When is the fiscal multiplier large?

- Lots of theory + empirical work. Two workhorse models:

1. **Representative agent (RA)** models
   - **response of monetary policy** is key
   - large when at ZLB

   [Eggertsson 2004; Christiano-Eichenbaum-Rebelo 2011]

2. **Two agent (TA)** models
   - aggregate **MPC** is key
   - large when deficit financed, effects not persistent

   [Galí-López-Salido-Vallés 2007; Coenen et al 2012; Farhi-Werning 2017]

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New: **Heterogeneous-agents (HA)** models

$\rightarrow$ **iMPCs** are key, can be used for calibration

$\rightarrow$ large and persistent Y effect when deficit financed

Our goal: compare fiscal multiplier in three types of models

1. **Benchmark model,** allows for RA, TA, HA
   - without capital & neutral monetary policy
   - multiplier $=$ function of **iMPCs** and **deficits** *only*

     $=$ **1** if zero deficits or flat iMPCs (RA)

     $>$ **1** if **deficit-financed** and **realistic iMPCs** (HA, TA?)

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    - large & persistent Y effects, despite these extra elements
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3. Role of **iMPCs** for the **GE effects of other shocks**

Outline

1. The intertemporal Keynesian Cross
2. iMPCs in models vs. data
3. Fiscal policy in the benchmark model
4. Fiscal policy in the quantitative model
5. Takeaways

The intertemporal Keynesian Cross

Common assumptions

▸ Unions

- GE, discrete time $t = 0 \ldots \infty$, no aggregate risk
- Mass 1 of households:
  - idiosyncratic shocks to skills e_{it}, various market structures
  - real pre-tax income $y_{it} \equiv W_t / P_t e_{it} n_{it}$
  - **after tax income** $z_{it} \equiv y_{it} - T_t(y_{it}) \equiv \tau_t y_{it}^{1-\lambda}$ [Bénabou, HSV]

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  - **tax revenues** $T_t = \int (y_{it} - z_{it})\, di$
  - **government spending** G_t
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  - linear production function $Y_t = N_t$
  - flexible prices $\Rightarrow$ $P_t = W_t$
  - sticky w $\Rightarrow \pi_t^w = \kappa^w \int N_t (v'(n_{it}) - \frac{\epsilon - 1}{\epsilon} \frac{\partial z_{it}}{\partial n_{it}} u'(c_{it})\, di) + \beta \pi_{t+1}^w$

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Asset market assumptions

Household i solves

$$\max \mathbb{E}\left[\sum \beta^t \left\{u\left(c_{it}\right) - v\left(n_{it}\right)\right\}\right]$$

- RA: no risk in e (or complete markets)
- TA: share μ of agents with $c_{it} = z_{it}$
- HA-std: one asset model

$$c_{it} + a_{it} = \left(1 + r\right) a_{it-1} + z_{it}$$
$$a_{it} \geq 0$$

- HA-iMPC: simplified two asset model
  - **illiquid** account a^{illiq} = **fixed** no. of bonds (+ capital)
  - **liquid** account a_{it} = all **remaining** bonds + ra^{illiq}

The aggregate consumption function

Eq definition

- Equilibrium defined as usual
- Given $\{a_{io}\}$ and r, **aggregate consumption function** is

$$C_t = \int c_{it} di = \mathcal{C}_t\left(\{Z_s\}\right)$$

with $Z_t \equiv$aggregate after-tax labor income

$$Z_t \equiv \int z_{it} di = Y_t - T_t$$

- $\mathcal{C}$ summarizes the heterogeneity and market structure

Intertemporal MPCs

- Goods market clearing $\leftrightarrow$

$$Y_t = G_t + \mathcal{C}_t\left(\{Y_s - T_s\}\right)$$

- Impulse response to shock $\{dG_t, dT_t\}$

$$dY_t = dG_t + \sum_{s=0}^{\infty} \underbrace{\frac{\partial \mathcal{C}_t}{\partial Z_s}}_{\equiv M_{t,s}} \cdot (dY_s - dT_s) \tag{1}$$

$\rightarrow$ Response $\{dY_t\}$ entirely characterized by $\{M_{t,s}\}$!

