Lecture 6: The open economy

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Fiscal and Monetary Policy with Heterogeneous Agents
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Open economy HANK

- So far, focus on *closed* economy models of fiscal & monetary policy
- **Next:** *Open* economy. What changes?
    - Exports & imports are new **source** and **destination** for demand
    - Extent to which is controlled by the **exchange rate**
- Material here based on Gali Monacelli (2005) and Auclert, Rognlie, Souchier, Straub (2024)

  Exciting other work in this area: de Ferra et al (2020), Cugat (2019), Giagheddu (2020), Zhou (2022), Kekre Lenel (2020), Guo Ottonello Perez (2021), Aggarwal et al (2022), Sundry (2024), Bellifemine Couturier Jamilov (2025, R&R REStud)

Proceed in three steps

1. Introduce model that nests RA & HA
   - RA model almost literally = Gali Monacelli (2005)
   - HA model: no bonds, but capitalized profits
   - Key parameter: **trade elasticity** χ
2. Effects of **exchange rate shocks** (e.g. due to capital flows or UIP shocks)
3. Paper: Effects of **monetary policy**

HANK meets Gali-Monacelli

Model overview

- Small open economy (SOE) model
- Two goods
  - "Home": H, produced at home, P_{Ht} at home, P_{Ht}^{*} abroad
  - "Foreign": F, produced abroad, P_{Ft} at home, $P_{Ft}^{*} \equiv 1$ abroad
  - Consumed in bundles. CPI P_t at home, P_t^{*} abroad
- Two kinds of agents:
  - Large mass of foreign households
  - mass 1 of **HA domestic households**

Households' consumption behavior

- Foreigners consume fixed real C^*. Home HA solve **intertemporal problem**:

$$\max_{c_{it}} \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_{it} \left(u(c_{it}) - v\left(N_t\right) \right) \qquad\qquad c_{it} + a_{it} \leq (1 + r_t^p) a_{it-1} + \underbrace{Z_t e_{it}}_{\text{real labor income}} \qquad a_{it} \geq 0$$

- Domestic & foreign consume CES bundle, solve **intratemporal problem:**

$$C_{Ht} = (1 - \alpha) \left(\frac{P_{Ht}}{P_t} \right)^{-\eta} C_t \qquad C_{Ht}^* = \alpha \left(\frac{P_{Ht}^*}{P^*} \right)^{-\gamma} C^*$$

- Domestic production and market clearing: $Y_t = N_t = C_{Ht} + C_{Ht}^*$

Prices and nominal rigidities

- Exchange rates: nominal $\mathcal{E}_t$, real $Q_t \equiv \mathcal{E}_t / P_t$, $\uparrow$ is depreciation
- Same wage rigidity as before

$$\pi_{wt} = \kappa_w \left(v'(N_t) - \frac{\epsilon - 1}{\epsilon} \frac{W_t}{P_t} u'(C_t) \right) + \beta \pi_{wt+1}$$

- Flexible prices everywhere else:

$$P_{Ft} = \mathcal{E}_t \qquad P_{Ht} = W_t \qquad P^*_{Ht} = \frac{P_{Ht}}{\mathcal{E}_t} \longleftarrow \text{"Producer currency pricing"}$$

Monetary policy and assets

Initial positions:

100% — Home equity

- Capitalize profits $(1-\mu^{-1})Y_t$ with realized return r_t^p

Arbitrage: pins down r_t^p

0% — Home bonds

- Nominal return i_t
- Set by monetary policy to ensure exogenous path of $r_t = i_t - \pi_{t+1}$

Arbitrage: UIP condition pins down exchange rate

$$1+r_t = \left(1+i_t^*\right)\frac{Q_{t+1}}{Q_t}$$

0% — ROW bonds

- Nominal (= real) return i_t^*
- Shocks = shocks to foreign discount factor
- Set by monetary policy

Baseline calibration

- Calibrate openness $\alpha = 0.40$ & balanced trade in steady state
- Same HA block as before
- Normalize all prices to 1 in steady state.
- *Note:* HA model already stationary, no need for debt-elastic interest rate

- Next: i_t^* shocks (assuming $r_t = r$), then (briefly) r_t shocks.

Capital flows and exchange rates

Shock

- Temporary shock $i_t^* \uparrow$
  - Real depreciation! Iterate UIP forward:

$$dQ_t = \frac{1}{1+r} \sum_{s \geq 0} di_{t+s}^*$$

  - $Q_t \uparrow \quad \frac{P_{Ht}}{P_t} \downarrow \quad \frac{P_{Ht}}{\mathscr{E}_t} \downarrow$
- Demand for home goods?
- First **RA**, then **HA**

What happens to aggregate demand?

