

Managing an Energy Shock: Fiscal and Monetary Policy

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Q How are **rising energy prices** affecting the economies of energy importers?

- Negative shock to aggregate supply: “productivity ↓” → Baqaee et al 2022, ...
- Negative shock to **aggregate demand**: real incomes ↓ → **this paper**
- When is this true? What is the role for **monetary and fiscal policy** here?
- Existing models to study these Q are **representative Agent (RA) NK-SOE**:
[Blanchard-Gali 2007, Blanchard-Riggs 2009, Bodenstein et al 2011 ...]
 - shock leads to **expenditure switching, raising domestic demand**
 - magnitude governed by a certain elasticity of substitution χ
 - **real income decline not affecting demand** much if at all
 - little trade-off for monetary policy: raise rates to limit boom & inflation

Heterogeneous agents provide a new perspective

Today: Revisit by embedding **Heterogeneous Agents (HA)** in NK-SOE model

[Part of fast growing literature: De Ferra-Mitman-Romei, Zhou, Guo-Ottonello-Perez, Oskolkov, Auclert-Rognlie-Souchier-Straub, Pironi ...]

- high MPCs: **real income decline affects demand a lot more**
- when χ is low: this effect dominates, consumption + demand fall!
 - can get “stagflationary shock”: recession, imported inflation, wage-price spiral
- **monetary policy**: hard to influence energy prices when used in isolation!
 - but **positive externalities**: more effective if all countries raise rates
- **fiscal policy**: powerful in isolation ...
 - but may have huge **negative externalities!**

- 1 Model
- 2 The energy shock: RA vs HA
- 3 Implications for inflation
- 4 Managing the energy shock: Monetary policy
- 5 Managing the energy shock: Fiscal policy

Model

Start with Gali-Monacelli model of a small open economy (SOE). Three changes:

1: Introduce one extra good: **energy E** (in addition to Foreign and Home)

- Large ROW is endowed with E , SOE is part of a continuum of E importers
- SOE households consume E , elasticity of sub. χ . E not used in production
- Energy trades at world price P_{Et}^* — this is what we shock

2: Households face **borrowing constraint + idiosyncratic income risk**

- Generates high (intertemporal) **marginal propensities to consume** (MPCs)

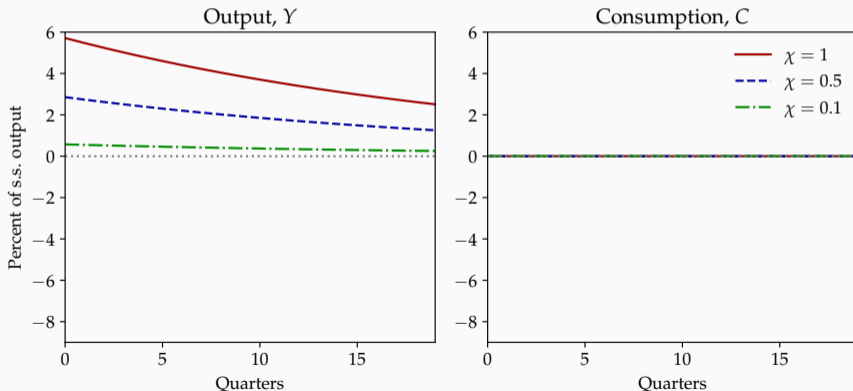
3: Standard **nominal wage rigidity**, various scenarios for mon policy

- Later, allow for real-wage stabilization motive (\sim Blanchard-Gali)

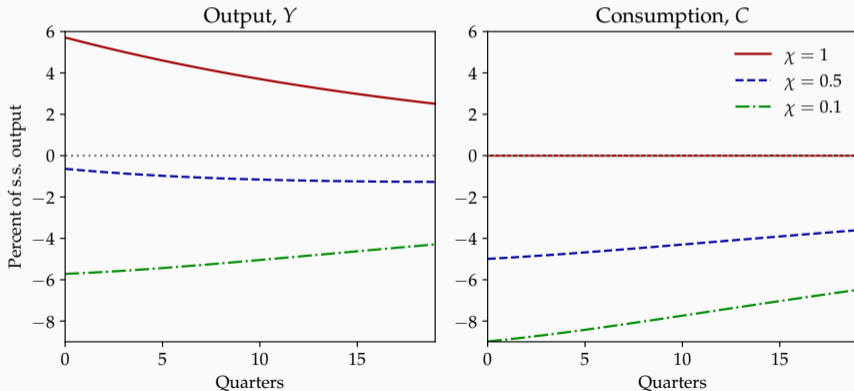
The energy shock: RA vs HA

- Tentative calibration to a European country
- AR(1) shock to P_{Et}^* , impact 100%, persistence 0.95 quarterly
- Consider:
 - **Representative agent (RA)**
 - **Heterogeneous agents (HA)**
- Monetary policy: raises nominal rate to stabilize real rate (for now)

- **RA: boom** due to expenditure switching! Scales in χ .
- With energy in production: same GDP + C (gross output different).



