Can Deficits Finance Themselves?

George-Marios Angeletos[1] Chen Lian[2] Christian Wolf[3]

[1]Northwestern and NBER

[2]UC Berkeley and NBER

[3]MIT and NBER

June 6, 2024

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.]

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.]
- **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

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

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)]

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

or after (log-)linearization and aggregation

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

  - $\tau_y > 0$: 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**

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

  - 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)

Equilibrium Characterization

1. **AD:** (3).
2. **AS:** NKPC, $\pi_t = \kappa y_t + \beta \mathbb{E}_t[\pi_{t+1}]$.
3. **Evolution of real value of public debt:**

$$d_{t+1} = \beta^{-1}\left(d_t + \varepsilon_t - \underbrace{\tau_d \cdot (d_t + \varepsilon_t)}_{\text{fiscal adjustment}} - \underbrace{\tau_y y_t}_{\text{self financing: tax base}}\right) - \underbrace{\frac{D^{ss}}{Y^{ss}}(\pi_{t+1} - \mathbb{E}_t[\pi_{t+1}])}_{\text{self financing: debt erosion}}.$$

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).

Outline

Channels of Self Financing

- Start with $d_0 = 0$ (steady state) and consider $\varepsilon_0 > 0$ (one-time unexpected positive deficit shock)
- Gov's intertemporal budget constraint $\Rightarrow$

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

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.*
     $[\tau_d \to 0 : \lim_{k\to\infty} \mathbb{E}_t [d_{t+k}] \to 0;\ H \to \infty : \lim_{H\to\infty} \mathbb{E}_0 [d_H] \to 0]$