RA: $C_t = C = const\,!$

$$Y_t = (1-\alpha)\boxed{\left(\frac{P_{Ht}}{P_t}\right)^{-\eta}} C_t + \alpha \boxed{\left(\frac{P_{Ht}}{\mathcal{E}_t}\right)^{-\gamma}} C^* \quad \Rightarrow \quad d\mathbf{Y} = \frac{\alpha}{1-\alpha}\chi d\mathbf{Q}$$

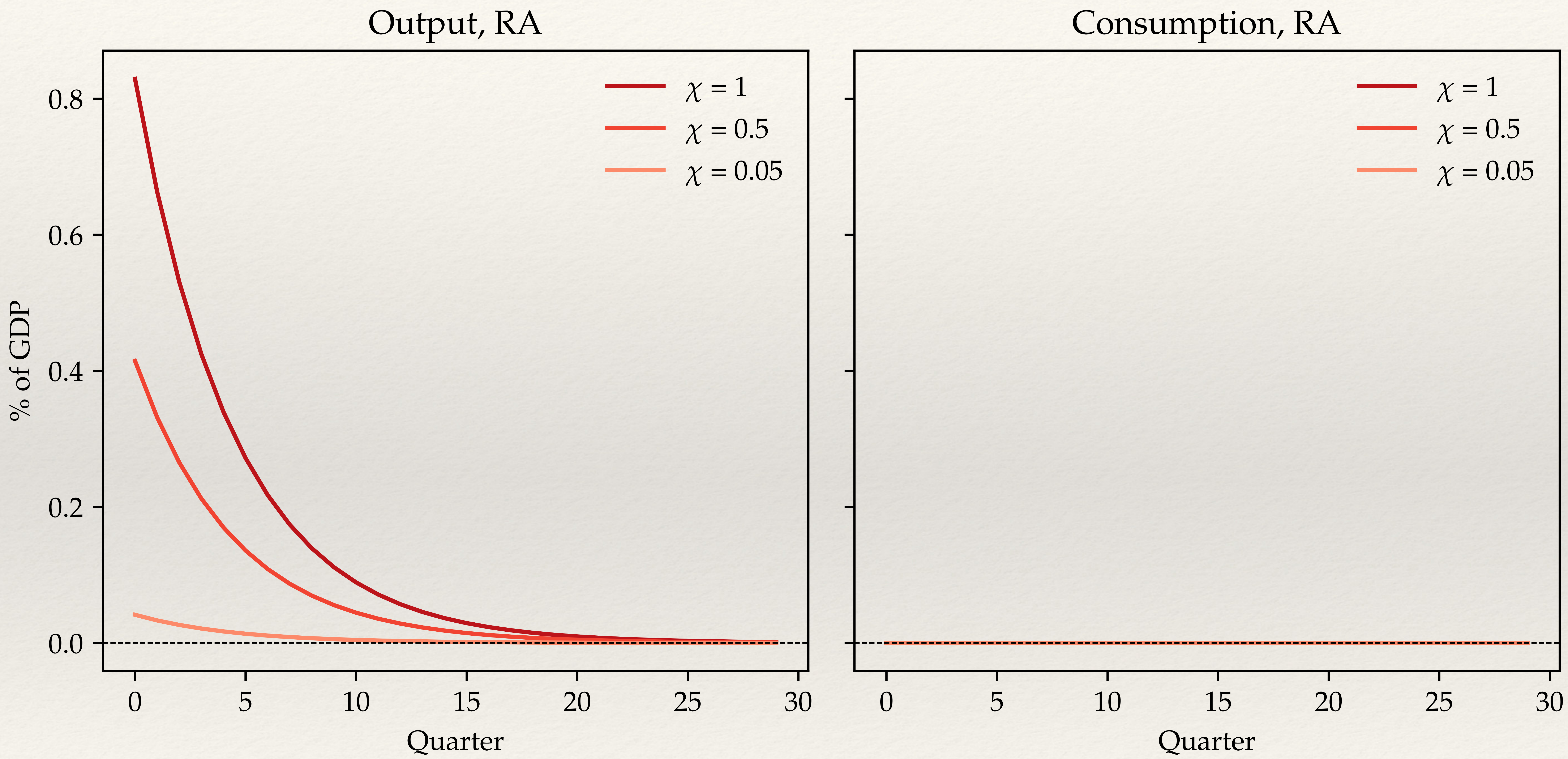
$\uparrow$ with elasticity $\eta\frac{\alpha}{1-\alpha}$