- **HA:** Higher MPCs \Rightarrow negative income effect; any movement in Y is amplified.
- $\chi = 1$: these forces offset each other, **HA = RA** ! [Cole-Obstfeld] Lower $\chi \Rightarrow$ bust.



Implications for inflation

Slower passthrough for quantification

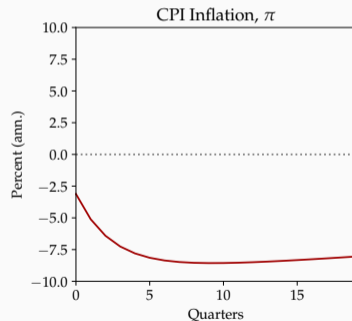
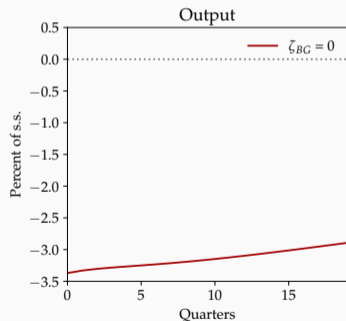
- For quantification, allow for price and *real* wage stickiness
1. Slow passthrough of exchange rate into energy and foreign goods
 - “pricing to market” nominal rigidities → standard Phillips curves
 2. Wage Phillips curve with real rigidity a la Blanchard-Gali

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

- $\zeta = 0$: only nominal wage rigidity
- $\zeta > 0$: both nominal and real wage rigidity

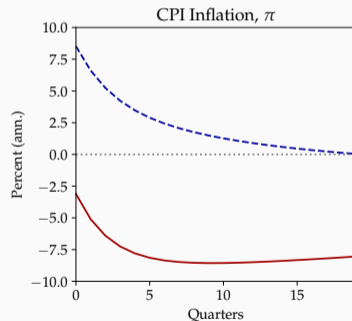
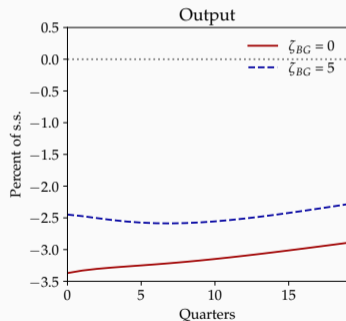
Effect of energy shock: output and inflation

- With $\zeta = 0$: energy price shock is negative domestic demand shock
- Why? $W/P \downarrow$, but $N, C \downarrow\downarrow$. Nominal wages fall (deflation)



Effect of Blanchard-Gali real wage rigidity

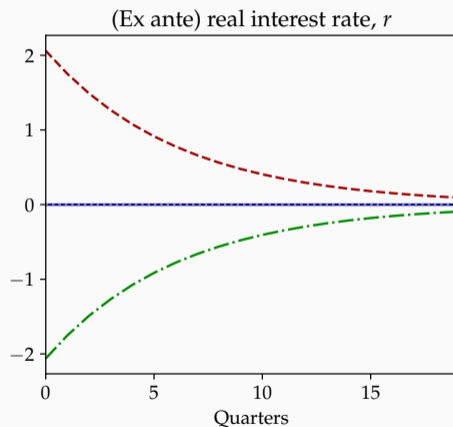
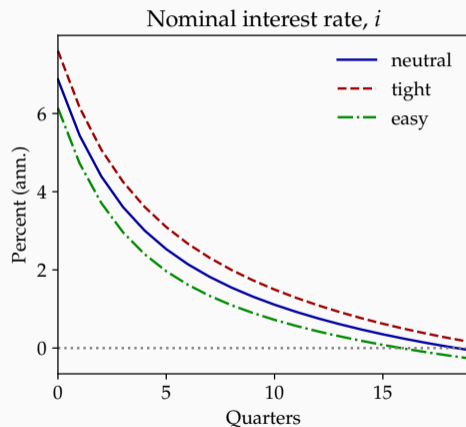
- With $\zeta > 0$: energy price shock is a stagflationary shock
- Wage setters averse to $W/P \downarrow$. Get **wage-price spiral** ! Important today?



