Fiscal and Monetary Policy with Heterogeneous Agents

Ludwig Straub Harvard

Bundesbank Spring Conference 2024

Demystifying "HANK" models

- Active literature on **Heterogeneous-Agent New-Keynesian** models
- **Today:** Three questions…
  - What is a "HANK" model?
  - When does heterogeneity matter for macro aggregates?
  - How can "HANK" models help us make sense of the current economy?

This talk

1. Introduce a canonical “HANK” model
2. Fiscal policy: Persistent inflation
3. Monetary policy: Reliance on investment for transmission
4. Energy shocks: Stagflation

This talk

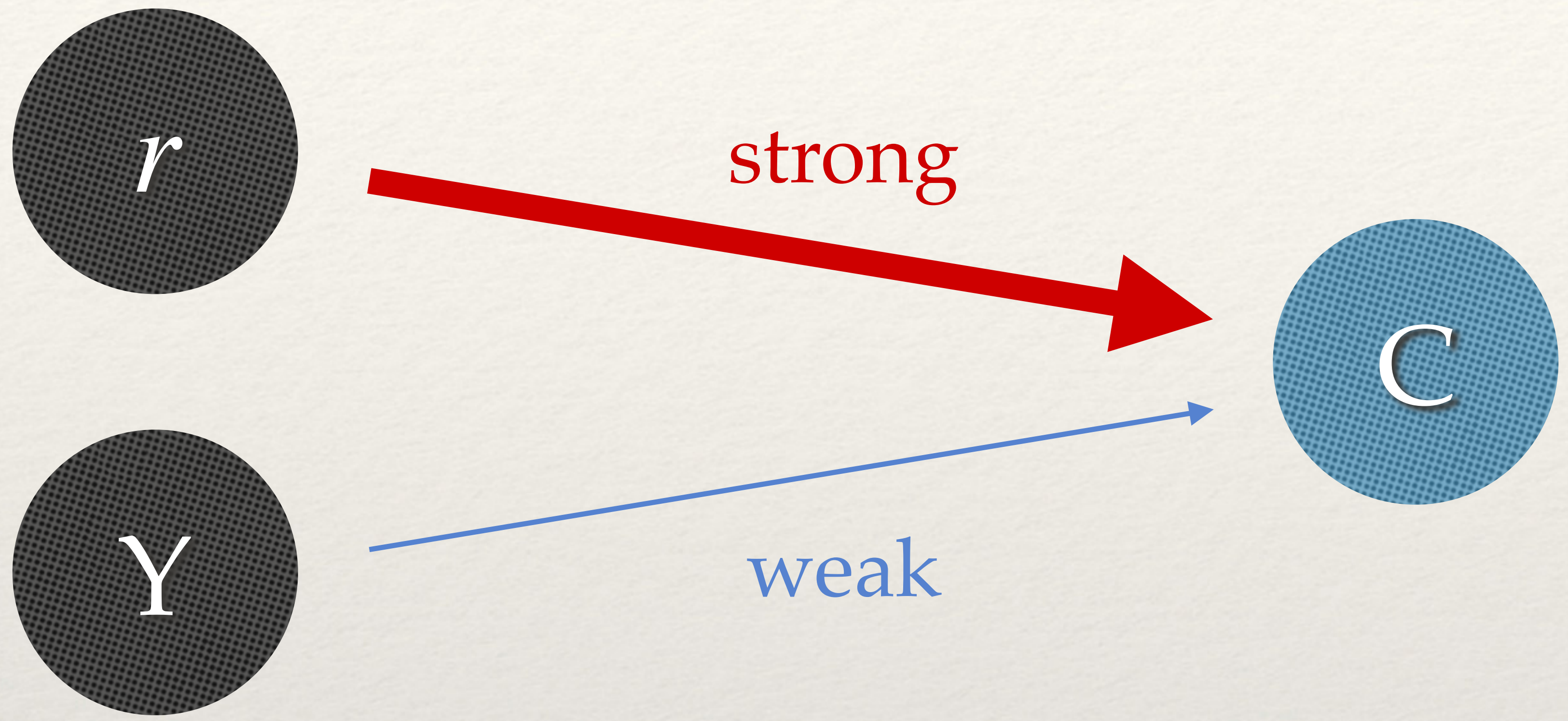
1. Introduce a canonical "HANK" model
2. Fiscal policy: Persistent inflation
3. Monetary policy: Reliance on investment for transmission
4. Energy shocks: Stagflation

- Throughout: work in the **sequence space**! Will buy us a lot of tractability.
- Based on joint agenda with Adrien Auclert and Matt Rognlie

  + Rishabh Aggarwal, Bence Bardóczy, Hugo Monnery, Martin Souchier…

Core idea why HANK is so different

RANK



Consumption mostly determined by **interest rates**

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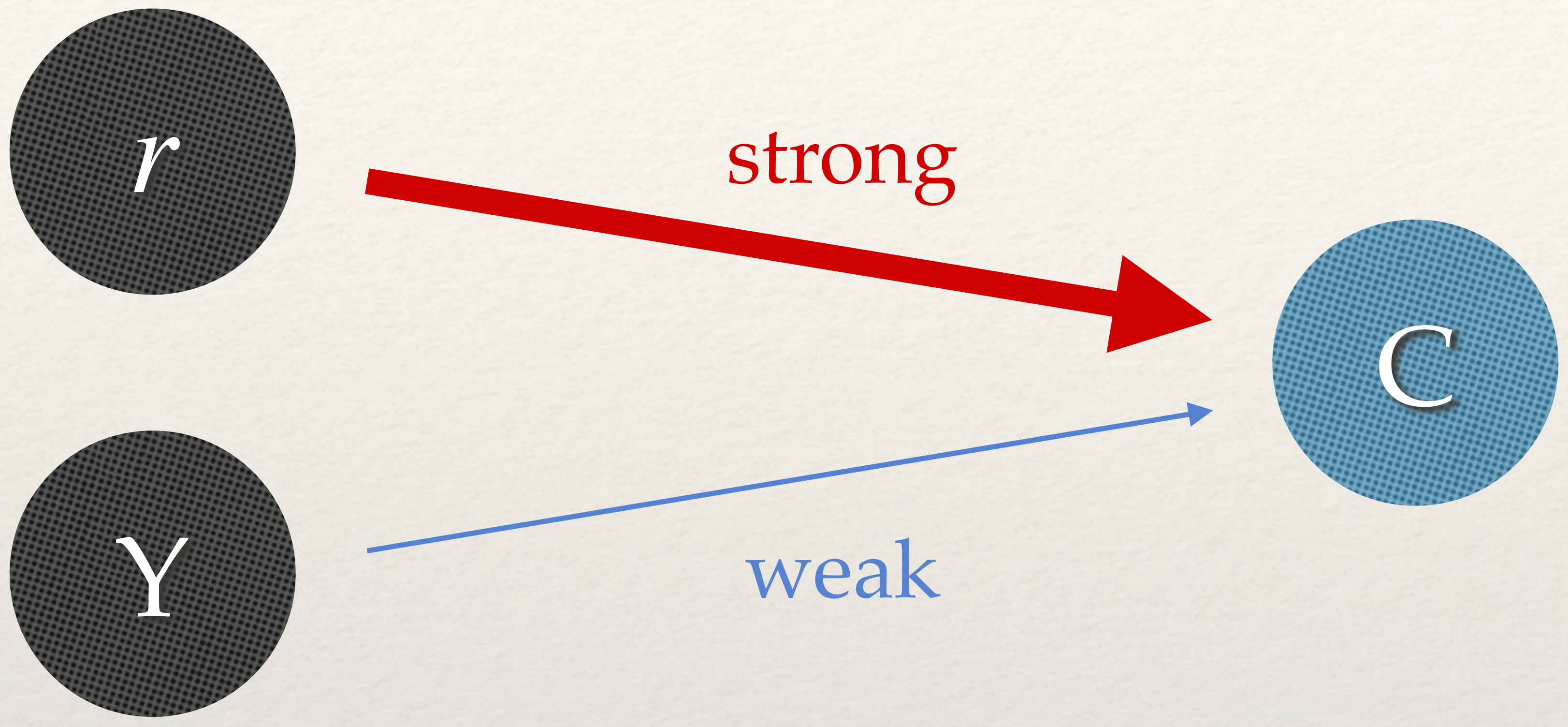

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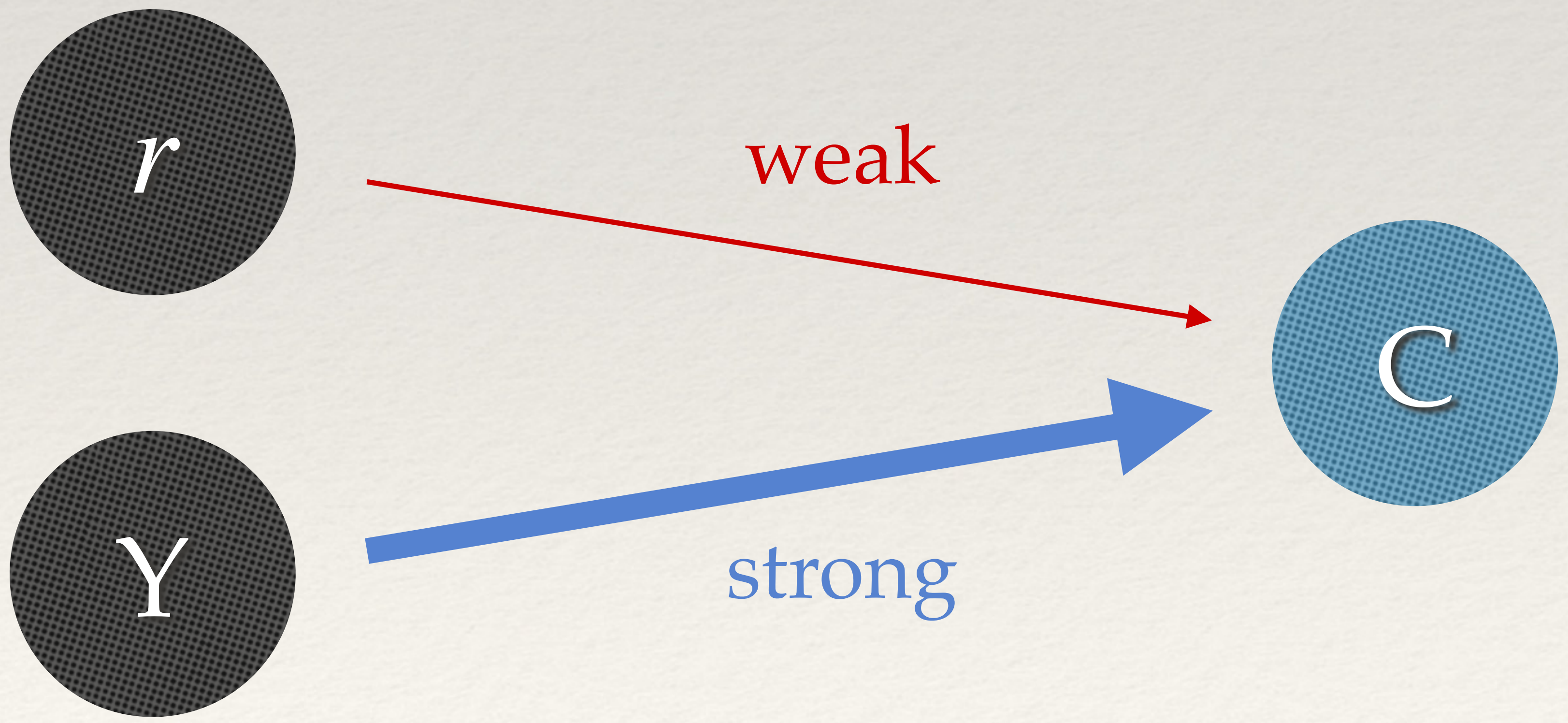

Consumption mostly determined by **income**

A canonical HANK model

Making of a canonical HANK model

- The textbook representative-agent NK (RANK) model consists of:

1. household side: representative agent
2. fiscal policy: irrelevant due to Ricardian equivalence
3. monetary policy: Taylor rule
4. supply side: linear production, sticky prices set by firms

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Auclert Rognlie Straub "Intertemporal Keynesian Cross"

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- Will go over all four ingredients in an economy with perfect foresight
  - without loss to first order (certainty equivalence)

Auclert Rognlie Straub "Intertemporal Keynesian Cross"

(1) Heterogeneous households

$$\max \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(u(c_{it}) - v\left(N_t\right) \right)$$

hours set by unions (later)

$$c_{it} + a_{it} \leq (1 + r_{t-1})a_{it-1} + e_{it}\left(1 - \tau_t\right) w_t N_t \qquad a_{it} \geq \underline{a}$$

idiosyncratic productivity shocks (Markov chain)

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→ Forward (distribution) iteration $\Psi_t(a, e)$

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idiosyncratic productivity shocks (Markov chain)

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↘

Policy functions $c_t^*(e, a)$

↙

Aggregate consumption:

$$\mathscr{C}_t = \int c_t^*(a, e) d\Psi_t(a, e)$$

← Forward (distribution) iteration $\Psi_t(a, e)$

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Aggregate consumption function in the sequence space

(2, 3) Fiscal and monetary policy

- Government sets $\{G_s, T_s\}$ subject to

$$B_t = \left(1 + r_{t-1}\right) B_{t-1} + G_t - T_t \qquad T_t = \tau_t w_t N_t \qquad B_t \text{ bounded}$$

- Central bank sets nominal rate

$$i_t = r_t + \phi \pi_{t+1} \qquad \text{today: } \phi \searrow 1 \qquad \text{i.e. real rate} = r_t$$

(4) Supply side

- Linear production $Y_t = N_t$ with flexible prices, so that real wage $w_t = 1$
- Sticky nominal wages, set by unions

$$\pi_t = \kappa \int \left(v'\left(n_{it}\right) - \frac{\epsilon}{\epsilon - 1} \left(1 - \tau_t\right) w_t e_{it} u'\left(c_{it}\right) \right) di + \beta \pi_{t+1}$$

  - useful starting point: labor rationed equally $n_{it} = N_t$

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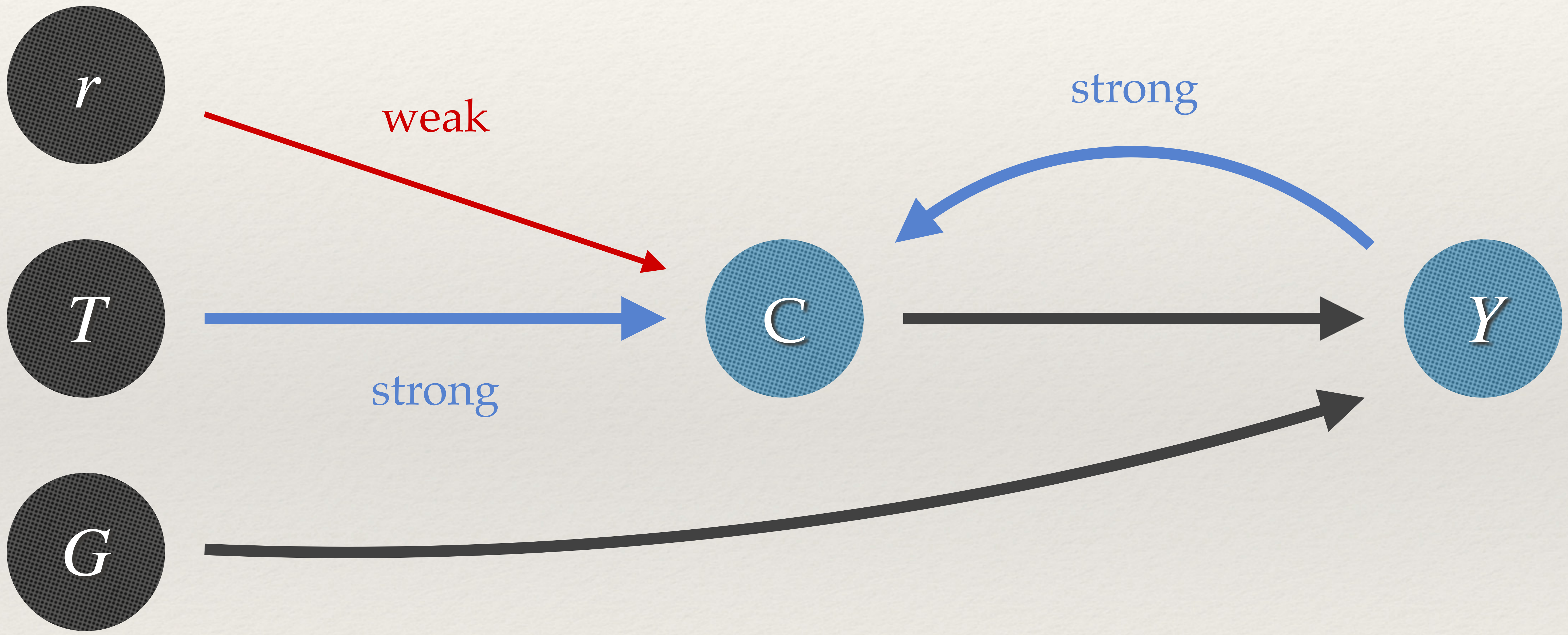
- That's it!

