Aggregate Demand Externalities in a Global Liquidity Trap

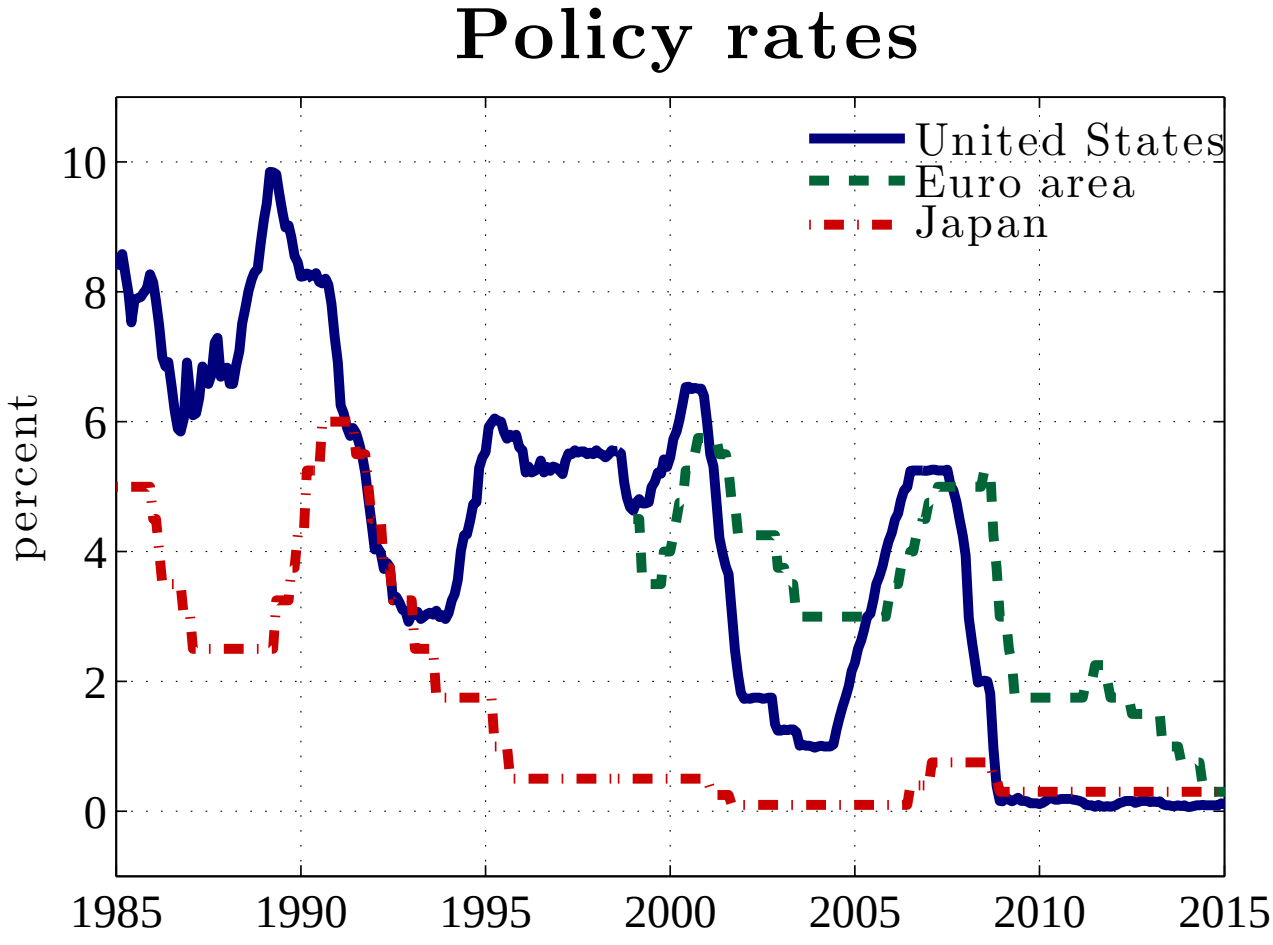
Luca Fornaro and Federica Romei

Motivation and research questions

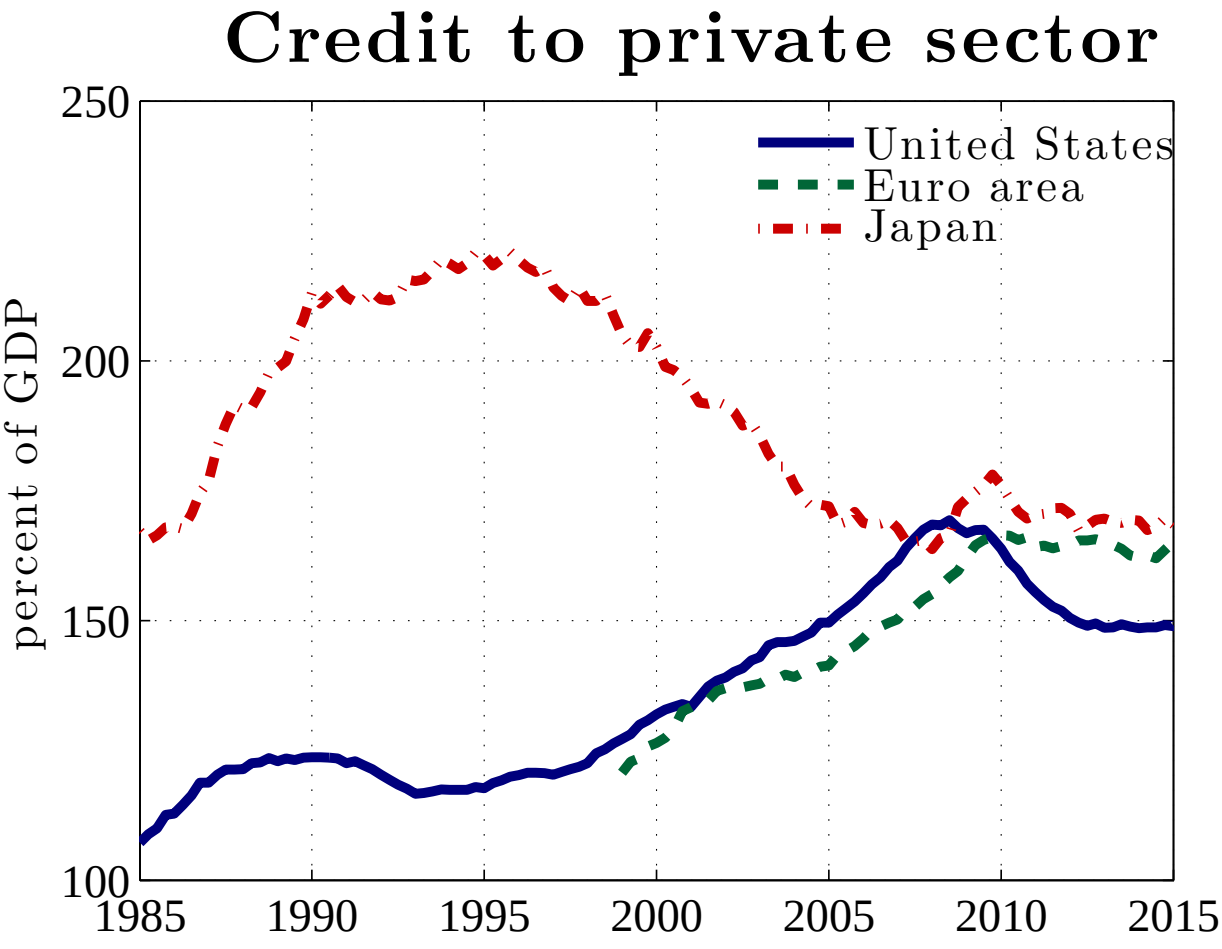
Two key facts characterizing the global economy

- Low interest rates (real and nominal)
- Liquidity traps associated with financial crises and debt deleveraging

Policy rates: 1985-2015



Credit to private sector: 1985-2015



Motivation and research questions

- Two key facts characterizing the global economy
  - Low interest rates (real and nominal)
  - Liquidity traps associated with financial crises and debt deleveraging
- Recent literature on macroprudential policies as stabilization tools (Farhi and Werning, 2015, 2016; Korinek and Simsek, 2016; Schmitt-Grohe and Uribe, 2016)
- **Open questions**
  - How should financial market interventions be designed in a world characterized by low interest rates and high financial integration?
  - Is there a need for international cooperation?

