Managing an Energy Shock with Heterogeneous Agents: Fiscal and Monetary Policy

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- Existing models to study these Q are **representative Agent (RA)** NK-SOE:
  [Blanchard-Gali 2007, Blanchard-Riggi 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, Pieroni ...]

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- **fiscal policy**: powerful in isolation ...
  - $\rightarrow$ but may have huge **negative externalities**!

Roadmap

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

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- SOE households consume E. E not used in production
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2: Households face **borrowing constraint + idiosyncratic income risk**

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

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)

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- For now: flexible prices, linear production $Y_t = N_t$, home markup μ

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

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**

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

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

  - 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

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- Foreigners have fixed demand C^* & price level P^*, flex prices, import from H

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

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- Domestic production and market clearing:

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

Monetary policy and assets

- Three types of assets
  - nominal home & foreign bonds in zero net supply
  - shares in H firms $v_t = (v_{t+1} + \text{div}_{t+1})/(1 + r_t)$ in positive supply
  - asset market clearing $A_t = v_t + NFA_t$

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  - for now, it targets constant CPI-based real interest rate, $i_t = r + \pi_{t+1}$
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- Mutual fund & foreigners invest freely in all assets
  - equalized $\mathbb{E}$ returns $\Rightarrow$ return on mutual fund is $r^p_{t+1} = r \; \forall t \geq 0$
  - UIP holds

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

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

The energy shock: RA vs HA

Feeding in the shock

- 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)**

Textbook RA complete markets model

- In **RA** with complete markets and Q constant $\Rightarrow C_t = C$ [Backus-Smith]

$$Y_t = (1 - \alpha_E - \alpha_F)\left(\frac{P_{Ht}}{P_{HFt}}\right)^{-\eta}\left(\frac{P_{HFt}}{P_t}\right)^{-\eta_E} C + (\alpha_E + \alpha_F)\left(\frac{P_{Ht}}{\mathcal{E}_t}\right)^{-\gamma} C^*$$

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- Linearize around SS with $Y = C = C^* = Q = P_E^* = 1$:

$$dY_t = \frac{\alpha_E}{1 - (\alpha_E + \alpha_F)} \cdot \chi \cdot dP_{Et}^*$$

  where χ is weighted average elasticity of substitution:

$$\chi = (1 - \alpha_E - \alpha_F)\left(\frac{\alpha_F}{1 - \alpha_E}\eta + \left(1 - \frac{\alpha_F}{1 - \alpha_E}\right)\eta_E\right) + (\alpha_E + \alpha_F)\gamma$$

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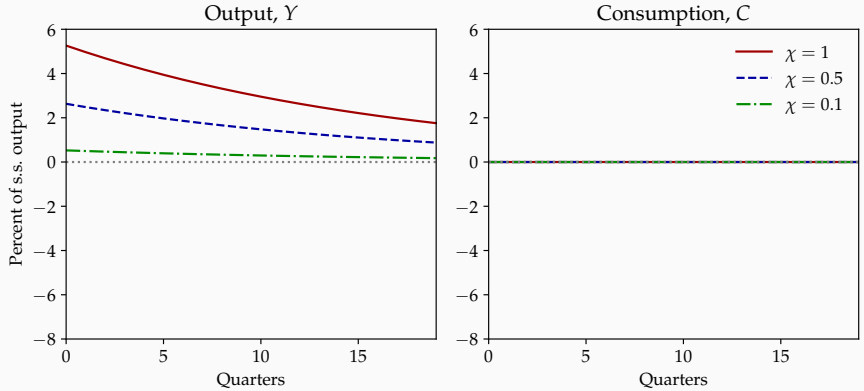
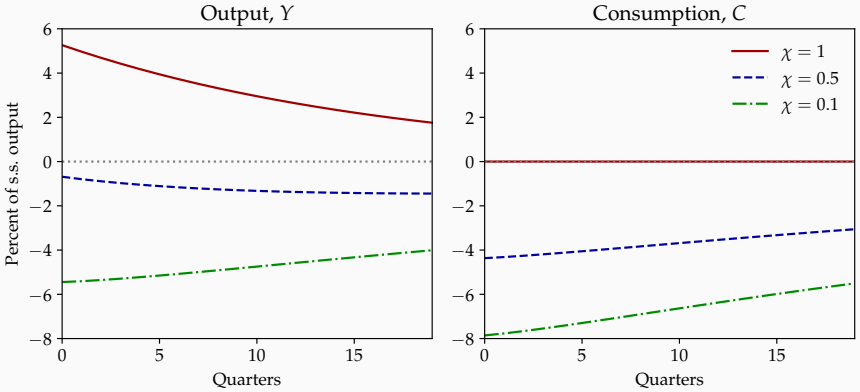
- Pure expenditure switching: **domestic boom!**
- In relatively closed economy $\chi \simeq \eta_E$ so quite low

