Dealing with the Trilemma

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Macro-Finance Linkages

Emmanuel Farhi, Harvard
Iván Werning, MIT

Trilemma

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

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."

IMF's Blessing

"[...] 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** [...]"

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.** "

Olivier Blanchard, June 2011

Goal

- Optimal monetary policy: well developed theory
- Do the same for capital controls
  - nature of shocks
  - persistence of shocks
  - price rigidity
  - openness
  - coordination
- Emphasis
  - hot money, sudden stops (volatile capital flows)
  - risk premium shocks

Related Literature

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

Setup

- Continuum of small open economies $i \in [0, 1]$
  - fixed exchange rate
  - different 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

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

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

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

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

(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

$$Y_t(j) = A_t N_t(j)$$

UIP

- No arbitrage (UIP)

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

- Euler

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

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

UIP

- No arbitrage (UIP)

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

- Euler

$$\beta \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} = \frac{1 + i_t}{1 + \pi_{t+1}} \qquad \beta \left(\frac{C^*_{t+1}}{C^*_t} \right)^{-\sigma} = \frac{1 + i^*_t}{1 + \pi^*_{t+1}}$$

$$C_t = \Theta_t C_t^* Q_t^{\frac{1}{\sigma}} \quad \text{(Backus-Smith)}$$

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

Timing

- Start at steady state t=-1
- At t=0
  - hit by unexpected shock (path for future)
  - no insurance (incomplete markets)

Shocks

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

5. Risk Premium (later)

Pricing

1. Flexible Prices
2. Rigid Prices
3. One-Period Ahead Sticky Prices
4. Calvo Pricing

Flexible Prices

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

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

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

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

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

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

Flexible Prices

- without capital controls, i.e. Θ_t constant

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

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

Rigid Prices

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

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

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Rigid Prices

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

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

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

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

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

Rigid Prices

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

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

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

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

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

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

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

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

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

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, Transitory Shocks

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

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, Transitory Shocks

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

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^*

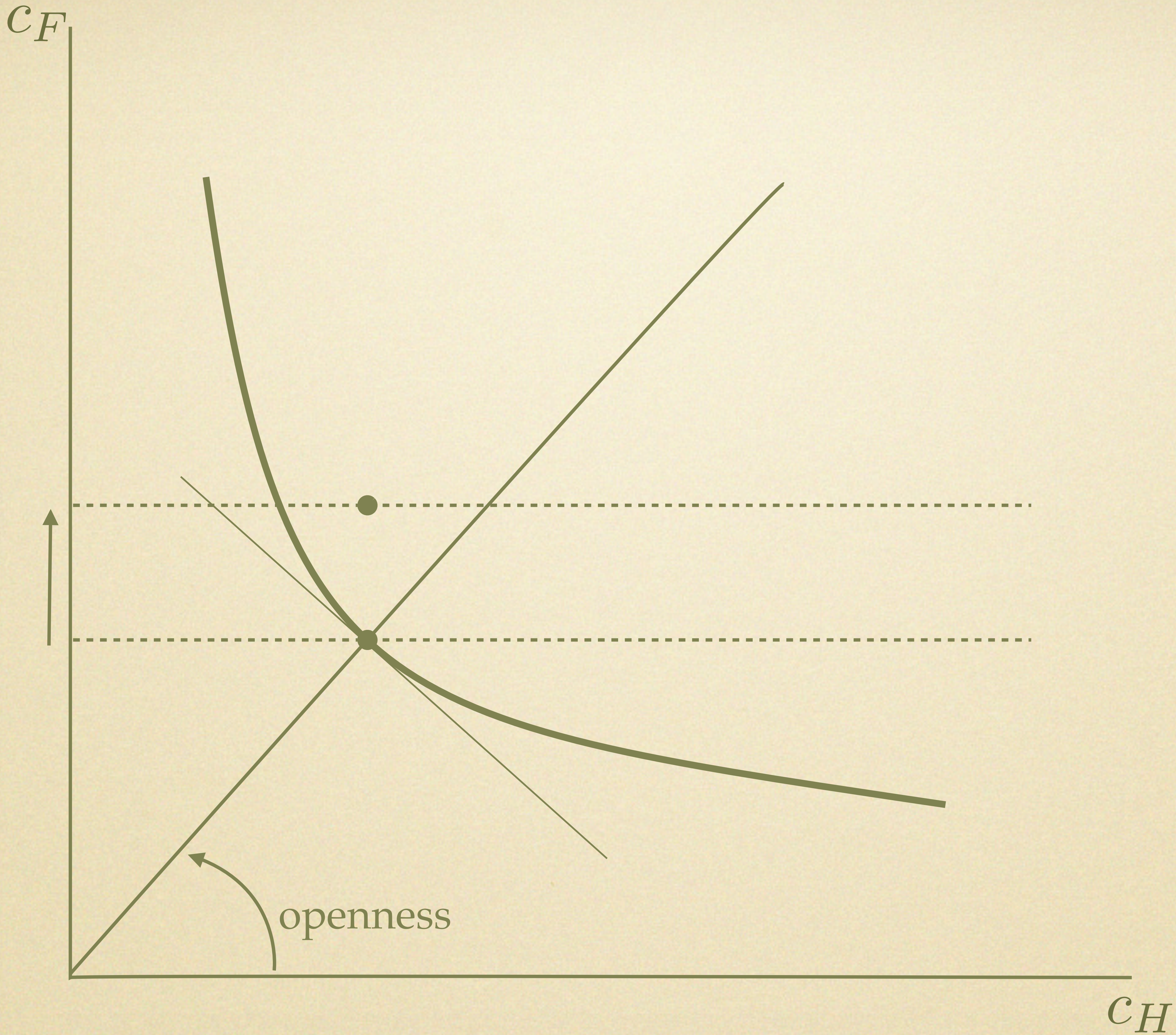
One Period Sticky, Permanent Shocks

- harder: shocks now affect V()