This paper

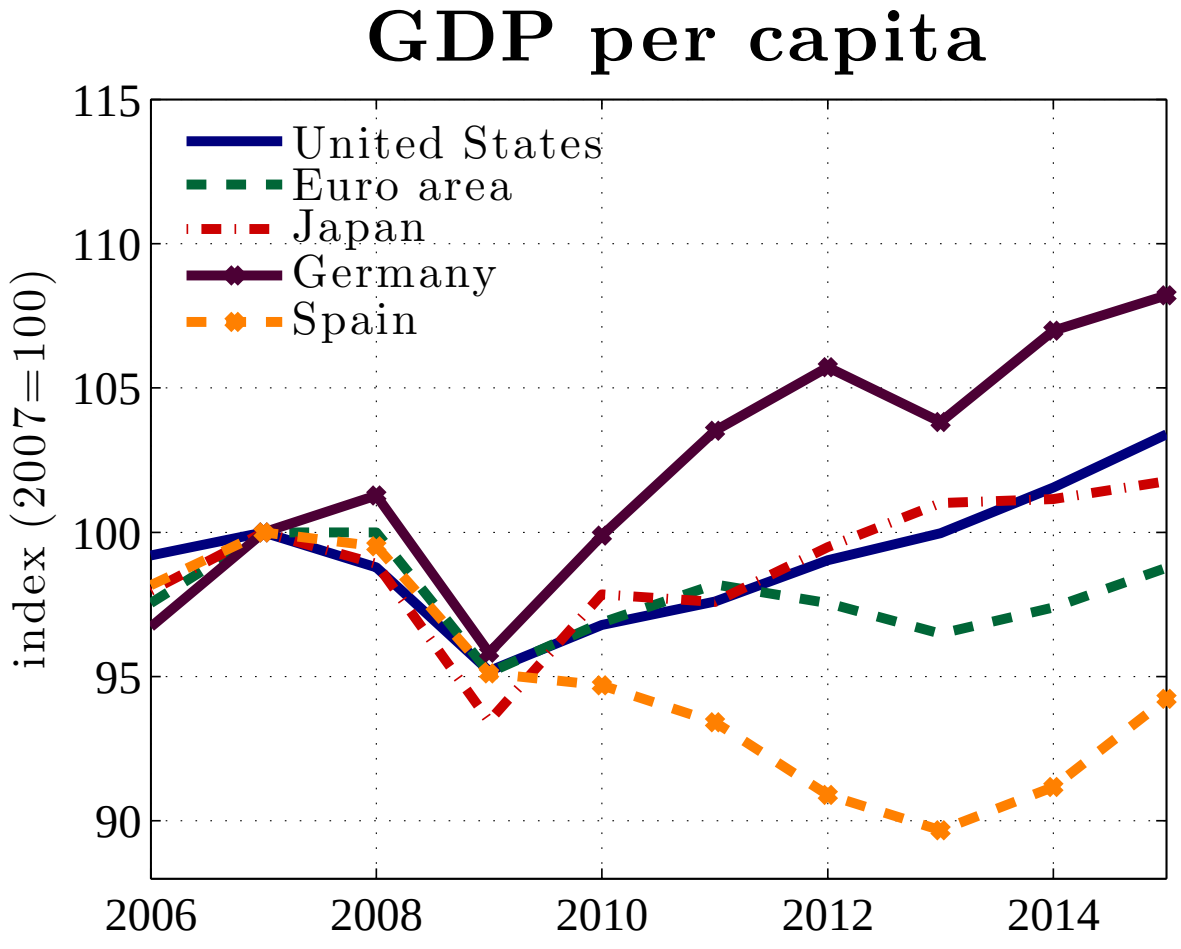
Model of financially integrated world

- Continuum of small open economies
- Idiosyncratic shocks $\rightarrow$ trade in financial assets
- Nominal rigidities

Global liquidity trap

- Low real interest rates
- Monetary policy occasionally constrained by zlb
- Asymmetric business cycles and liquidity traps

GDP per capita: US, Euro area, Japan, Germany, Spain



Preview of results

Key insight: Uncoordinated capital market interventions are inefficient (and sometime worse than laissez faire)

- Governments in booming countries implement counter-cyclical macroprudential policies to insure against future recessions
- Public intervention in credit markets increases the global supply of savings and decreases the global demand for consumption
- Recession in countries currently at the zlb gets worse

This **international aggregate demand externality** calls for cooperation when designing capital market interventions in a low interest rate world