RA: Output and consumption

- Calibrate to $\alpha_F = 0.2$, $\alpha_E = 0.04$ [Baqaee et al]
- If energy was used in production: same output + consumption; hours higher.



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



Implications for inflation

Slower passthrough for quantification

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1. Slow passthrough of exchange rate into energy and foreign goods:

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2. Wage Phillips curve with a Blanchard-Gali real rigidity

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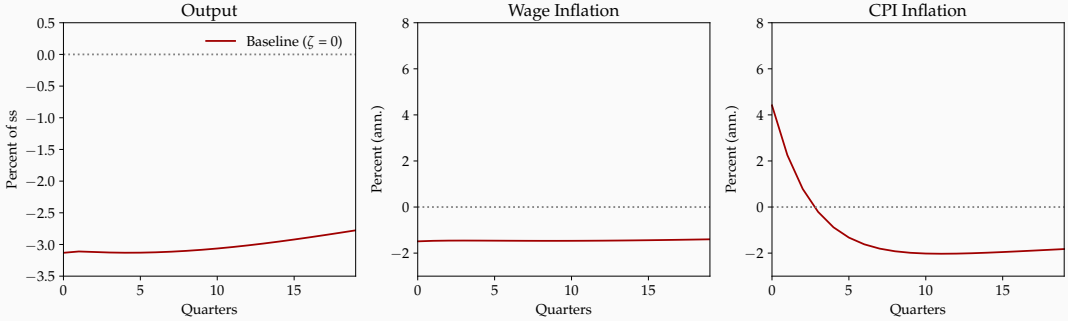
- Set $\eta_E = 0.1$, $\eta = 1$, $\gamma = 0.1$ (so $\chi \simeq 0.25$), $\theta_E = \theta_F = 0.65$

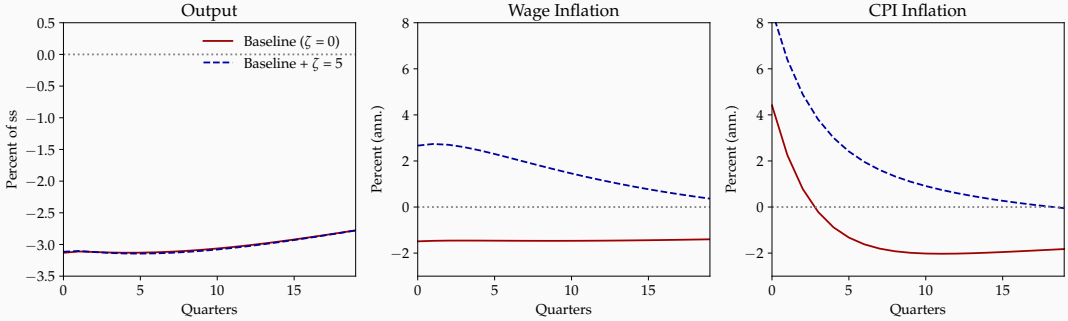
Effect of energy shock: output and inflation