Equilibrium as a graph



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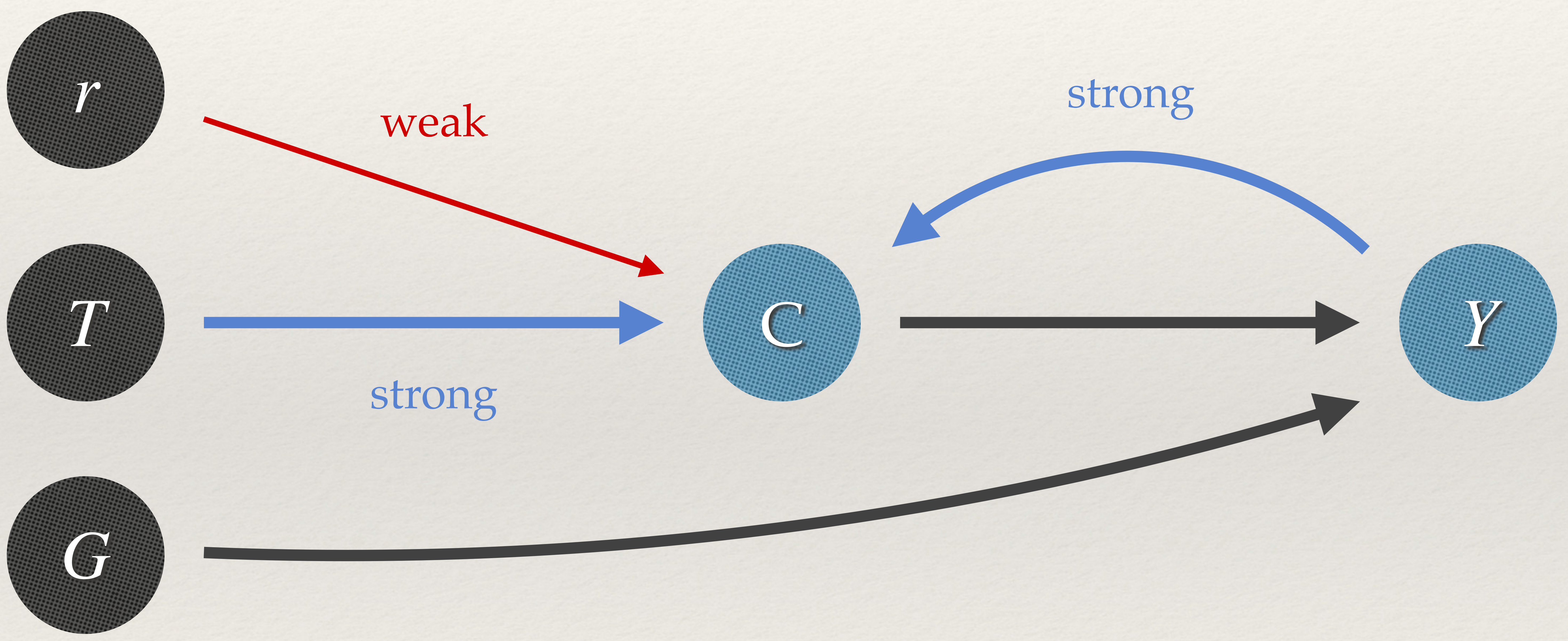

$$Y_t = G_t + \mathscr{C}_t\left(\{r_s, Y_s - T_s\}\right)$$

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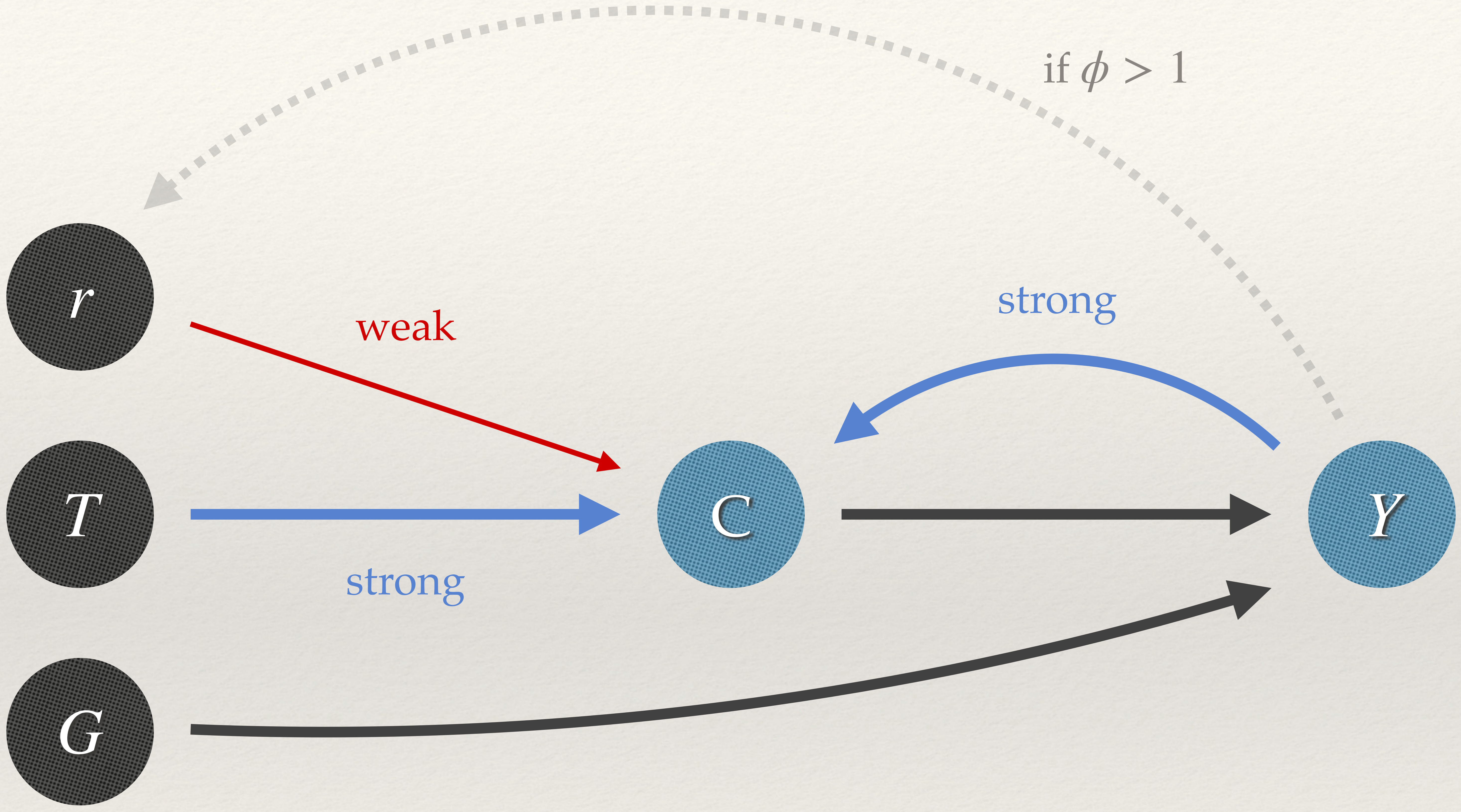

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Fiscal policy in HANK

Intertemporal Keynesian cross

- Imagine central bank keeps real interest rate constant: $r_t = r$.
- Fiscal policy shock $d\mathbf{G} = (dG_0, dG_1, \ldots)$, $d\mathbf{T} = (dT_0, dT_1, \ldots)$, same NPV.
- What happens to **output**, $d\mathbf{Y} = ?$

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Derivative of $\mathscr{C}_t$
"intertemporal MPCs"

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Auclert Rognlie Straub "Intertemporal Keynesian Cross"

What is M ?

- $\mathbf{M}$ is the matrix derivative (Jacobian) of the cons. function $\mathscr{C}_t\left(\{Y_s - T_s\}\right)$

$$\mathbf{M} = \begin{pmatrix} M_{00} & M_{01} & M_{02} & \cdots \\ M_{10} & M_{11} & M_{12} & \cdots \\ M_{20} & M_{21} & M_{22} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{pmatrix}$$

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Impulse response of **C** to date 0 (unanticipated) increase in income **Z**

Impulse response of **C** to date 1 (anticipated) increase in income **Z**

What is M for a representative agent?

- **M** is the matrix derivative (Jacobian) of the cons. function $\mathscr{C}_t\left(\left\{Y_s - T_s\right\}\right)$

$$\mathbf{M} = \begin{pmatrix} 1-\beta & (1-\beta)\beta & (1-\beta)\beta^2 & \cdots \\ 1-\beta & (1-\beta)\beta & (1-\beta)\beta^2 & \cdots \\ 1-\beta & (1-\beta)\beta & (1-\beta)\beta^2 & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{pmatrix}$$

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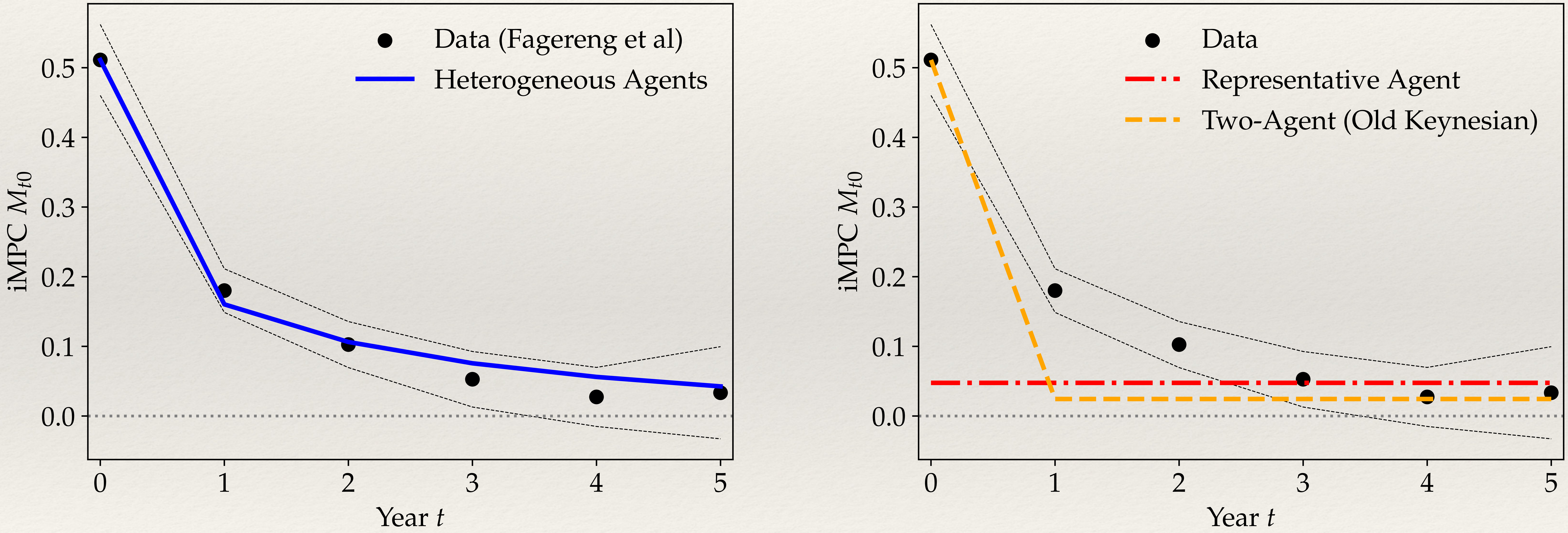
M in models and the data

- Can compare first column with the data from Fagereng-Holm-Natvik:



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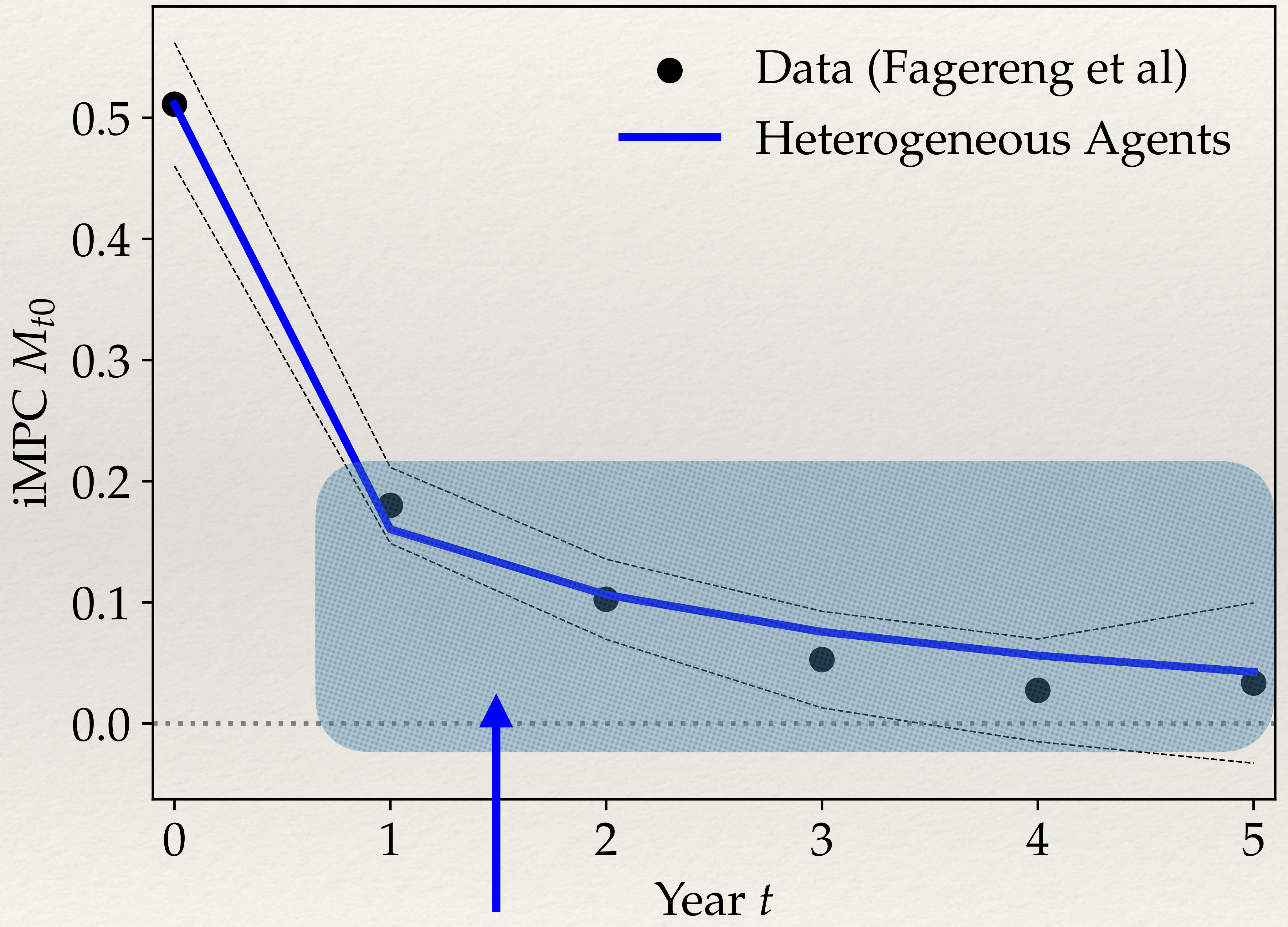

