Open economy HANK

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Monetary policy in 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)

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**:

$$\max_{c_{it}} \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_{it} \left(u(c_{it}) - v\left(N_t\right) \right) \qquad c_{it} + a_{it} \le (1 + r_t^p) a_{it-1} + Z_t e_{it} \qquad a_{it} \ge 0$$

real labor income

- 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 $\mathscr{E}_t$, real $Q_t \equiv \mathscr{E}_t / P_t$, $\uparrow$ is depreciation
- Same wage rigidity as before

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

- Flexible prices everywhere else:

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

Monetary policy and assets

Initial positions:

100% | **0%** | **0%**

Home equity

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

Arbitrage

pins down r_t^p

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

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

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

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

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

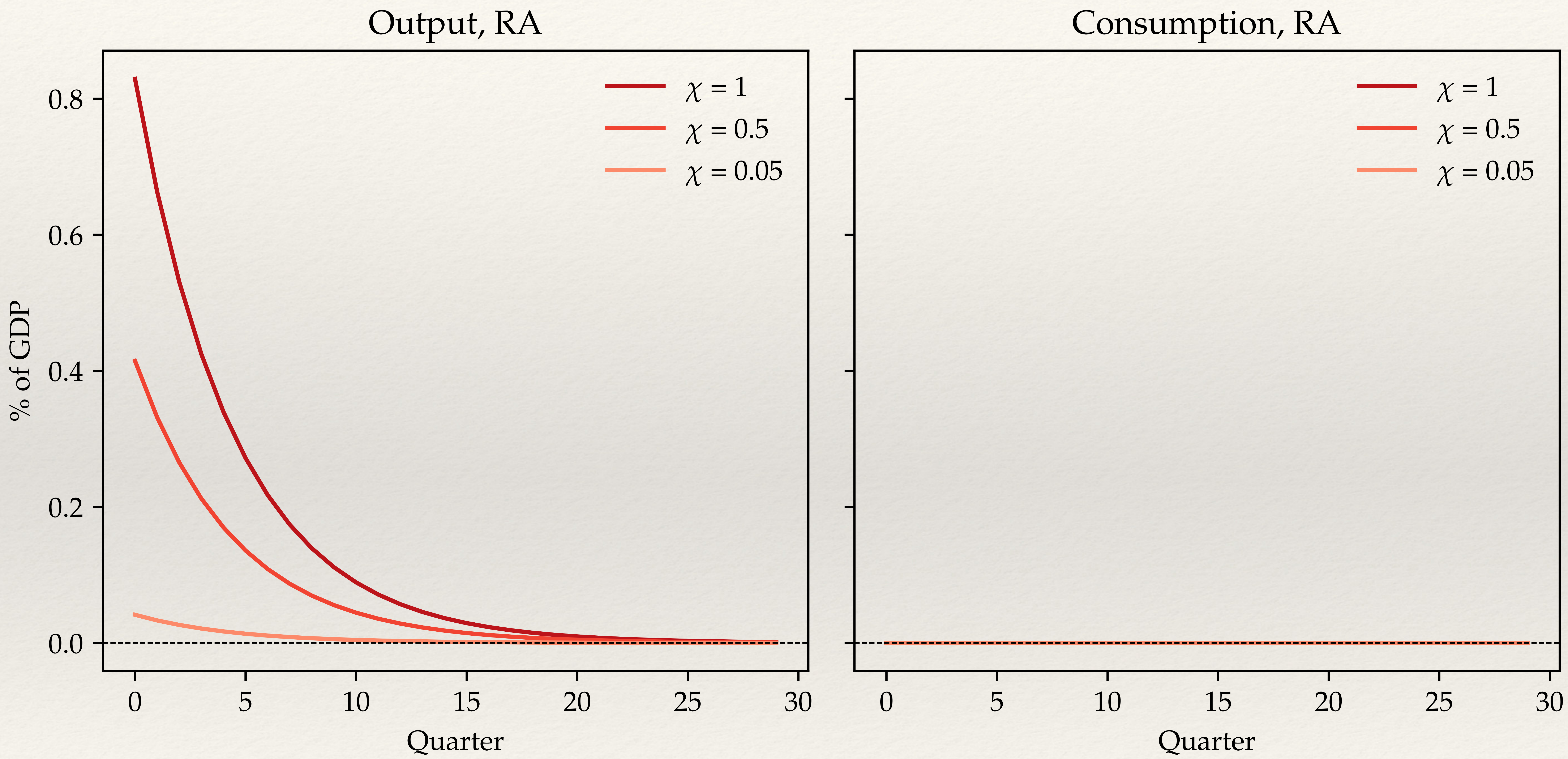
↑ with elasticity $\gamma \frac{1}{1-\alpha}$