$\uparrow$ with elasticity $\gamma\frac{1}{1-\alpha}$

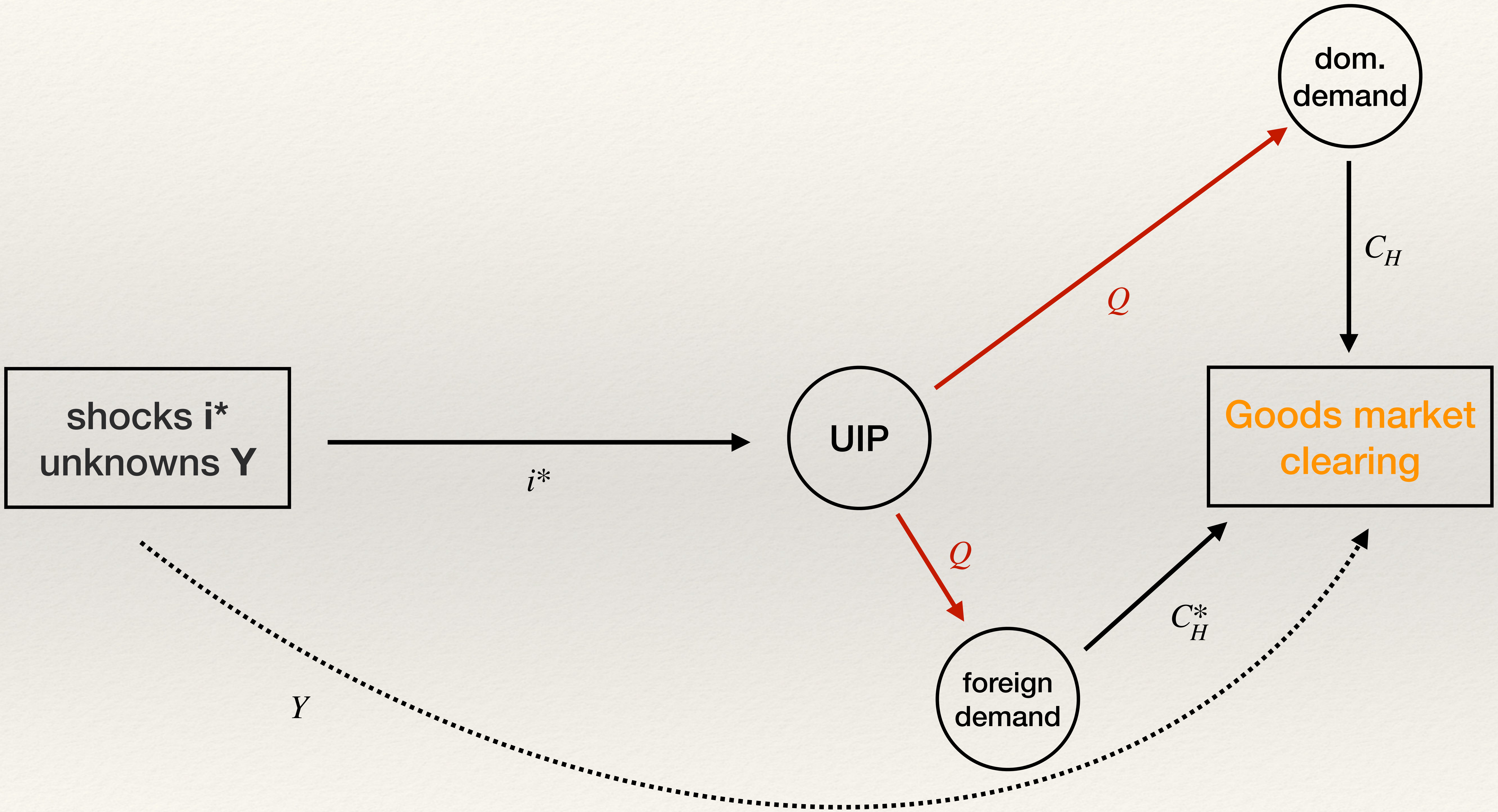
trade elasticity: $\chi \equiv \eta(1-\alpha) + \gamma$

"Expenditure switching"