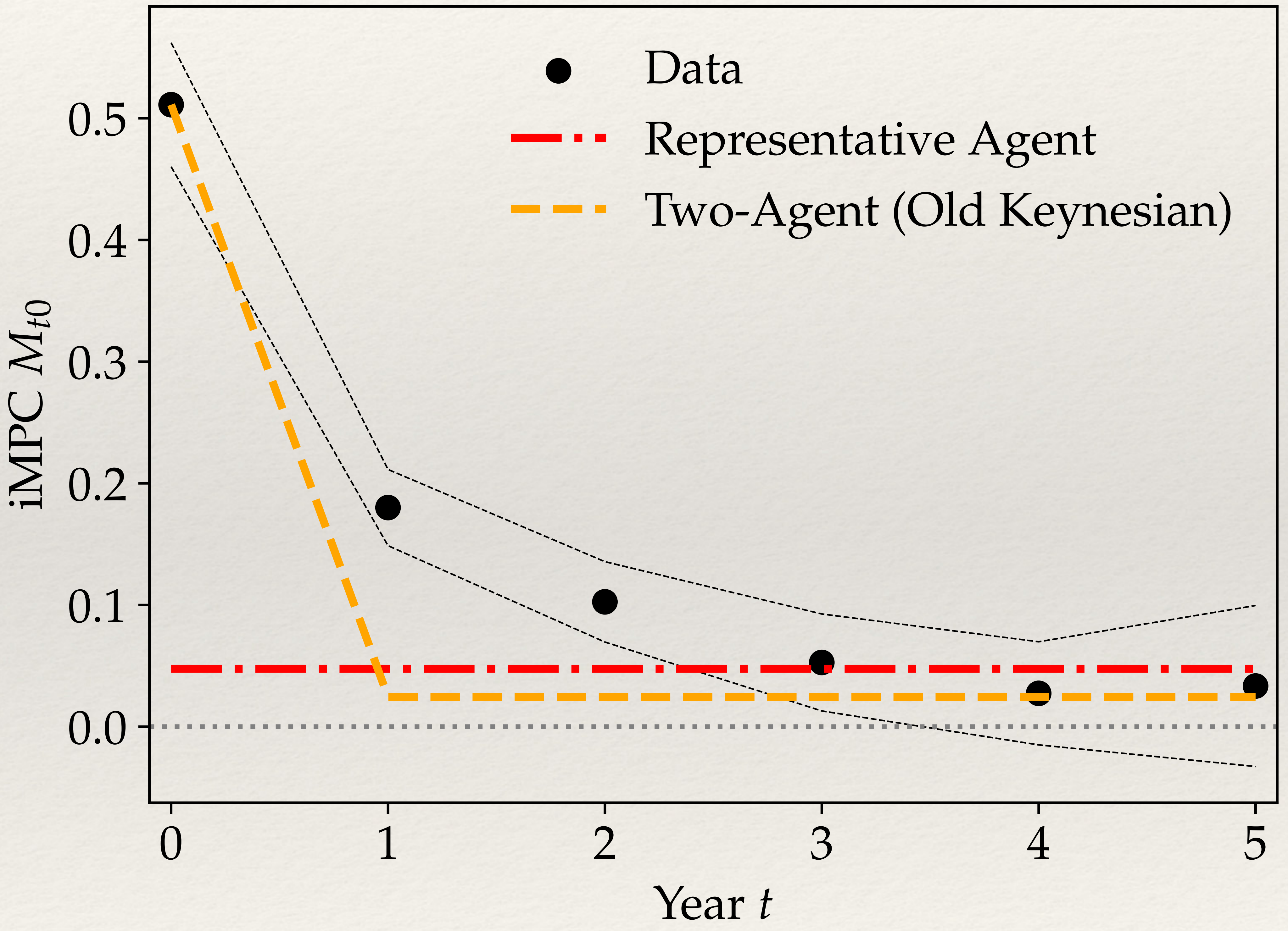

HA: Households spend down transfer relatively slowly

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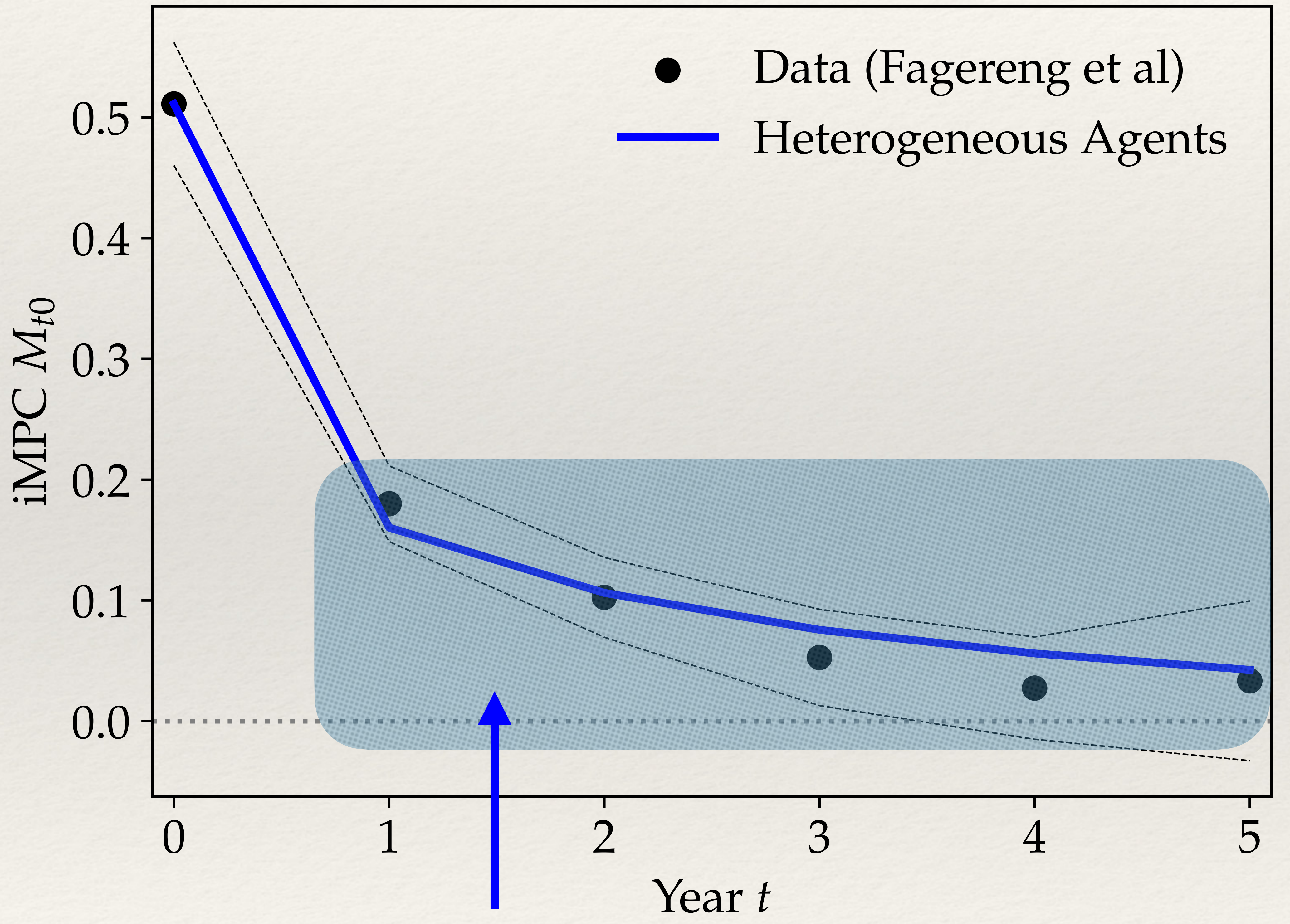

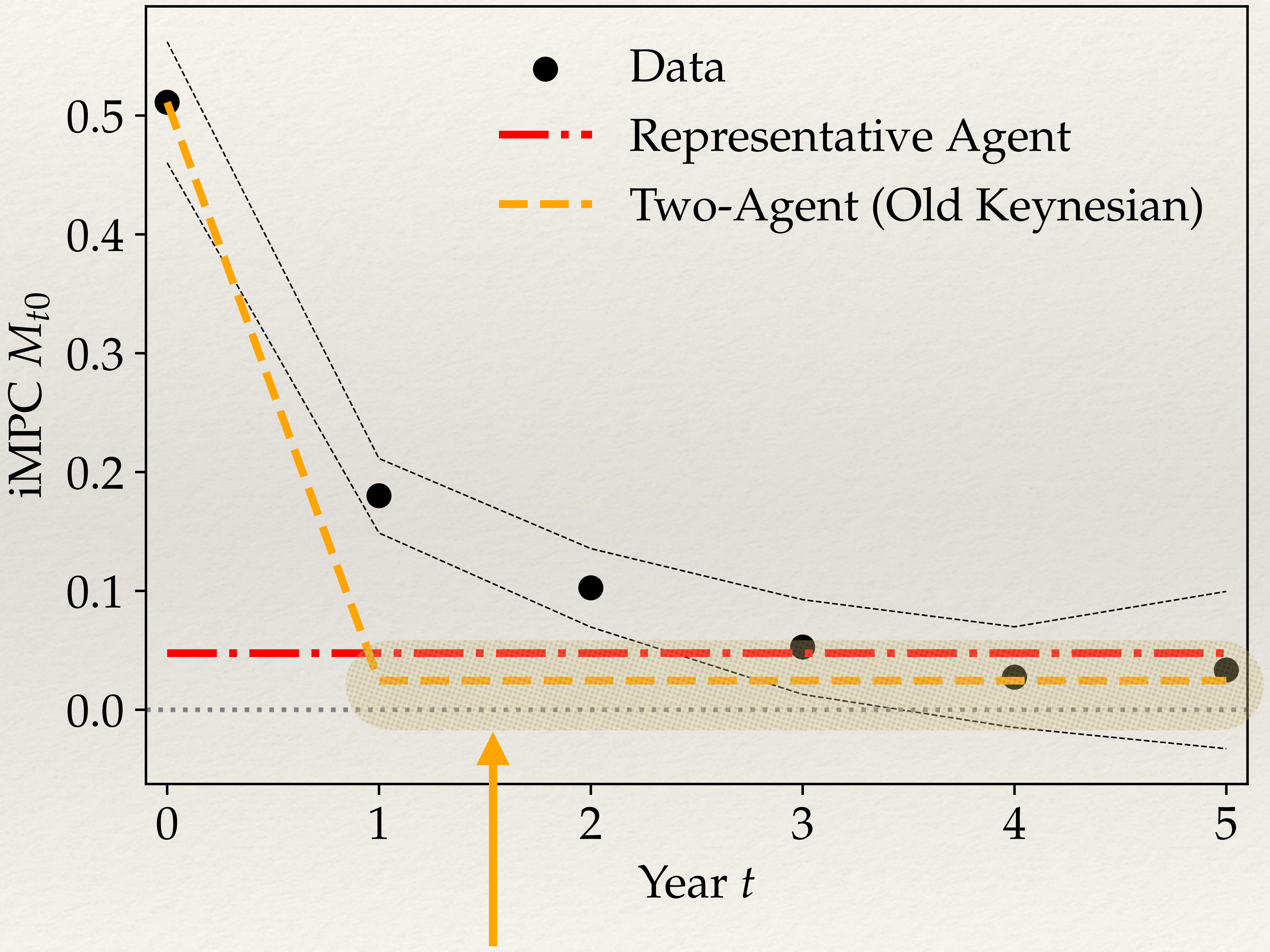

HA: Households spend down transfer relatively slowly

TA: Households spend either right away or little

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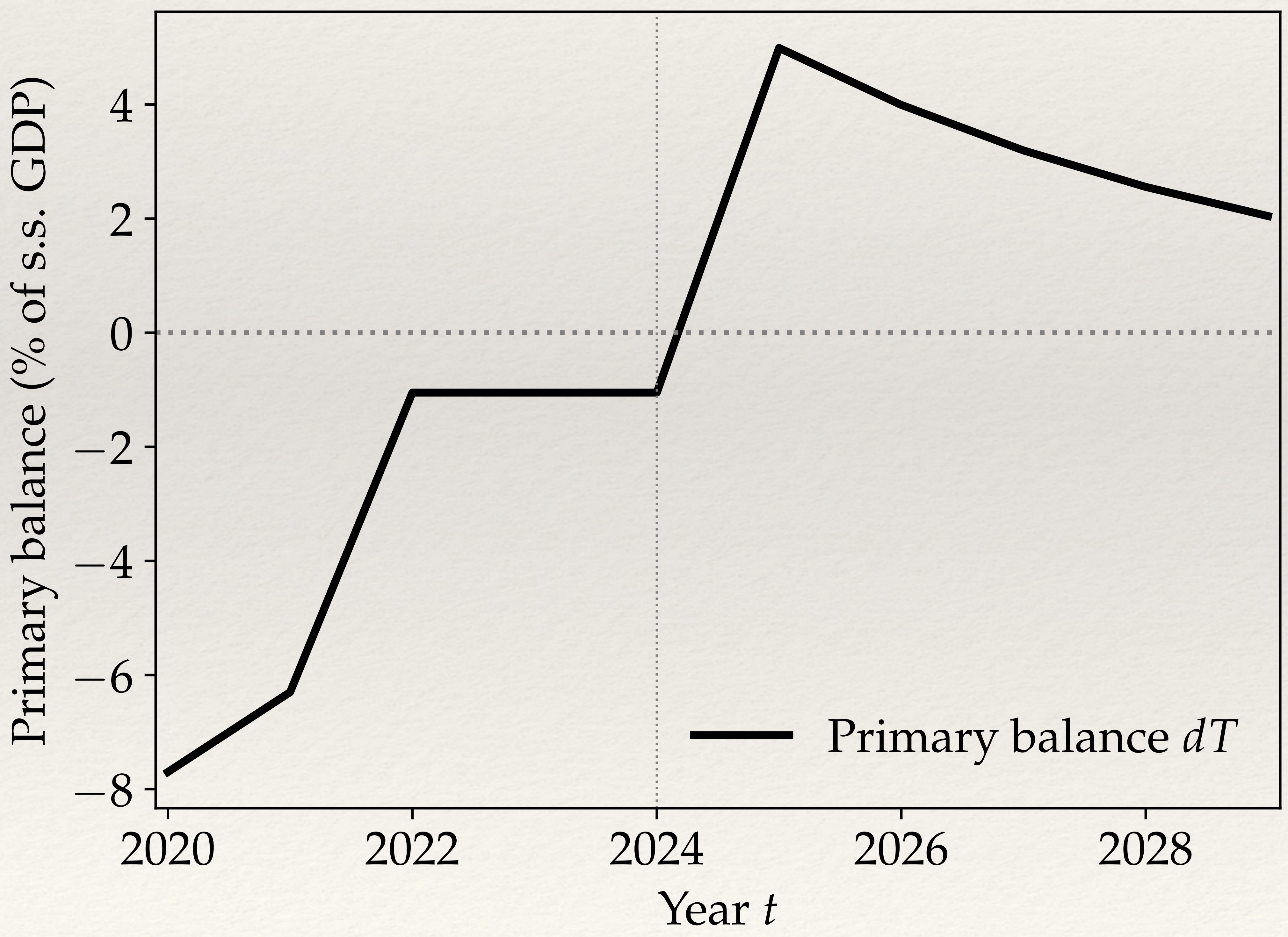
The long shadow of Covid stimulus

- Feed in Covid stimulus and solve for consumption and inflation.

Tax change



Constructed as 70% of observed primary balance beyond pre-Covid surplus of -2%

See also Bayer Born Luetticke Müller

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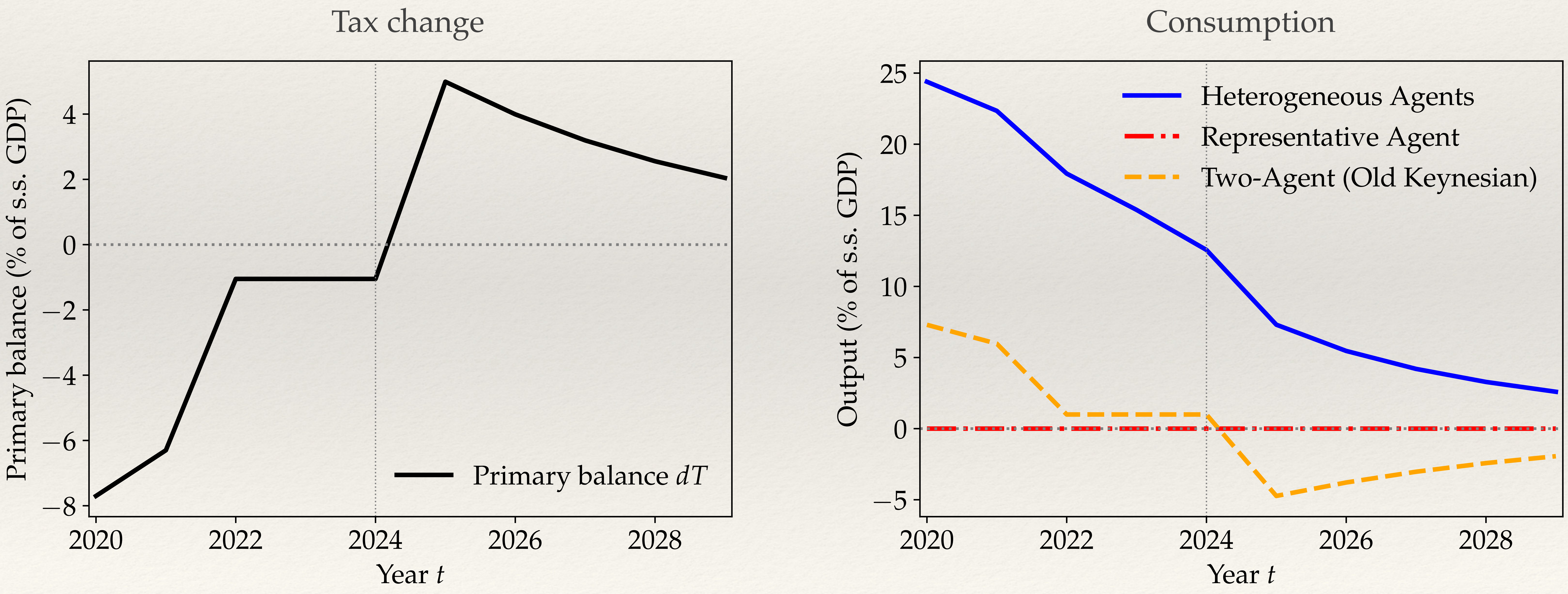