Managing the energy shock: Monetary policy

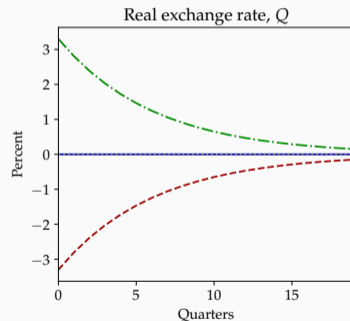
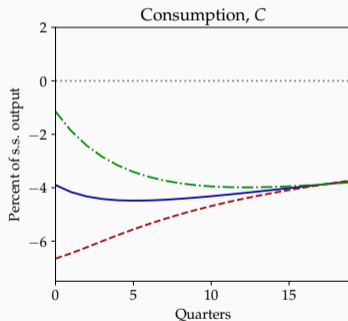
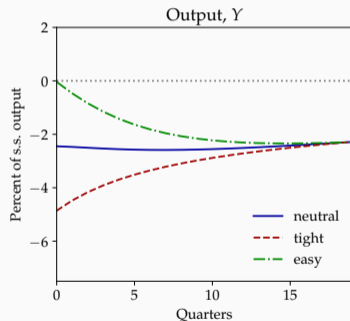
Monetary policy: three scenarios

- Three scenarios for monetary policy



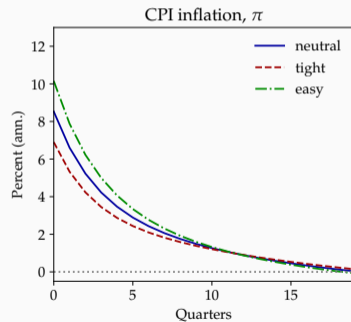
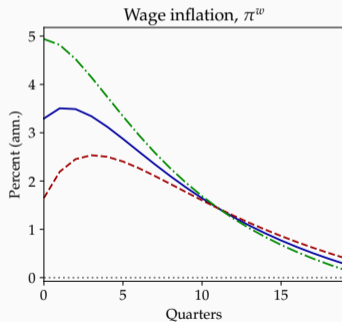
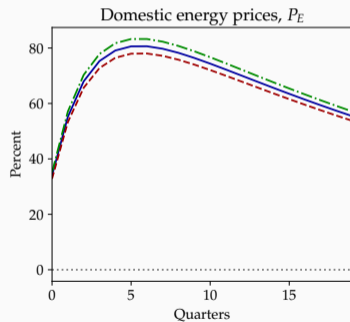
Monetary policy: Output and consumption

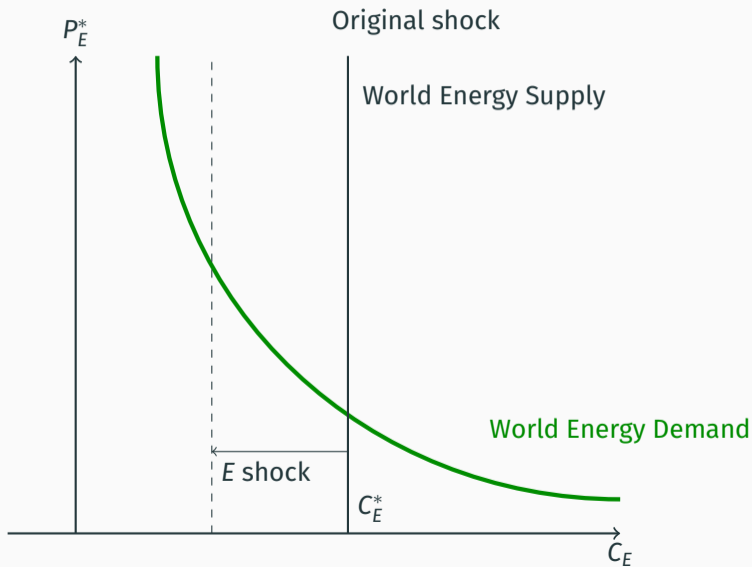
- Tight monetary policy causes deeper recession (as expected)

