$, $\frac{\text{transfer}}{y} = 0.07$ [also as in Kaplan-Moll-Violante (2018)]
  3. Total wealth: calibrate to U.S. economy liquid wealth/income ratio
  4. GE income incidence: uniform [note that this is conservative for our purposes]

implies: average MPC somewhat below 0.3