- 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

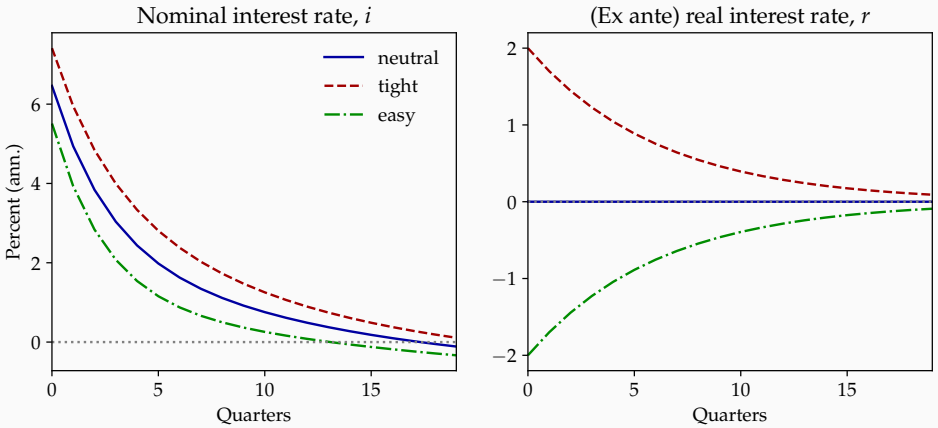
- With $\zeta > 0$: energy price shock is a stagflationary shock
- Wage setters averse to $W/P \downarrow$. Get **wage-price spiral** ! Important today?



Managing the energy shock: Monetary policy

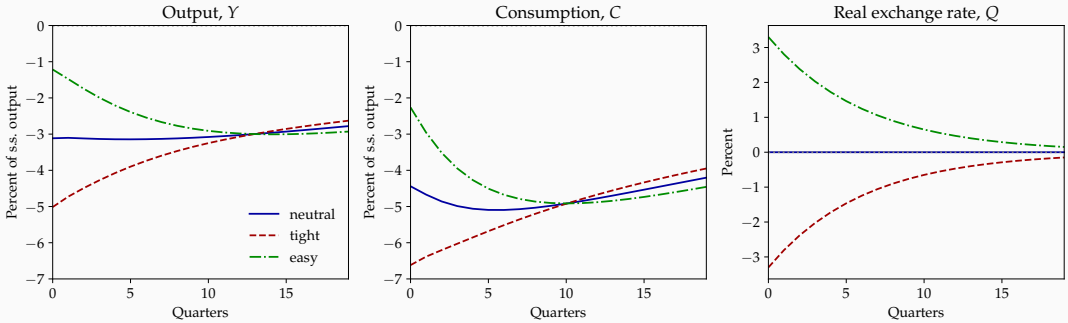
Monetary policy: three scenarios

- Three scenarios for monetary policy



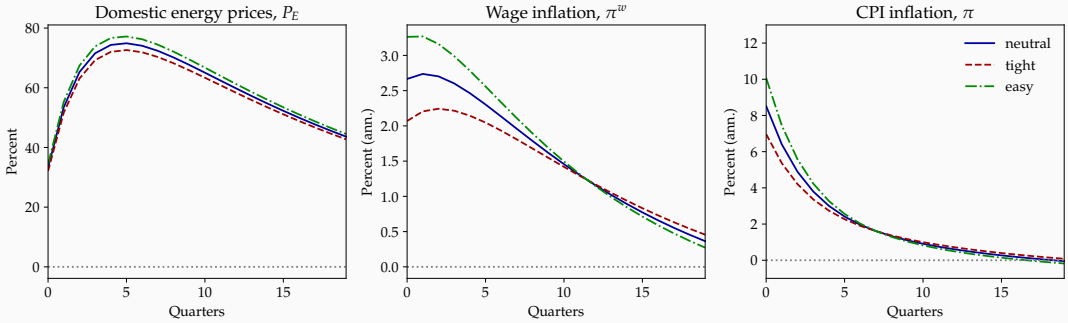
Monetary policy: Output and consumption

- Tight monetary policy causes deeper recession (as expected)

