Dealing with the Trilemma

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Trilemma

1. Fixed exchange rates
2. Independent monetary policy
3. Free capital flows

Motivation

- Constrained monetary policy...
  - fixed or de facto fixed exchange regimes
  - currency unions
- Capital controls: regain monetary autonomy...
  - Bretton Woods (Keynes-White)
- Recent capital controls...
  - developing countries and capital controls
  - IMF blessing
  - Eurozone?

Goal

- Provide characterization of optimal capital controls
    - nature of shocks?
    - persistence of shocks?
    - price rigidity?
    - openness?
    - coordination?
- Emphasis
    - hot money, sudden stops (volatile capital flows)
    - risk premium shocks

Our Approach

- Open economy model
  - nominal rigidities: prices and wages
  - fixed exchange rates
  - optimal policy
    - uncoordinated
    - coordinated
- Build on Gali-Monacelli (2005, 2009), Clarida-Gali-Gertler (2001)

Related Literature

- Calvo, Mendoza
- Caballero-Krishnamurthy, Caballero-Lorenzoni
- Korinek, Jeanne, Bianchi, Bianchi-Mendoza
- Mundel, Fleming, Gali-Monacelli , Schmitt-Grohe-Uribe, Boucekkine-Pommeret-Prieu

Setup

- Continuum of small open economies $i \in [0, 1]$
  - measure zero
  - different shocks
  - otherwise identical

- Experiments
  - Start at deterministic steady state
  - One-time unanticipated shock at t=0 (incomplete markets)
  - No further shocks

Households

- Focus on one country
- Representative household maximizes

$$\sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} \right]$$

subject to

$$P_t C_t + D_{t+1} + \int_0^1 E_{i,t} D_{t+1}^i di \leq W_t N_t + \Pi_t$$

$$+ T_t + (1+i_{t-1}) D_t + (1+\tau_{t-1}) \int_0^1 E_t^i (1+i_{t-1}^i) D_t^i$$

Differentiated Goods

- Consumption aggregates

$$C_t = \left[(1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

$$C_{H,t} = \left(\int_0^1 C_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}}$$

$$C_{F,t} = \left(\int_0^1 C_{i,t}^{\frac{\gamma-1}{\gamma}} di \right)^{\frac{\gamma}{\gamma-1}}$$

$$C_{i,t} = \left(\int_0^1 C_{i,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}}$$

(country i and variety j)

Differentiated Goods

- Price Indices

$$P_t = \left[(1-\alpha)P_{H,t}^{1-\eta} + \alpha P_{F,t}^{1-\eta}\right]^{\frac{1}{1-\eta}}$$

$$P_{H,t} = \left(\int_0^1 P_{H,t}(j)^{1-\epsilon} dj\right)^{\frac{1}{1-\epsilon}}$$

$$P_{F,t} = \left(\int_0^1 P_{i,t}^{1-\gamma} di\right)^{\frac{1}{1-\gamma}}$$

$$P_{i,t} = \left(\int_0^1 P_{i,t}(j)^{1-\epsilon} dj\right)^{\frac{1}{1-\epsilon}}$$

(country i and variety j)

LOP, TOT and RER

- Law of one price

$$P_{F,t} = E_t P_t^*$$

- Terms of trade

$$S_t = \frac{P_{F,t}}{P_{H,t}}$$

- Real exchange rate

$$Q_t = \frac{E_t P_t^*}{P_t} = \frac{P_{F,t}}{P_t}$$

Firms

- Each variety:
  - produced monopolistically
  - technology $Y_t(j) = A_t N_t(j)$
- Different price setting assumptions:
  - flexible
  - set one period in advance
  - Calvo

Equilibrium

- Goods market clearing

$$Y_t = (1-\alpha)C_t \left(\frac{Q_t}{S_t}\right)^{-\eta} + \alpha \Lambda_t C_t^* S_t^\gamma$$

- Labor market clearing

$$N_t = \frac{Y_t}{A_t}\Delta_t$$

- Price dispersion

$$\Delta_t = \int_0^1 \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\epsilon}$$

Household FOCs

- Labor supply

$$C_t^{\sigma} N_t^{\phi} = \frac{W_t}{P_t}$$

- Euler

$$\beta \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} = \frac{1+i_t}{1+\pi_{t+1}}$$

- Consumption smoothing (Backus-Smith)

$$C_t = \Theta_t C_t^* \mathcal{Q}_t^{\frac{1}{\sigma}} \longrightarrow \quad 1 + i_t = (1 + i_t^*) \frac{E_{t+1}}{E_t} (1 + \tau_t)$$

- Capital controls

$$\left(\frac{\Theta_{t+1}}{\Theta_t} \right)^{\sigma} = 1 + \tau_t$$

Household FOCs

- Labor supply

$$C_t^{\sigma} N_t^{\phi} = \frac{W_t}{P_t}$$

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- Capital controls

$$\left(\frac{\Theta_{t+1}}{\Theta_t} \right)^{\sigma} = 1 + \tau_t$$

Trilemma

- Wedge in UIP

$$1 + i_t = (1 + i_t^*) \frac{E_{t+1}}{E_t} (1 + \tau_t)$$

- Capital Controls
  - regain monetary autonomy
  - second best instrument

Shocks

1. Productivity $\{A_t\}$
2. Export demand $\{\Lambda_t\}$
3. Foreign consumption $\{C_t^*\}$
4. Net Foreign Asset NFA_0

5. Risk Premium Interest Rate (later)

Pricing

- Flexible Prices
- Rigid Prices
- One-Period Sticky
- Calvo

Flexible Prices

$$\max \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} \right]$$

$$Y_t = (1-\alpha) C_t \left(\frac{Q_t}{S_t} \right)^{-\eta} + \alpha \Lambda_t C_t^* S_t^{\gamma}$$

$$Q_t = \left[(1-\alpha) \left(S_t \right)^{\eta-1} + \alpha \right]^{\frac{1}{\eta-1}}$$

$$N_t = \frac{Y_t}{A_t}$$

$$C_t^{-\sigma} S_t^{-1} Q_t = \frac{\epsilon}{\epsilon - 1} \frac{1+\tau^L}{A_t} N_t^{\phi}$$

$$0 = \sum_{t=0}^{\infty} \beta^t C_t^{*-\sigma} \left(S_t^{-1} Y_t - Q_t^{-1} C_t \right)$$

Flexible Prices

- without capital controls, i.e. Θ_t constant
  - trade is balanced
  - incomplete markets = complete markets

Proposition (C-O, flex price).
No capital controls at optimum.

- non Cole-Obstfeld ➡ capital controls (Costinot-Lorenzoni-Werning)

Rigid Prices

$$\max \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} \right]$$

$$Y_t = (1-\alpha) C_t \left(\frac{\mathcal{Q}_t}{S_t} \right)^{-\eta} + \alpha \Lambda_t C_t^* S_t^{\gamma}$$

$$\mathcal{Q}_t = \left[(1-\alpha) \left(S_t \right)^{\eta-1} + \alpha \right]^{\frac{1}{\eta-1}}$$

$$N_t = \frac{Y_t}{A_t}$$

$$C_t^{-\sigma} S_t^{-1} \mathcal{Q}_t = \frac{\epsilon}{\epsilon-1} \frac{1+\tau^L}{A_t} N_t^{\phi}$$

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Rigid Prices

$$\max \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} \right]$$

$$Y_t = (1-\alpha) C_t \left(\frac{Q_t}{S_t} \right)^{-\eta} + \alpha \Lambda_t C_t^* S_t^{\gamma}$$

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Rigid Prices

$$\max \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} \right]$$

$$Y_t = (1-\alpha) C_t \left(\frac{1}{1} \right)^{-\eta} + \alpha \Lambda_t C_t^* \; 1^{\gamma}$$

$$1 \;= \left[(1-\alpha) \left(1 \; \right)^{\eta - 1} + \alpha \right]^{\frac{1}{\eta - 1}}$$

$$N_t = \frac{Y_t}{A_t}$$

$$0 = \sum_{t=0}^{\infty} \beta^t C_t^{*-\sigma} \left(1 \quad Y_t - 1 \quad C_t \right)$$

Rigid Prices

$$\max \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} \right]$$

$$Y_t = (1-\alpha)C_t + \alpha \Lambda_t C_t^*$$

$$N_t = \frac{Y_t}{A_t}$$

$$0 = \sum_{t=0}^{\infty} \beta^t C_t^{*-\sigma} \left(Y_t - C_t \right)$$

Rigid Prices

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$$Y_t = (1-\alpha) C_t + \alpha \Lambda_t C_t^*$$

$$N_t = \frac{Y_t}{A_t}$$

$$0 = \sum_{t=0}^{\infty} \beta^t C_t^{*-\sigma} (Y_t - C_t)$$

Proposition. Tax on inflows has sign...