Related literature

- **Aggregate demand externalities and macroprudential policies:** Farhi and Werning (2015), Korinek and Simsek (2015), Schmitt-Grohe and Uribe (2015)
- **Liquidity traps and secular stagnation in open economies:** Benigno and Romei (2014), Fornaro (2014), Eggertsson et al. (2014), Caballero et al. (2015)
- **International coordination:** Benigno (2001), Obstfeld and Rogoff (2002), Benigno and Benigno (2003), Sergeyev (2016), Acharya and Bengui (2016)

Outline

1. **Baseline model**
2. Equilibrium and optimal financial policy
3. Full model and numerical analysis

Baseline model

- World composed of a continuum of small open economies
- Each economy is inhabited by identical households and firms
- Each economy has its own currency and central bank
- Perfect foresight

Households

- Representative household with lifetime utility

$$\sum_{t=0}^{\infty} \beta^t \log C_{i,t} \quad \text{with} \quad C_{i,t} = \left(C_{i,t}^T\right)^{\omega} \left(C_{i,t}^N\right)^{1-\omega}$$

- One unit labor endowment, no labor disutility
- Receives endowment of tradables
- Budget constraint

$$P_{i,t}^T C_{i,t}^T + P_{i,t}^N C_{i,t}^N + A_{i,t+1} = P_{i,t}^T Y_{i,t}^T + W_{i,t} L_{i,t} + R_{i,t-1}^A A_{i,t}$$

Financial assets and borrowing constraint

- Real bond B
  - Denominated in units of tradables
  - Pays world interest rate R_t
- Nominal bond B^n
  - Pays nominal interest rate $R^n_{i,t}$ (policy rate)
  - Zero net supply
- Borrowing limit

$$B_{i,t+1} + \frac{B^n_{i,t+1}}{P^T_{i,t}} \geq -\kappa \quad \text{with} \quad \kappa \to 0$$

Optimality conditions

- Euler equation

$$\frac{1}{C_{i,t}^T} = \frac{\beta R_t}{C_{i,t+1}^T} + \mu_{i,t}$$

$$\mu_{i,t}\left(B_{i,t+1} + \frac{B_{i,t+1}^n}{P_{i,t}^T}\right) = 0$$

- No arbitrage (uncovered interest parity)

$$R_{i,t}^n = R_t \frac{P_{i,t+1}^T}{P_{i,t}^T} \rightarrow R_{i,t}^n = R_{j,t}^n \frac{S_{i,t+1}^j}{S_{i,t}^j}$$

- Intratemporal allocation of expenditure

$$C_{i,t}^N = \frac{1-\omega}{\omega} \frac{P_{i,t}^T}{P_{i,t}^N} C_{i,t}^T$$

Aggregate demand for non-tradable good

$$C_{i,t}^N = \frac{R\pi_{i,t+1}}{R_{i,t}^n} \frac{C_{i,t}^T}{C_{i,t+1}^T} C_{i,t+1}^N \qquad \text{(AD)}$$

Aggregate demand

- Decreasing in $R_{i,t}^n/\pi_{i,t+1}$, where $\pi_{i,t} \equiv P_{i,t}^N/P_{i,t-1}^N$
- Increasing in $C_{i,t+1}^N$
- Increasing in $C_{i,t}^T/C_{i,t+1}^T$
- Increasing in R

Firms and labor market

- Non-tradable good produced by competitive firms

$$Y_{i,t}^N = L_{i,t}$$

- Zero-profit condition implies

$$P_{i,t}^N = W_{i,t}$$

- Downward wage rigidities

$$W_{i,t} \geq \gamma W_{i,t-1}$$

- Equilibrium on labor market

$$(L_{i,t} - 1)(W_{i,t} - \gamma W_{i,t-1}) = 0$$

Monetary policy

- Central bank targets domestic inflation $\pi_{i,t}$
- Assume inflation target $\bar{\pi} > \gamma$ so that

$$\pi_{i,t} = \bar{\pi} \rightarrow Y_{i,t}^N = 1$$

- Central bank sets $R_{i,t}^n$, subject to $R_{i,t}^n \geq 1$

$$R_{i,t}^n = \begin{cases} \geq 1 & \text{if } Y_{i,t}^N = 1, \pi_{i,t} = \bar{\pi} \\ = 1 & \text{if } Y_{i,t}^N < 1, \pi_{i,t} = \gamma \end{cases} \qquad \text{(MP)}$$