- *partial equilibrium* derivatives, **"intertemporal MPCs"**
- how much of income change at date s is spent at date t
- $\sum_{t=0}^{\infty}(1+r)^{s-t}M_{t,s} = 1$

The intertemporal Keynesian cross

- Stack objects: $\mathbf{M} = \{M_{t,s}\} = \left\{\frac{\partial \mathcal{C}_t}{\partial Z_s}\right\}$, $d\mathbf{Y} = \{dY_t\}$, etc
- Rewrite equation (1) as

$$d\mathbf{Y} = d\mathbf{G} - \mathbf{M}d\mathbf{T} + \mathbf{M}d\mathbf{Y}$$

- This is an **intertemporal Keynesian cross**
    - entire complexity of model is in $\mathbf{M}$
    - with $\mathbf{M}$ from data, could get $d\mathbf{Y}$ without model!

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- When unique, solution is

$$d\mathbf{Y} = \mathcal{M} \cdot (d\mathbf{G} - \mathbf{M}d\mathbf{T})$$

where $\mathcal{M}$ is (essentially) $(I - \mathbf{M})^{-1}$

Benchmark model takeaway

- Government chooses $d\mathbf{G}$ and $d\mathbf{T}$ such that $\sum_{t=0}^{\infty} \frac{G_t - T_t}{(1+r)^t} = 0$
- $d\mathbf{Y}$ is solution to **intertemporal Keynesian cross**

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- RA, TA, HA differ in their $\mathbf{M}$ matrices
- **Next:**
    - look at $\mathbf{M}$'s in data and compare with RA, TA, HA
    - implications for $d\mathbf{Y}$

iMPCs in models vs. data

Measuring aggregate iMPCs using individual iMPCs

- Object of interest: **(aggregate) iMPCs**

$$M_{t,s} = \frac{\partial \mathcal{C}_t}{\partial Z_s}$$

where $C_t = \int c_{it} di \text{ and } Z_s = \int z_{is} di$

- Direct evidence on $M_{t,s}$ is hard to come by for general s
- More work on column $s = 0$ (unanticipated income shock)

  - Can write

$$M_{t,0} = \int \underbrace{\frac{z_{i0}}{Z_0}}_{\text{income weight}} \cdot \underbrace{\frac{\partial c_{it}}{\partial z_{i0}}}_{\text{individual iMPC}} di$$

$\rightarrow$ aggregate iMPCs are **weighted individual iMPCs**

Obtain date-0 iMPCs from cross-sectional microdata

- Two sources of evidence on $\frac{\partial c_{it}}{\partial z_{i0}}$:

1. Fagereng Holm Natvik (2018) measure in Norwegian data

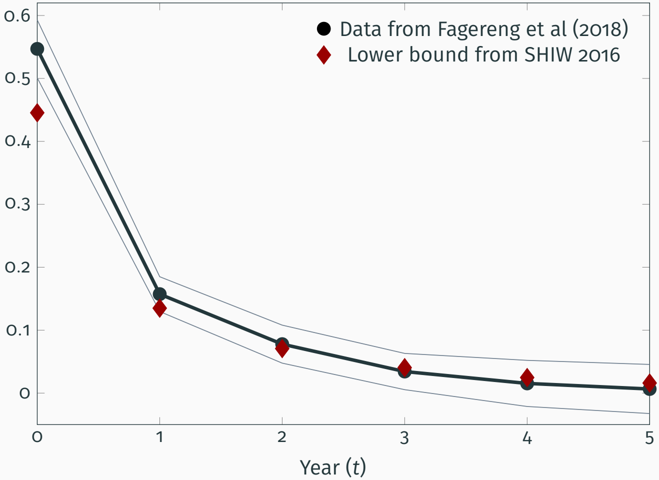
$$c_{it} = \alpha_i + \tau_t + \sum_{k=0}^{5} \gamma_k \text{lottery}_{i,t-k} + \theta x_{it} + \epsilon_{it}$$