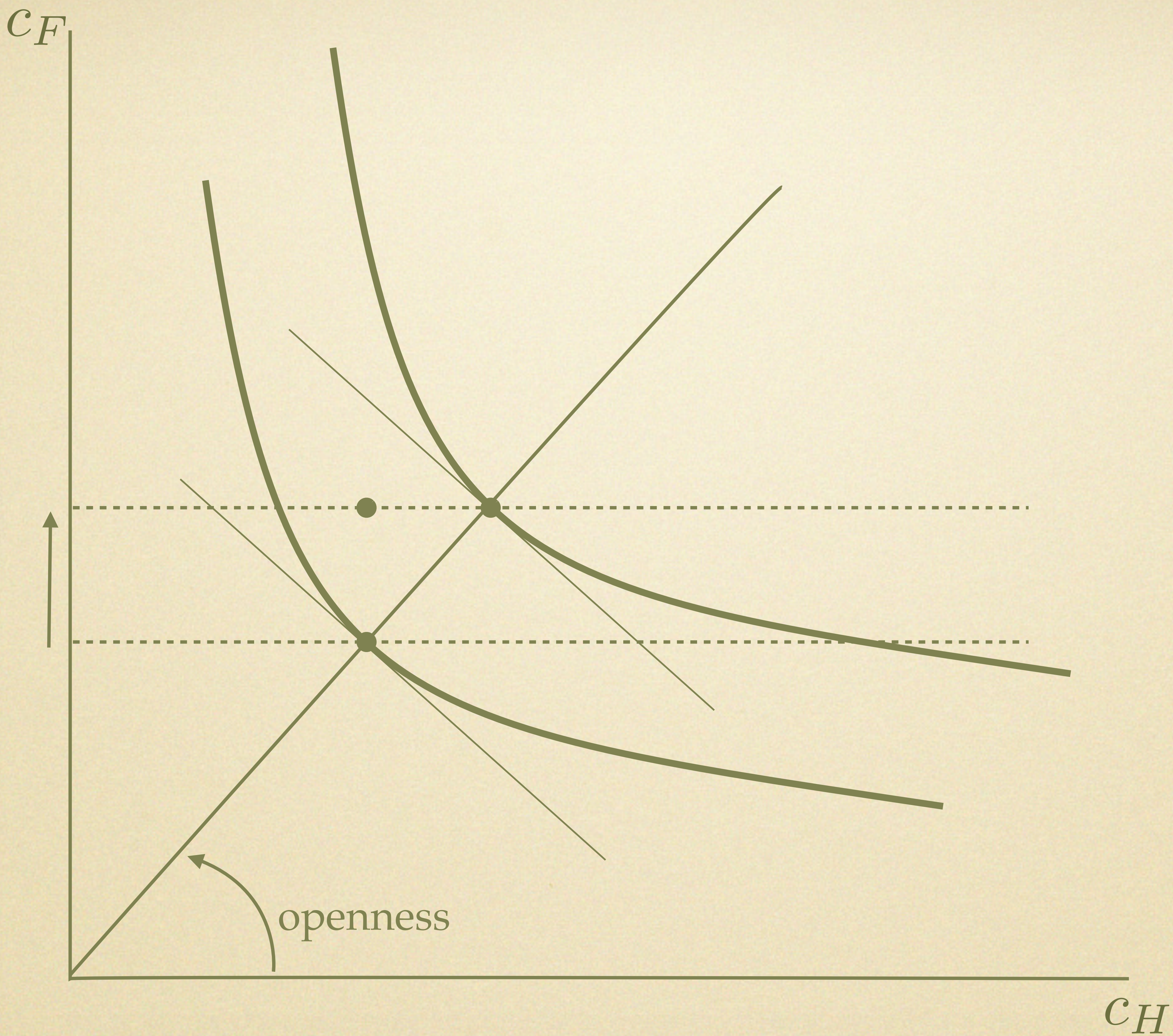
Proposition.
Positive initial tax on inflows:
1. decrease in productivity A
2. increase in exports Λ
3. increase in foreign consumption C^*
4. increase in wealth NFA_0