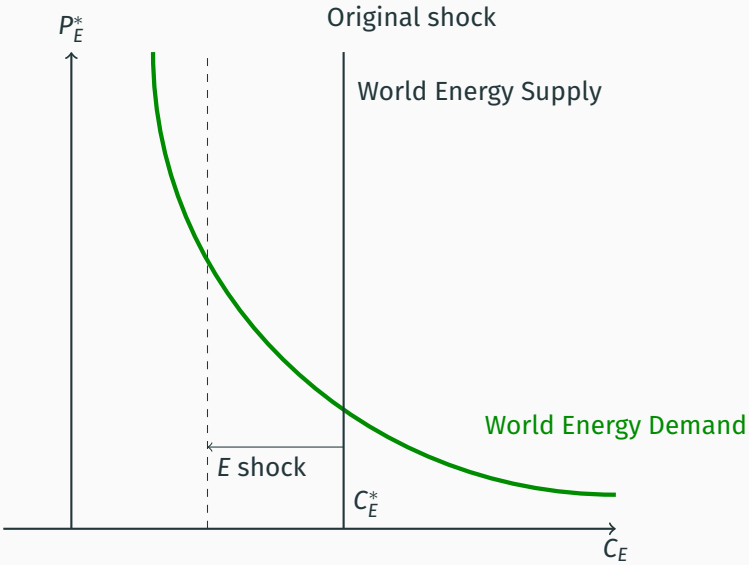


Monetary policy: Inflation

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



Microfounding P_E^* in world economy



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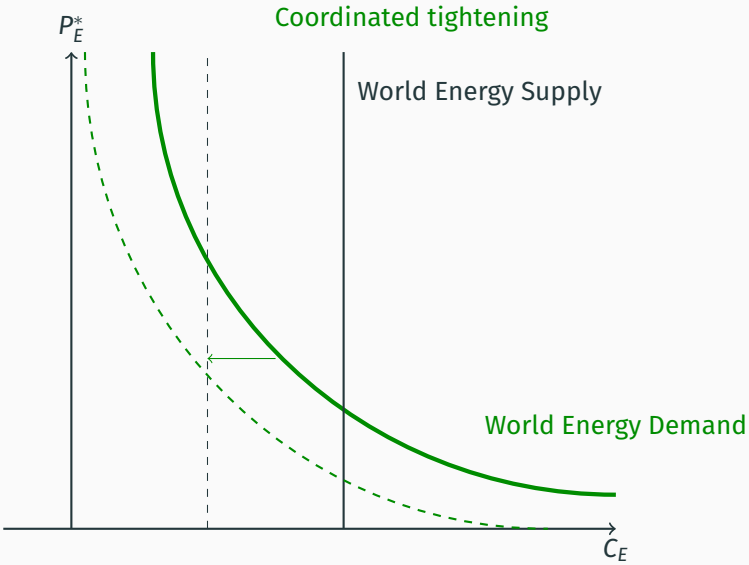

Monetary policy: Coordination

- **Positive spillover** from domestic $i \uparrow$: brings down P_E^* for everyone else.

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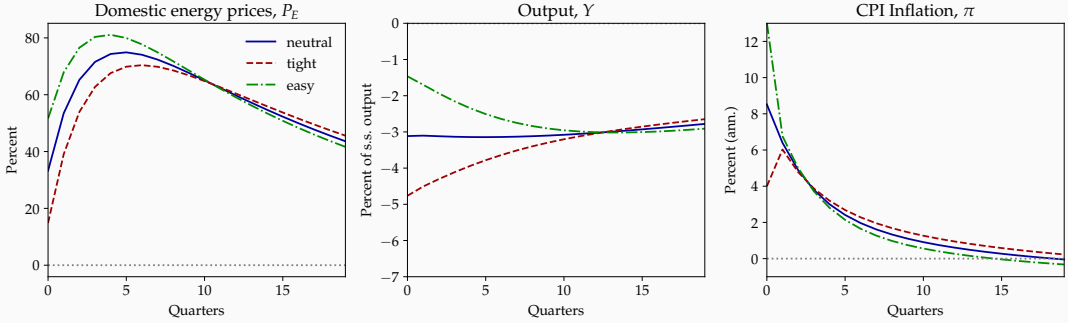
- **Positive spillover** from domestic $i \uparrow$: brings down P_E^* for everyone else.
- Coordination problem. If continuum of SOE's consume E and all hike:



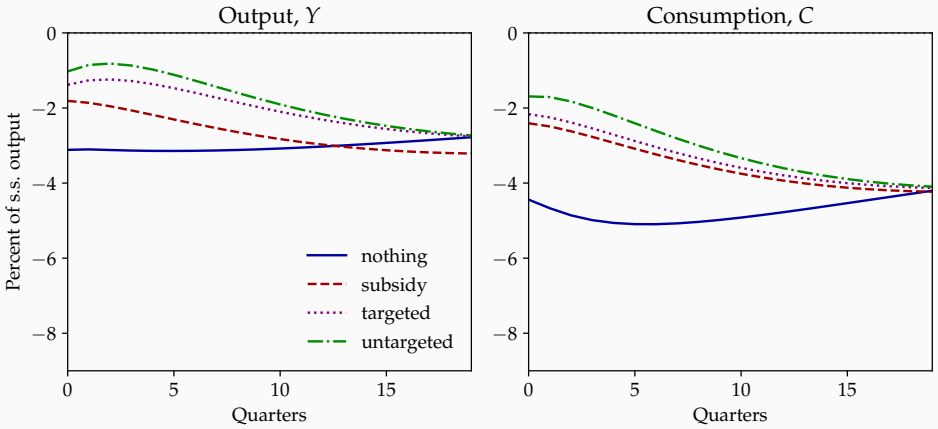
Managing the energy shock: Fiscal policy

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 output loss...



Fiscal policy (uncoordinated): inflation

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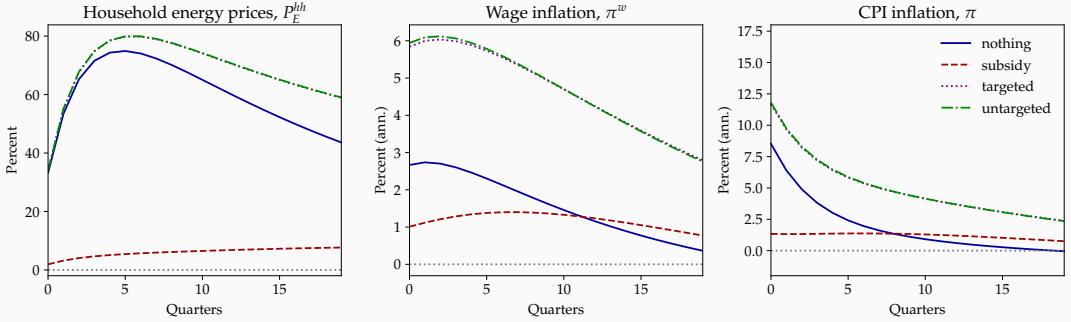
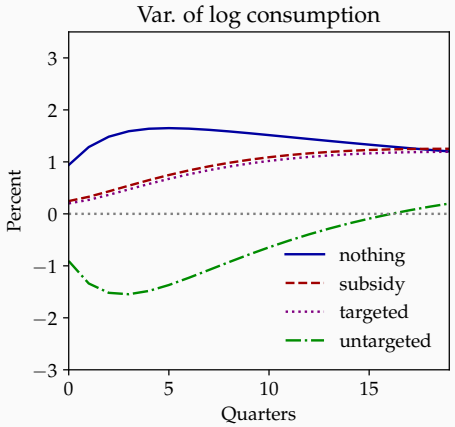
- ... but subsidy seems like a silver bullet?



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.