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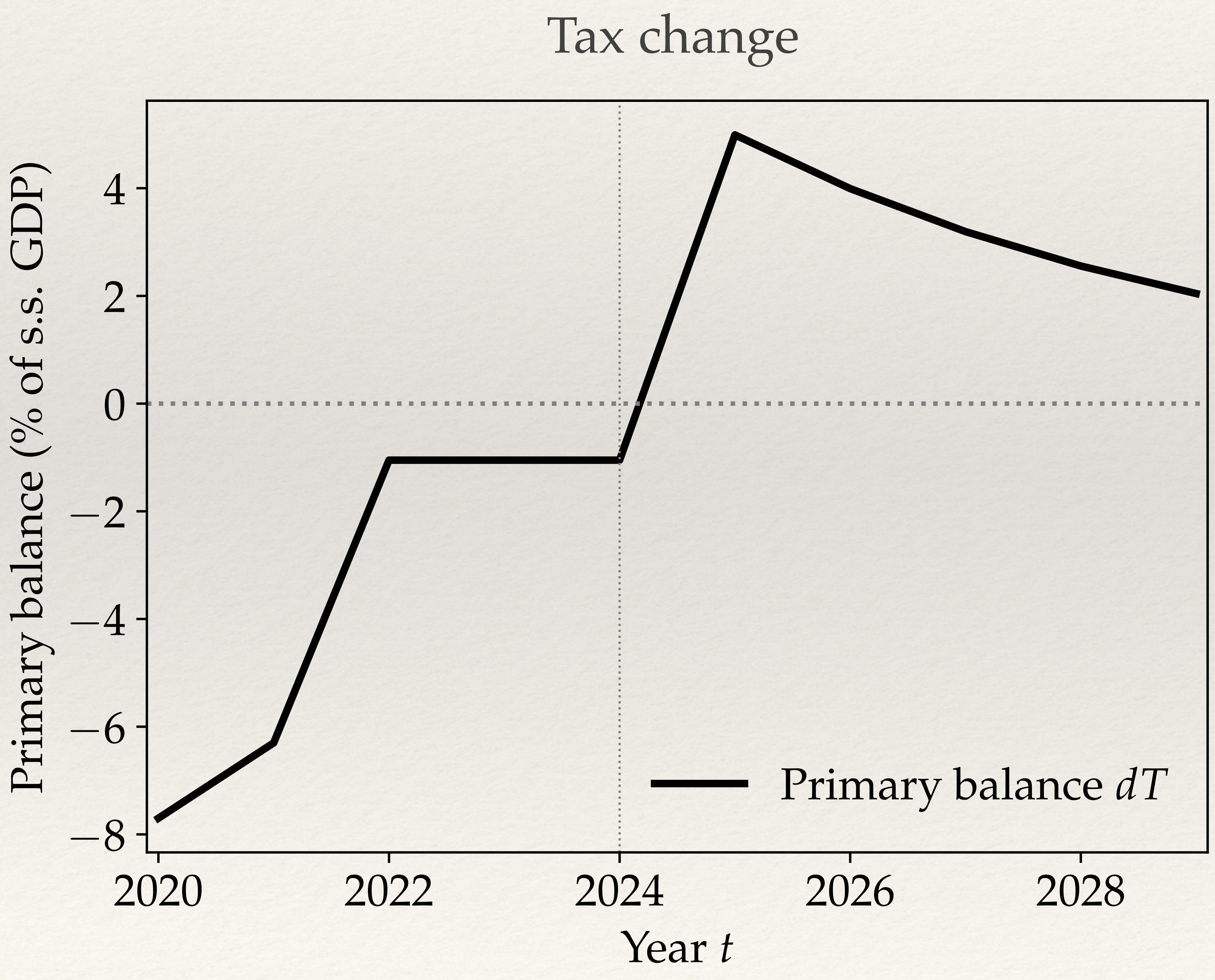

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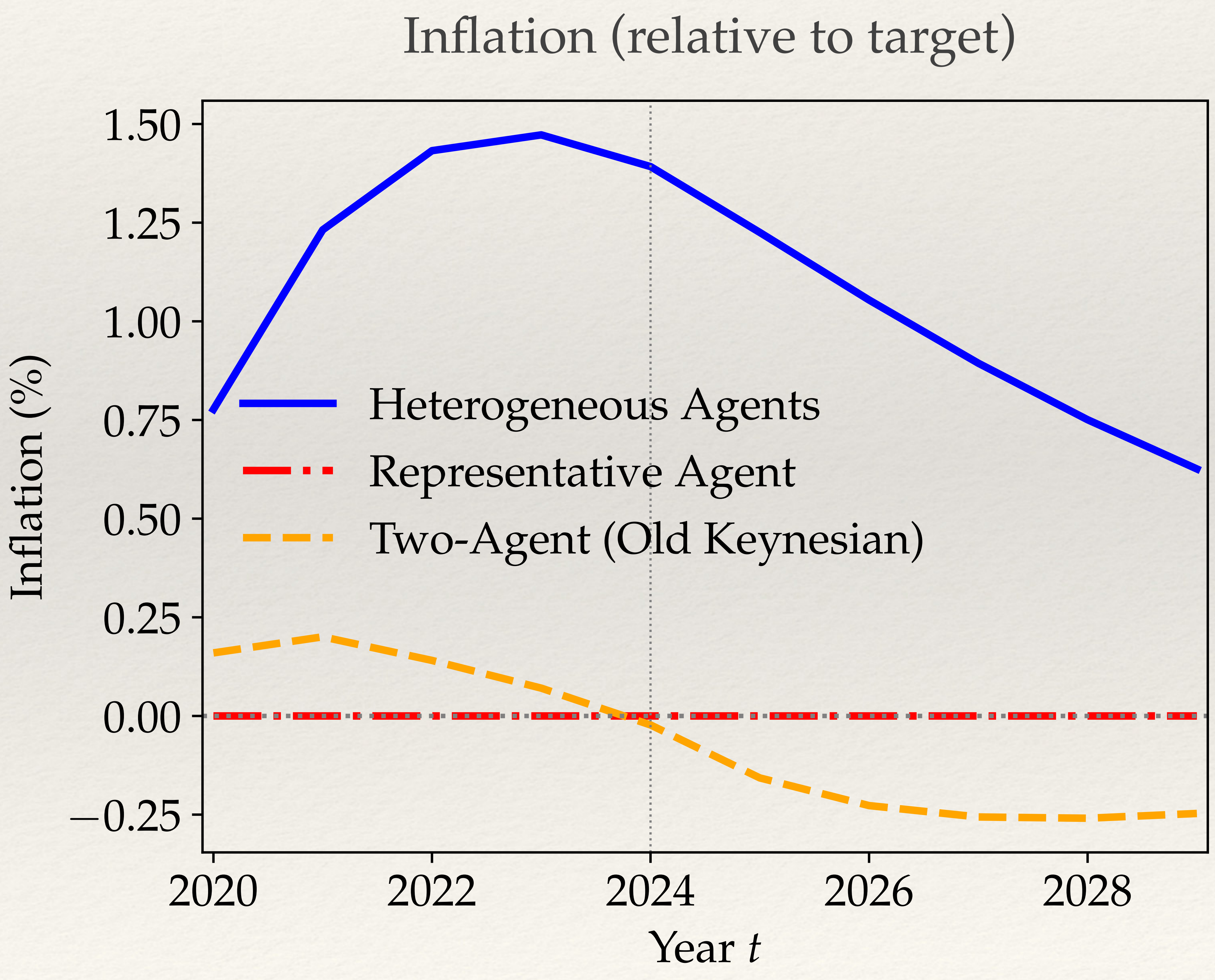

Standard hybrid NKPC with 50% weight on lagged inflation, $\kappa = 0.01$

Why does heterogeneity lead to persistence?

Auclert Rognlie Straub "Trickling Up of Excess Savings"

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AGGREGATE DEMAND

Auclert Rognlie Straub “Trickling Up of Excess Savings”

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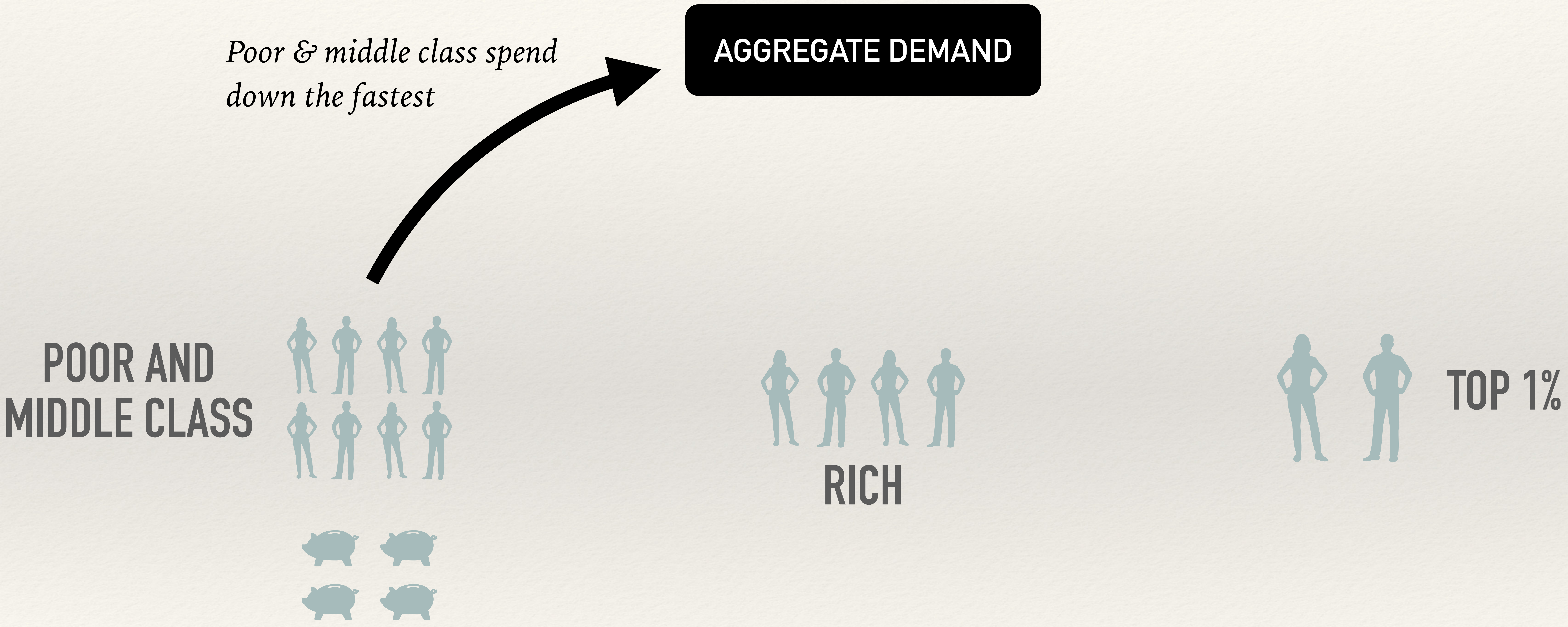

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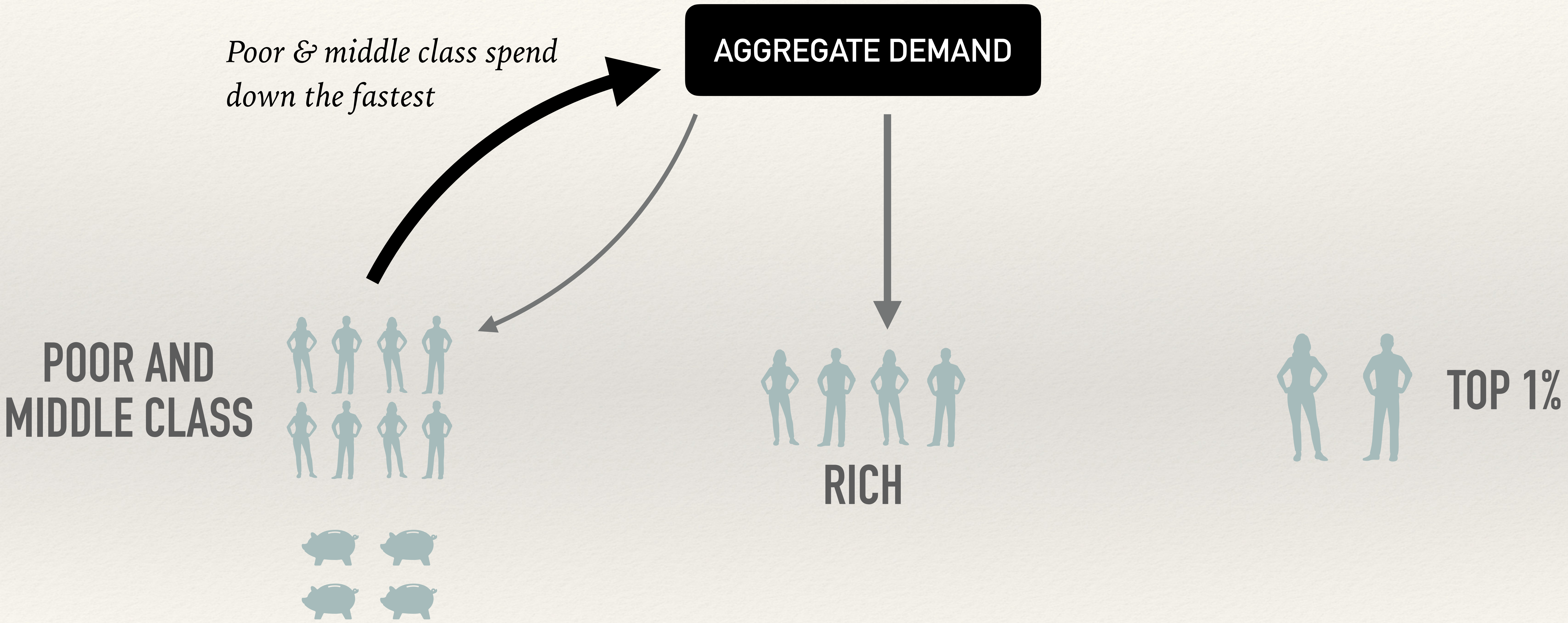

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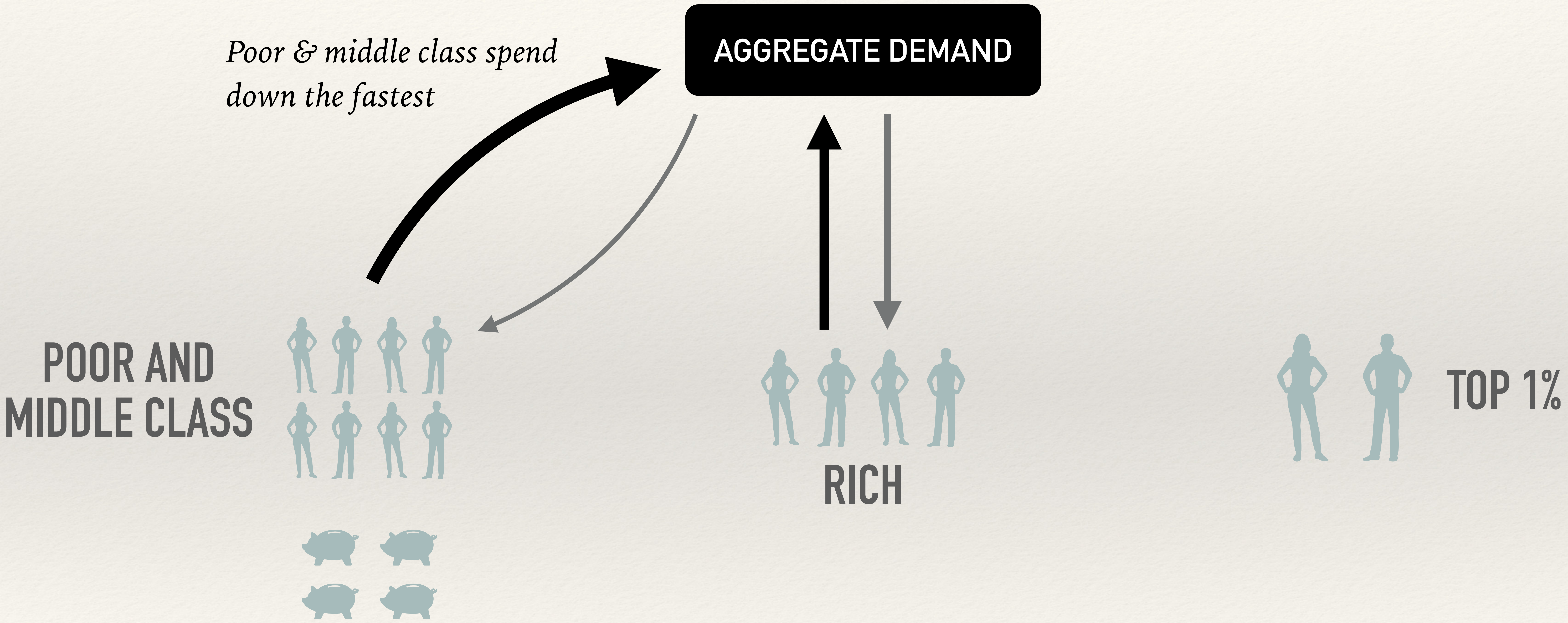