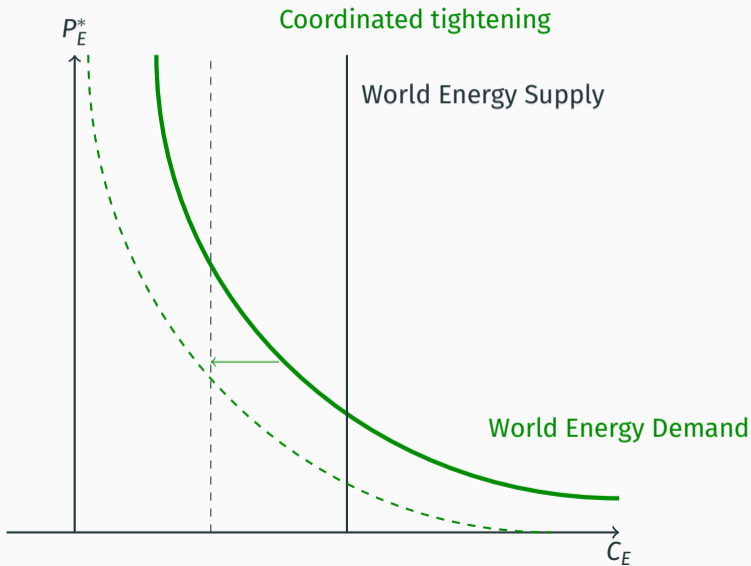


Monetary policy: Inflation

- Tight monetary policy not that effective against imported inflation
 - Can only appreciate the exchange rate so much without collapse in output

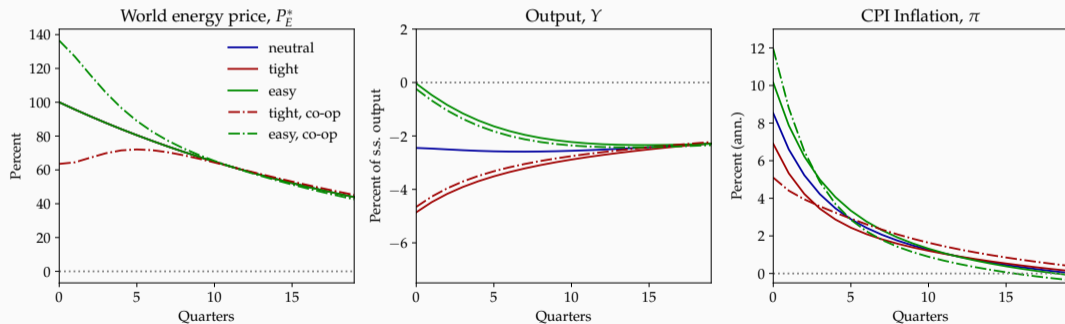






Monetary policy: Coordination

- **Positive spillover** from domestic $i \uparrow$: brings down P_E^* for everyone else.
- Coordination problem. If continuum of SOE's consume E and all hike:

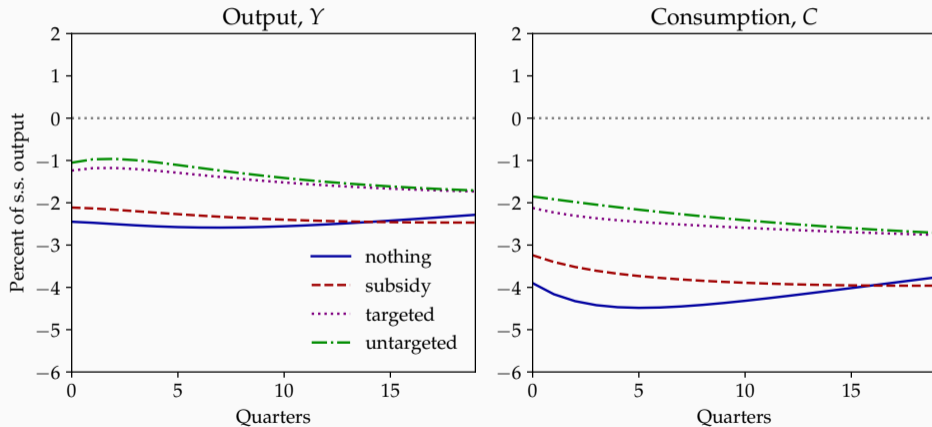


Managing the energy shock: Fiscal policy

- Next: **fiscal policy**
- Compare:
 - price subsidy
 - targeted transfers (based on usual level of E consumption)
 - untargeted transfers
- All initially deficit financed