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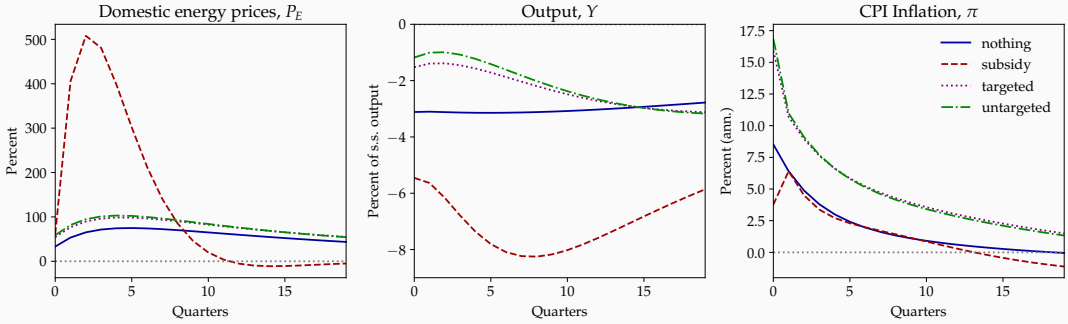
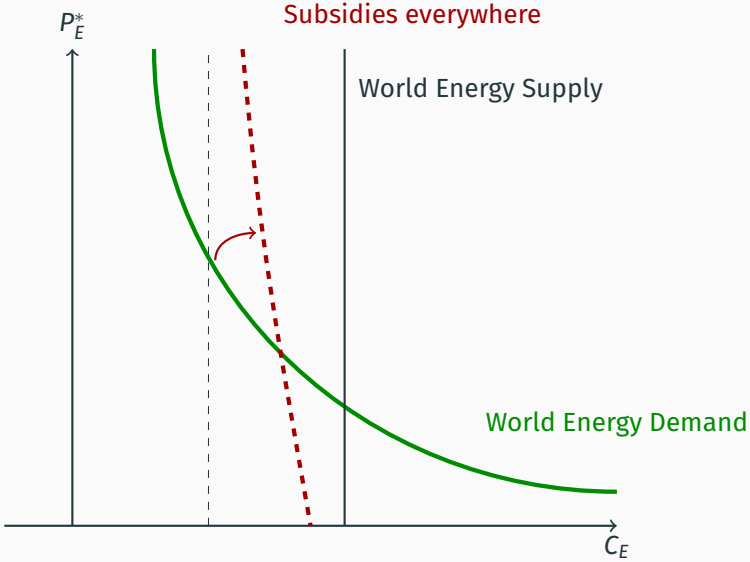
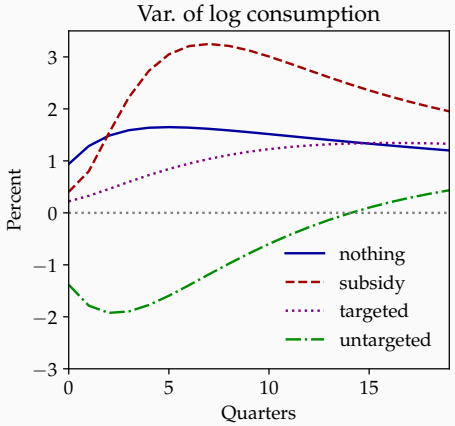


World economy equilibrium with subsidies



Fiscal policy (coordinated): inequality

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



Conclusion

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- 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**.

  $\rightarrow$ Want major countries to hike together.
- **Fiscal support** alone is very powerful, but hugely **negative externalities**.

  $\rightarrow$ Developing countries with less fiscal space may bear the cost. Do less?

Appendix

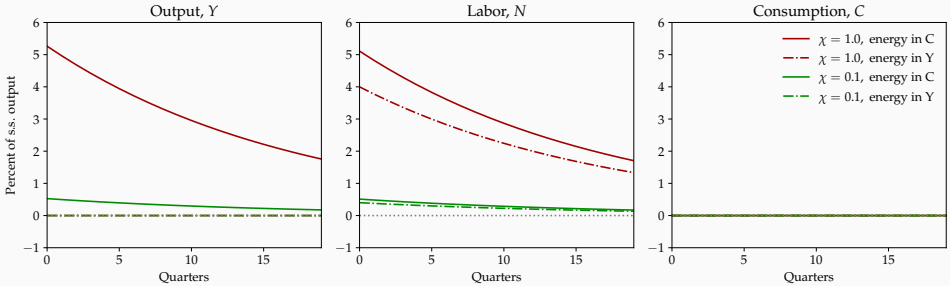
Calibration

- The energy shock: 100% AR(1) shock with (quarterly) persistence 0.95
- Consumption shares: $\alpha_F = 0.2$, $\alpha_E = 0.04$
- Elasticities of substitution: $\eta_E = 0.1$, $\eta = 1$, $\gamma = 0.1$
- Unions: $\zeta = 5$, $\theta_w = 0.95$
- Importers: $\theta_E = 0.65$, $\theta_F = 0.65$. Entirely foreign owned.

Aside: RA with energy in output

back

- Same predictions for output + consumption if energy is input to production. Only hours are higher.



Proposition

$d\mathbf{Y}$ solves an "international Keynesian cross" with energy price as shock

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

where $M_{t,s} \equiv \frac{\partial C_t}{\partial Y_s}$ is the matrix of iMPCs

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- Entire role of heterogeneity encoded in $\mathbf{M}$ matrix, RA corresponds to $\mathbf{M} = 0$
- Use this to prove that $\chi = 1$ implies HA=RA