1. same $A_{t+1} - A_t$
2. opposite $\Lambda_{t+1} - \Lambda_t$
3. opposite $C^*_{t+1} - C^*_t$
4. zero for NFA

One Period Sticky

$$\max_{Y_0, C_0, W_1} \left[\frac{C_0^{1-\sigma}}{1-\sigma} - \frac{N_0^{1+\phi}}{1+\phi} + \beta V(NFA_1) \right]$$

flexible price value function

$$Y_0 = (1-\alpha)C_0 + \alpha \Lambda_0 C_0^*$$

$$N_0 = \frac{Y_0}{A_0}$$

$$NFA_0 = -C_0^{*-\sigma}(Y_0 - C_0) + \beta NFA_1$$

One Period Sticky

$$\max_{Y_0, C_0, W_1} \left[\frac{C_0^{1-\sigma}}{1-\sigma} - \frac{N_0^{1+\phi}}{1+\phi} + \beta V(NFA_1) \right]$$

flexible price value function

$$Y_0 = (1-\alpha) C_0 + \alpha \Lambda_0 C_0^*$$

$$N_0 = \frac{Y_0}{A_0}$$

$$NFA_0 = -C_0^{*-\sigma} (Y_0 - C_0) + \beta NFA_1$$

Proposition.

Positive initial tax on inflows

1. decrease in productivity A_0
2. increase in exports Λ_0
3. increase in foreign consumption C_0^*

Permanent Shocks

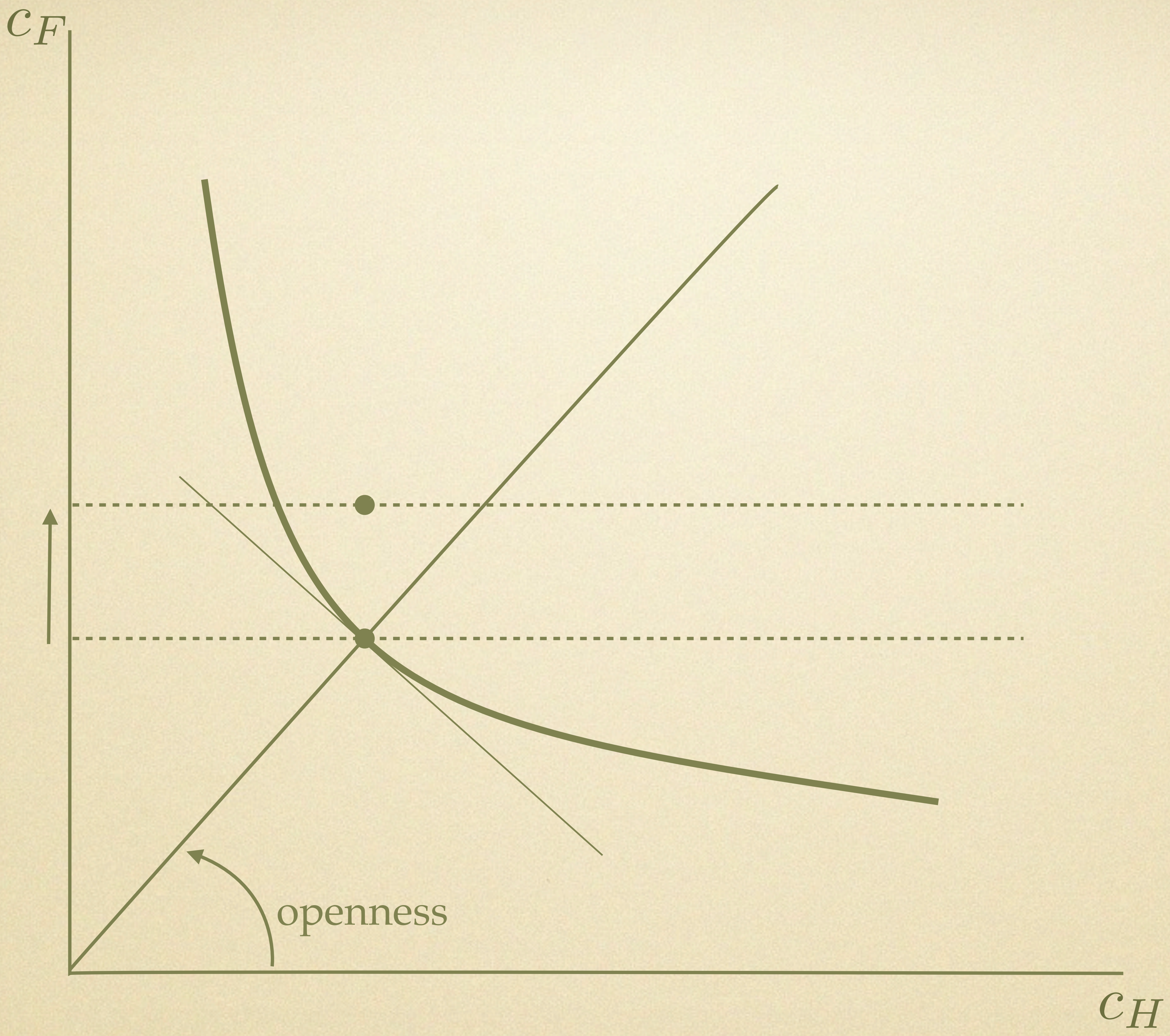
- harder: shocks now affect V()

Proposition.
Positive initial tax on inflows:

1. decrease in productivity A
2. increase in exports Λ
3. increase in foreign consumption C^*
4. increase in wealth NFA_0

- price adjustment makes permanent shocks more similar to temporary effects...
- ... future shocks matter less (news shocks)

c_F
openness
c_H


c_F
openness
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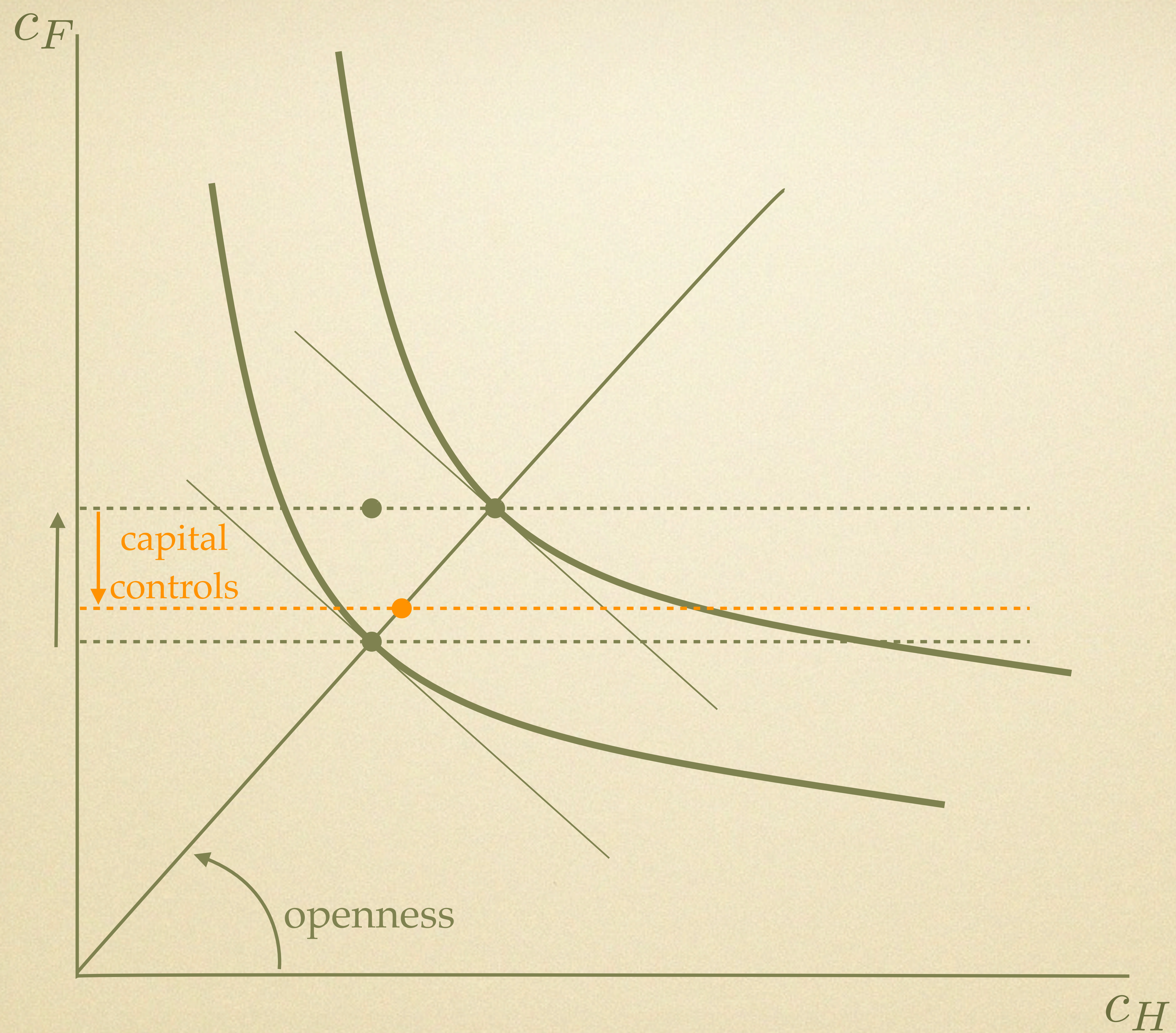
c_F
openness
c_H