"Expenditure switching"

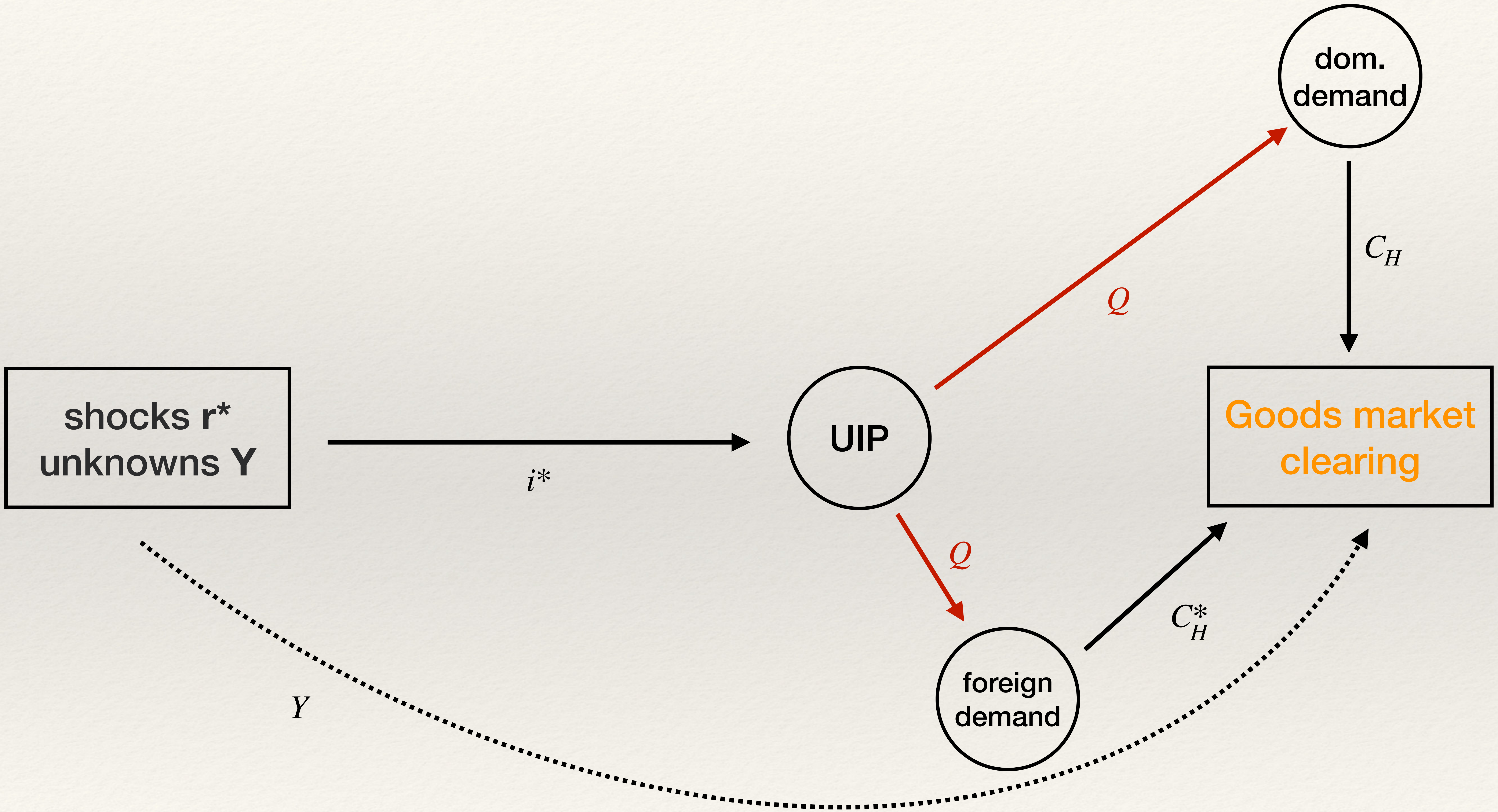
$$d\mathbf{Y} = \frac{\alpha}{1-\alpha}\chi d\mathbf{Q}$$