Market clearing

- Goods market

$$C_{i,t}^T = Y_{i,t}^T - B_{i,t+1} + R_{t-1} B_{i,t}$$

$$C_{i,t}^N = Y_{i,t}^N$$

- Labor market

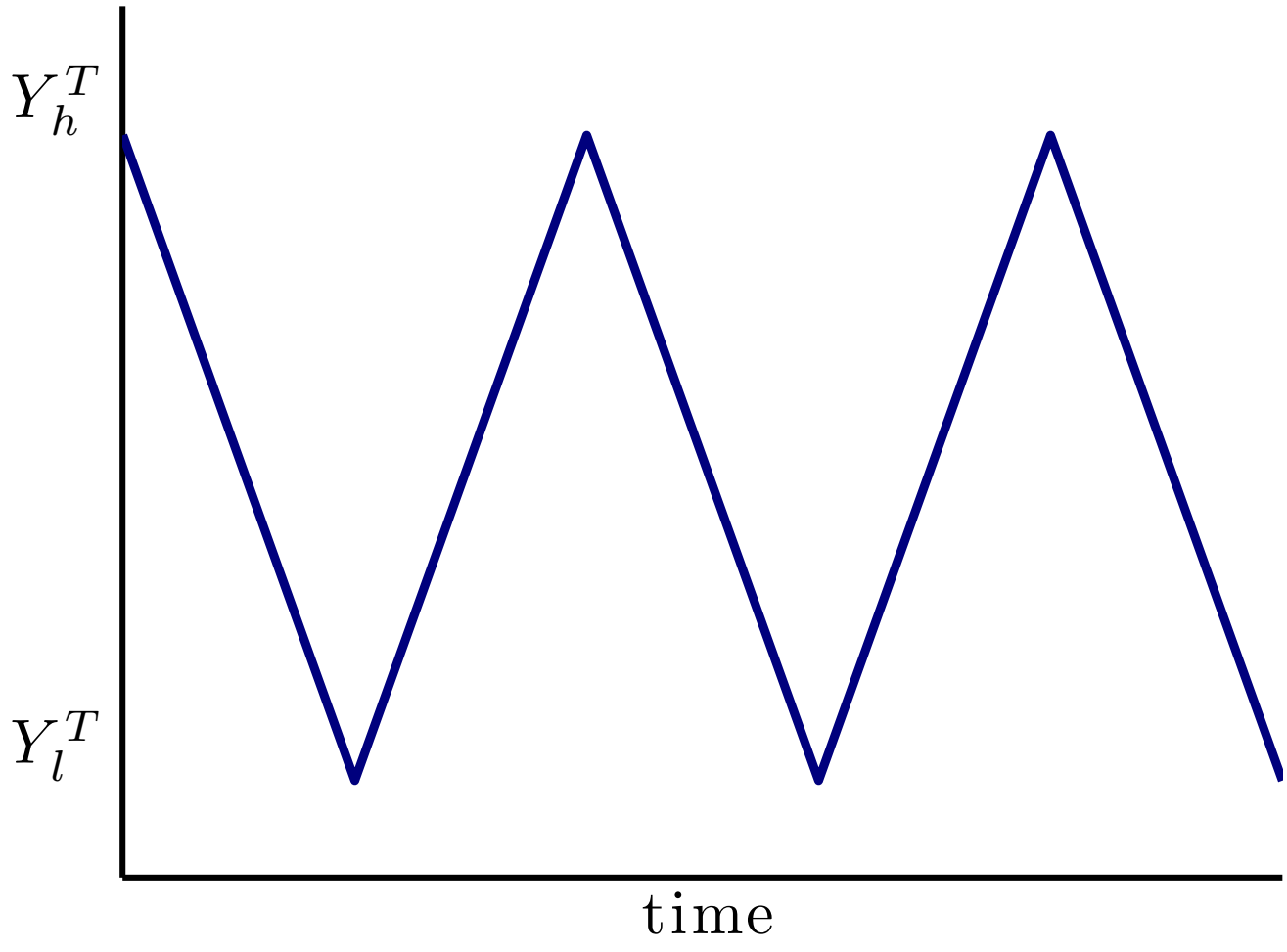
$$Y_{i,t}^N = L_{i,t} \leq 1$$

- Asset market

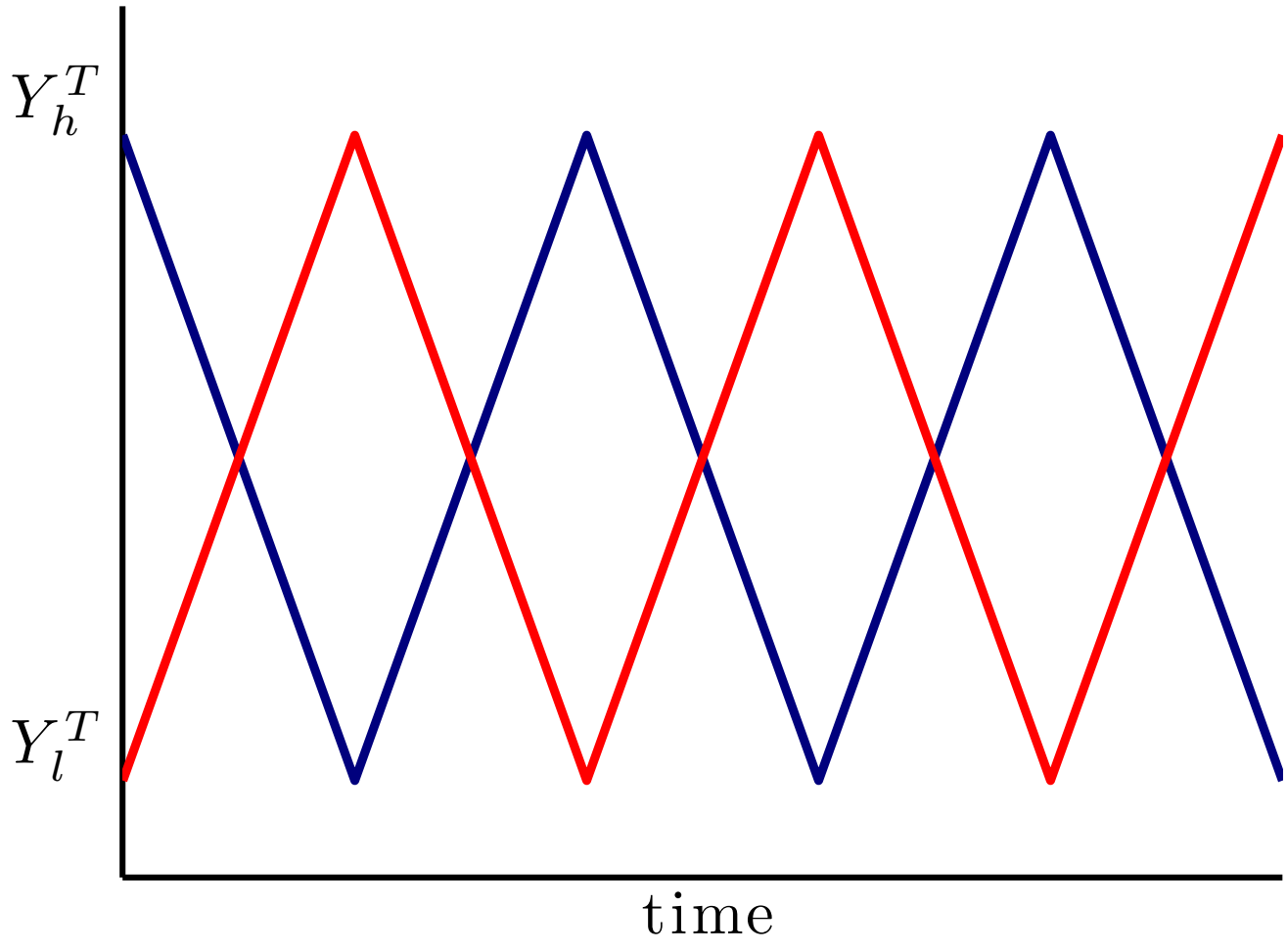
$$B_{i,t+1}^n = 0$$

$$\int_0^1 B_{i,t+1}\, di = 0 \quad \rightarrow \quad \int_0^1 C_{i,t}^T\, di = \int_0^1 Y_{i,t}^T\, di$$

Tradable endowment process



Tradable endowment process



Outline

FINANCIAL LAISSEZ FAIRE

- Consider a small open economy with $\beta R < 1$
- Borrowing constraint binds in l state

$$B_l = 0$$

- Euler equation in h state

$$\frac{1}{C_h^T} \geq \frac{\beta R}{C_l^T} \quad \rightarrow \quad C_h^T > C_l^T$$