   - Weighting by income in year of lottery receipt $\Rightarrow M_{t,0}$

2. Italian survey data (SHIW 2016) on $\frac{\partial c_{i0}}{\partial z_{i0}}$

   - Construct lower bound for impulse using distribution of MPCs + stationarity assumption

iMPCs in the data



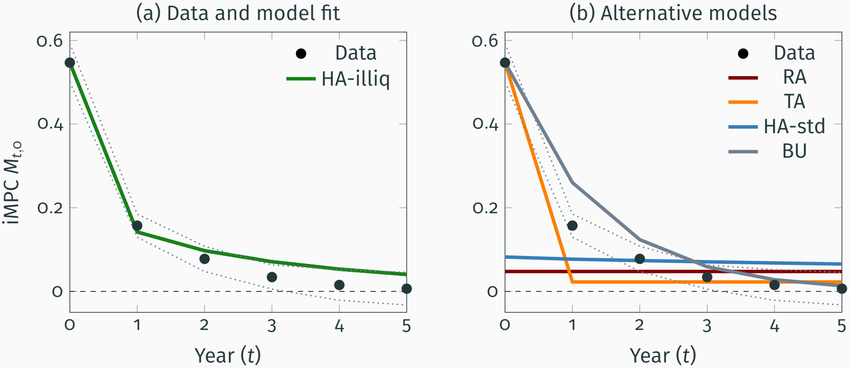
- Annual $M_{0,0}$ consistent with evidence from other sources

Compare iMPCs across models

Calibration

- RA
- TA: share of hand-to-mouth calibrated to match $M_{0,0}$
- HA-std: one-asset HA, standard calibration
- **HA-iMPC**: two-asset HA calibrated to match iMPCs

iMPCs across models

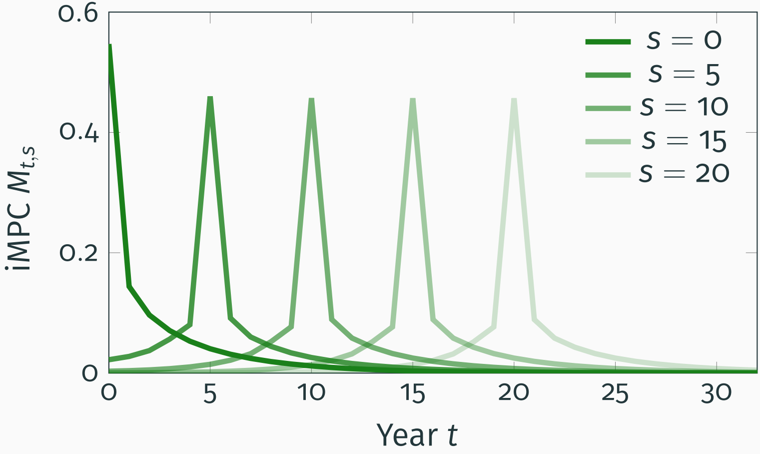


What about non-date-0 iMPCs?

- Existing evidence useful for response to date-0 income shocks, $\{M_{t,0}\}$
- What about respones to future shocks?

$\rightarrow$ use calibrated **HA-iMPC** model to fill in the blanks!

Response of HA-iMPC to other income shocks



Fiscal policy in the benchmark model

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- Recall **intertemporal Keynesian cross:**

$$d\mathbf{Y} = d\mathbf{G} - \mathbf{M} \cdot d\mathbf{T} + \mathbf{M} \cdot d\mathbf{Y}$$

- $d\mathbf{Y}$ entirely determined by iMPCs $\mathbf{M}$ and fiscal policy $(d\mathbf{G}, d\mathbf{T})$

- Next: Characterize role of iMPCs for
  1. balanced budget policies, $d\mathbf{G} = d\mathbf{T}$
  2. deficit-financed policies

The balanced-budget unit multiplier

- With **balanced budget**, $d\mathbf{G} = d\mathbf{T} \Rightarrow$ **multiplier of 1:**

$$d\mathbf{Y} = d\mathbf{G}$$

- Similar reasoning already in Haavelmo (1945)
- Generalizes Woodford's RA results
  - heterogeneity irrelevant for balanced budget fiscal policy
  - similar to Werning (2015)'s result for monetary policy
- Proof: $d\mathbf{Y} = d\mathbf{G}$ is unique solution to

$$d\mathbf{Y} = (I - \mathbf{M}) \cdot d\mathbf{G} + \mathbf{M} \cdot d\mathbf{Y}$$