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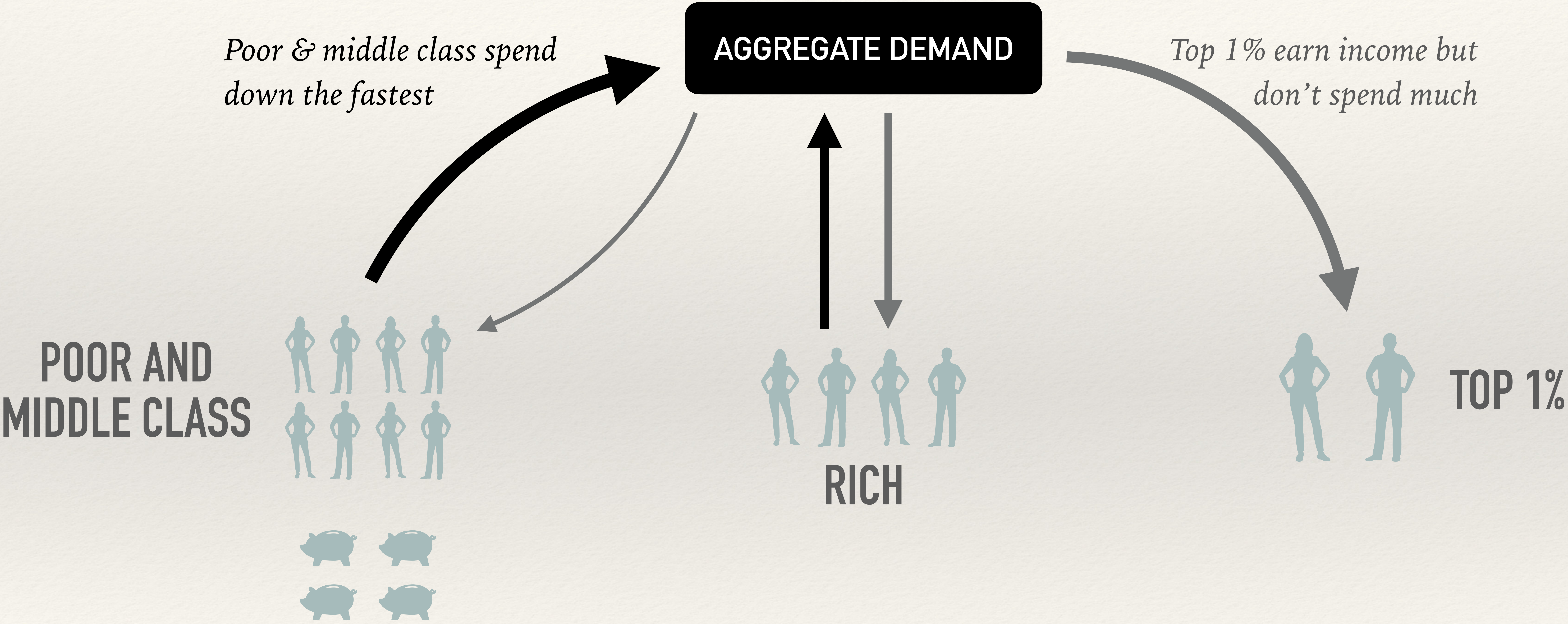

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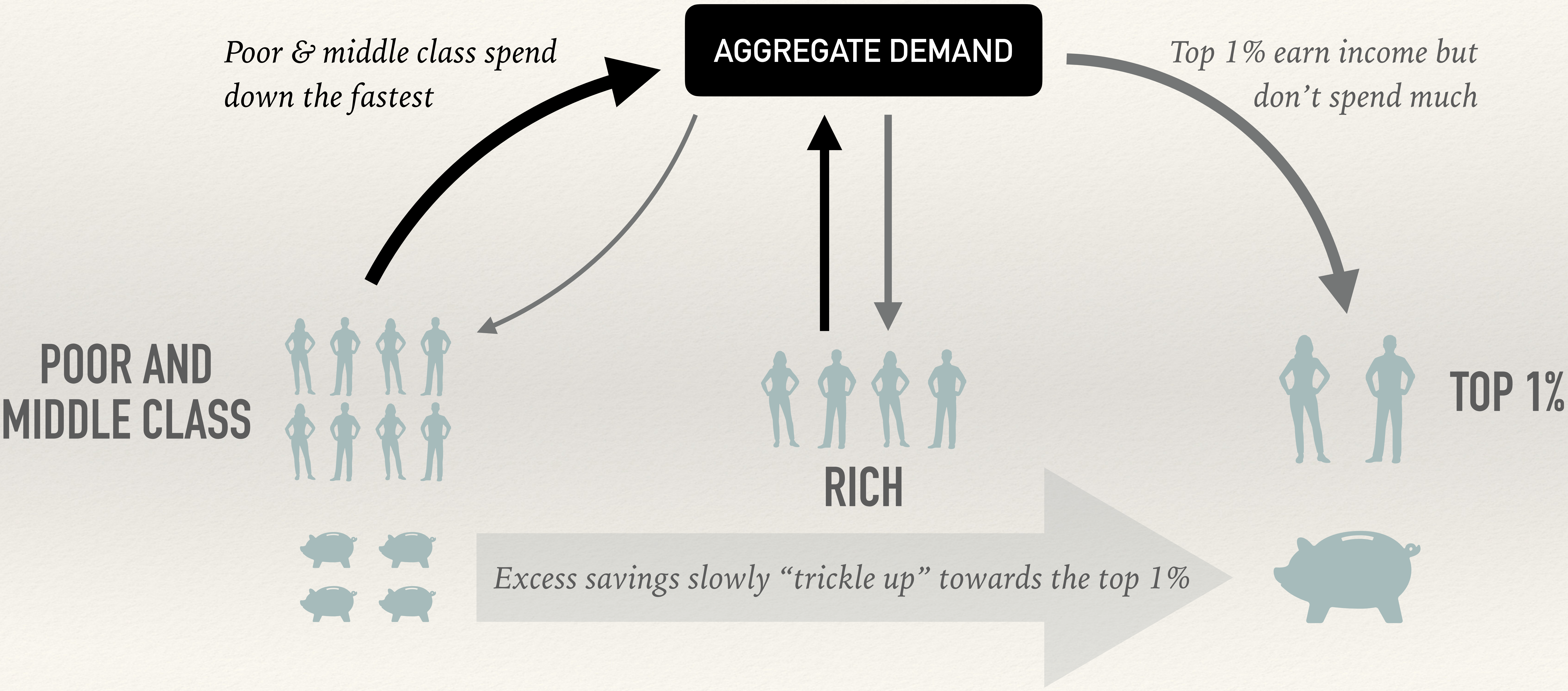
Why does heterogeneity lead to persistence?



Auclert Rognlie Straub "Trickling Up of Excess Savings"

Monetary policy

Monetary policy

- Allow for central bank to shock the real interest rate $\{r_s\}$
- Assume gov. keeps debt repayment $(1+r_{t-1})B_t$ constant and adjusts T_t

$$Y_t = G_t + \mathscr{C}_t\left(\{r_s, Y_s - T_s\}\right) \qquad T_t = (1+r)B + G - \frac{(1+r)B}{1+r_t}$$

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direct effect of r

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direct effect of r

indirect effect via gov. budget

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Key channel with RA → direct effect of r

indirect effect via gov. budget

indirect effect via Y

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Key channel with RA

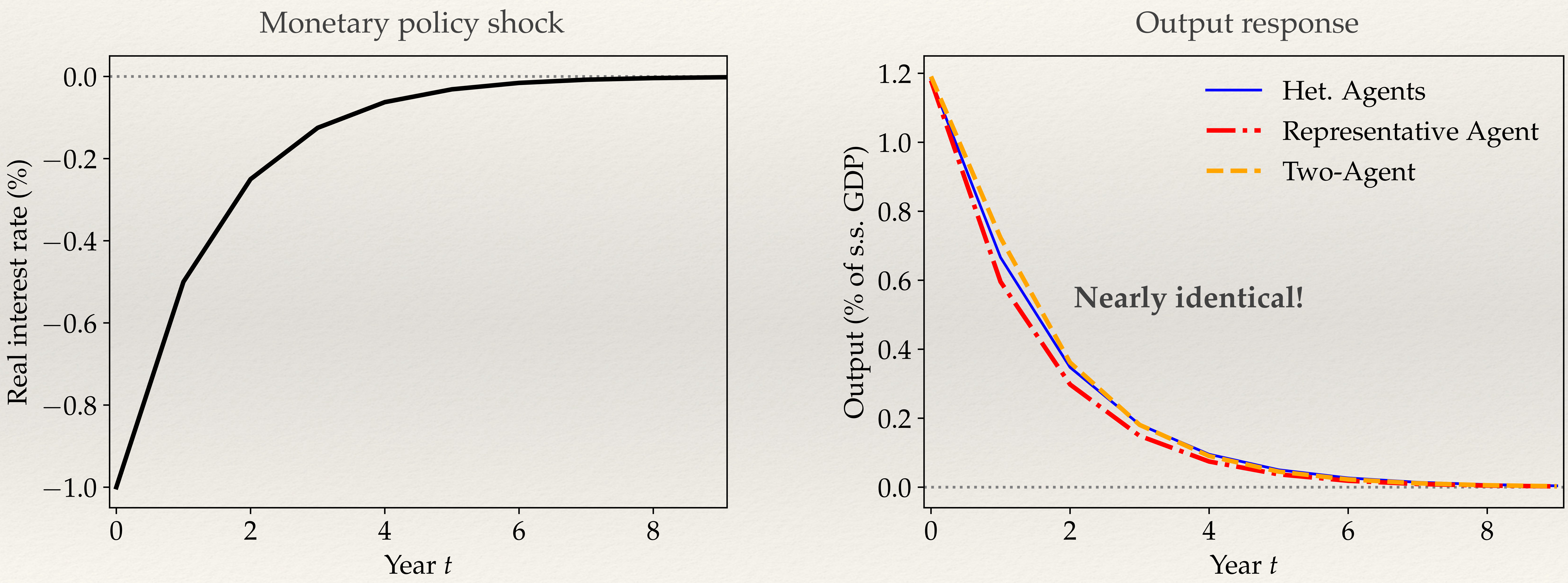
Key channels with HA (Kaplan Moll Violante)

Aggregate effects of monetary policy

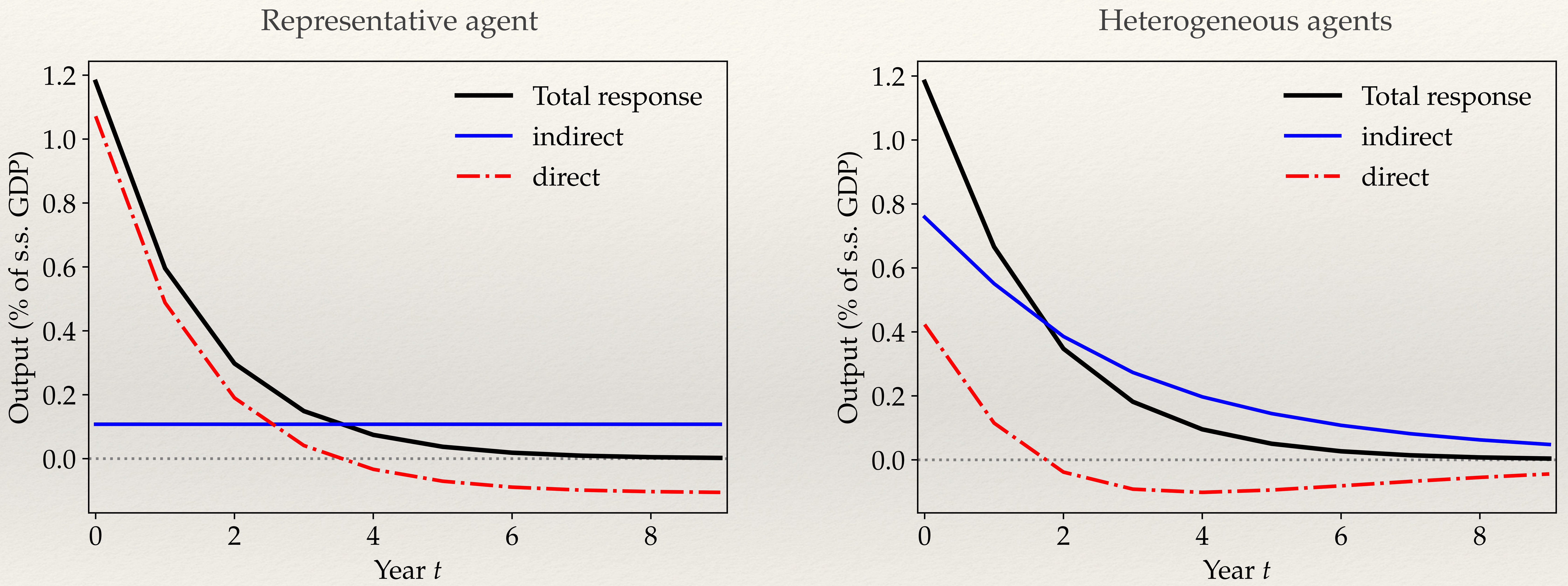
- Does HANK matter for aggregate effects of monetary policy?

Aggregate effects of monetary policy

- Does HANK matter for aggregate effects of monetary policy?



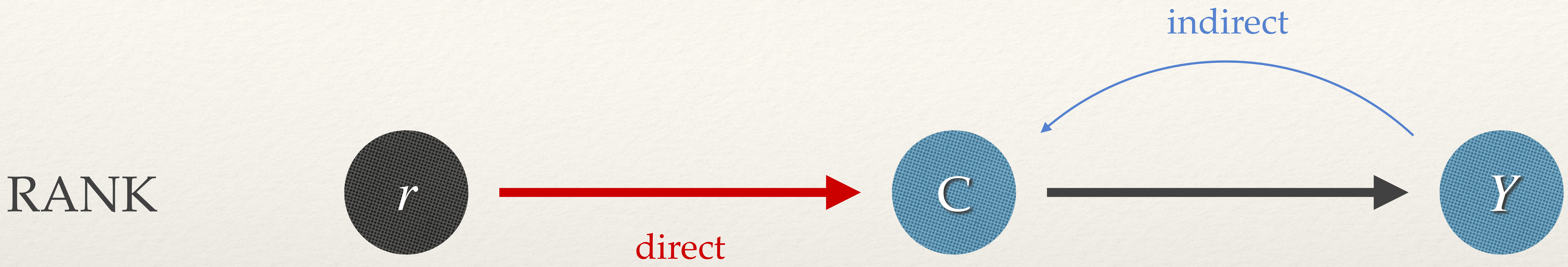
Direct and indirect effects



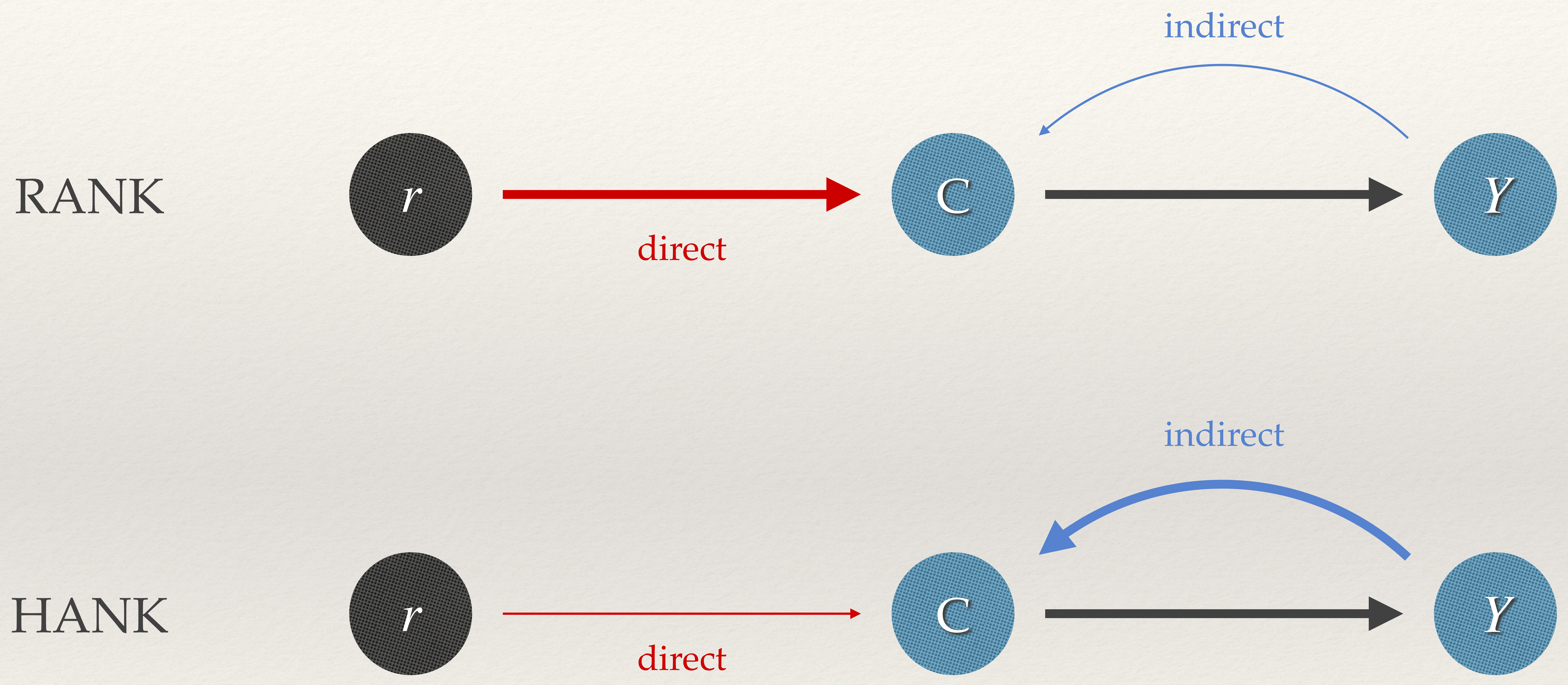
- HANK similar to RANK because stronger indirect offsets weaker direct effect!