Representative agent: Exchange rate shock



DAG

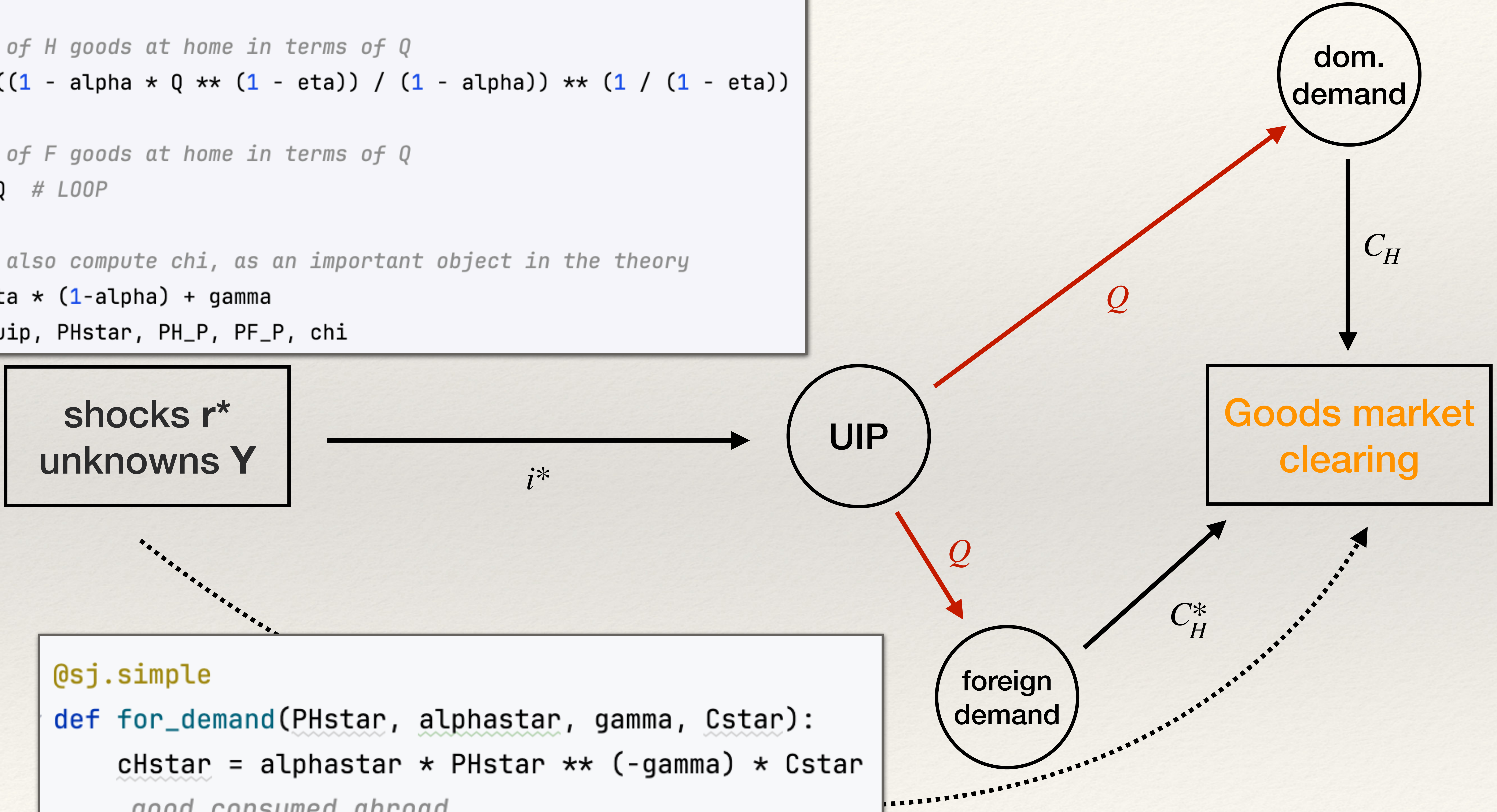


shocks i*
unknowns Y
i^*
UIP
Q
Q
dom. demand
C_H
foreign demand
C_H^*
Goods market clearing
Y

AG

```python
@sj.solved(unknowns={'Q': (0.01, 300.)}, targets=['uip'])
def UIP(Q, r, rstar, eta, alpha, gamma):
    # recursive equation for UIP to pin down RER Q
    uip = 1 + r - (1 + rstar) * Q(1) / Q

    # price of H goods abroad in terms of Q
    PHstar = ((Q ** (eta - 1) - alpha) / (1 - alpha)) ** (1 / (1 - eta))

    # price of H goods at home in terms of Q
    PH_P = ((1 - alpha * Q ** (1 - eta)) / (1 - alpha)) ** (1 / (1 - eta))

    # price of F goods at home in terms of Q
    PF_P = Q  # LOOP

    # let's also compute chi, as an important object in the theory
    chi = eta * (1-alpha) + gamma
    return uip, PHstar, PH_P, PF_P, chi
```

```python
@sj.simple
def dom_demand(C, PF_P, PH_P, eta, alpha):
    cH = (1 - alpha) * PH_P ** (-eta) * C
     domestically
    cF = alpha * PF_P ** (-eta) * C  # PF_
     domestically
    return cH, cF
```




```python
@sj.simple
def for_demand(PHstar, alphastar, gamma, Cstar):
    cHstar = alphastar * PHstar ** (-gamma) * Cstar
     good consumed abroad
    return cHstar
```

What changes with heterogeneous agents?