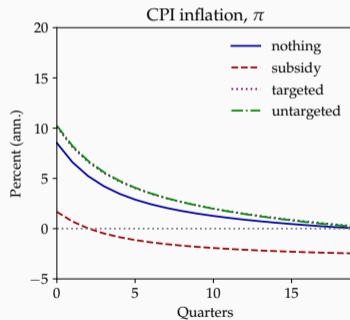
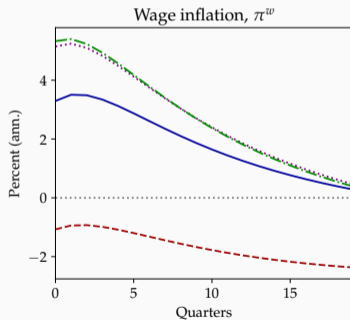
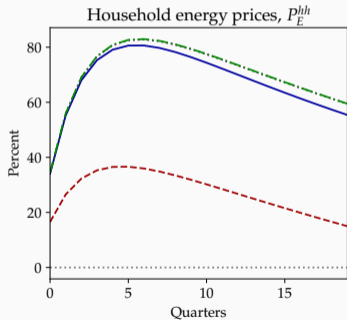
Fiscal policy (uncoordinated): output and consumption

- All three policies effectively mitigate consumption decline...



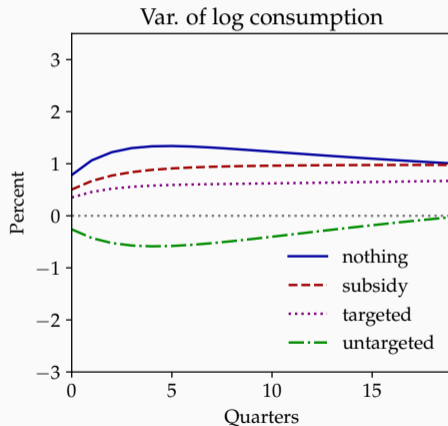
Fiscal policy (uncoordinated): inflation

- Transfer programs are inflationary...
- ... but subsidy seems like a silver bullet?



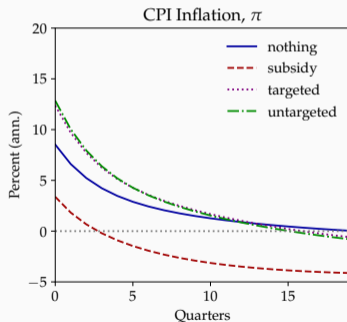
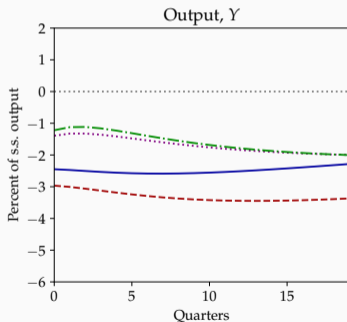
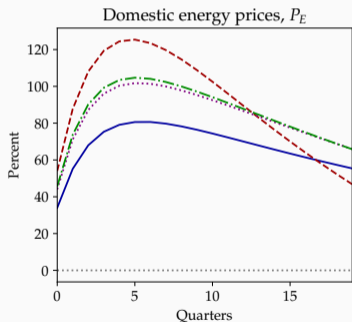
Fiscal policy (uncoordinated): inequality

- All programs seem to reduce inequality (var of log consumption)

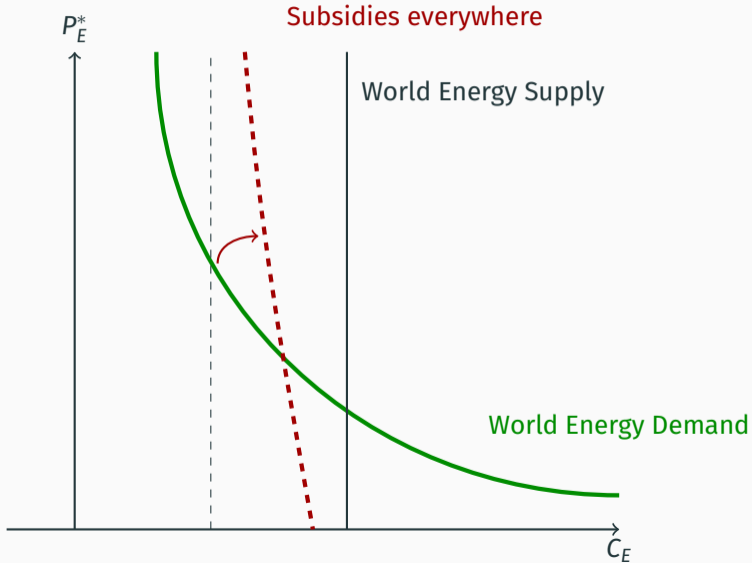


Fiscal policy (coordinated): inflation

- Subsidy is a disaster if everyone uses it. No one adjusts E consumption!
- Huge **negative externalities** on everyone else.