[Werning 2015]

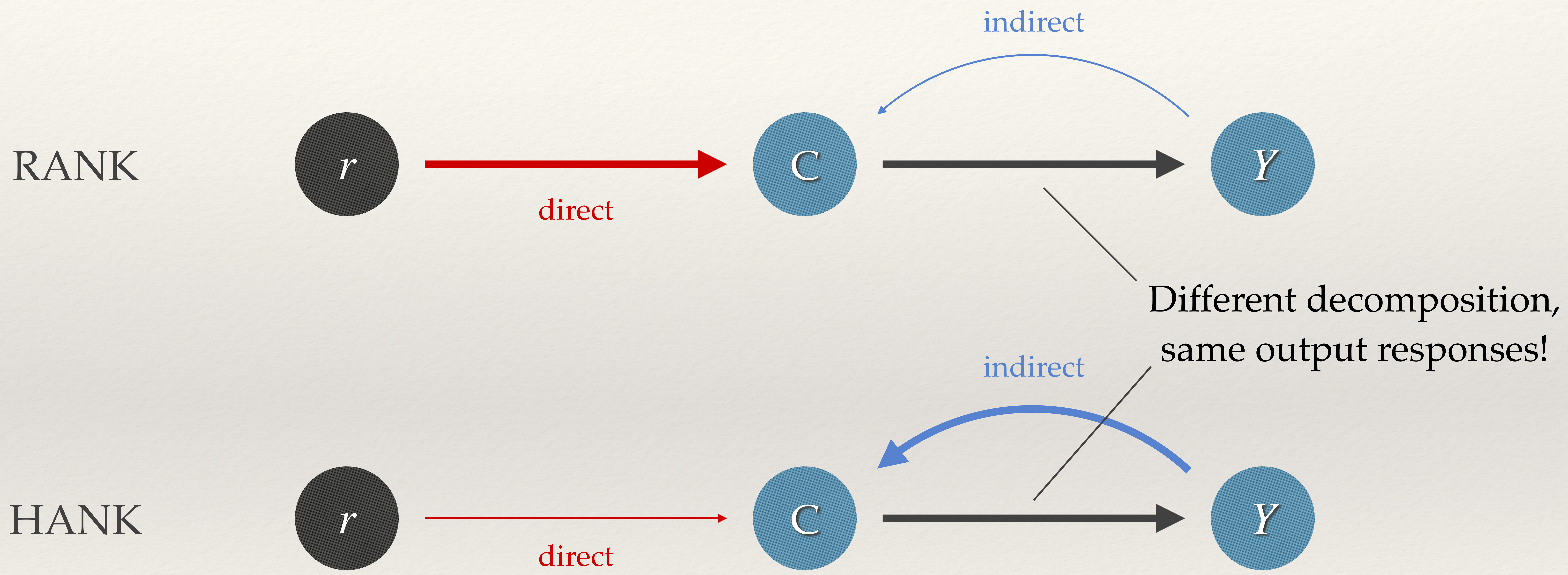
Monetary policy flowcharts



Monetary policy flowcharts



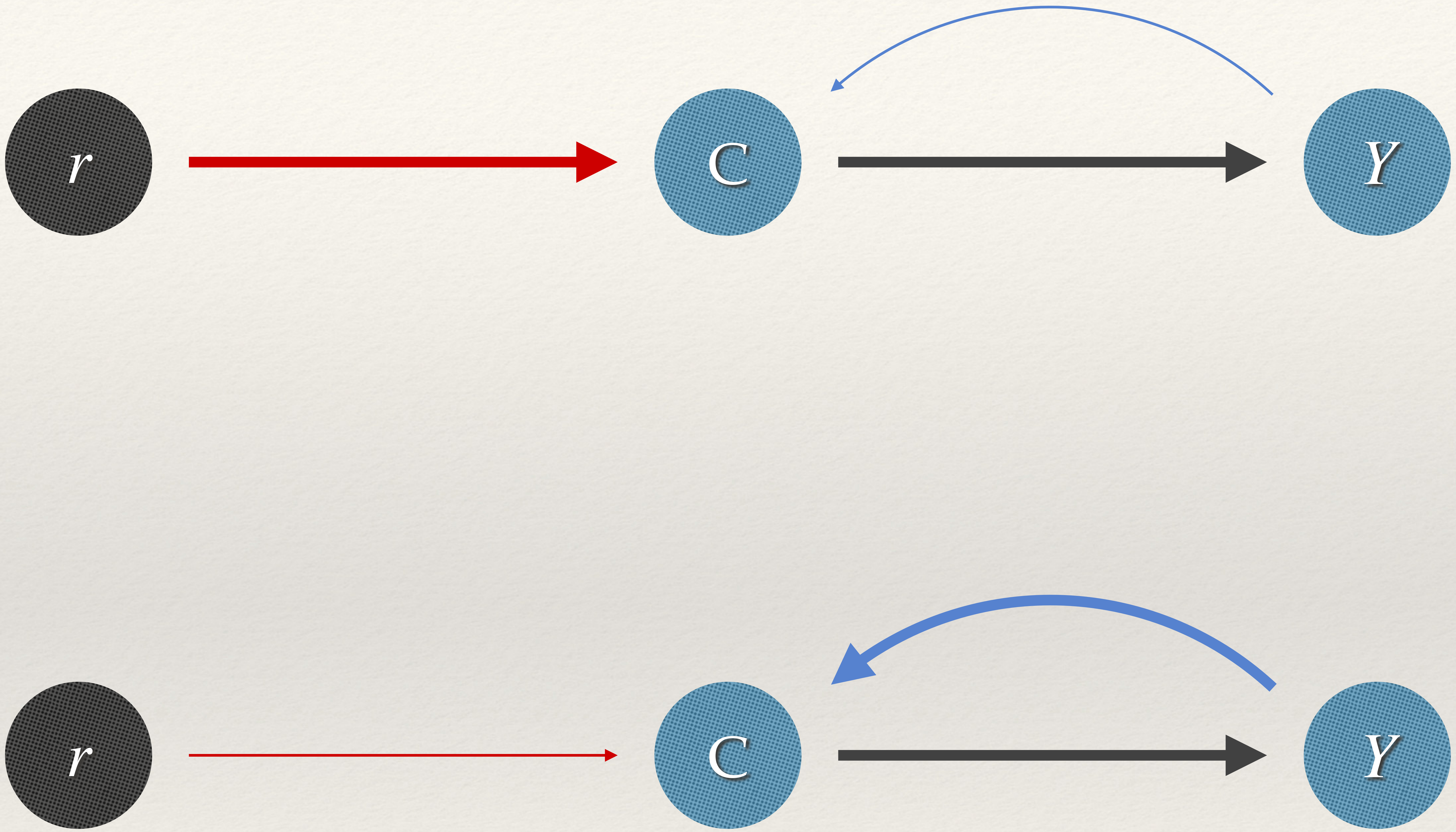
Monetary policy flowcharts



What if there is investment?

RANK

HANK



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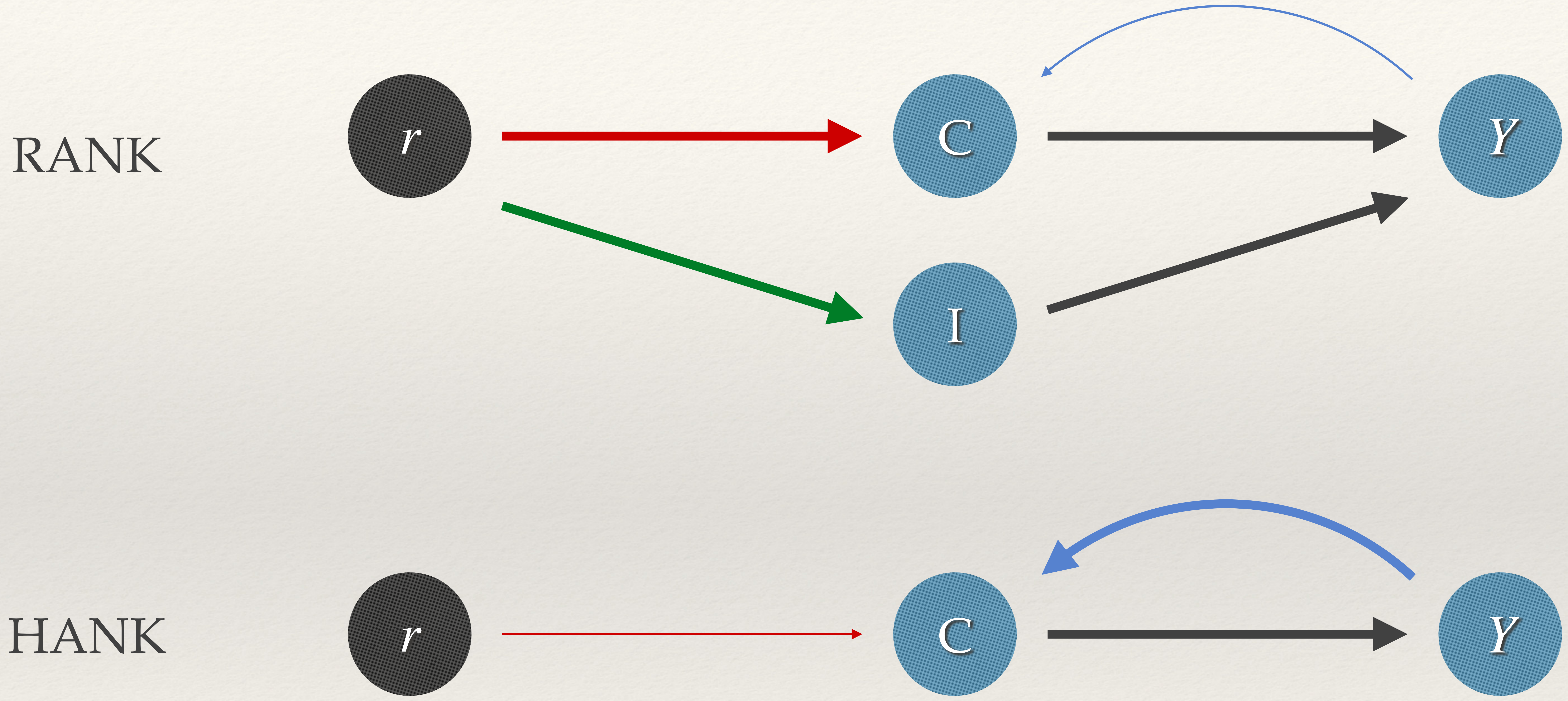

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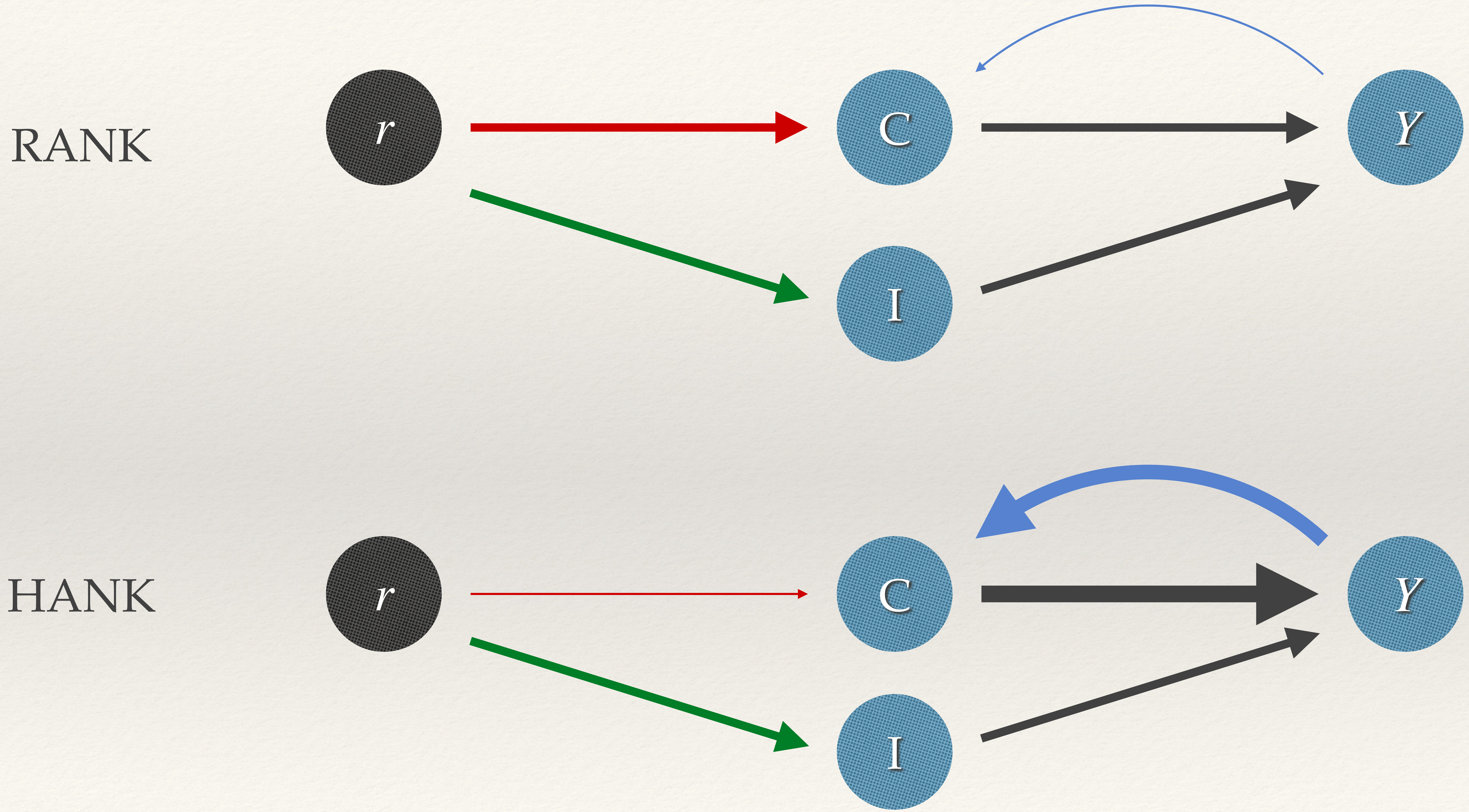

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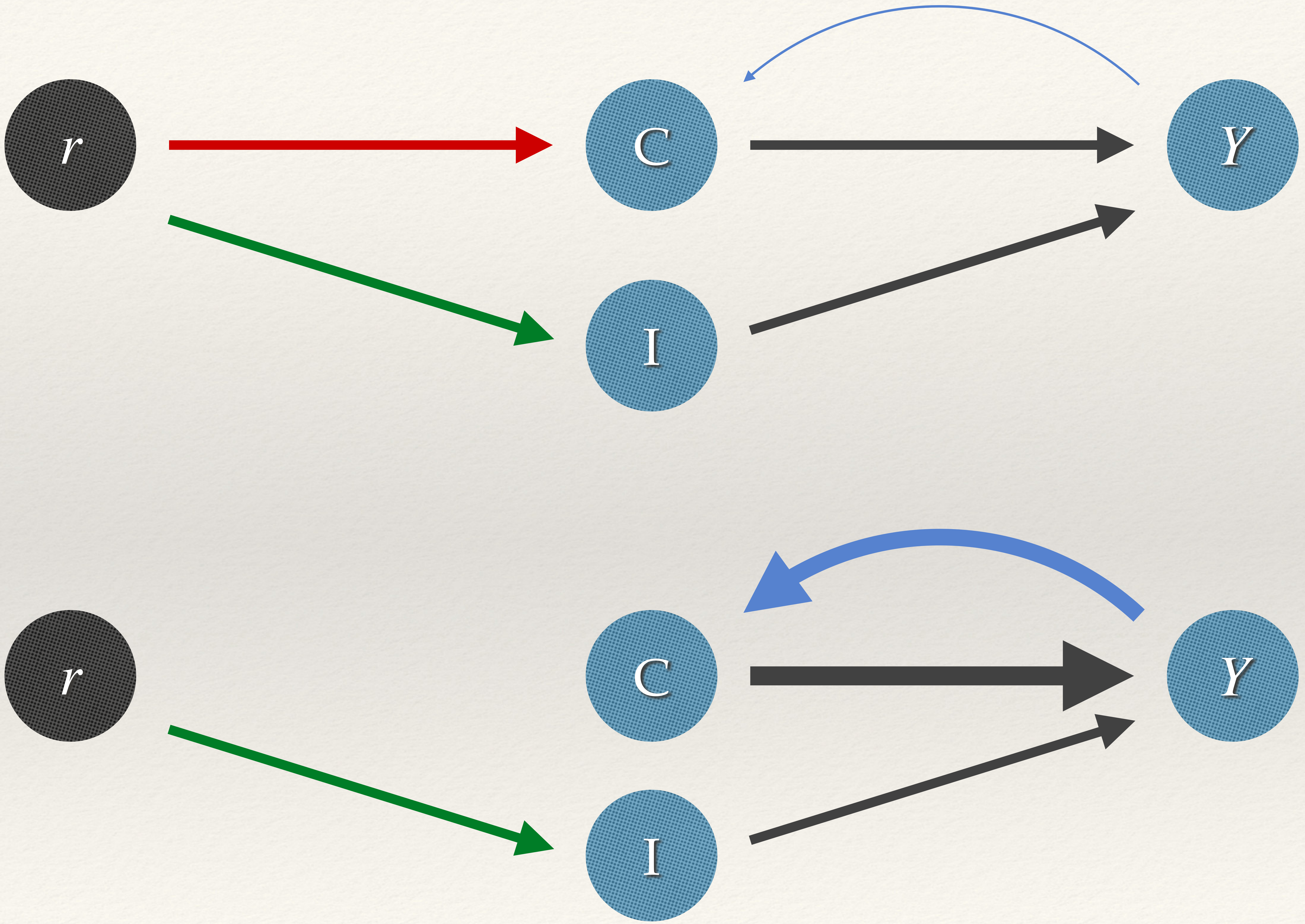