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

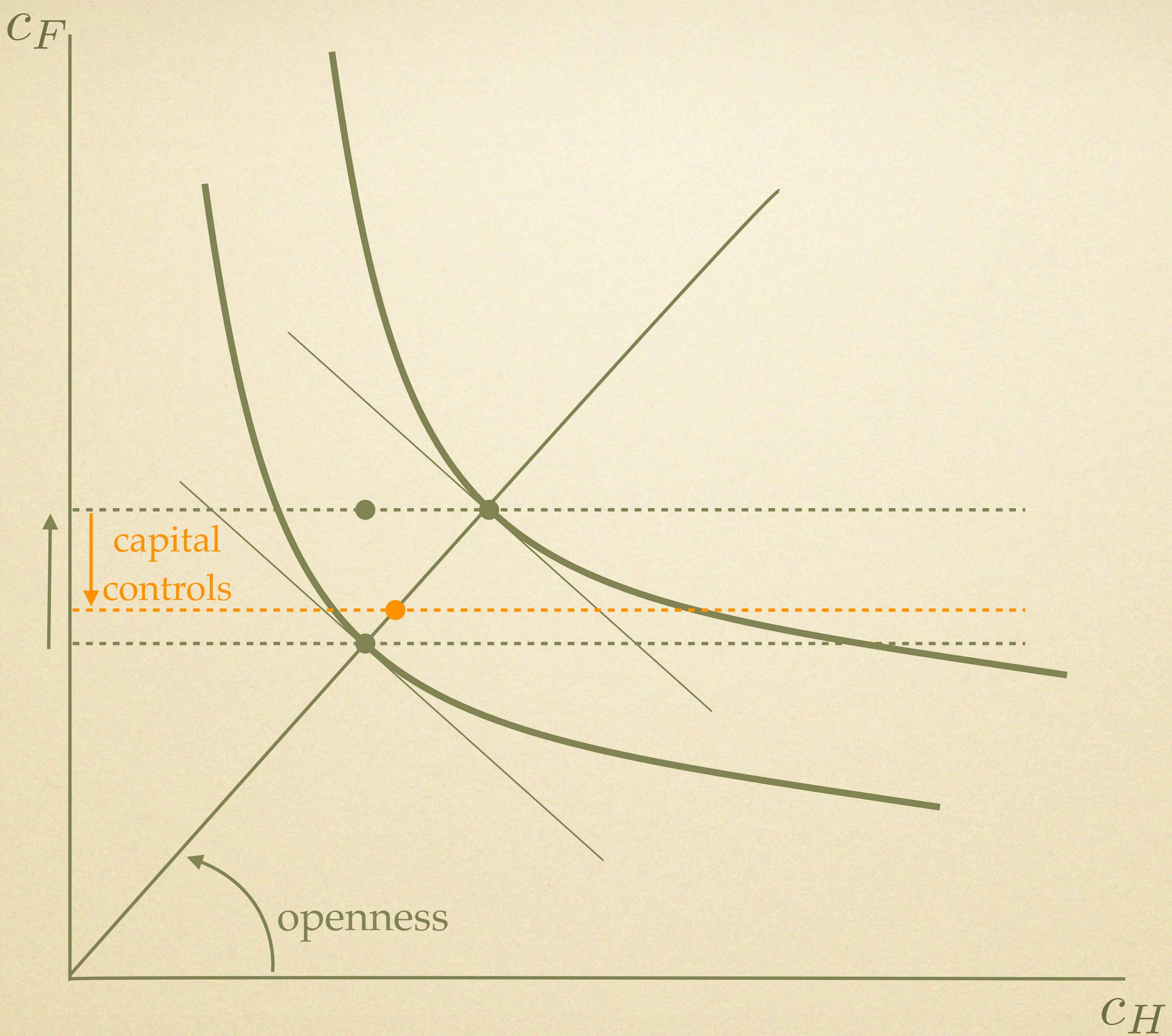
c_F
openness
c_H



c_F
openness
c_H



c_F
openness
c_H


c_F
capital
controls
openness
c_H

Role of Openness

- Closed economy limit $\alpha \to 0$

- Perfect stabilization?
  - No intervention: No
  - Optimal Capital Controls: Maybe

- Depends on
  - type of shock: risk premium yes
  - form of price rigidity

Calvo Pricing

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

- Continuous time: convenient, initial prices given
- 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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$$\dot{\hat{\theta}}_t = i_t - i_t^*$$

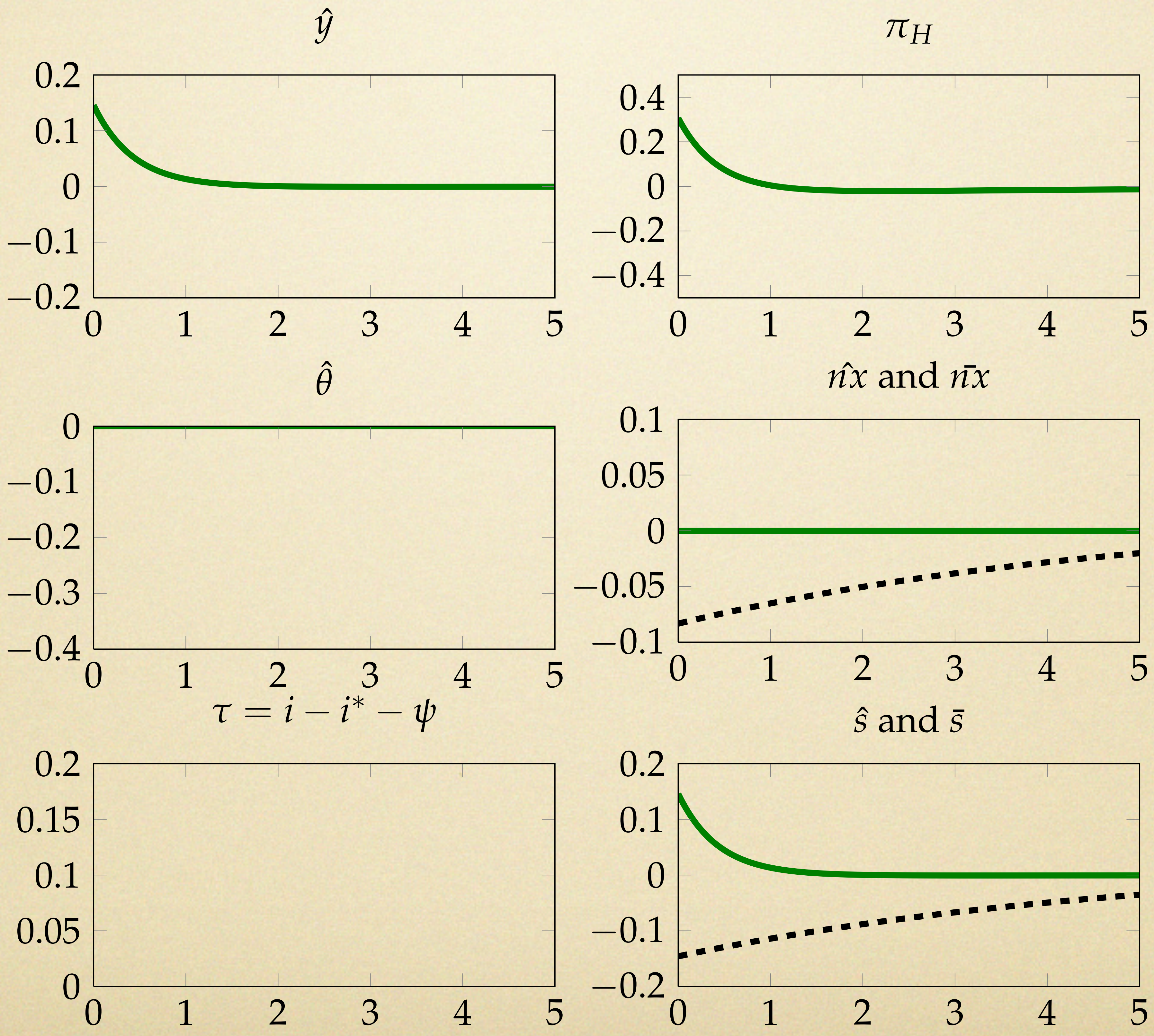
$$\int e^{-\rho t} \hat{\theta}_t dt = 0$$

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

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.