HA: $C_t = \mathscr{C}_t\left(r_0^p, \{Z_s\}\right)$! $\quad\Rightarrow\quad$ $d\mathbf{C} = \mathbf{M}/\mu d\left(\frac{P_{Ht}}{P_t}Y_t\right) + \mathbf{m}A_{ss}dr_0^p = \overline{\mathbf{M}}d\left(\frac{P_{Ht}}{P_t}Y_t\right) = -\frac{\alpha}{1-\alpha}\overline{\mathbf{M}}d\mathbf{Q} + \overline{\mathbf{M}}d\mathbf{Y}$

$$\overline{\mathbf{M}} \equiv \frac{1}{\mu}\mathbf{M} + \left(1 - \frac{1}{\mu}\right)\mathbf{m}\mathbf{q}'$$

Intertemporal MPCs out of total income

$$Y_t = (1-\alpha)\boxed{\left(\frac{P_{Ht}}{P_t}\right)^{-\eta}} C_t + \alpha \boxed{\left(\frac{P_{Ht}}{\mathscr{E}_t}\right)^{-\gamma}} C^*$$

↑ with elasticity $\eta(1-\alpha)$

↑ with elasticity γ

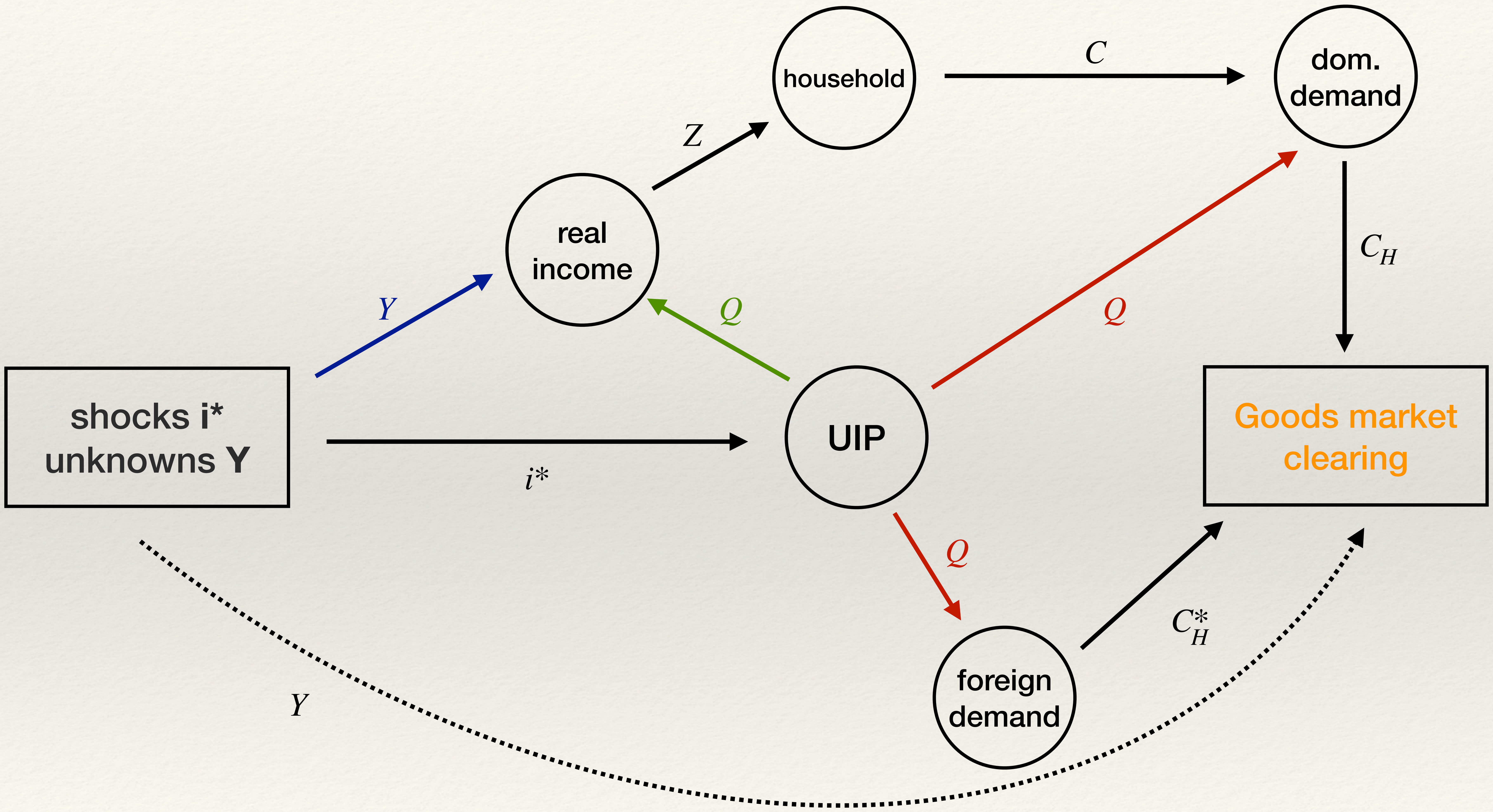
Real income channel

Multiplier

$$d\mathbf{Y} = \frac{\alpha}{1-\alpha}\chi d\mathbf{Q} - \alpha\overline{\mathbf{M}}d\mathbf{Q} + (1-\alpha)\overline{\mathbf{M}}d\mathbf{Y}$$