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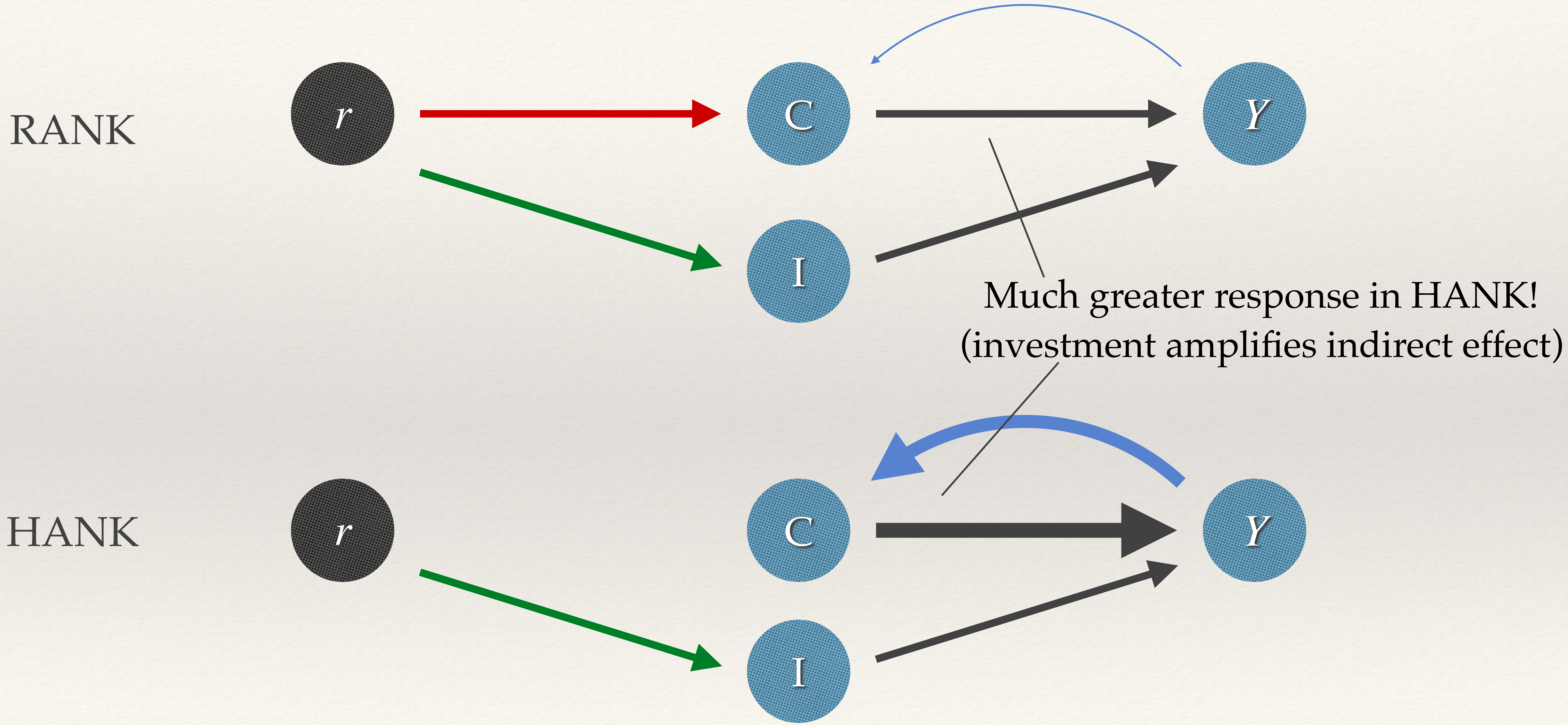
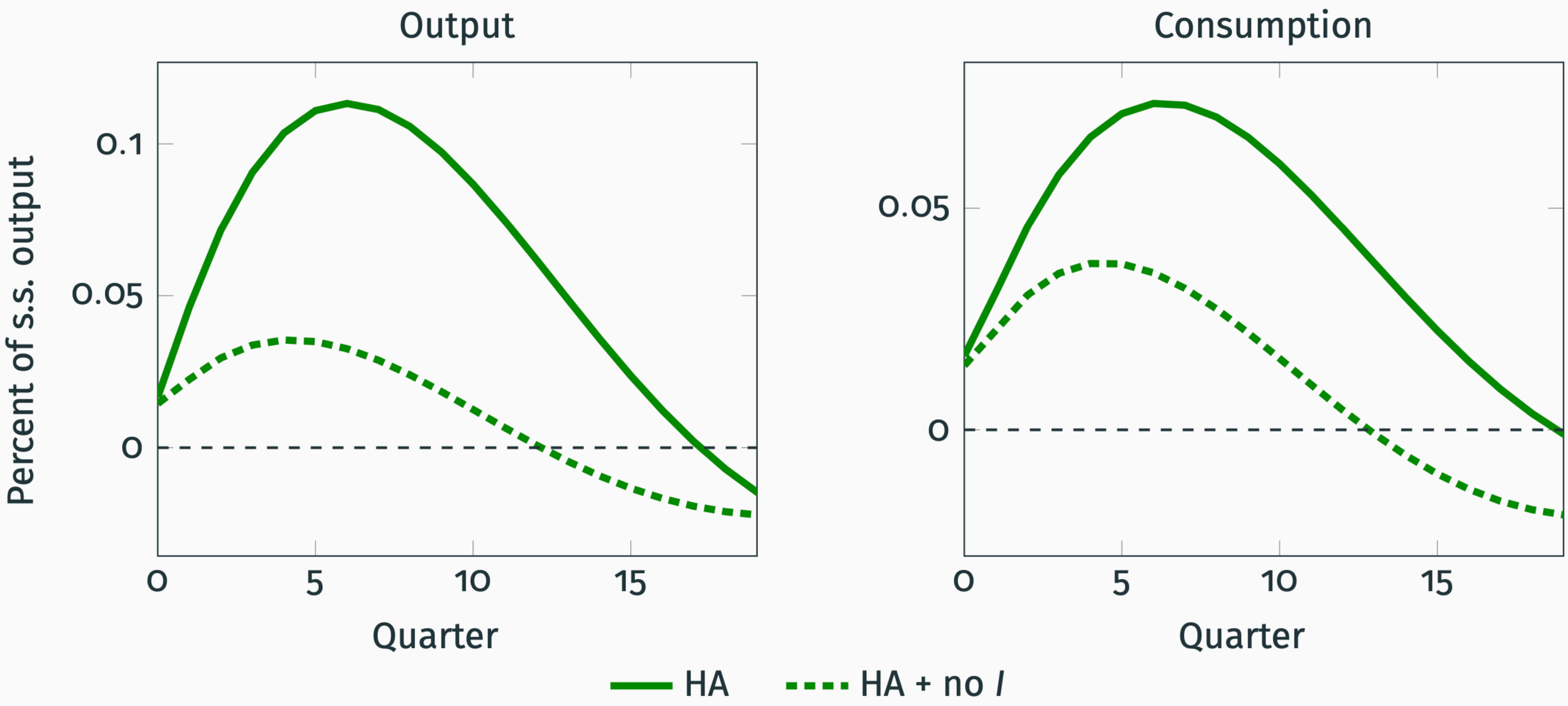
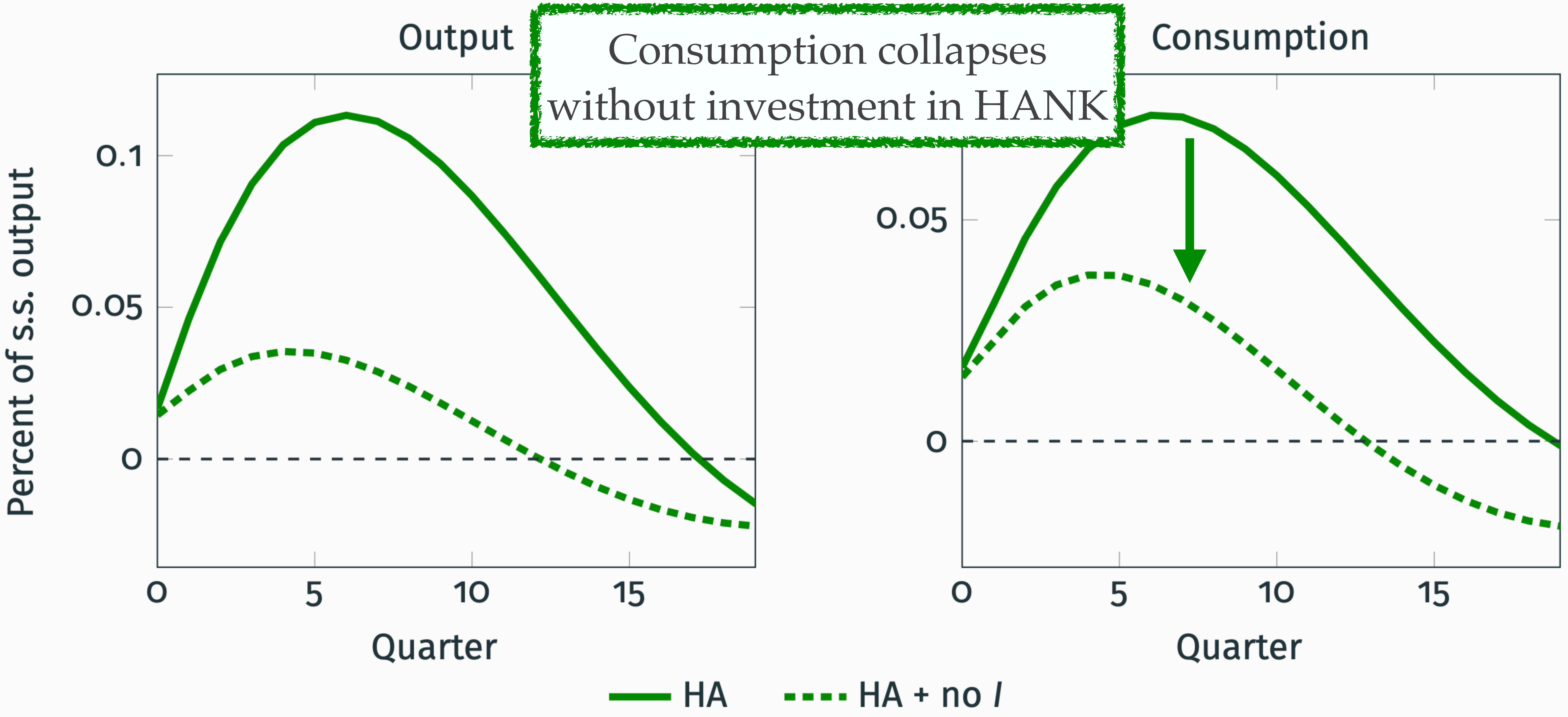


Role of investment in monetary transmission



From Auclert Rognlie Straub "Micro Jumps and Macro Humps"

Role of investment in monetary transmission



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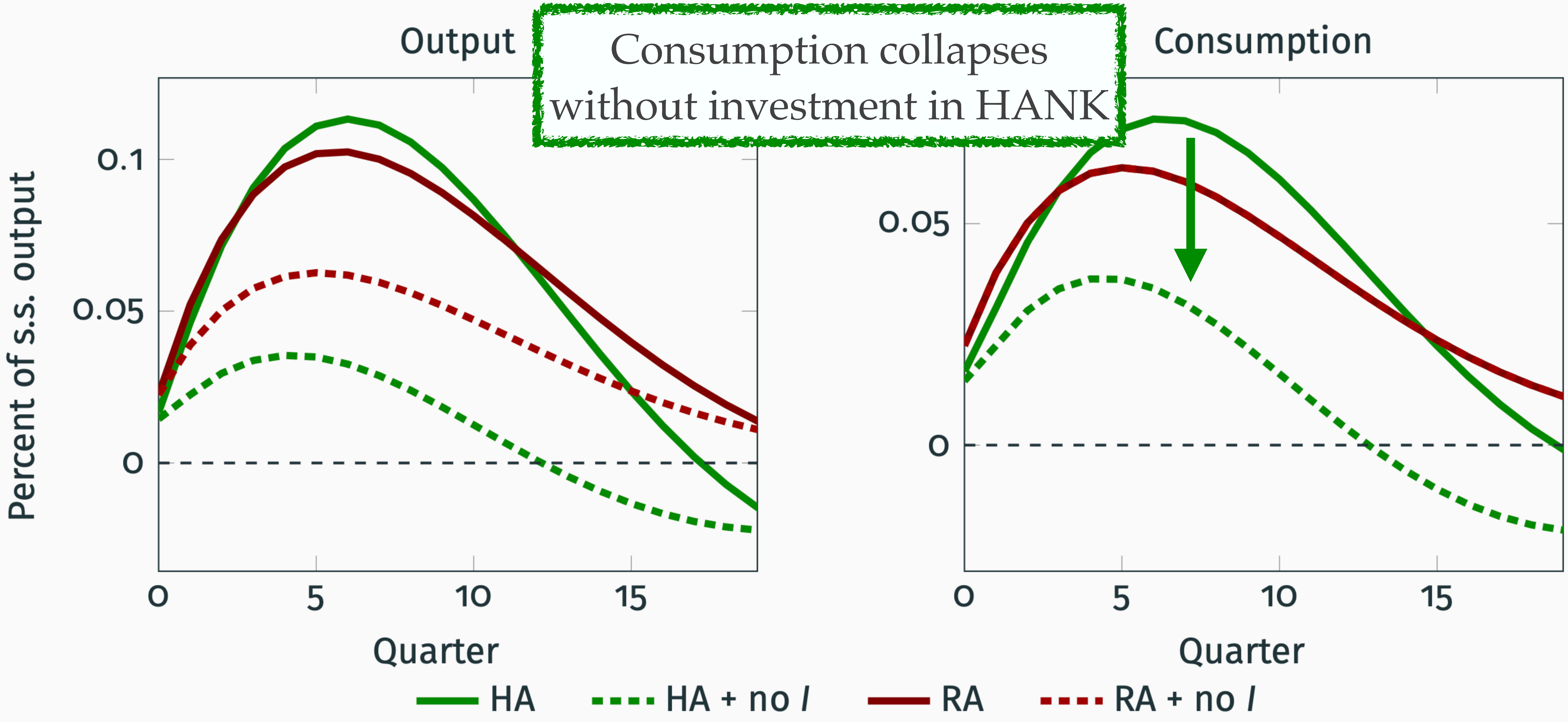

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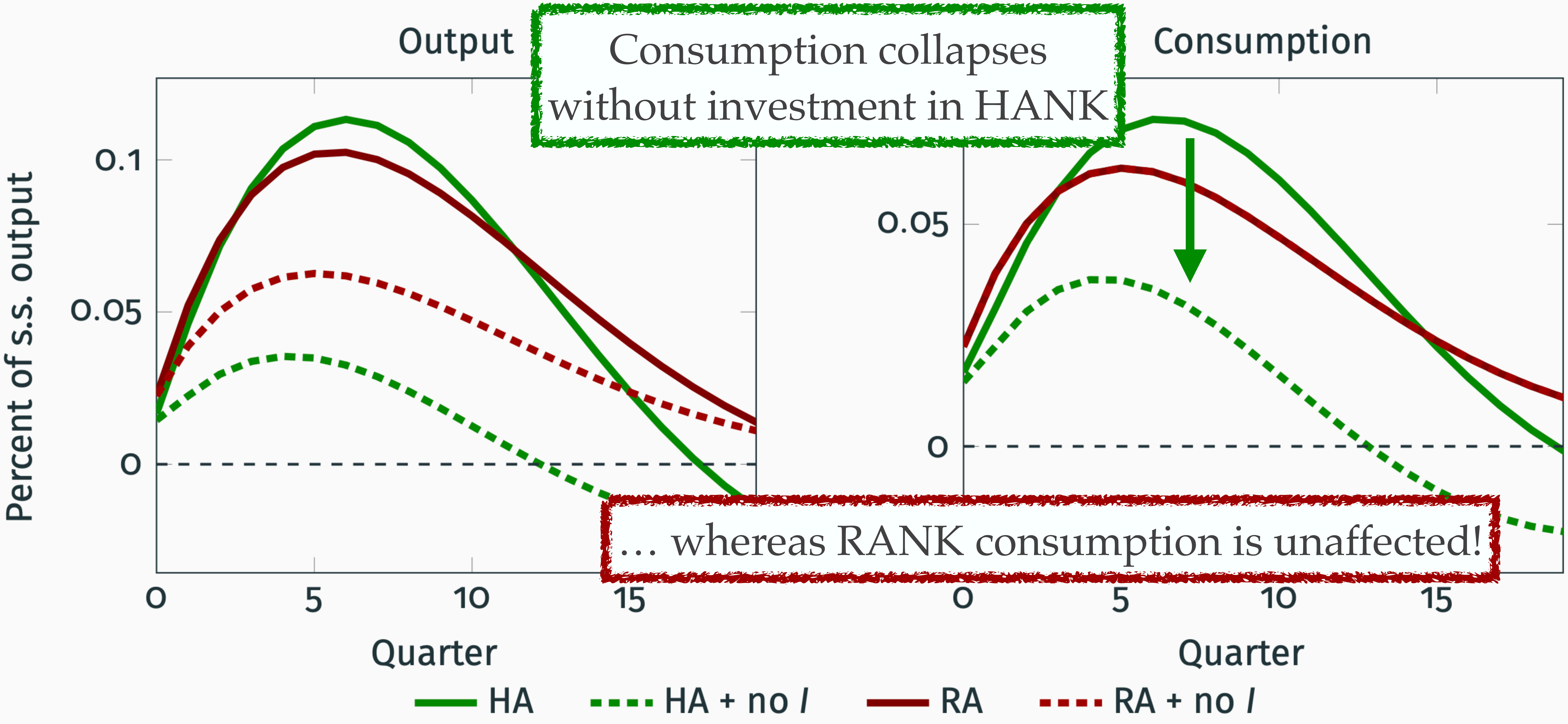