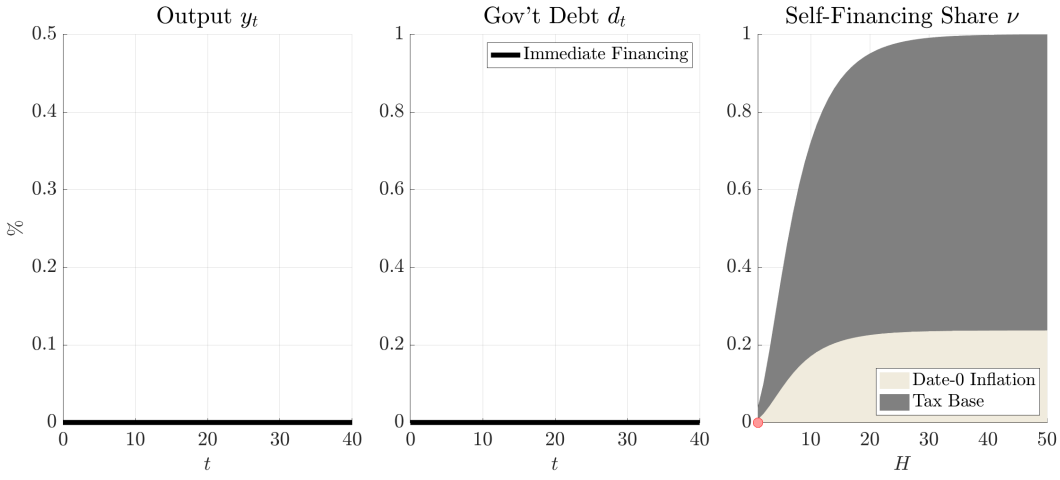
The Self Financing Result

Theorem

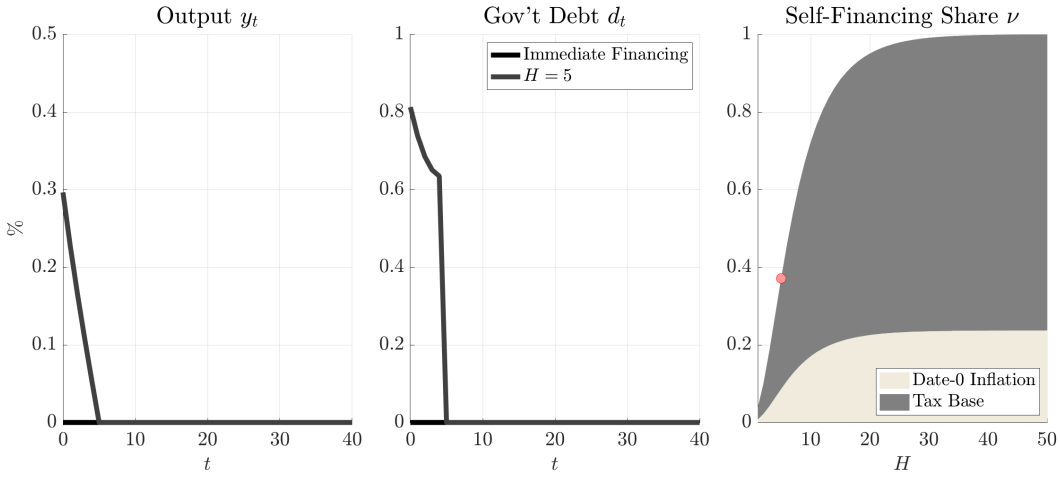
*Suppose that $\omega < 1$ and $\tau_y > 0$. The **self-financing share ν** has the following properties.*

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.*
     $[\tau_d \to 0 : \lim_{k\to\infty} \mathbb{E}_t [d_{t+k}] \to 0;\ H \to \infty : \lim_{H\to\infty} \mathbb{E}_0 [d_H] \to 0]$
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*

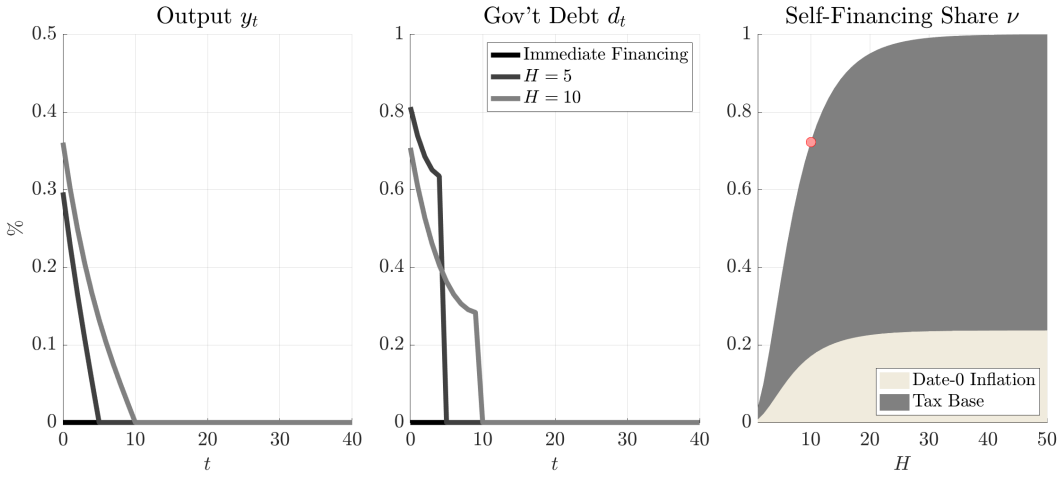
A Graphical Illustration $[t_t = \tau_y y_t - \varepsilon_t \text{ for } t < H \text{ and } t_t = d_t \text{ for } t \geq H]$