Expenditure switching

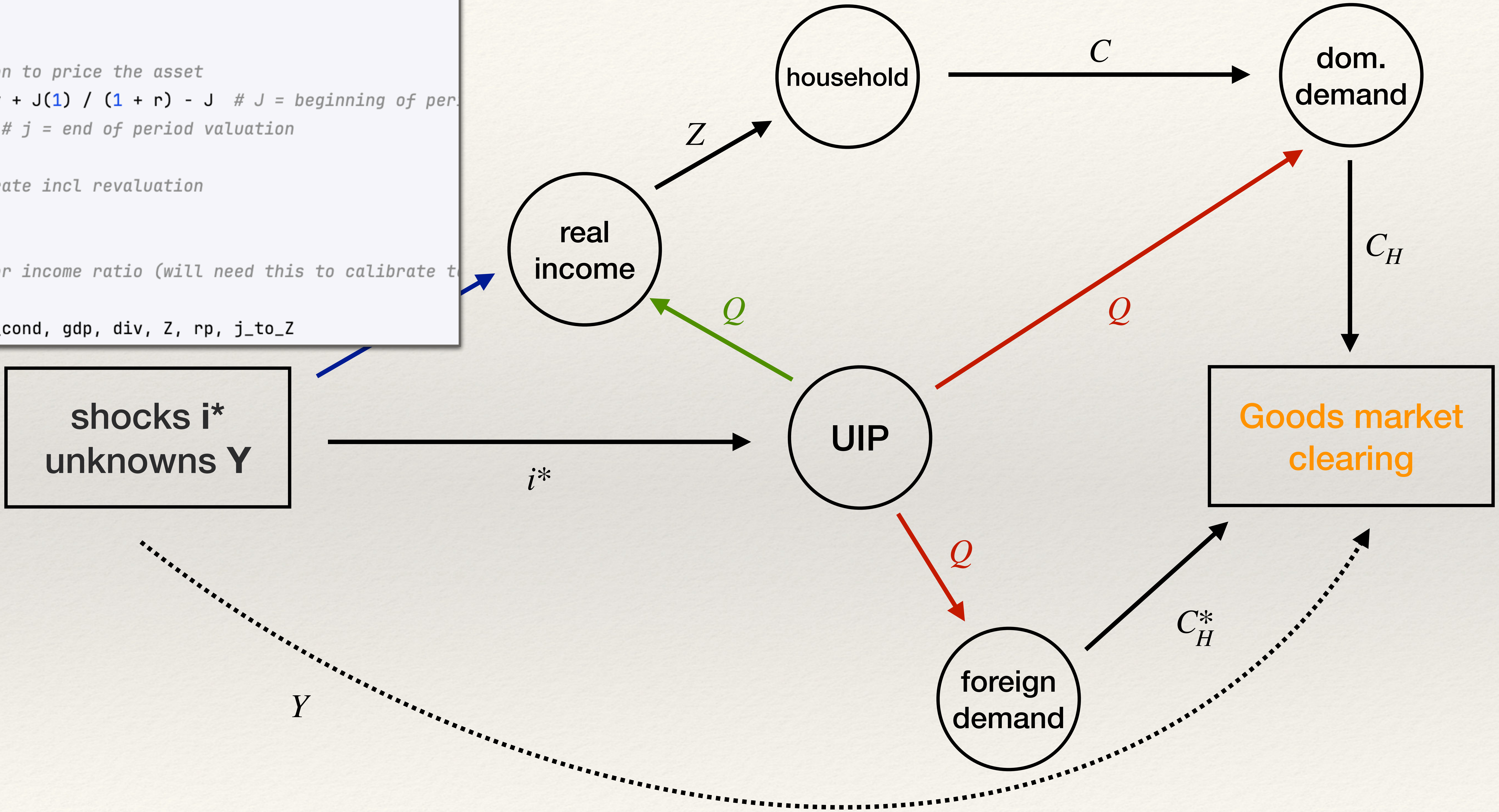
DAG



shocks i*
unknowns Y
real income
household
dom. demand
UIP
foreign demand
Goods market clearing
Y
Z
C
Q
C_H
i^*
Q
Q
C_H^*
Y

DAG

```python
@sj.solved(unknowns={'J': (0.001, 100.)}, targets=['valuation_cond'])
def income(Y, PH_P, J, r, markup_ss):
    # real labor income
    Z = 1 / markup_ss * PH_P * Y

    # real dividend
    div = (1 - 1 / markup_ss) * PH_P * Y

    # nominal PPP adjusted GDP
    gdp = PH_P * Y

    # valuation condition to price the asset
    valuation_cond = div + J(1) / (1 + r) - J  # J = beginning of per
    j = J(1) / (1 + r)  # j = end of period valuation

    # ex post interest rate incl revaluation
    rp = J / j(-1) - 1

    # get assets to labor income ratio (will need this to calibrate t
    j_to_Z = j / Z
    return j, valuation_cond, gdp, div, Z, rp, j_to_Z
```



How do RA and HA compare?