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

Representative agent: Exchange rate shock



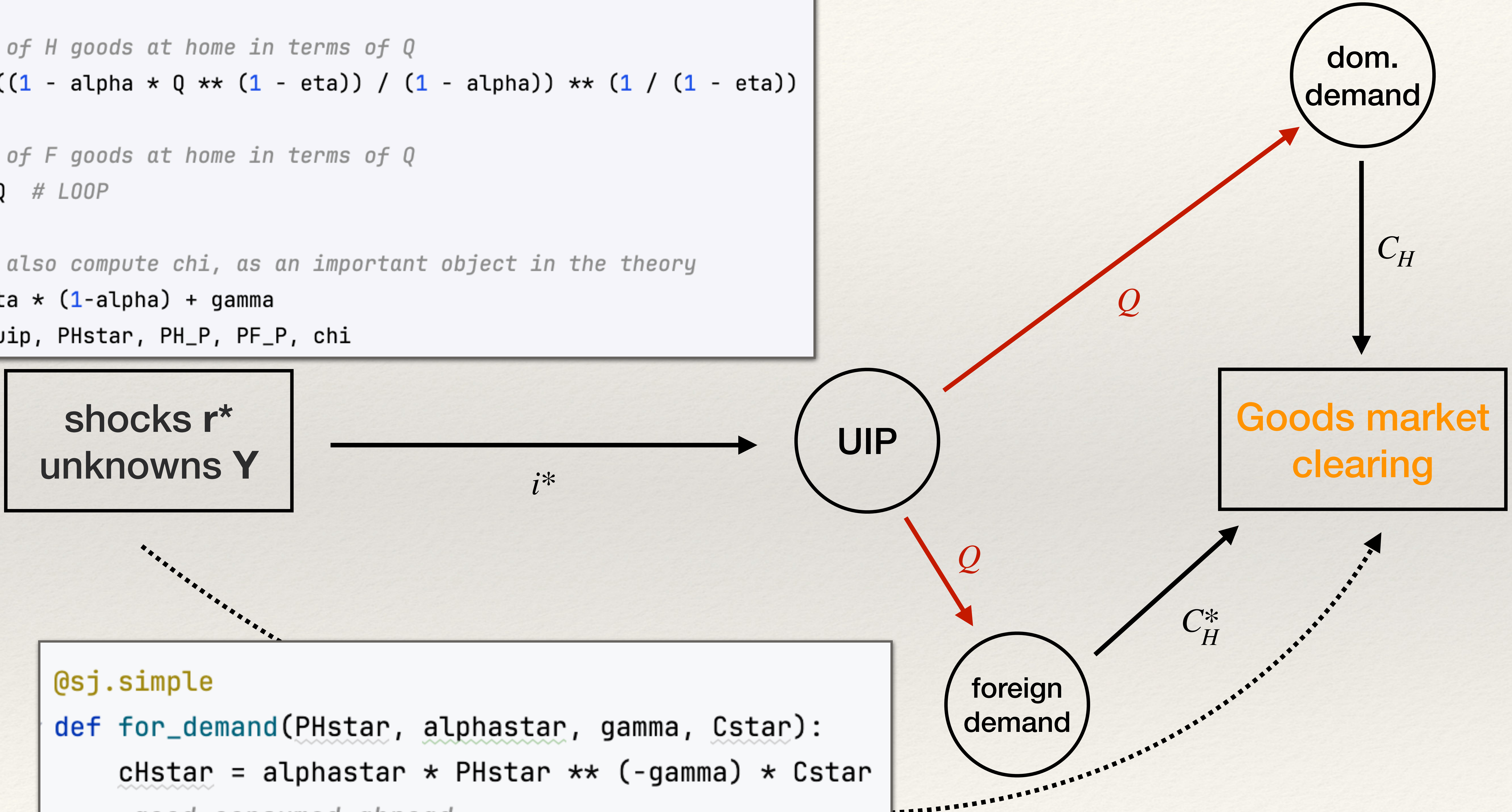
DAG



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

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

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

↑ 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

What changes with heterogeneous agents?