From Auclert Rognlie Straub “Micro Jumps and Macro Humps"

Broader implications of investment in HANK

- Limited response to monetary policy tightening
  - if house prices & residential investment doesn't respond much!
- Investment stimulus (e.g. CHIPS, IRA) spills over into consumption!
  - Generates outsized positive effect on aggregate demand

Energy shocks

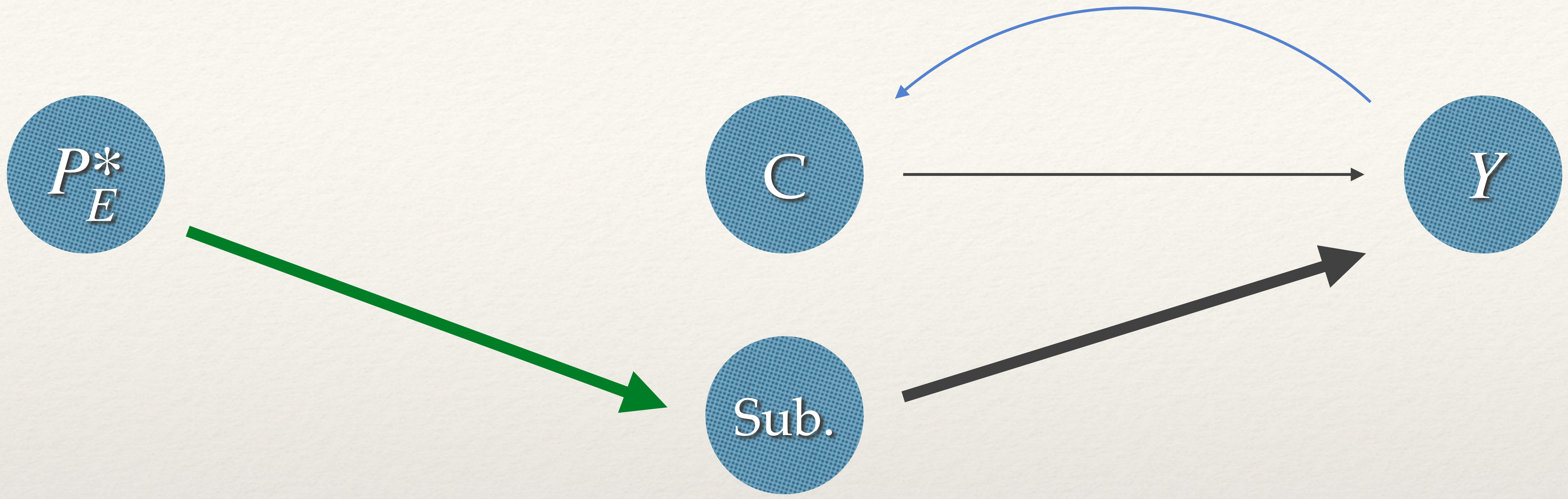
Extending the model

- Small open economy
- Produces "home" goods, imports "foreign" and "energy"
- Exogenous shock to world price of energy P^*_{Et}

- Two forces:
  - Higher relative price for energy → substitution towards home
  - Lower real income of households → households cut spending

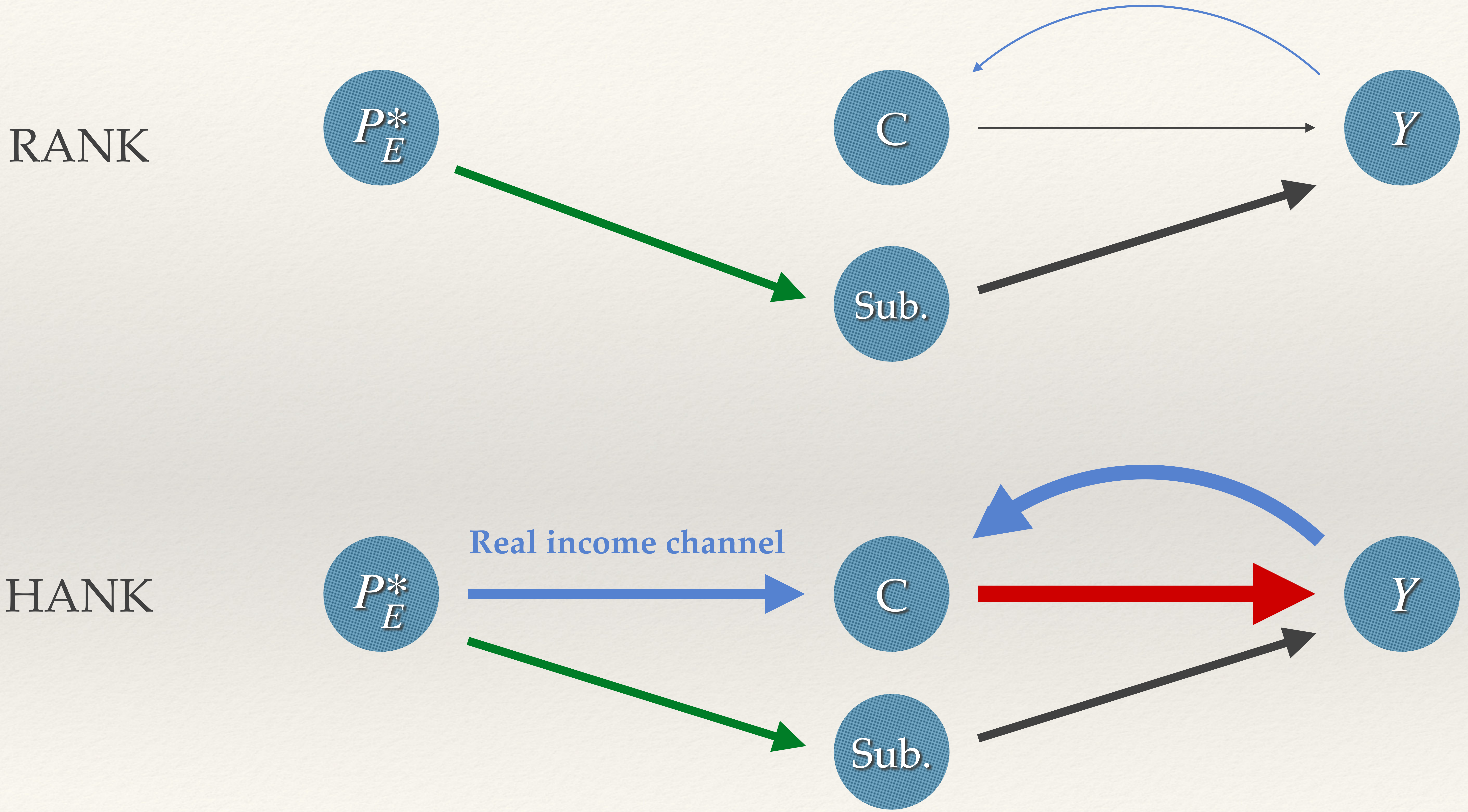
Energy shocks in HANK

RANK

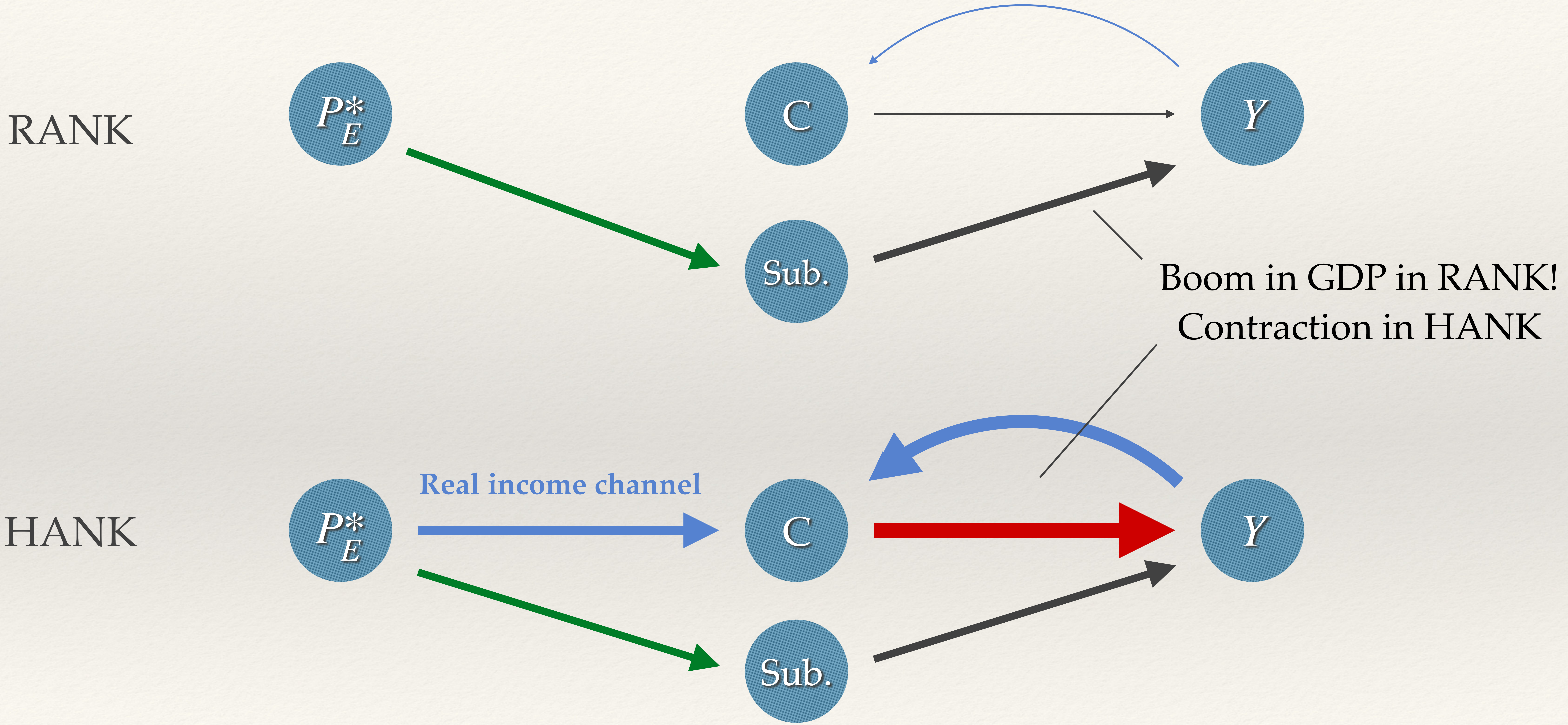


Real income channel

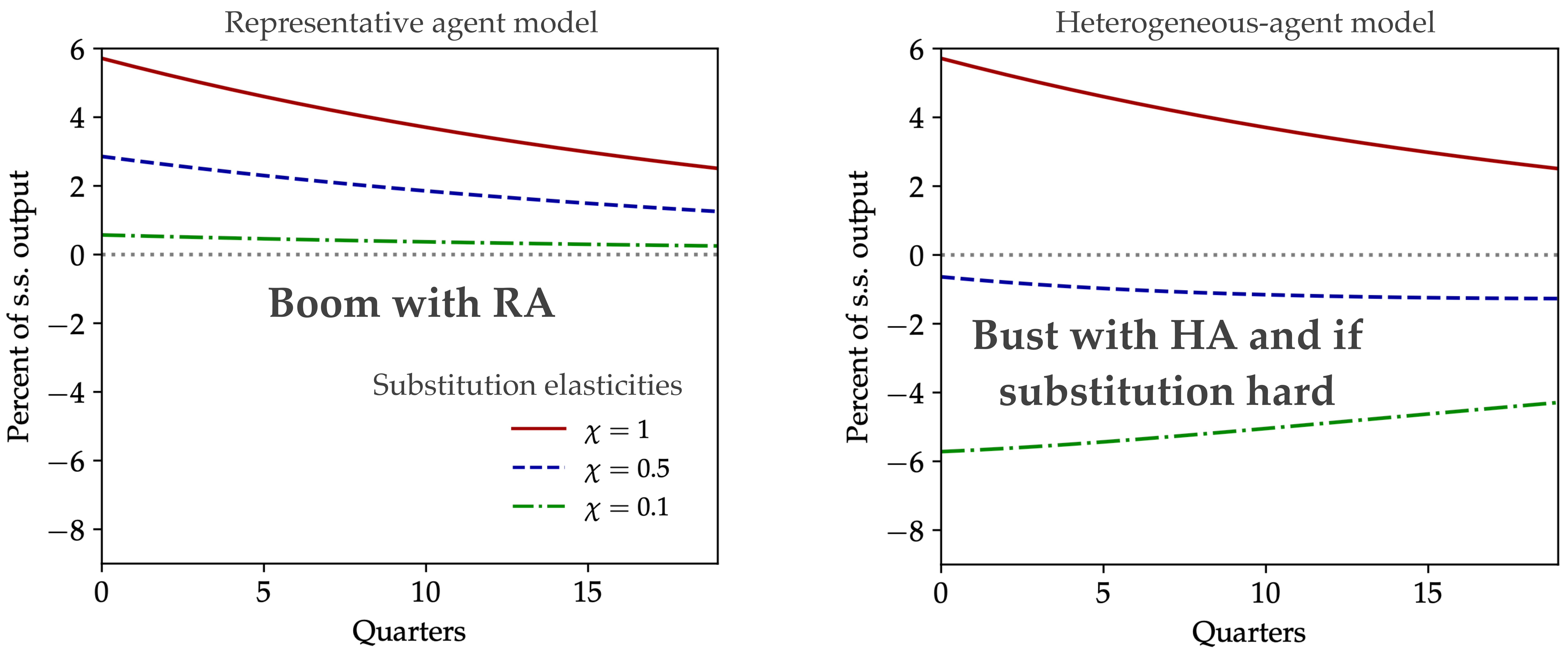
Energy shocks in HANK



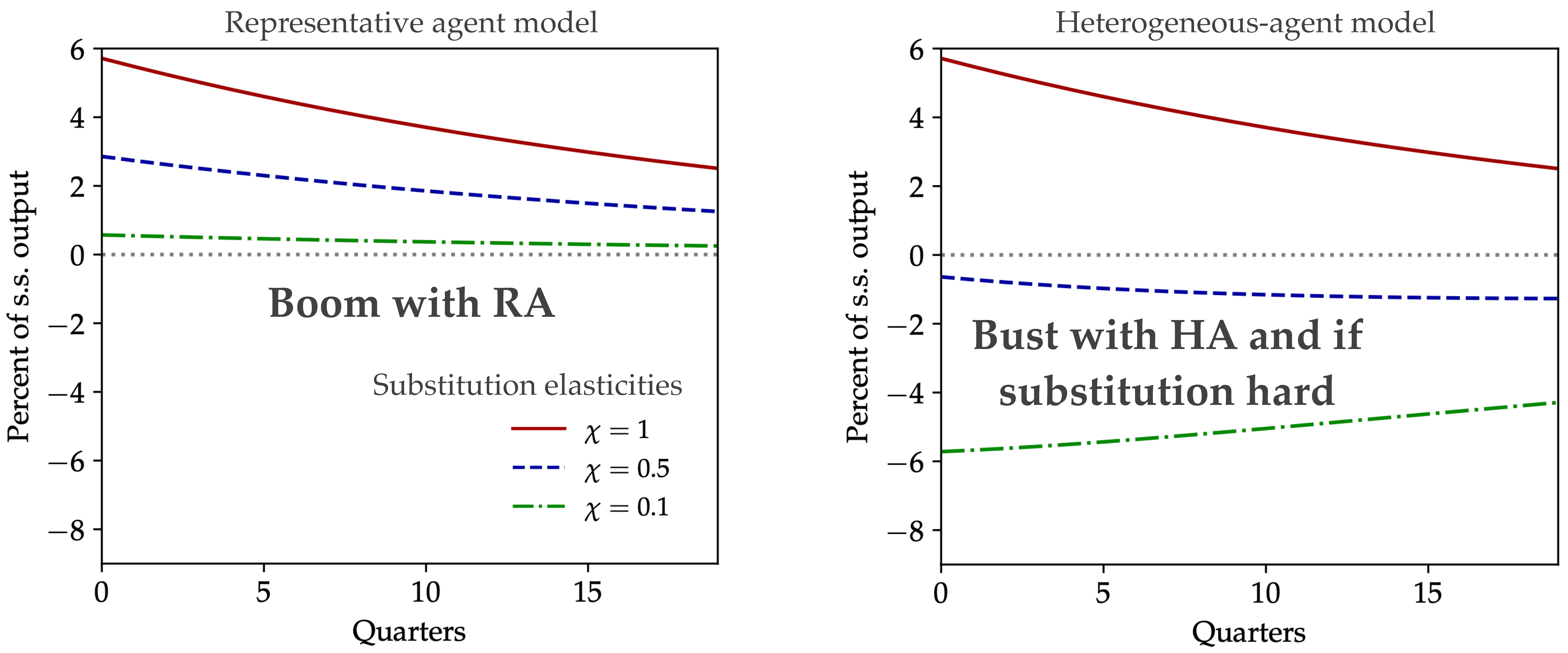
Energy shocks in HANK



Output responses to energy shock



Output responses to energy shock



This result holds whether energy is used in production or not !

Conclusion

Conclusion: Three takeaways

- **HANK** implies that consumption depends more on **income** than **interest rates**
- Natural to organize and analyze HANK models in the **sequence space**
- Three lessons:
  - deficit-financed fiscal stimulus is persistent
  - monetary policy only works if investment responds
  - Energy shocks are stag-flationary
- **Lots of work to do!**