Deficit-financed fiscal policy

- With deficit financing $d\mathbf{G} \neq d\mathbf{T}$ we have

$$d\mathbf{Y} = d\mathbf{G} + \underbrace{\mathcal{M} \cdot \mathbf{M} \cdot (d\mathbf{G} - d\mathbf{T})}_{d\mathbf{C}}$$

  Consumption $d\mathbf{C}$ depends on **primary deficits** $d\mathbf{G} - d\mathbf{T}$

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  Consumption $d\mathbf{C}$ depends on **primary deficits** $d\mathbf{G} - d\mathbf{T}$

- Example: TA model with deficit financing

$$d\mathbf{Y} = d\mathbf{G} + \frac{\mu}{1-\mu}(d\mathbf{G} - d\mathbf{T})$$

  - consumption $d\mathbf{C}$ depends only on **current** deficits
  - **initial multiplier** can be large $\in \left[1, \frac{1}{1-\mu}\right] \dots$
  - but **cumulative multiplier** is $= 1$!

$$\frac{\sum (1+r)^{-t} dY_t}{\sum (1+r)^{-t} dG_t} = 1$$

Simulate model responses for more general shocks

▸ Impulse

- Parametrize: $dG_t = \rho_G dG_{t-1}$ and $dB_t = \rho_B \left(dB_{t-1} + dG_t\right)$
    - vary **degree of deficit-financing** ρ_B

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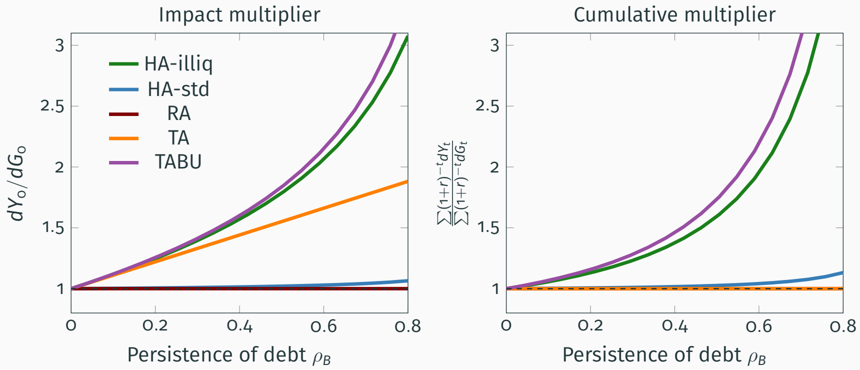


Calibration: $\rho_G = 0.7$

Fiscal policy in the quantitative model

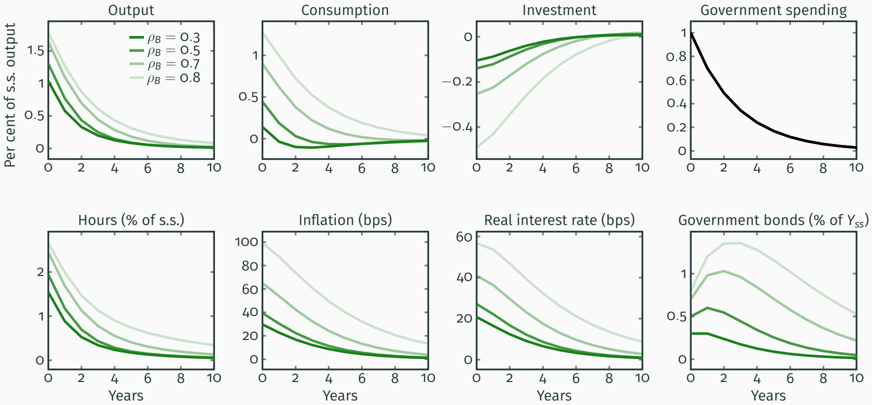
Adding new elements to the HA-iMPC model ...