c_F
capital
controls
openness
c_H

Capital Controls

- Second Best instrument...
  - affects intertemporal spending
  - can't affect spending on H vs. F goods...
  - ....only indirectly through inflation

- Capital controls $\approx$ flexible exchange rate with Local Currency Pricing (LCP)

Calvo Pricing

- Poisson opportunity to reset price
  - cost of inflation
  - capital controls affect inflation...
    ... prudential interventions?

- τ_L chosen optimally without coordination

- Continuous time: convenient, initial prices given
- Assume Cole-Obstfeld case: $\sigma = \gamma = \eta = 1$
- Log-linearize around symmetric steady state

Planning Problem

$$\min \int e^{-\rho t} \left[\alpha_\pi \pi_{H,t}^2 + \hat{y}_t^2 + \alpha_\theta \hat{\theta}_t^2 \right] dt$$

$$\dot{\pi}_{H,t} = \rho \pi_{H,t} - \hat{\kappa} \hat{y}_t - \lambda \alpha \hat{\theta}_t$$

$$\dot{\hat{y}}_t = (1-\alpha)(i_t - i_t^*) - \pi_{H,t} + i_t^* - \bar{r}_t$$

$$\dot{\hat{\theta}}_t = i_t - i_t^*$$

$$\int e^{-\rho t} \hat{\theta}_t dt = 0$$

$$\hat{y}_0 = (1-\alpha)\hat{\theta}_0 + \hat{s}_0$$

Planning Problem

$$\min \int e^{-\rho t} \left[\alpha_\pi \pi_{H,t}^2 + \hat{y}_t^2 + \alpha_\theta \hat{\theta}_t^2 \right] dt$$

$$\dot{\pi}_{H,t} = \rho \pi_{H,t} - \hat{\kappa} \hat{y}_t - \lambda \alpha \hat{\theta}_t$$

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$$\dot{\hat{\theta}}_t = i_t - i_t^*$$

$$\int e^{-\rho t} \hat{\theta}_t dt = 0$$

$$\hat{y}_0 = (1-\alpha)\hat{\theta}_0 - \bar{s}_0$$

Calvo Outline

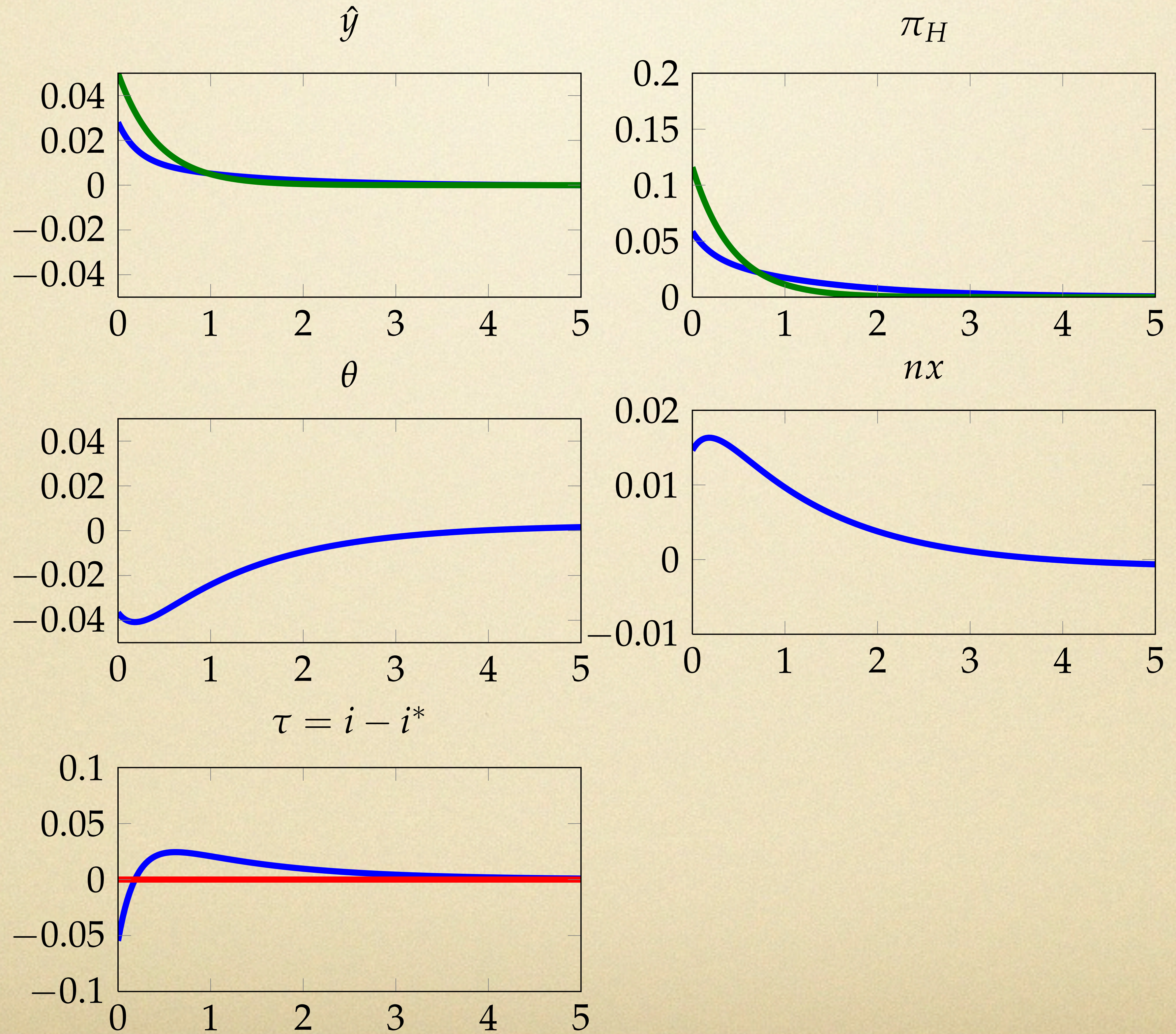
- Closed forms
  - flexible price
  - rigid prices
  - closed economy Limit
- Risk premium shocks

Numerical Exploration

- Two experiments
  - A: terms of trade shock
  - B: mean-reverting productivity shock (half-life 3.5 years)
- Openness $\alpha \in \{0.4, 0.1\}$