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

- Stabilize CA: constant $nx_t/\bar{nx}_t = 1 - \frac{\frac{1+\phi(1-\alpha)}{1+\phi}}{1-\alpha+\frac{\alpha_\theta}{1-\alpha}} \leq 1$
- Lean against the wind...
- ...more effective when economy more closed

Closed Economy Limit

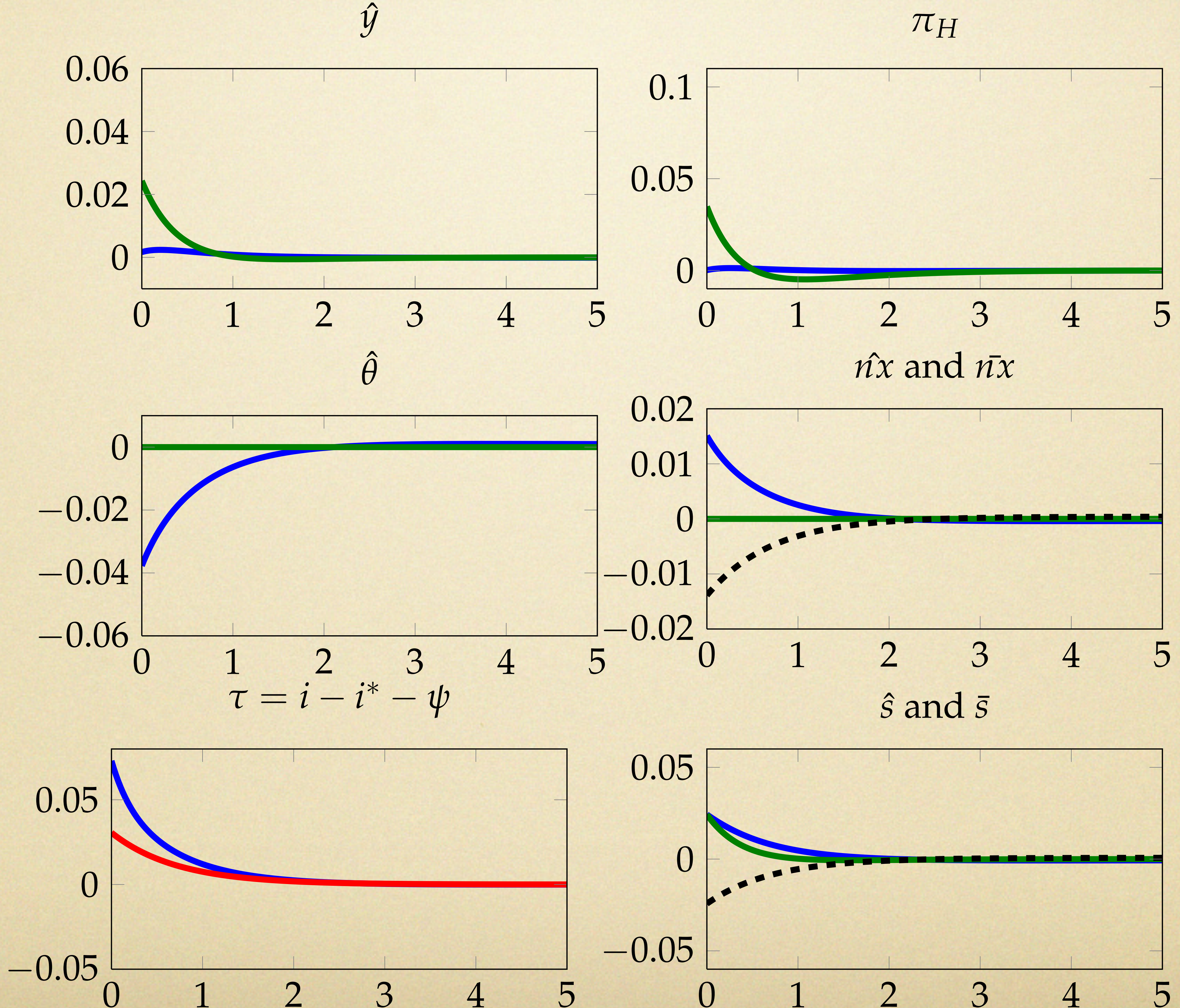
Proposition.