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

$Y_t = (1 -$

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Larry Summers Thinks Trump's Tariffs Are a Disaster

These policies are a major penalty to U.S. consumers that reduce the real income of middle-class families. They are a pro-inflation impulse and, ironically, they help exporters to the United States at the expense of

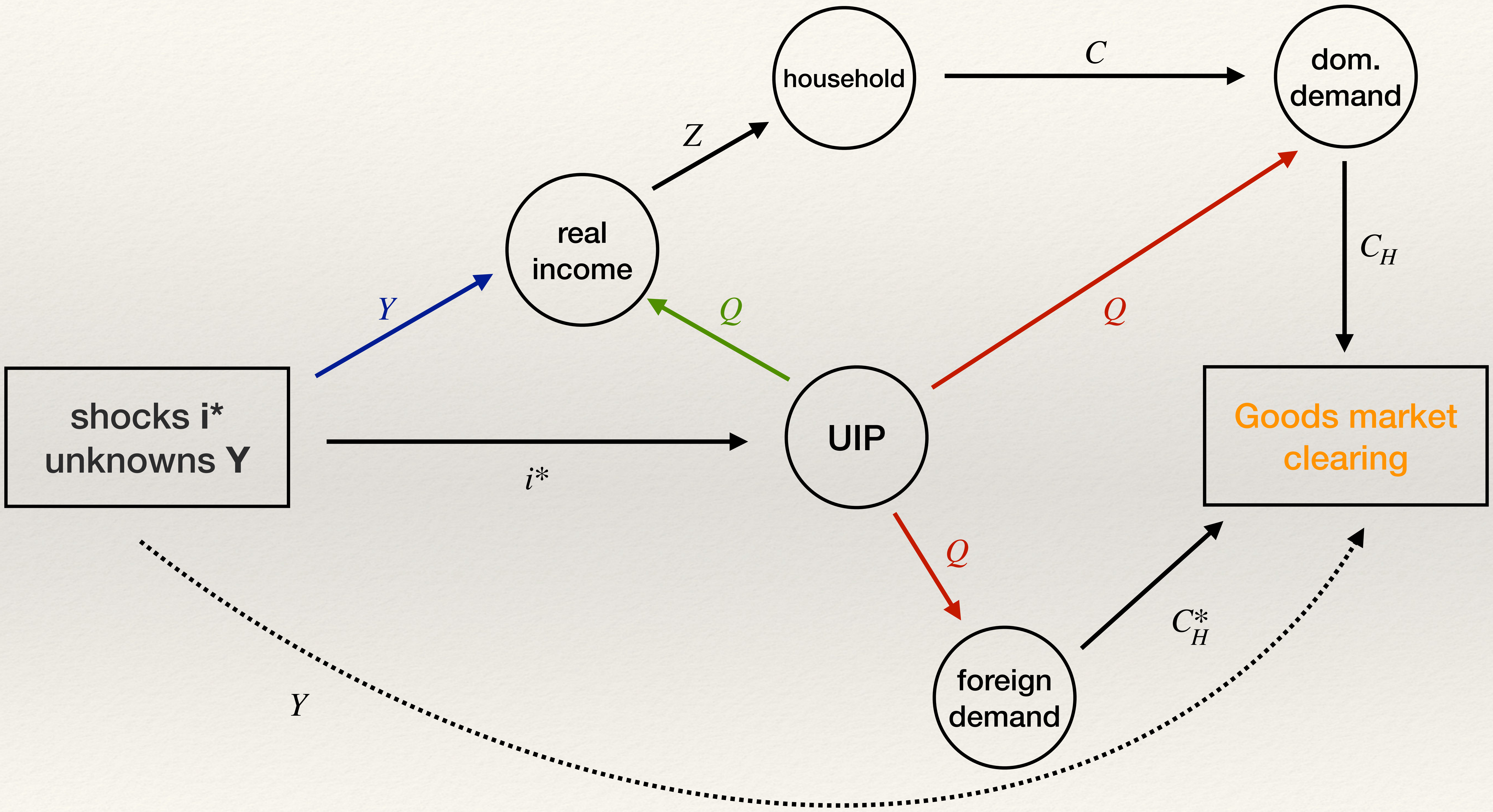
Real income channel

Multiplier