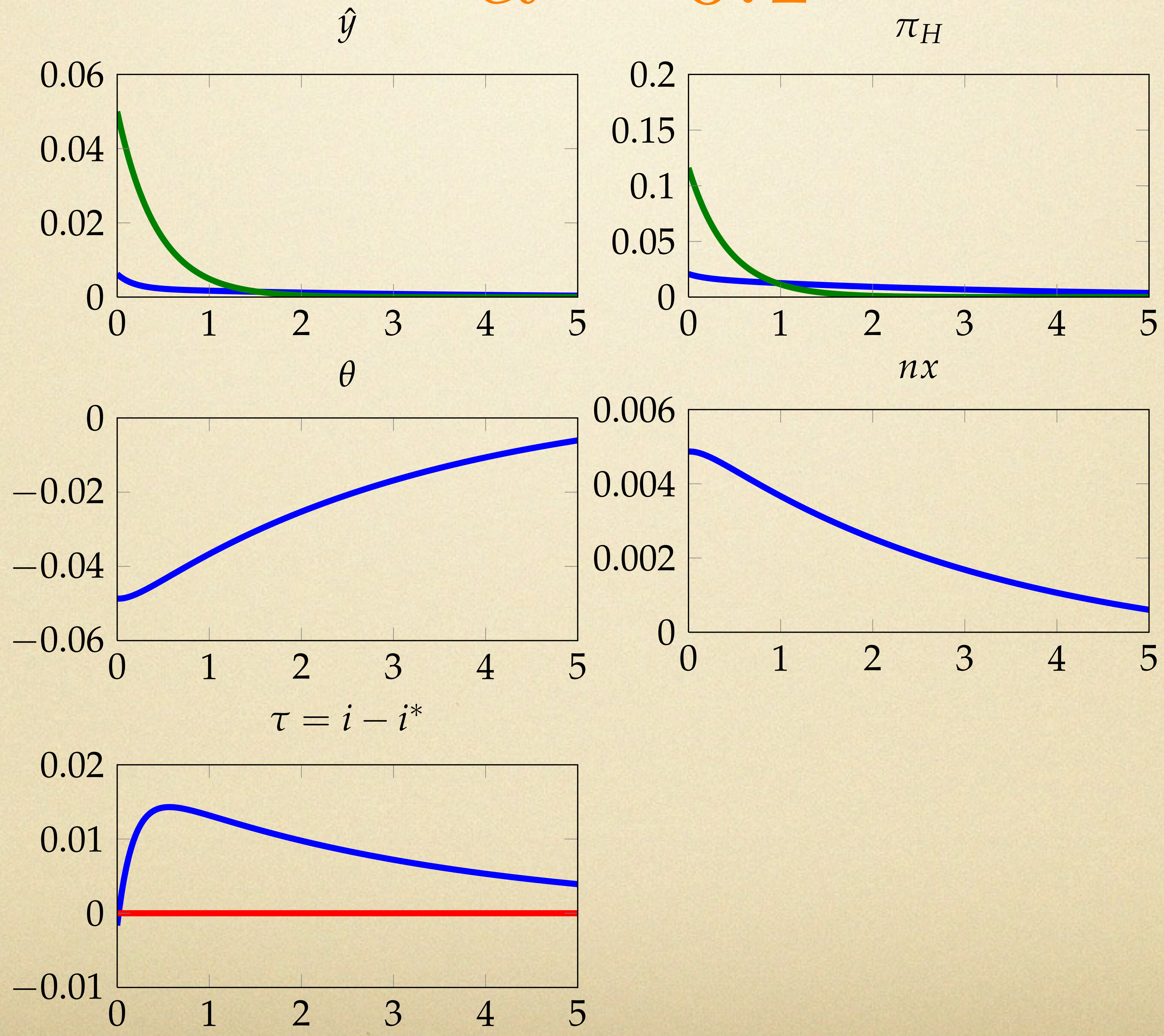
A: Terms of Trade

$\alpha = 0.4$



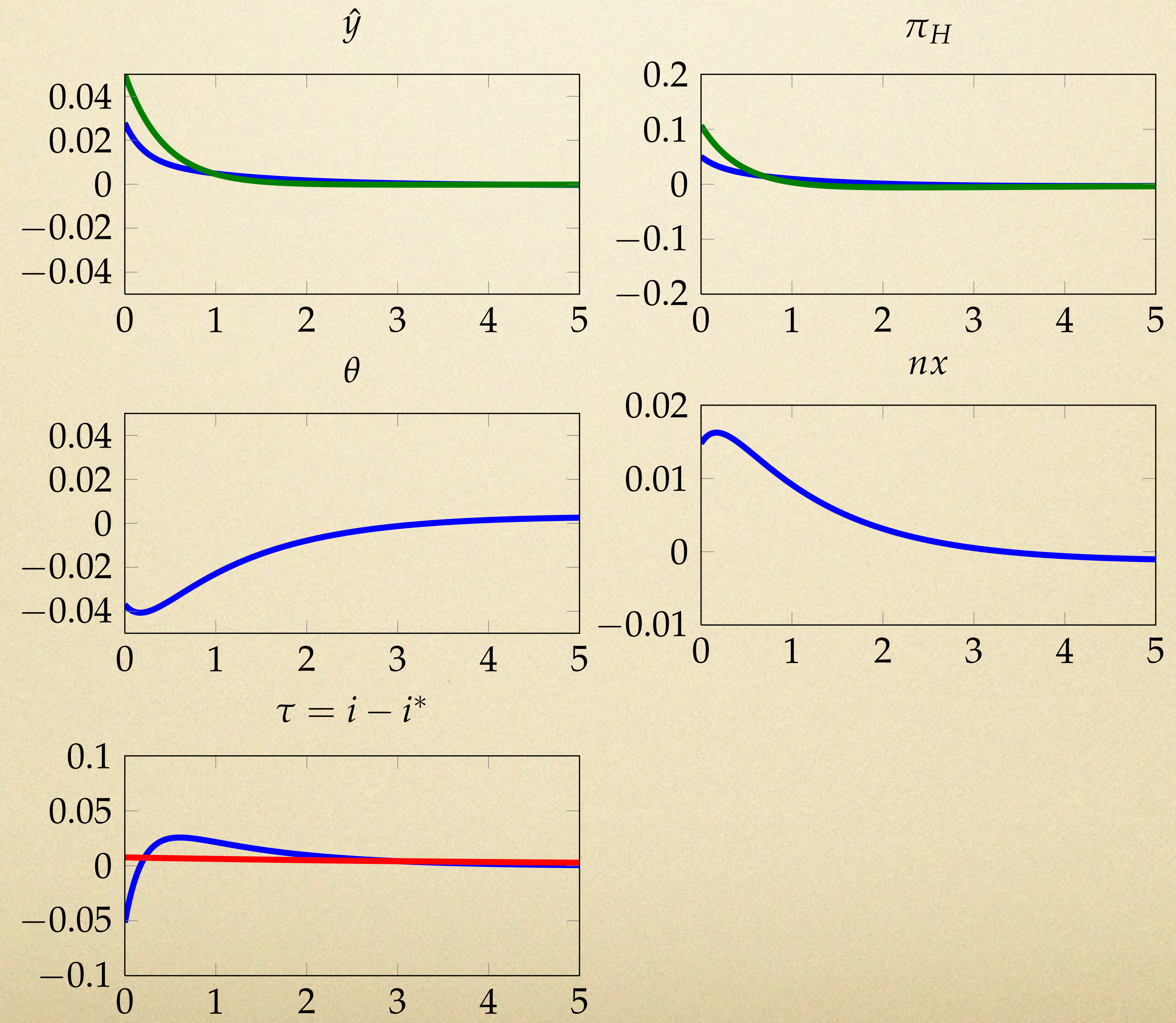
A: Terms of Trade

$\alpha = 0.1$



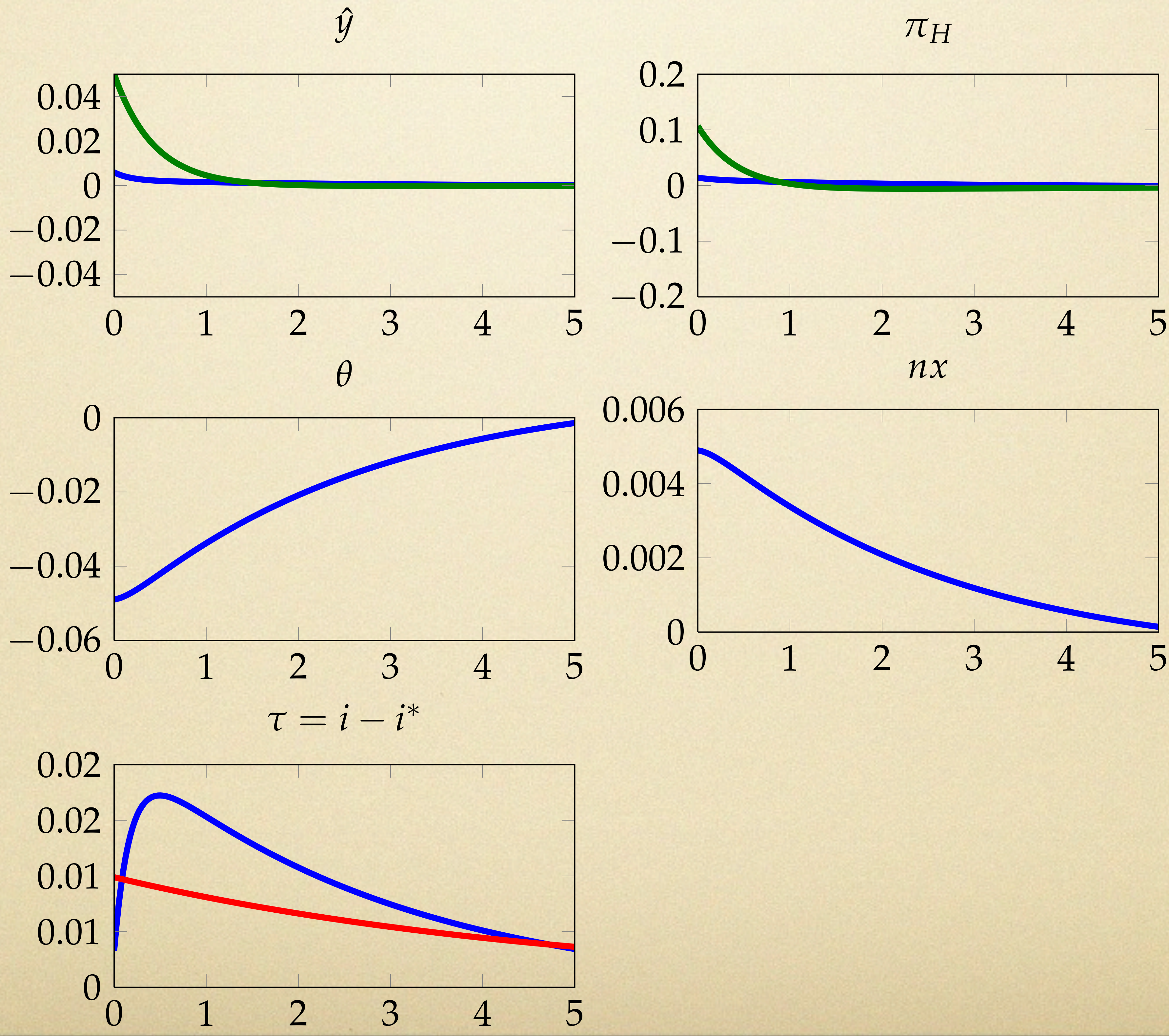
B: Productivity

$$\alpha = 0.4$$



B: Productivity

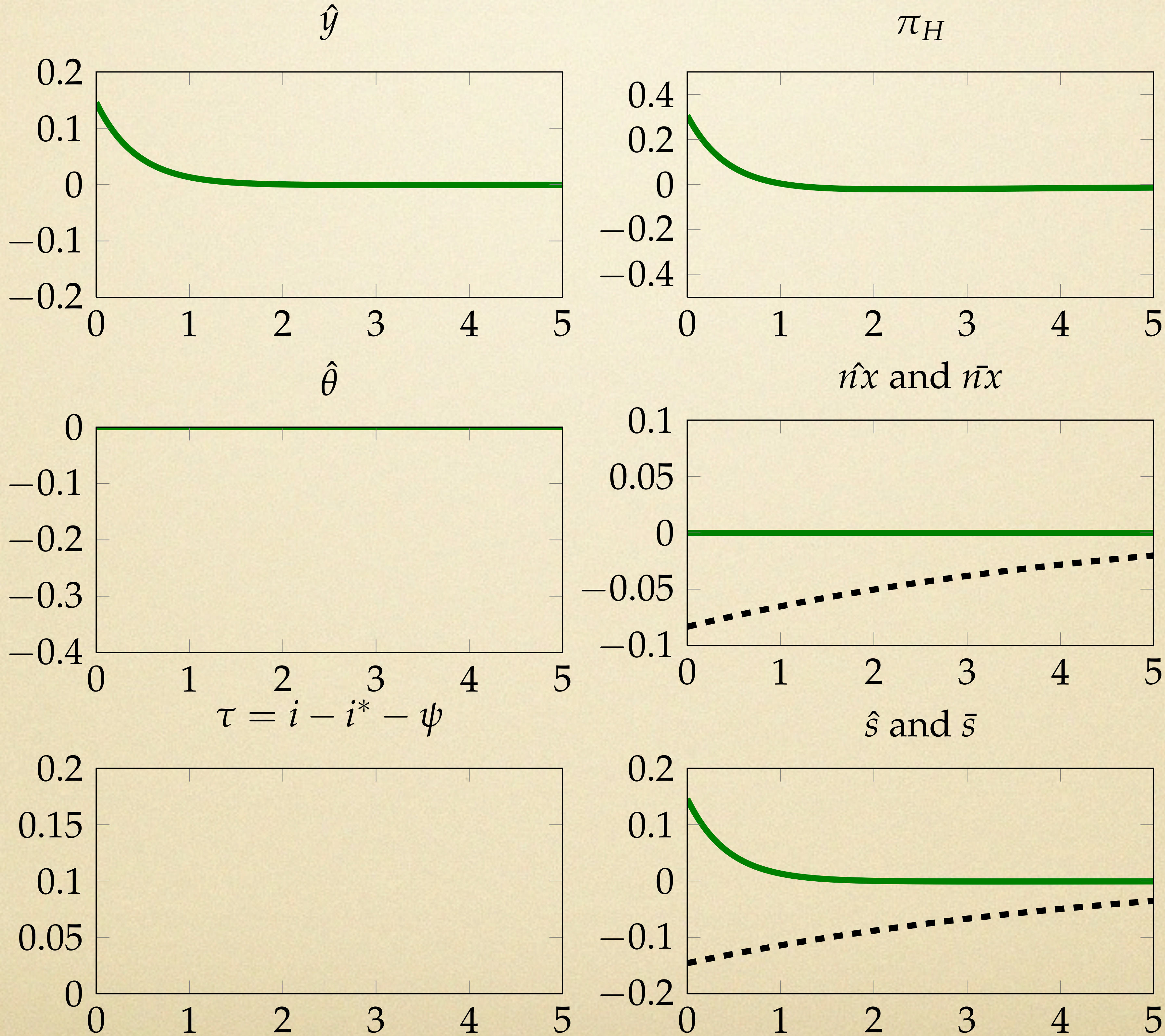
$\alpha = 0.1$



Risk Premia Shock

- Risk Premia $i_t = i_t^* + \psi_t + \tau_t$
- $\psi_t < 0$...
  - natural allocation...
    - appreciation
    - current account deficit
  - equilibrium with no capital controls...
    - (smaller) appreciation via inflation
    - (same) current account deficit
    - output and consumption boom

Risk Premia Shock



Rigid Prices

Proposition.

$$\tau_t = -\underbrace{\frac{1-\alpha+\frac{2\alpha}{1+\phi}}{1-\alpha+\frac{\alpha_\theta}{1-\alpha}}}_{\leq 1}\psi_t$$

- Stabilize CA: constant $nx_t/\bar{n}x_t = \frac{\frac{\alpha_\theta}{1-\alpha}}{1-\alpha+\frac{\alpha_\theta}{1-\alpha}} < 1$
- Stabilize real exchange rate
- Lean against the wind...
- ...the more so, the more closed the economy