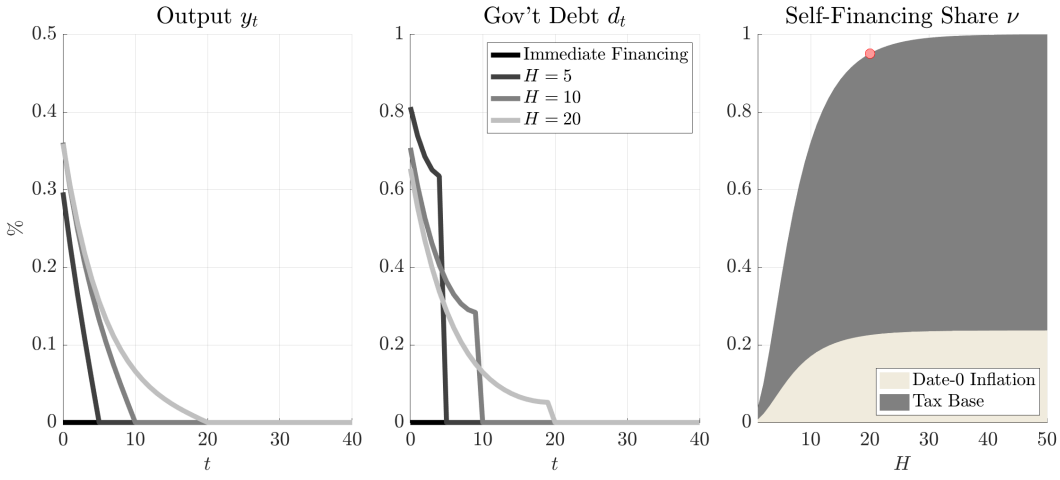
A Graphical Illustration [$t_t = \tau_y y_t - \varepsilon_t$ for $t < H$ and $t_t = d_t$ for $t \geq H$]



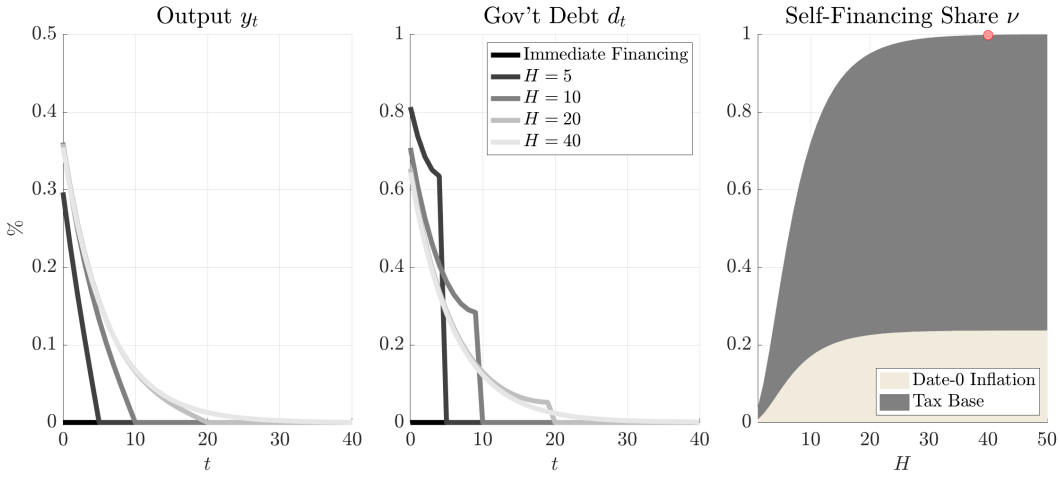
A Graphical Illustration $[t_t = \tau_y y_t - \varepsilon_t$ for $t < H$ and $t_t = d_t$ for $t \geq H]$



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



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



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: $R(1 - \nu)\varepsilon$

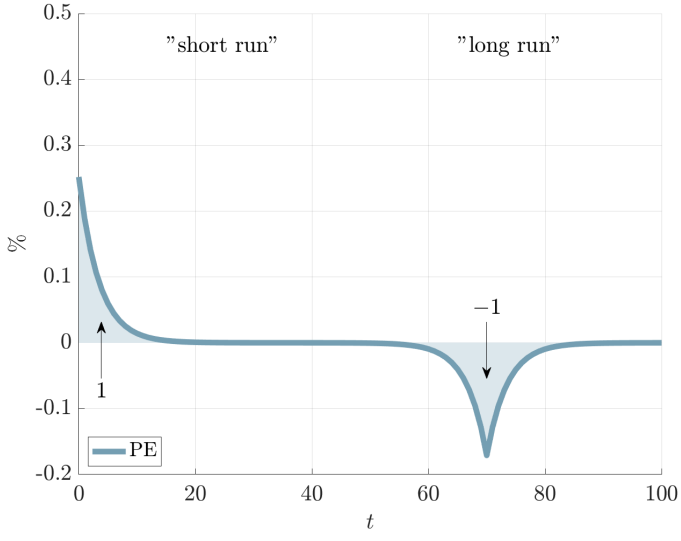
- **Full self-financing** would require $\text{MPC} = 1$, giving $y = \frac{1}{\tau_y} \times \varepsilon$.
  [Hint: Dynamic: cumulative MPC $= 1$]