$$\tau_t = -\psi_t$$

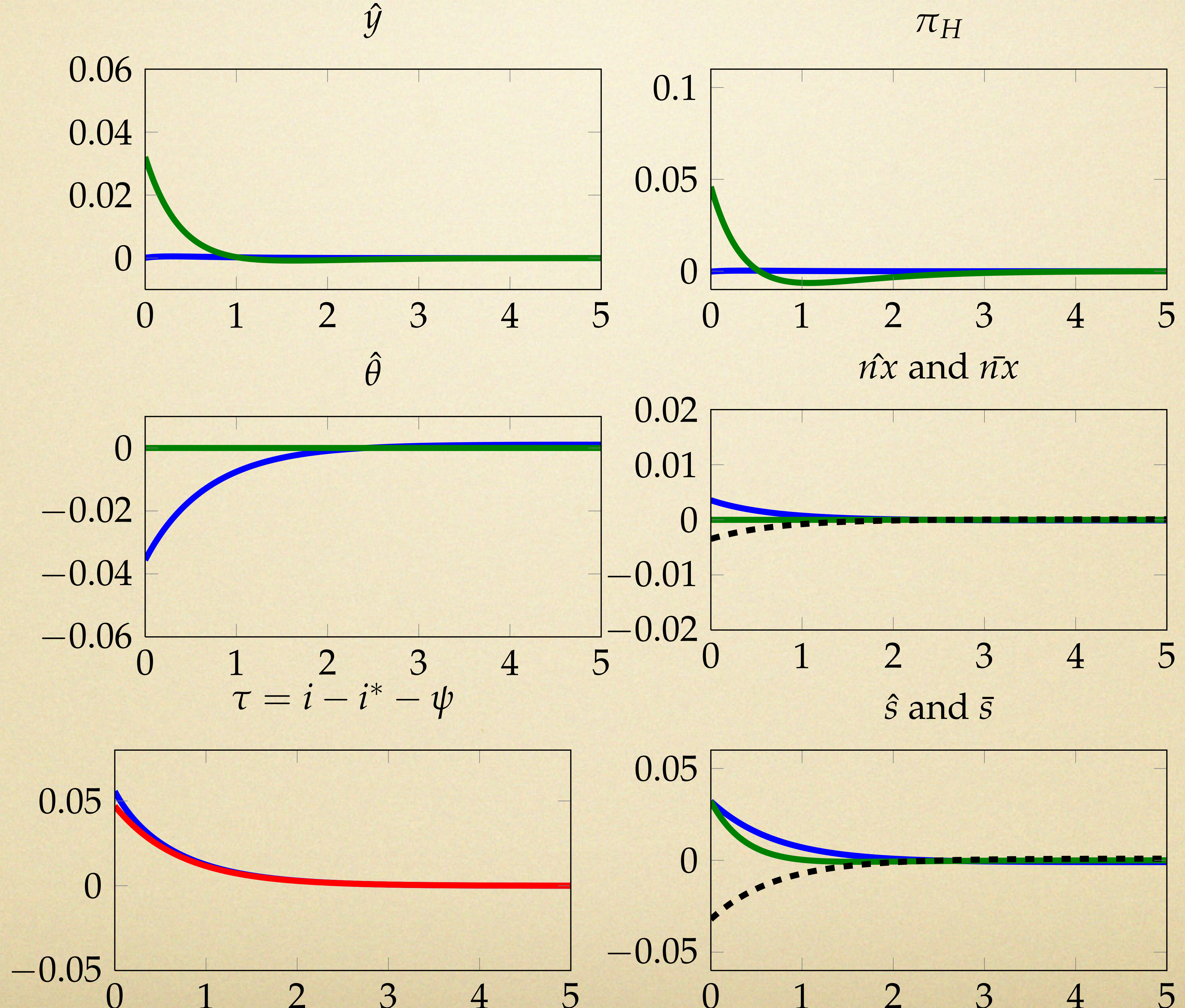
$$\hat{y}_t = \pi_{H,t} = 0$$

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

Risk Premium $\alpha = 0.4$



Risk Premium $\alpha = 0.1$



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

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 (Small α)

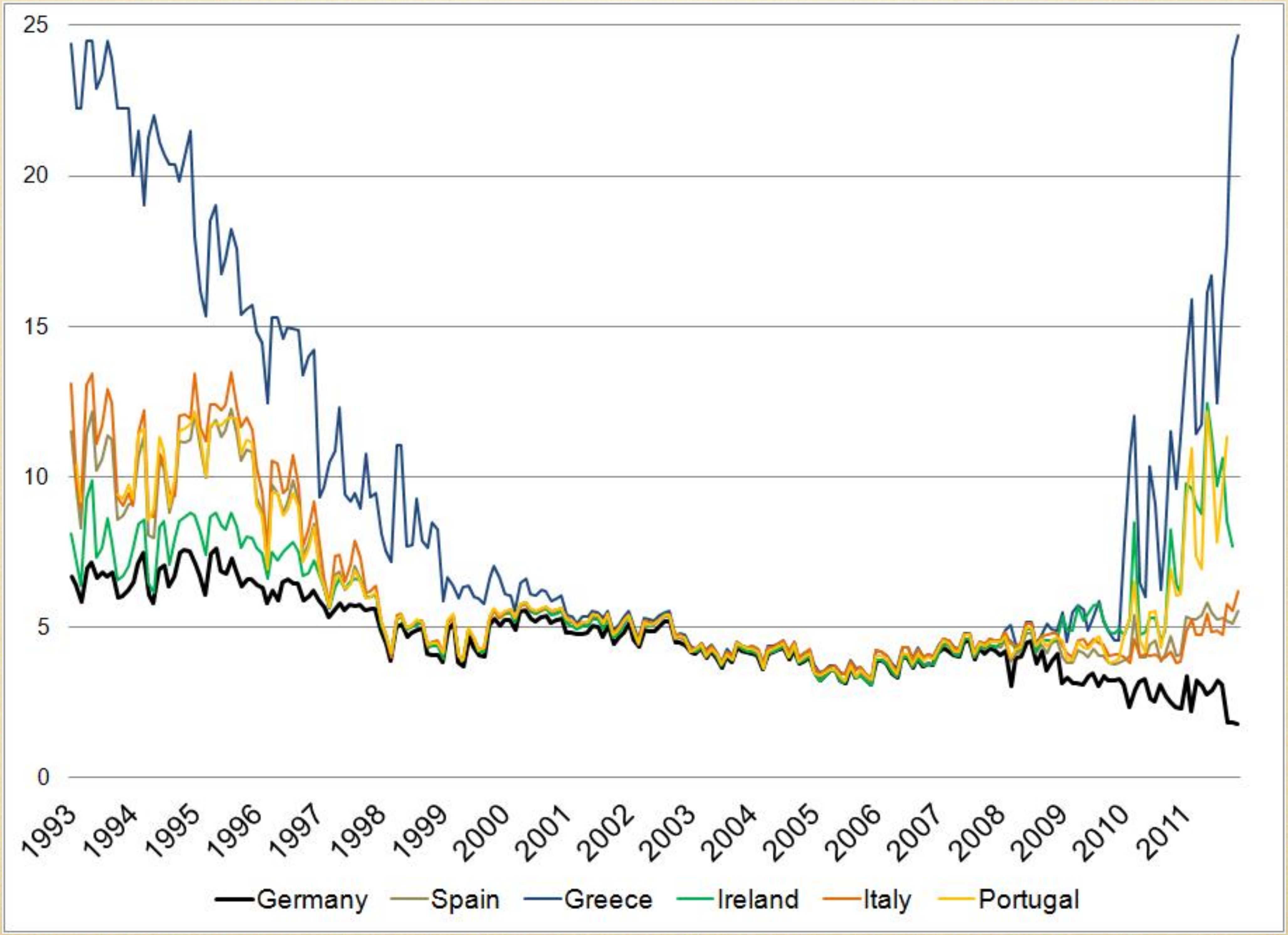
- Capital controls
  - same with or without coordination!
- Gains from coordination...
  - transition: uncoordinated capital controls restricts feasible aggregates
  - long-run: coincide