Closed Economy Limit

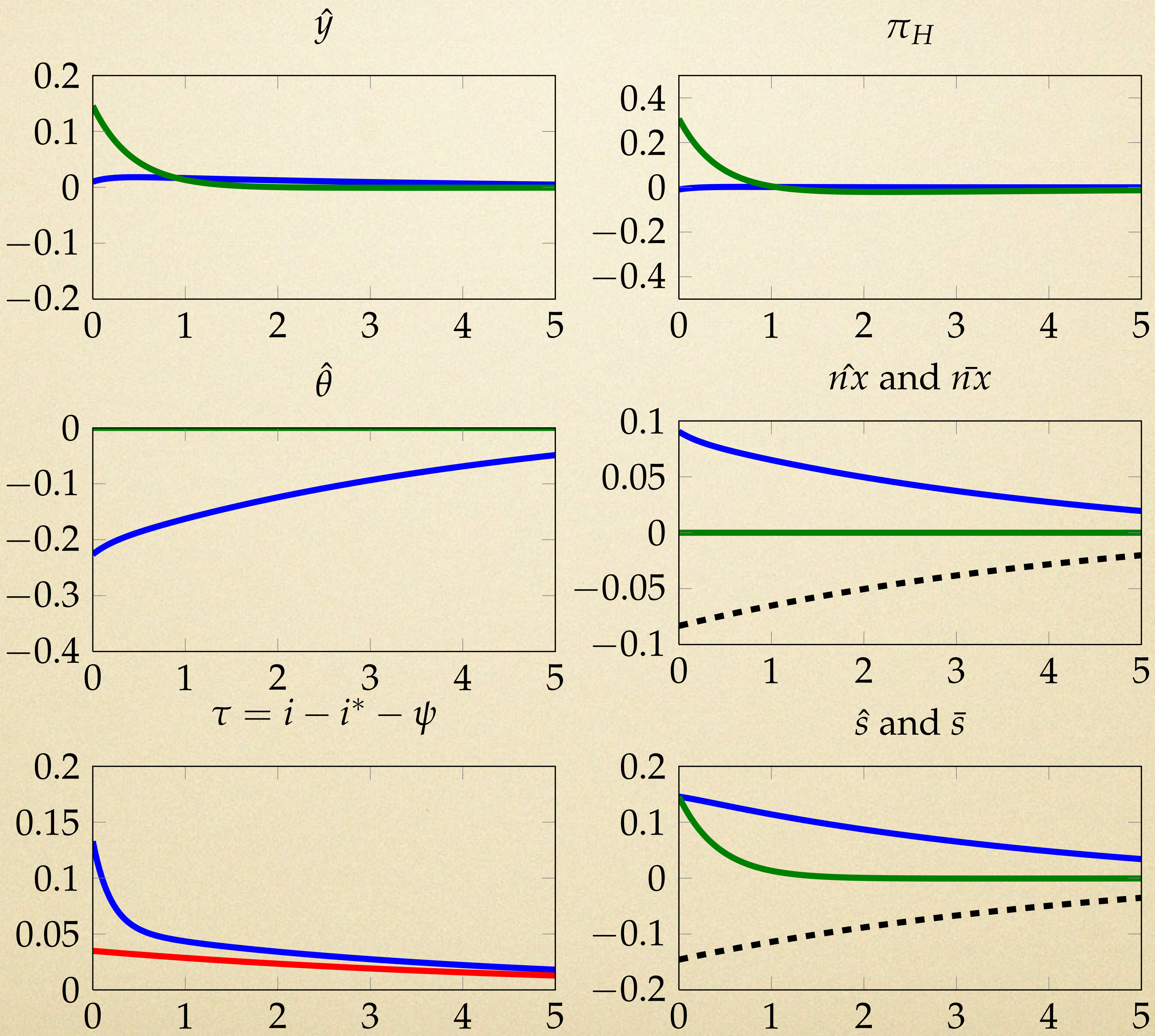
Proposition.

$$\tau_t = -\psi_t$$

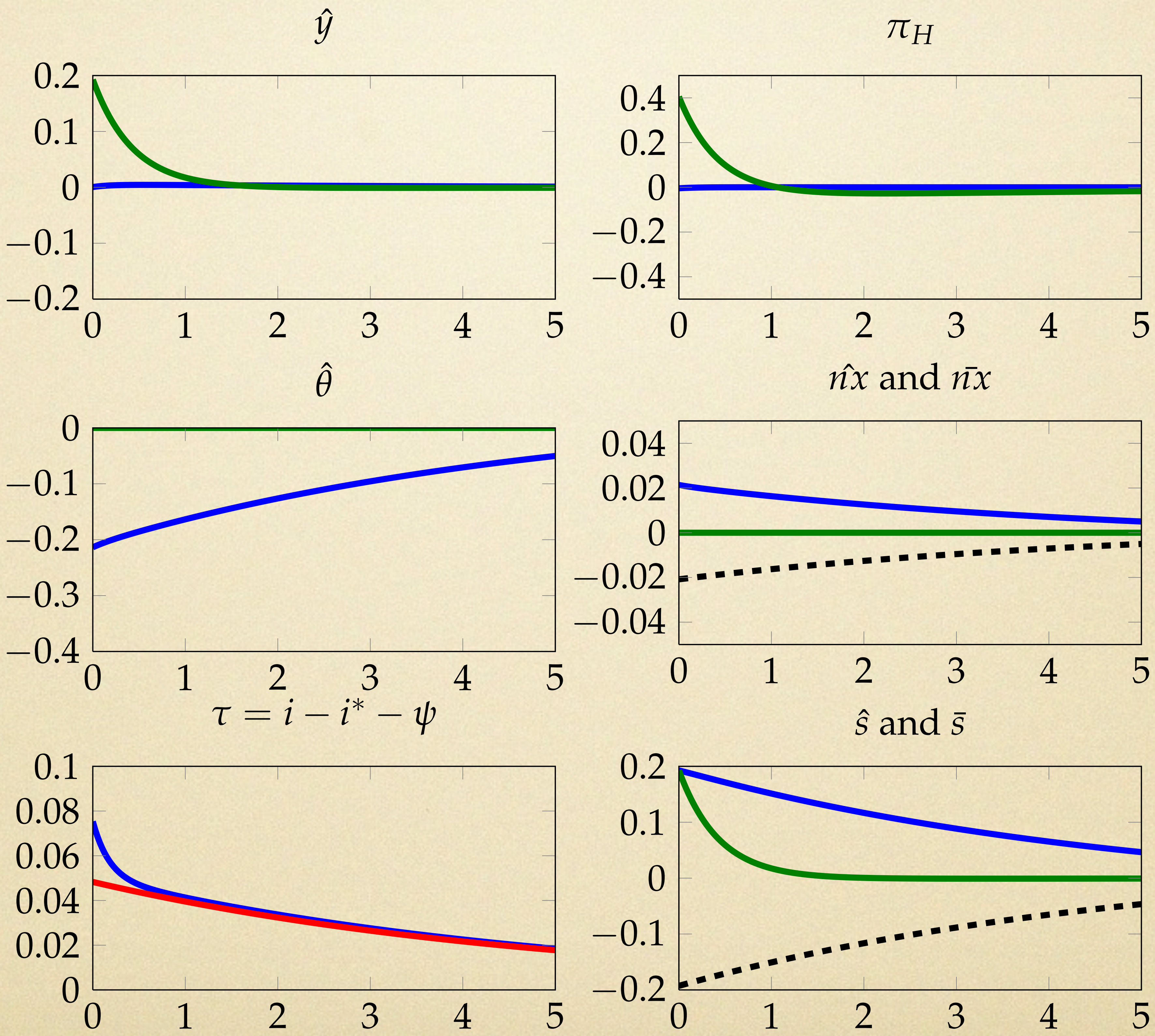
$$\hat{y}_t = \pi_{H,t} = 0$$

- Lean against the wind (one-for-one)
- Perfectly stabilize economy...
- ...**not** true for other shocks

Risk Premia Shock



Risk Premia Shock



Extensions

- Flexible exchange rates
- Sticky Wages
- Government Spending
- Coordination

Flexible Exchange Rate

Proposition.

$$\tau_t = -\alpha_\psi \psi_t - \frac{\lambda\alpha}{\alpha_\theta}\alpha_\pi \pi_{H,t}$$

$$\pi_{H,t} \neq 0$$

- Lean against the wind...
- ...less than with fixed exchange rate
- New: stabilize nominal exchange rate

Sticky Wages

- Add sticky wages (in addition to prices)
  - similar results: greater stickiness
- Even with flexible exchange rates
  - perfect stabilization not possible
  - role for capital controls emerges
- Flexible exchange rates
  - good, but not panacea

Fiscal Policy

- Now: fiscal policy (government spending)

- Solution independent of openness

Coordination

- Up to now...
  - single country taking rest of world as given
- Now, look at world equilibria...
  - without coordination
  - with coordination
- Beggar thy neighbor?