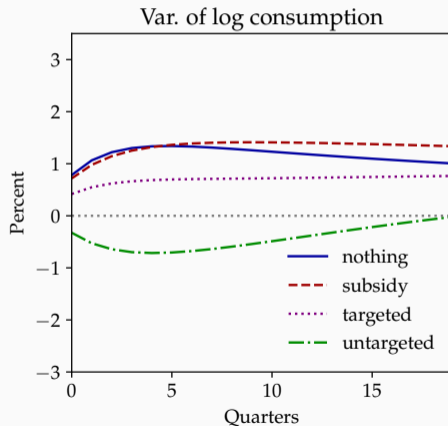


World economy equilibrium with subsidies



Fiscal policy (coordinated): inequality

- Even the inequality benefits are gone if everyone subsidizes energy.



Conclusion

- Use **open economy HA model** to speak to current energy price shock
- **Negative demand shock** given low short-run elasticity of substitution
 - Adding real wage concerns, shock is even **stagflationary**
- **Monetary tightening** alone does little, but has **positive externalities**
 - Want major countries to hike together
- **Fiscal support** alone is very powerful, but hugely **negative externalities**
 - Developing countries with less fiscal space may bear the cost. Do less?

Appendix

Consumer demand and price-setting

- Each household has 2-tier CES demand, so consumption of E , F and H is

$$c_{iEt} = \alpha_E \left(\frac{P_{Et}}{P_t} \right)^{-\eta_E} c_{it}$$

$$c_{iFt} = \alpha_F \left(\frac{P_{Ft}}{P_{HFt}} \right)^{-\eta} \left(\frac{P_{HFt}}{P_t} \right)^{-\eta_E} c_{it}$$

$$c_{iHt} = (1 - \alpha_E - \alpha_F) \left(\frac{P_{Ht}}{P_{HFt}} \right)^{-\eta} \left(\frac{P_{HFt}}{P_t} \right)^{-\eta_E} c_{it}$$

- η_E is elasticity of substitution between E and non- E (low!)
- η is elasticity of substitution between H and F in non- E bundle (higher)
- For now: flexible prices, linear production $Y_t = N_t$, home markup μ

$$P_{Et} = P_{Et}^* \cdot \mathcal{E}_t \quad P_{Ft} = 1 \cdot \mathcal{E}_t \quad P_{Ht} = \mu \cdot W_t$$

where \mathcal{E}_t is nominal exchange rate ($\mathcal{E}_t \uparrow$ is nominal depreciation)

Household consumption behavior

- c_{it} is determined by **intertemporal problem** of **HA**

$$\max_{\{c_{it}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_i^t \left\{ \frac{c_{it}^{1-\sigma}}{1-\sigma} - v(N_t) \right\}$$

$$c_{it} + a_{it+1} = (1 + r_t^p) a_{it} + e_{it} \frac{W_t}{P_t} N_t \quad a_{it+1} \geq 0 \quad C_t \equiv \int c_{it} di$$

- a_{it} = position in domestic mutual fund, r_t^p is return
- W_t is sticky, so income $\frac{W_t}{P_t} N_t$ taken as given by households
- Foreigners have fixed demand C^* & price level P^* , flex prices, import from H

$$C_{Ht}^* = (\alpha_E + \alpha_F) \left(\frac{P_{Ht}}{\mathcal{E}_t P^*} \right)^{-\gamma} C^*$$