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

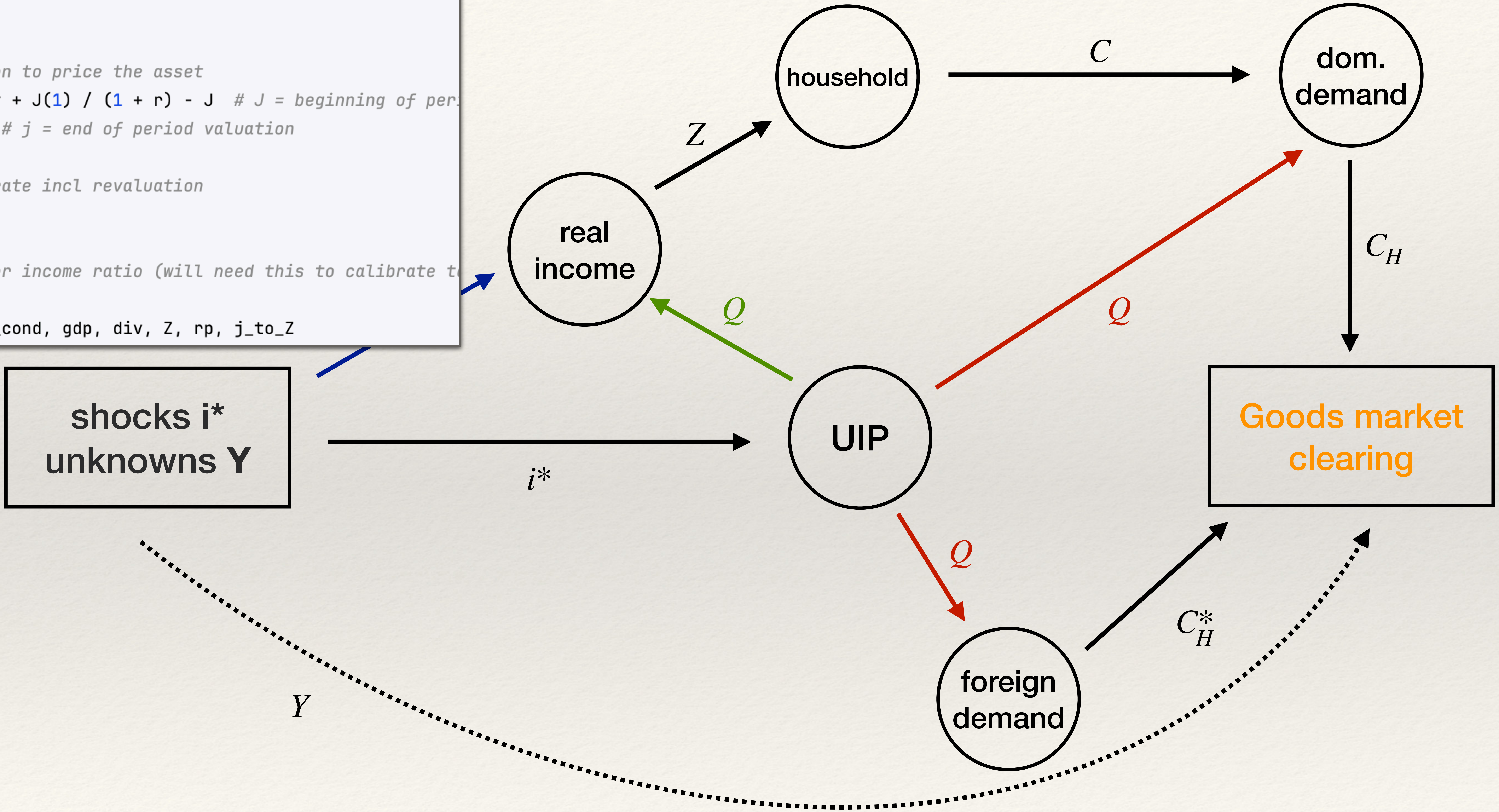
Expenditure switching

DAG


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



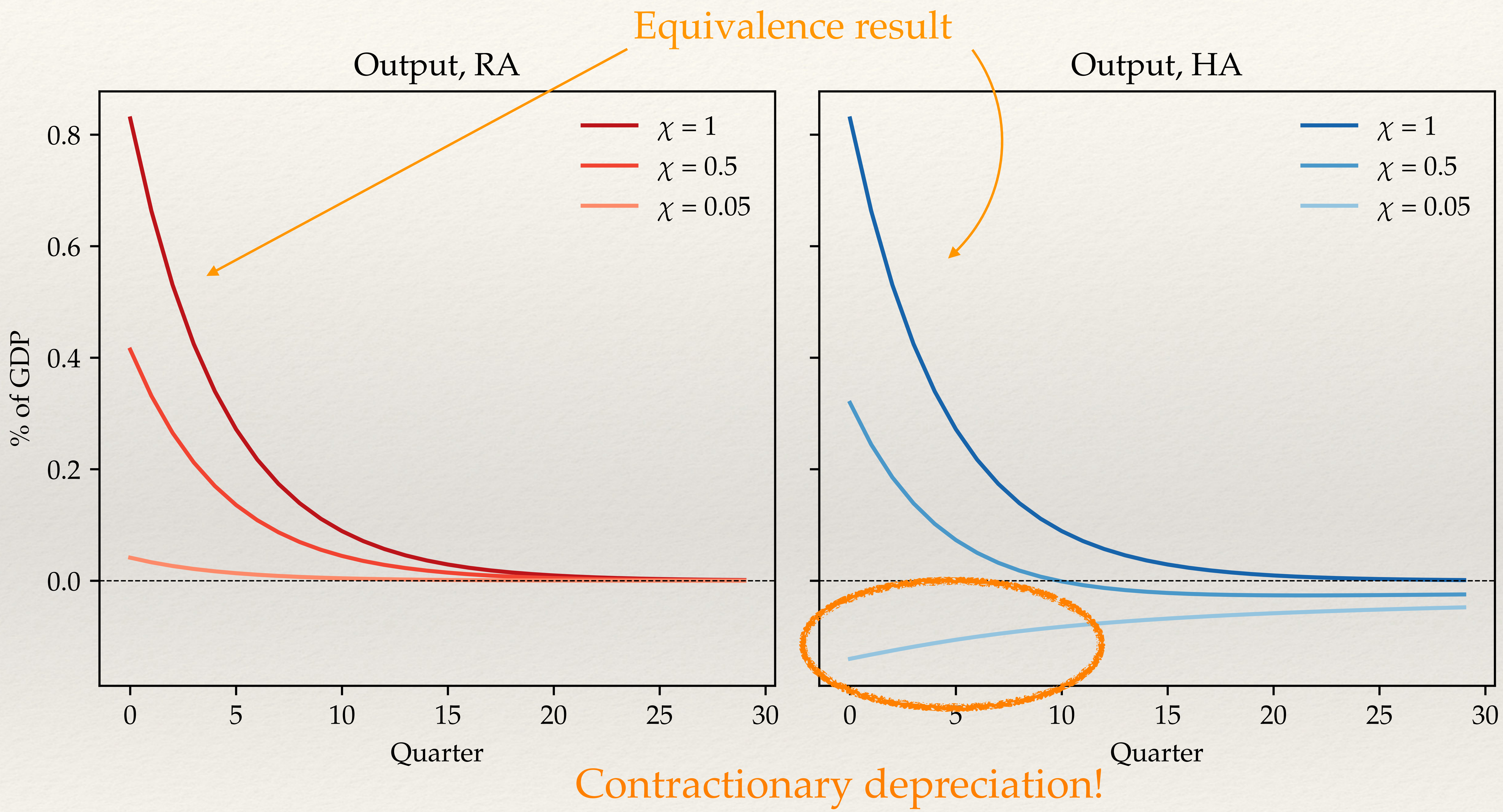
How do RA and HA compare?