- Coordination on what? Here...
  - Fix labor tax at some level
  - Coordinate capital taxes

Coordination

- Two cases:
  - uncoordinated tax on labor (higher)
  - coordinated tax on labor (lower)

- Terms of trade manipulation...
  - planner at uncoordinated tax: wants more output
  - standard "inflation bias"

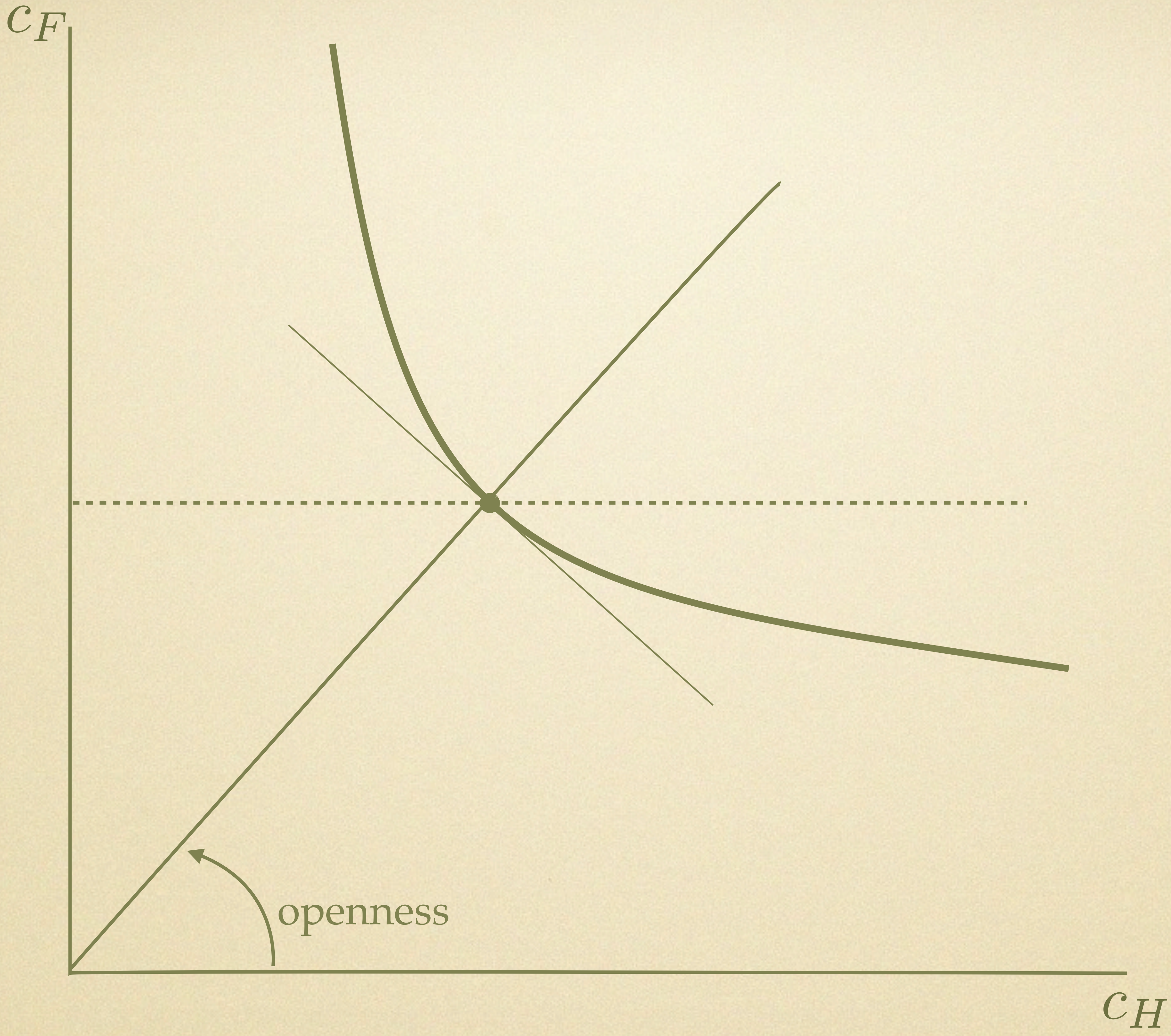
Coordination

- Capital controls
  - same with or without coordination!
- Gains from coordination...
  - transition: uncoordinated capital controls restricts feasible aggregates
  - long-run: coincide

- Overall: limited role for coordination

Conclusions

- Provided characterization of optimal capital controls
  - nature of shocks
  - openness
  - persistence
  - price stickyness
- Coordination?
  - does not affect capital controls!
  - limited role



c_F
openness
c_H

c_F
openness
c_H

c_F
openness
c_H

c_F
capital
controls
openness
c_H

IMF's Blessing

"A recent discussion of this issue at the IMF Executive Board, focused on dealing with inflows [...] our views are evolving. In the IMF, in particular, while the tradition had long been that capital controls should not be part of the toolbox, **we are now more open to their use in appropriate circumstances**, although of course countries should be careful not to use them as substitutes for good macroeconomic policies."

DSK, March 2011

"[...] while **the issue of capital controls is fraught with ideological overtones, it is fundamentally a technical one, indeed a highly technical one.** Put simply, governments have five tools to adjust to capital flows: monetary policy, fiscal policy, foreign exchange intervention, prudential tools, and capital controls. The challenge is to find, for each case, the right combination. This is not easy."

Olivier Blanchard, June 2011

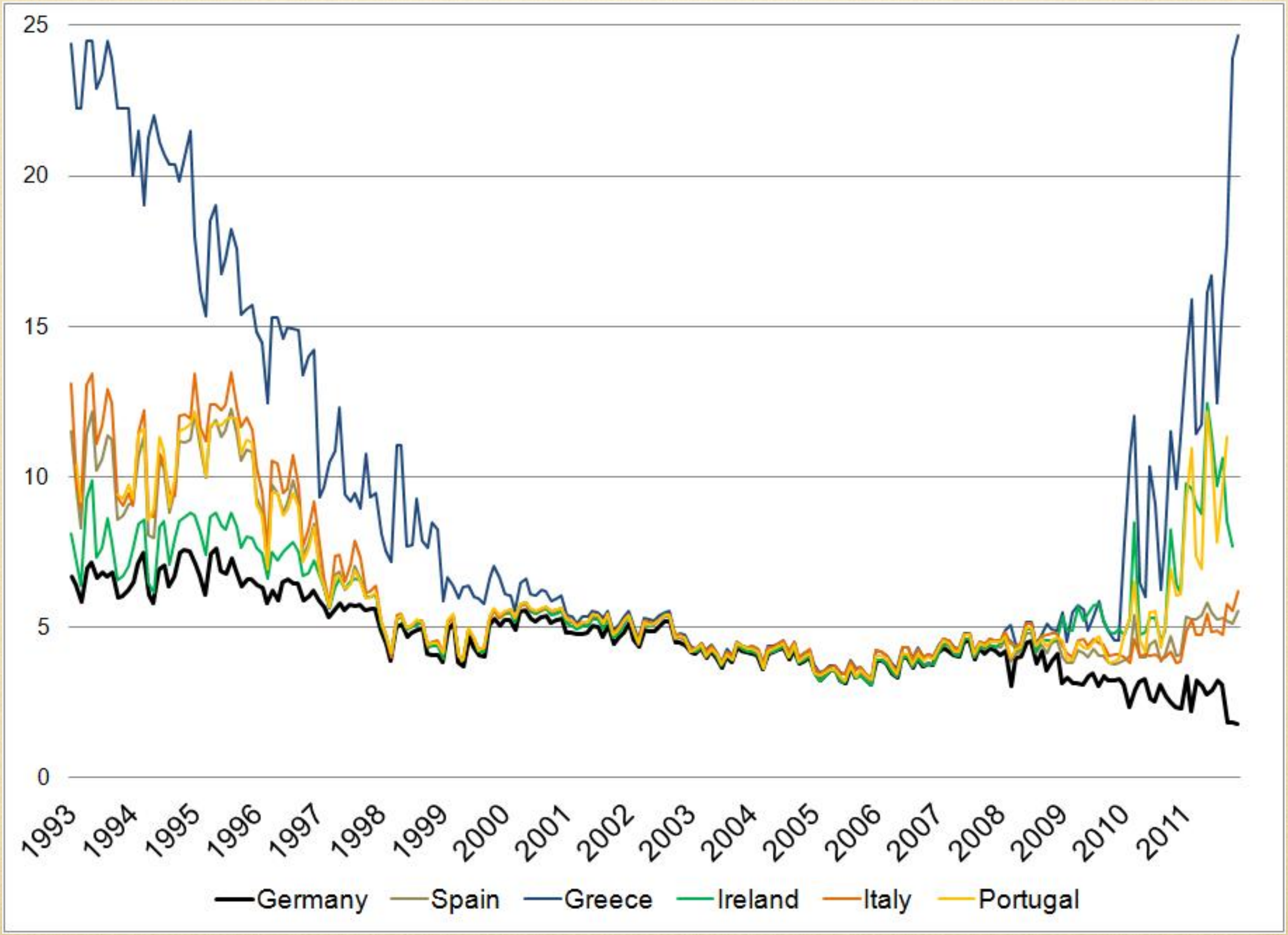
John Maynard Keynes

“In my view the whole management of the domestic economy depends on being free to have the appropriate rate of interest without reference to the rates prevailing elsewhere in the world. **Capital controls is a corollary to this.**”