- Assume $\chi = 1$. Then: $d\mathbf{Y}^{HA} = d\mathbf{Y}^{RA} = \frac{\alpha}{1-\alpha} d\mathbf{Q}$

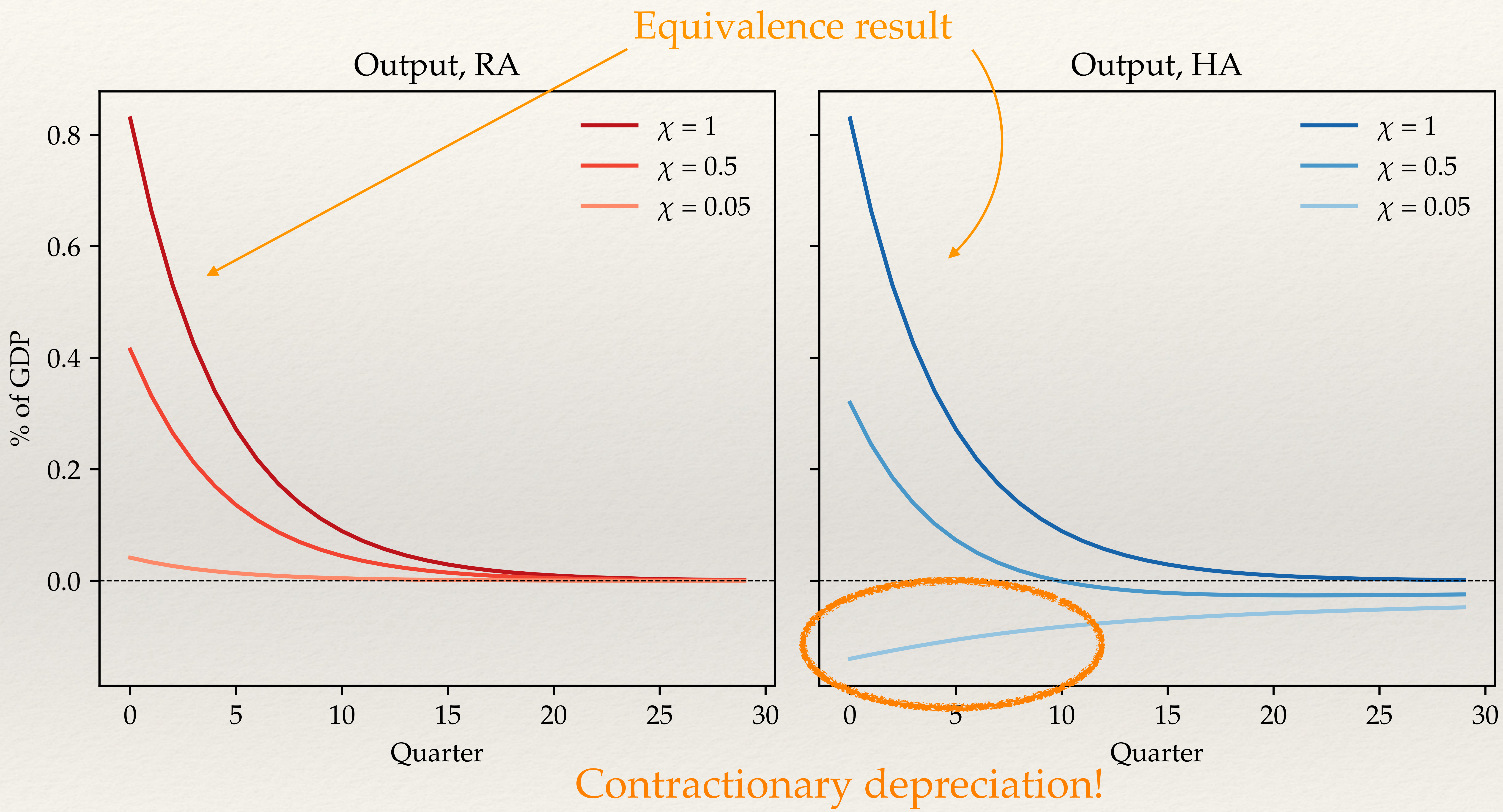
- HA and RA are identical in this case! What about the two new terms? **Cancel!**

$$\alpha \overline{\mathbf{M}} d\mathbf{Q} = (1-\alpha)\overline{\mathbf{M}} d\mathbf{Y}$$