- <u>Overall</u>: limited role for coordination

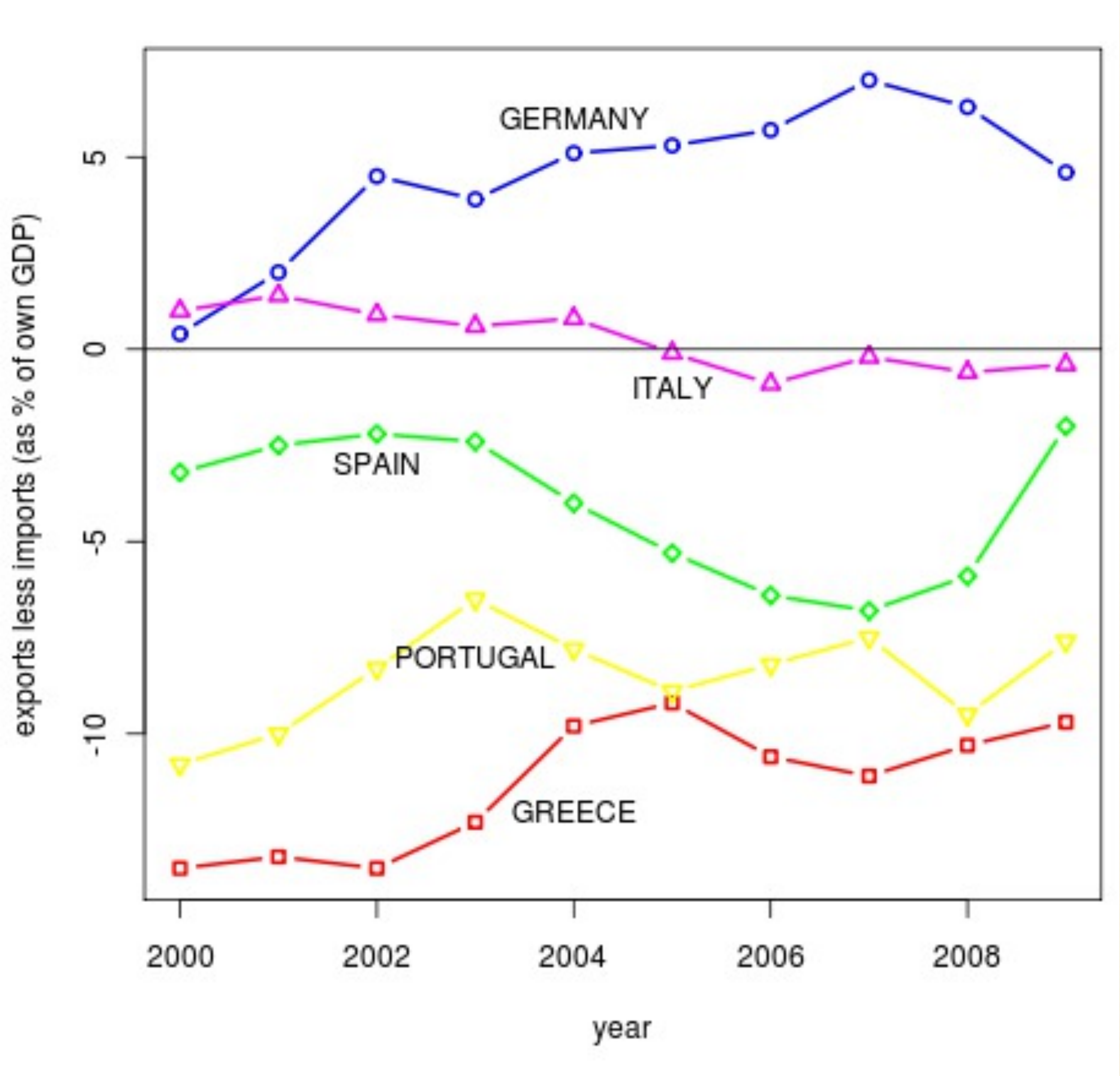
Conclusions

- Tight characterization of optimal capital controls...
  - nature of shocks
  - openness
  - persistence
  - price stickiness
  - coordination