- 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!**

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

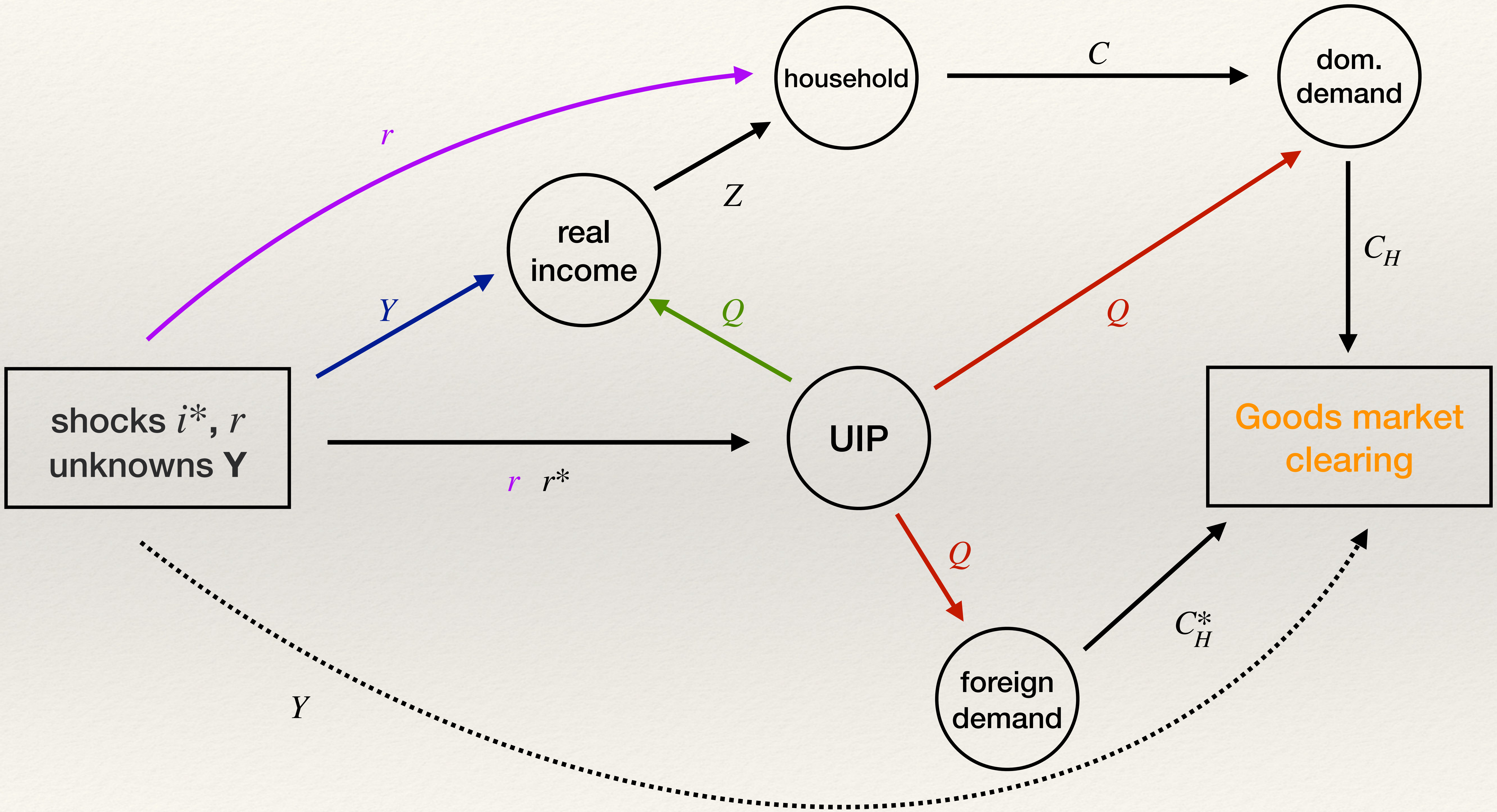
- **Intuition:** Depreciation causes just enough of a boom that the loss in real income due to depreciation is offset. [geeky comment: this is a little like the balanced budget multiplier]
- What if $\chi \neq 1$?

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, …