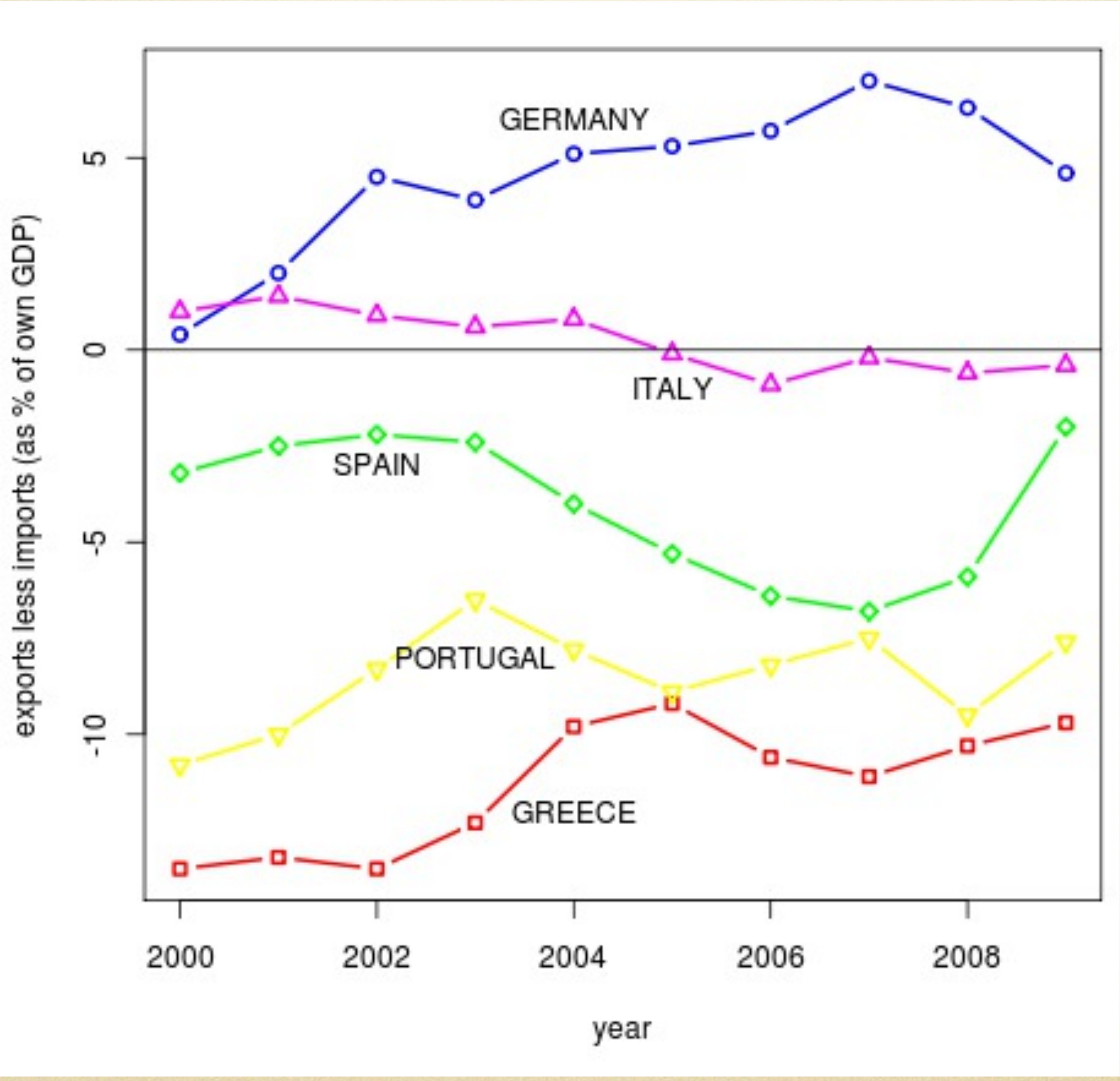
“[...] control of capital movements, both inward and outward, should be a **permanent feature of the post-war system**.”

“What used to be a heresy is now endorsed as orthodoxy."

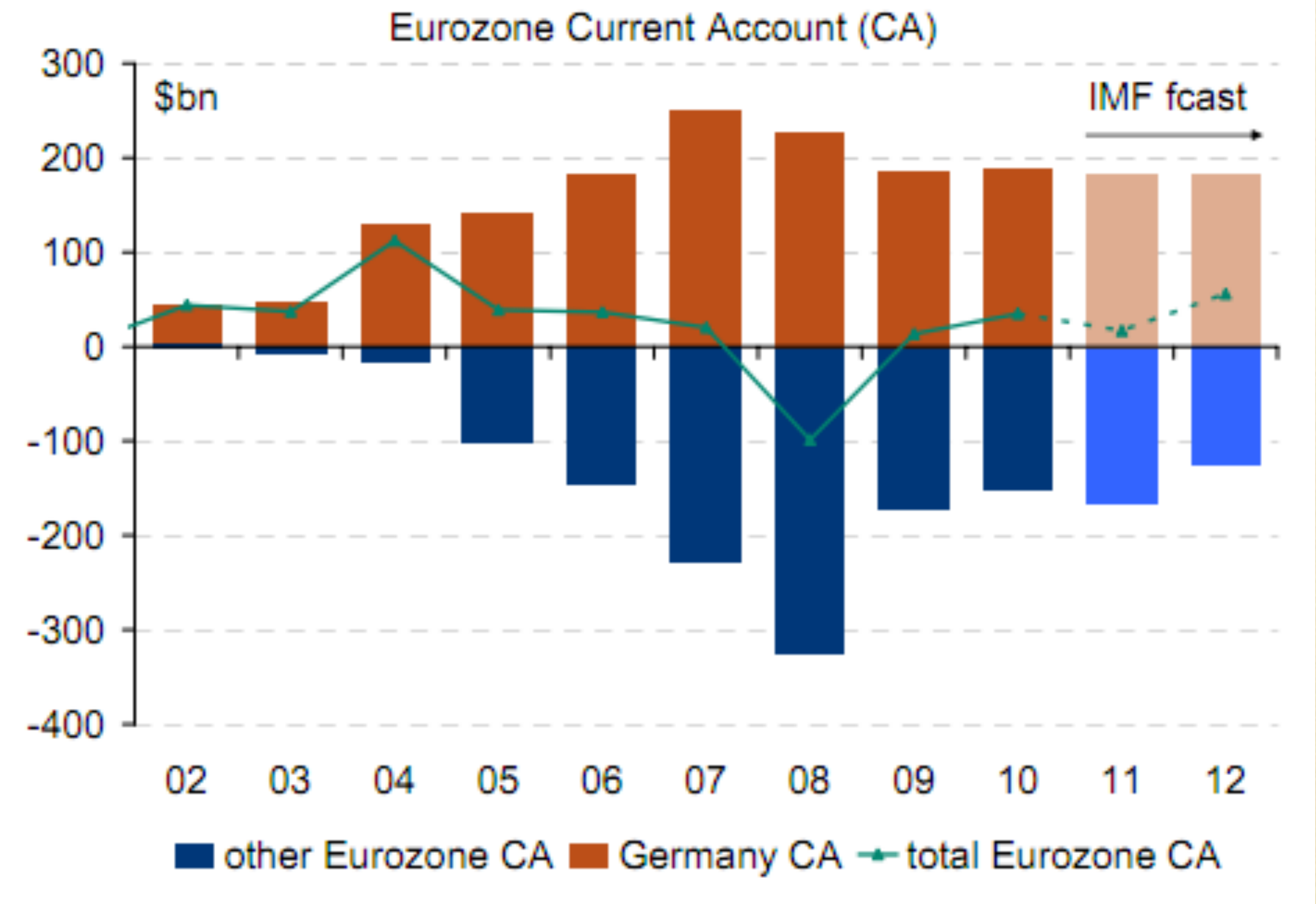
Eurozone Interest Rates



Eurozone Trade Balance



Eurozone Current Account



Source: IMF, BofA Merrill Lynch Global Commodities Research