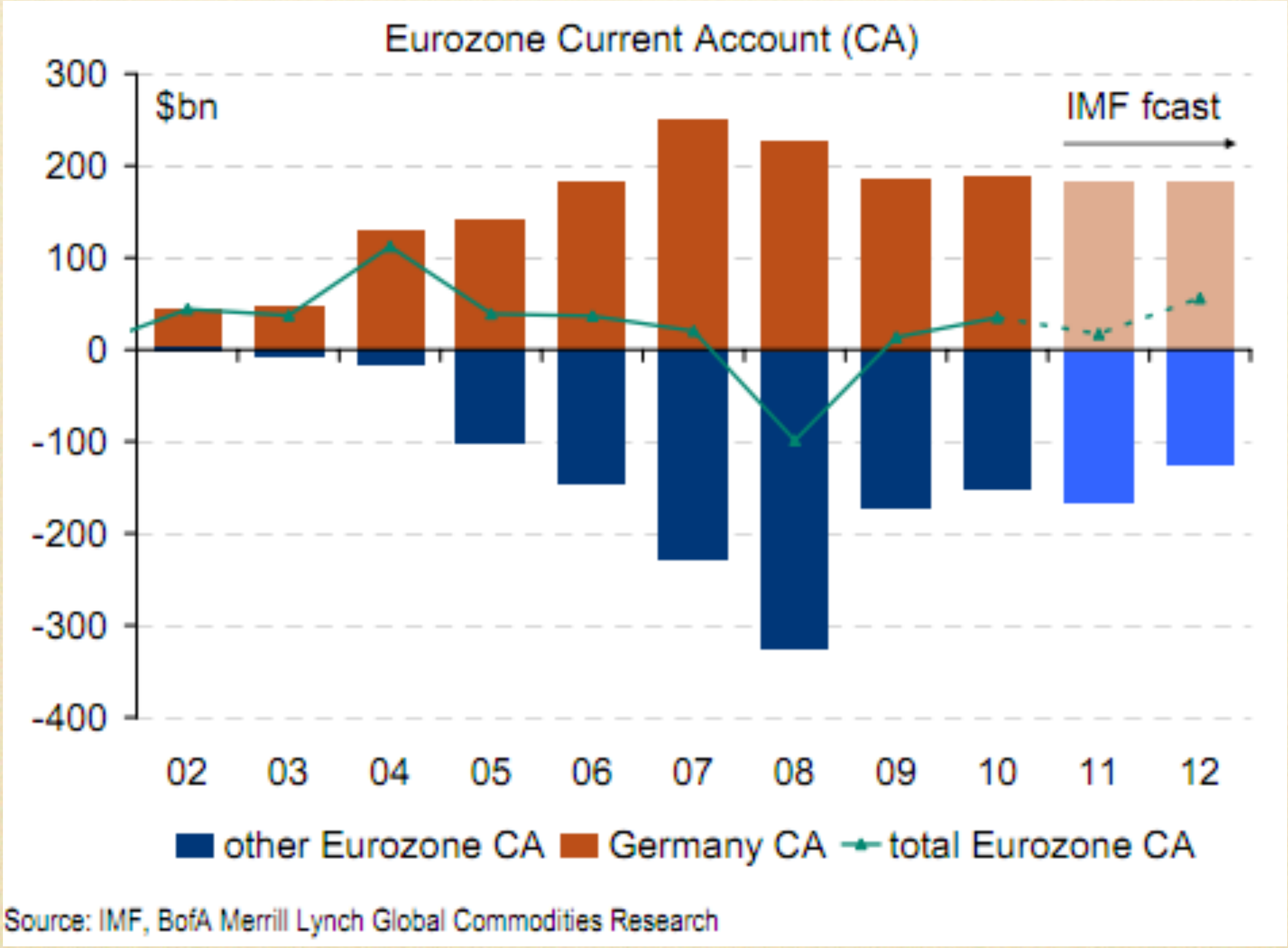
Eurozone Interest Rates



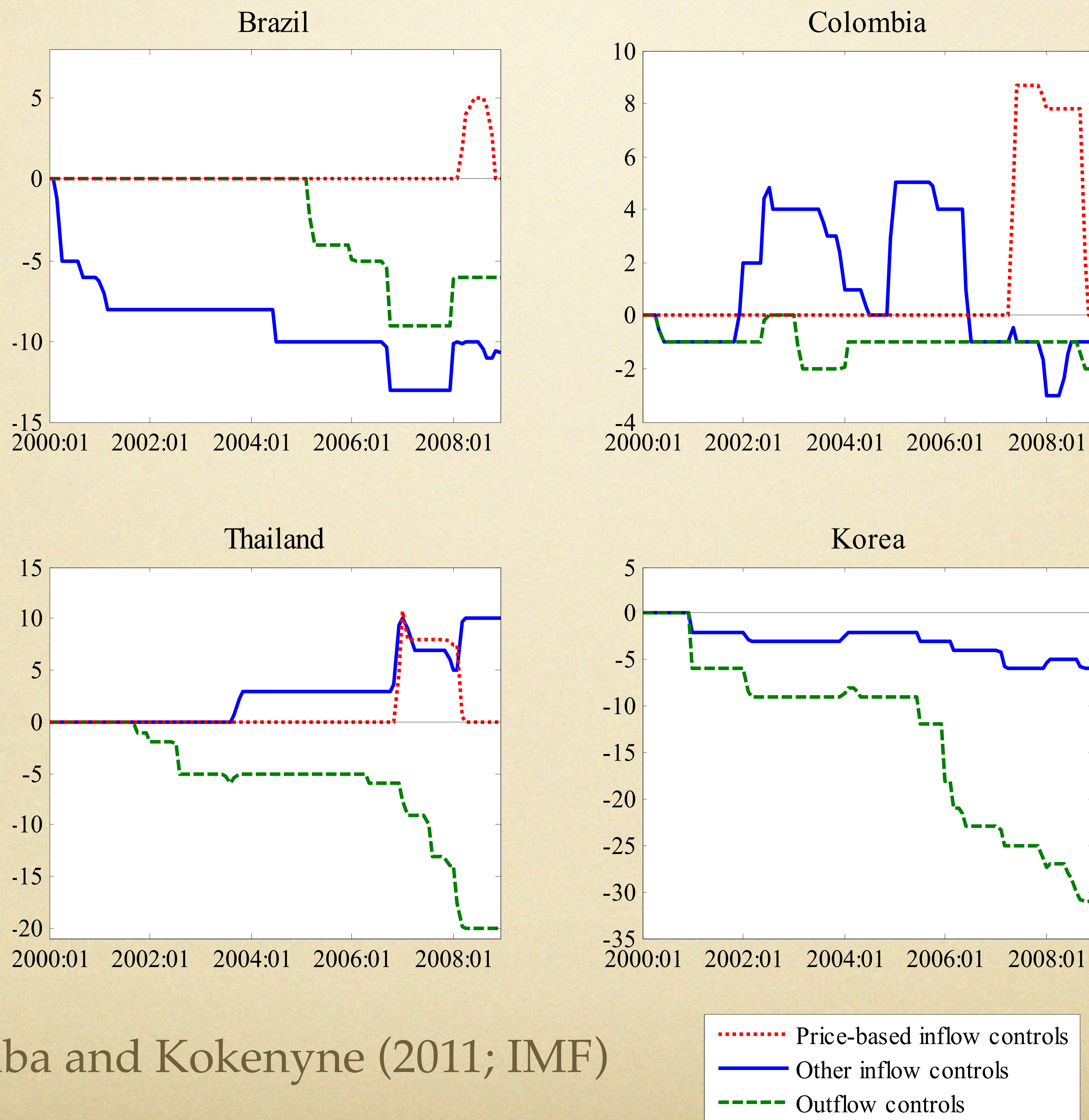
Eurozone Trade Balance



Eurozone Current Account