- **Intuition:** Depreciation causes just enough of a boom that the loss in real income due to depreciation is offset. [geeky comment: this is a little like the balanced budget multiplier]

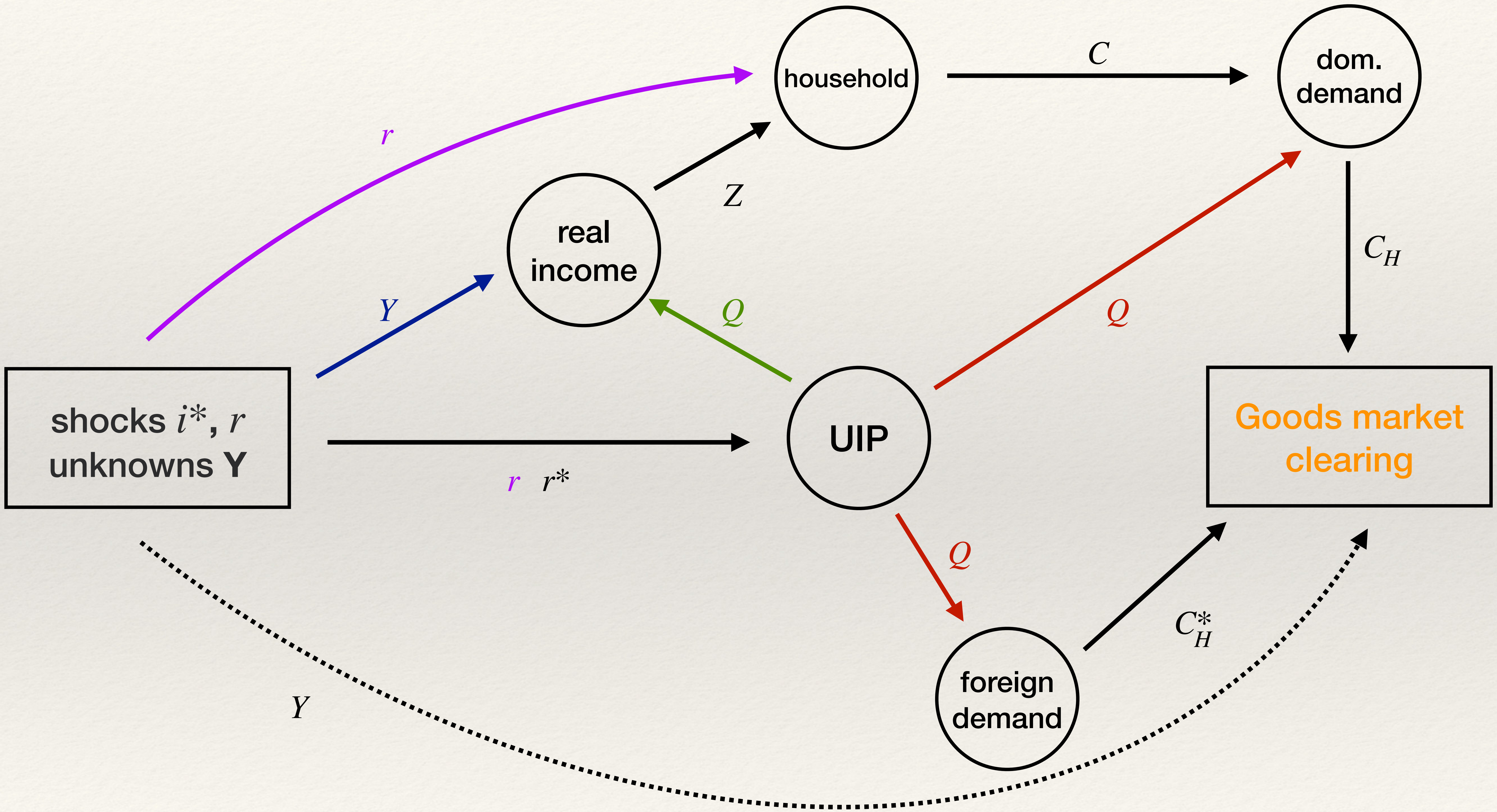
- What if $\chi \neq 1$?

Contractionary depreciations for low χ



- This is more likely when substitution away from imports is hard (e.g. energy, food)

What about monetary policy?



Summary

- Merged HANK with Gali-Monacelli.
  - Maybe the most natural way to apply HANK to open economies?
- Learned:
  - New channels: Real income, Keynesian Multiplier
  - Can generate contractionary depreciations for low trade elasticities
- Lots more in paper: Taylor rules, non-trivial gross positions, slow trade adjustments (J curve), non-homothetic demand, DCP, slow pass-through, …