▸ Calibration

- **Government:**
  - gov spending shock, $dG_t = \rho_G dG_{t-1}$
  - fiscal rule, $dB_t = \rho_B \left(dB_{t-1} + dG_t\right)$
  - Taylor rule, $i_t = r_{ss} + \phi\pi_t$, $\phi > 1$
- **Supply side:**
  - Cobb-Douglas production, $Y_t = K_t^{\alpha} N_t^{1-\alpha}$
  - K_t subject to quadratic capital adjustment costs
  - sticky prices à la Calvo, $\pi_t = \kappa^p mc_t + \frac{1}{1+r_t}\pi_{t+1}$
- **Two reasons for lower multipliers:**
  - monetary policy & crowding-out of investment

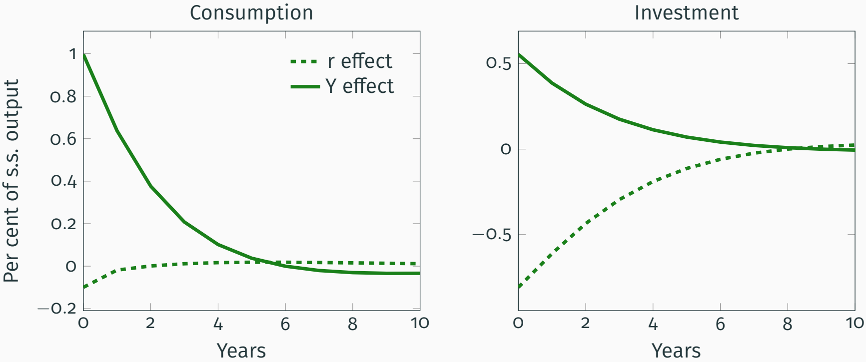
Sizeable output response to deficit-financed G

▸ Other



Calibration: $\rho_G = 0.7$, $\kappa^w = \kappa^p = 0.1$, $\phi = 1.5$; vary ρ_B in $dB_t = \rho_B\,(dB_{t-1} + dG_t)$

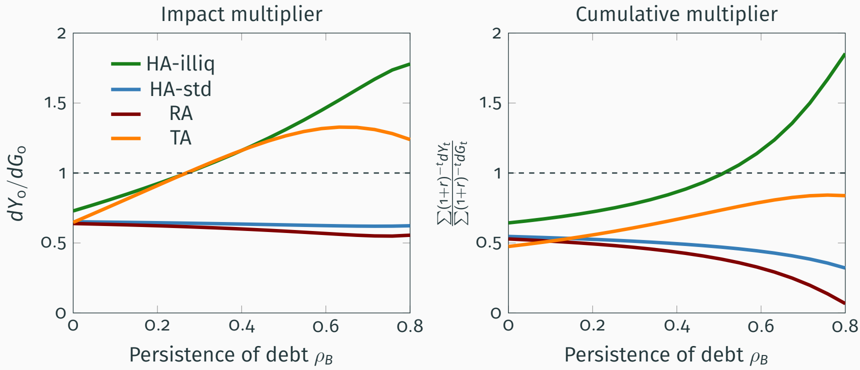
Equilibrium effect from Y important for both C and I



Calibration: $\rho_G = 0.7$, $\rho_B = 0.7$, $\kappa^w = \kappa^p = 0.1$, $\phi = 1.5$

iMPCs *still* a crucial determinant of response!

▸ Impulse



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Summary: HA-iMPC & TA have large **on-impact** multipliers

On-impact multipliers $\frac{dY_0}{dG_0}$

Fiscal rule	Model	RA	HA-std	TA	HA-illiq
bal. budget	benchmark	1.0	1.0	1.0	1.0
	quantitative	0.6	0.7	0.6	0.7
deficit-financed	benchmark	1.0	1.0	**1.8**	**2.5**
	quantitative	0.6	0.6	**1.3**	**1.6**

Calibration: $\rho_G = 0.7$, $\kappa^w = \kappa^p = 0.1$, $\rho_B = 0.5$, $\phi = 1.5$

. . . but only HA-iMPC has large **cumulative** multipliers

Cumulative multipliers $\frac{\sum_t (1+r)^{-t} dY_t}{\sum_t (1+r)^{-t} dG_t}$

Fiscal rule	Model	RA	HA-std	TA	HA-illiq
bal. budget	benchmark	1.0	1.0	1.0	1.0
	quantitative	0.5	0.5	0.5	0.6
deficit-financed	benchmark	1.0	1.1	1.0	**2.6**
	quantitative	0.2	0.4	0.8	**1.4**