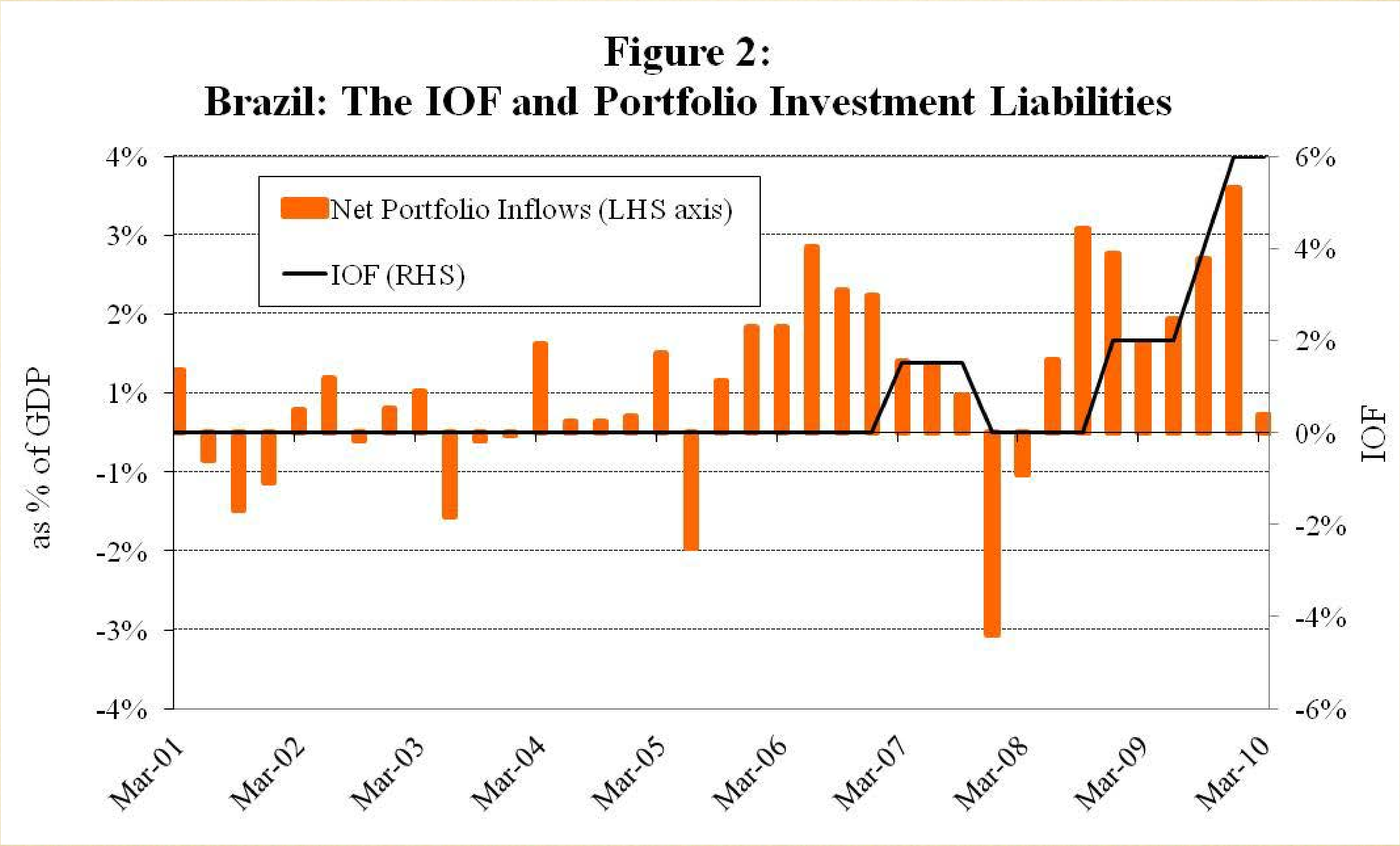


Recent Examples



Source: Baba and Kokenyne (2011; IMF)

Recent Examples



Source: Forbes et al (2011)