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 $\boldsymbol{t}^{PE} = (-1, \cdots, \beta^{-H})$]



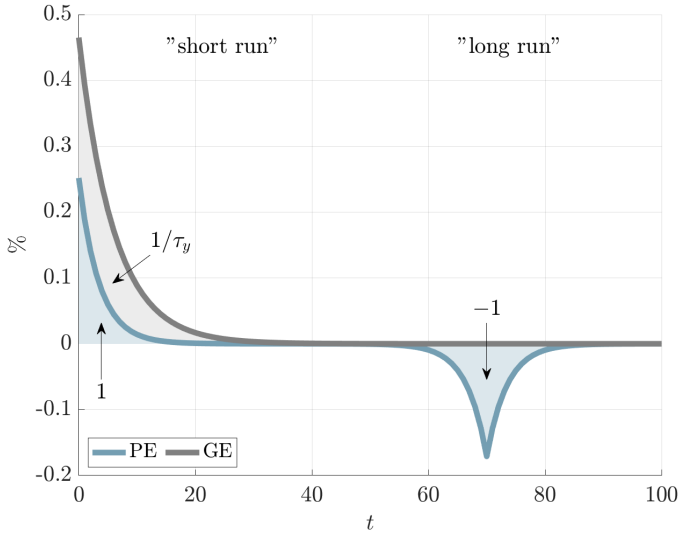
Economic Intuition [Fully Rigid Price, $\kappa = 0$]

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: $\lim_{\ell \to \infty} \beta^{-\ell} \mathscr{M}_{t,t+\ell} = 0$]

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:

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

Outline

Extensions & Generality

- Monetary policy:
  - **full self-financing remains to hold with mildly active MP** when the Taylor principle holds
  - partial self-financing with very active MP
- More **general aggregate demand**
  - Discounting + front-loaded MPCs
- 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
- Allow for **investment**, limit result unaffected [same IKC among consumers]

Outline

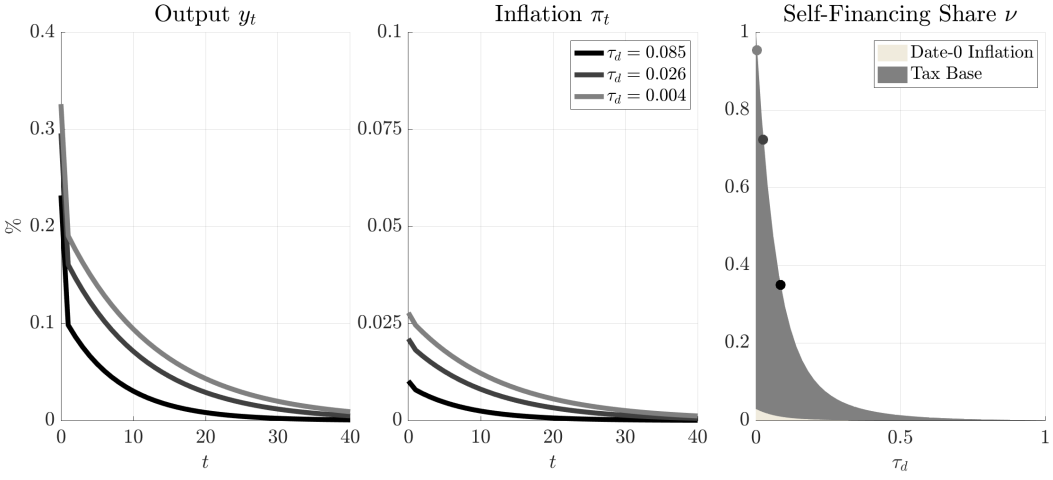
Model & Calibration Strategy

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.]
  - Results based on full-blown one-asset HANK similar

- **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



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