- Domestic production and market clearing:

$$Y_t = N_t = C_{Ht} + C_{Ht}^*$$

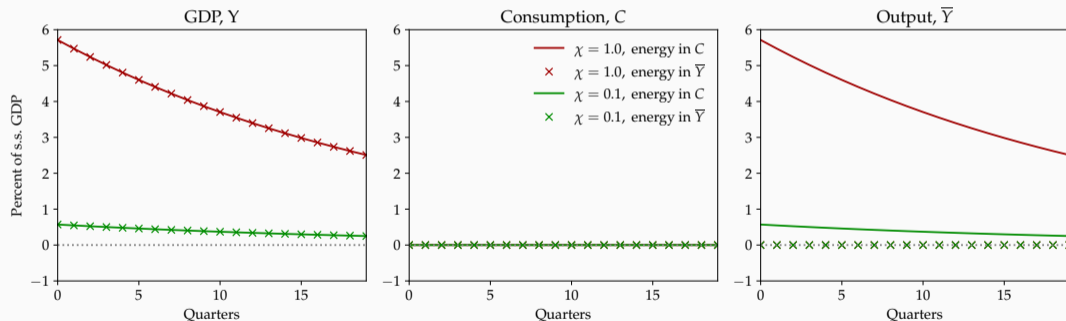
- Three types of assets
 - nominal home & foreign bonds in zero net supply
 - shares in H firms $v_t = (v_{t+1} + \text{div}_{t+1}) / (1 + r_t) v_t = (v_{t+1} + \text{div}_{t+1}) / (1 + r)$ in positive supply
 - asset market clearing $A_t = v_t + NFA_t$
- Domestic central bank sets nominal rate i_t on nominal home bonds
 - for now, it targets constant CPI-based real interest rate, $i_t = r + \pi_{t+1}$
- Interest rate on foreign bonds is constant $r^* = r$
- Mutual fund & foreigners invest freely in all assets
 - equalized \mathbb{E} returns \Rightarrow return on mutual fund is $r_{t+1}^p = r \forall t \geq 0$
 - UIP holds

$$1 + i_t = (1 + r) \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \quad 1 + r = (1 + r) \frac{Q_{t+1}}{Q_t}$$

so in our baseline the real exchange rate $Q \equiv \frac{\mathcal{E}_t}{P_t}$ is held constant

- The energy shock: 100% AR(1) shock with (quarterly) persistence 0.96
- Consumption shares: $\alpha_F = 0.26$, $\alpha_E = 0.04$
- Elasticities of substitution: $\eta_E = 0.1$, $\eta = 0.5$, $\gamma = 0.5$
- Unions: $\zeta = 5$, $\theta_W = 0.91$
- Importers: $\theta_E = 0.65$, $\theta_F = 0.9$. Entirely foreign owned.

- Same predictions for output + consumption if energy is input to production. Gross output is unchanged.



The incomplete market representative agent

- Drop international risk-sharing, consider incomplete-market **RA**
- Given st. state $r = \beta^{-1} - 1$ and variable perfect foresight income stream Z_t

$$\max_{\{C_t\}} \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\sigma}}{1-\sigma}$$

$$C_t + A_t = (1 + r)A_{t-1} + Z_t$$

- Given A_{-1} , consumption is function of Z_t ...

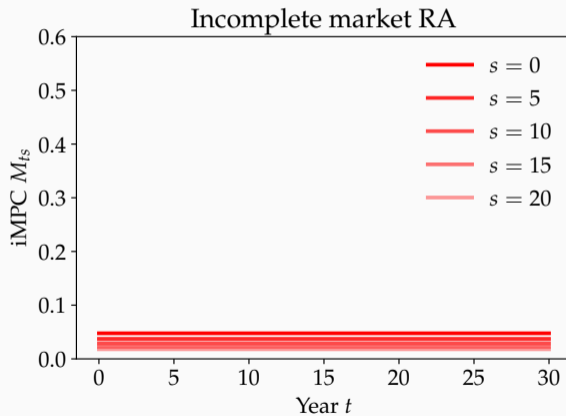
$$C_t = \mathcal{C}_t(\{Z_0, Z_1, Z_2, \dots\})$$

- What does this function look like in the RA case?

→ Perfect consumption smoothing, **very small C responses to Z shocks!**

Consumption responses to income shocks

- Responses to income shocks at various dates, **intertemporal MPCs**



- Now add **idiosyncratic productivity shocks** e_{it} + **borrowing constraint**

$$\max_{\{c_{it}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_{it}^{1-\sigma}}{1-\sigma}$$

$$c_{it} + a_{it} = (1+r)a_{it-1} + e_{it}Z_t \quad a_{it} \geq 0 \quad C_t \equiv \int c_{it} di$$

- Given initial distribution $\{a_{i,-1}\}$, consumption is still *some* function of Z_t ...

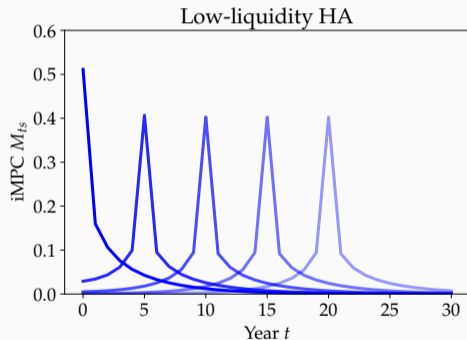
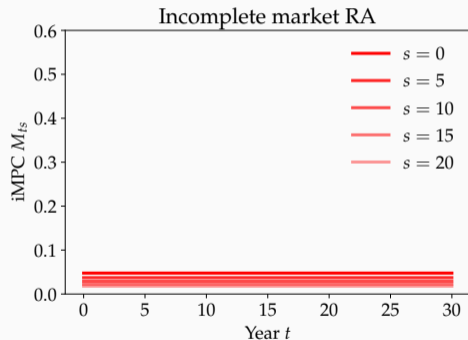
$$C_t = C_t(\{Z_0, Z_1, Z_2, \dots\})$$

- Feed in small Z_t shocks again ...

Consumption responses to income shocks in HA vs RA

- Responses to income shocks at various dates in HA vs RA (if low liquidity)

[Auclert-Rognlie-Straub 2018]



- Can stack responses into matrix \mathbf{M} as columns, “MPC matrix”
- Then, for any given path $d\mathbf{Z} = (dZ_0, dZ_1, dZ_2, \dots)'$, consumption path is

$$d\mathbf{C} = \mathbf{M} \cdot d\mathbf{Z}$$

- a bit like undergraduate macro, where $\Delta C = \text{mpc} \cdot \Delta Y$
- Proof of international keynesian cross follows three steps:
 - [Simplified case with zero liquidity, otherwise also include MPC from capital gains]
 - 1. observe that real income is $Z_t = \frac{W_t}{P_t} N_t = \frac{P_H}{P_t} Y_t$
 - 2. linearize the consumption equation around ss with $P_H/P = Y = 1$

$$d\mathbf{C} = \mathbf{M} d \left(\frac{\mathbf{P}_H}{\mathbf{P}} \right) + \mathbf{M} d\mathbf{Y}$$

3. use demand system to relate $d \left(\frac{\mathbf{P}_H}{\mathbf{P}} \right)$ to $d\mathbf{P}_E^*$ and $d\mathbf{Y}$ to $d\mathbf{C}$

Proposition

In the HA model, $d\mathbf{Y}$ solves an “international Keynesian cross”

$$d\mathbf{Y} = \underbrace{\frac{\alpha_E}{1 - (\alpha_E + \alpha_F)} \chi d\mathbf{P}_E^*}_{\text{Expenditure switching}} - \underbrace{\alpha_E \mathbf{M} d\mathbf{P}_E^*}_{\text{Real income}} + \underbrace{(1 - (\alpha_E + \alpha_F)) \mathbf{M} d\mathbf{Y}}_{\text{Multiplier}}$$

where $d\mathbf{P}_E^*$ is the energy price shock and $M_{t,s} \equiv \frac{\partial C_t}{\partial Y_s}$ is the matrix of iMPCs

- Entire role of heterogeneity encoded in \mathbf{M} matrix, RA corresponds to $\mathbf{M} = \mathbf{0}$
- When $\chi = 1$, last two terms cancel, so HA=RA

[related: Cole-Obstfeld, Werning, Auclert-Rognlie-Straub, Auclert-Rognlie-Souchier-Straub]

- Energy suppliers

- endowed with \bar{E}_t
- can adjust “inventory” $I_{i,t+1}^E = I_{i,t}^E + (\bar{E}_t - E_{it})$
- maximize

$$\sum_{j=0}^{\infty} \left(\frac{1}{1+r^*} \right)^j \left[P_{E,t+j}^* E_{i,t+j} - \frac{\Gamma}{2} \left(I_{i,t+1}^E \right)^2 \right]$$

- Optimal inventory

$$I_{i,t+1}^E = \frac{\left(\frac{1}{1+r^*} \right) P_{E,t+1}^* - P_{E,t}^*}{\Gamma}$$

built up when future price is expected to be high relative to today