- Savings in h state

$$B_h = \max\left\{\frac{\beta R}{1+\beta}\left(Y_h^T - \frac{Y_l^T}{\beta R}\right), 0\right\}$$

Non-tradable good market

- Aggregate demand

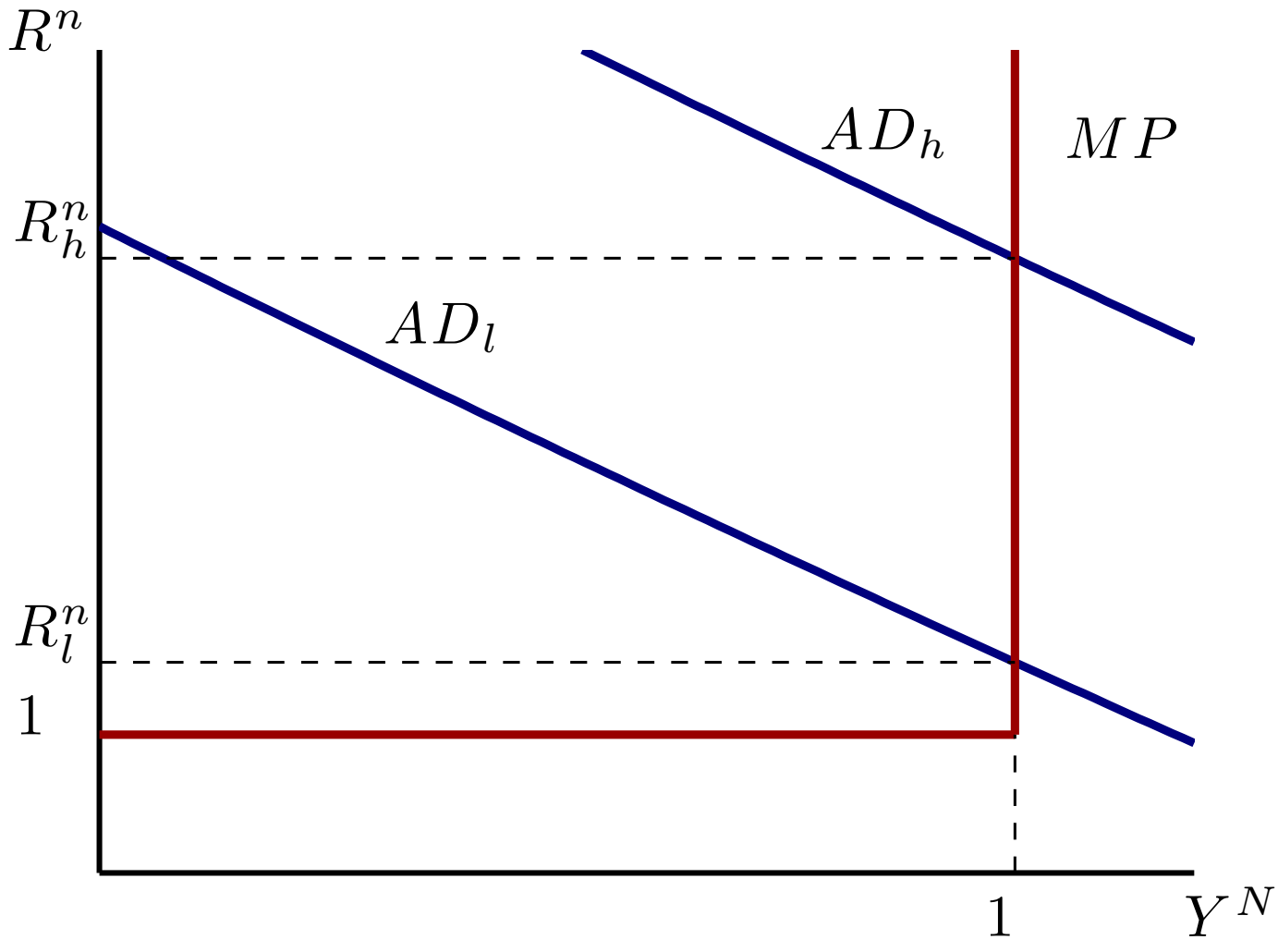
$$C_{i,t}^N = \frac{R\pi_{i,t+1}}{R_{i,t}^n} \frac{C_{i,t}^T}{C_{i,t+1}^T} C_{i,t+1}^N \qquad \text{(AD)}$$

- Monetary policy rule

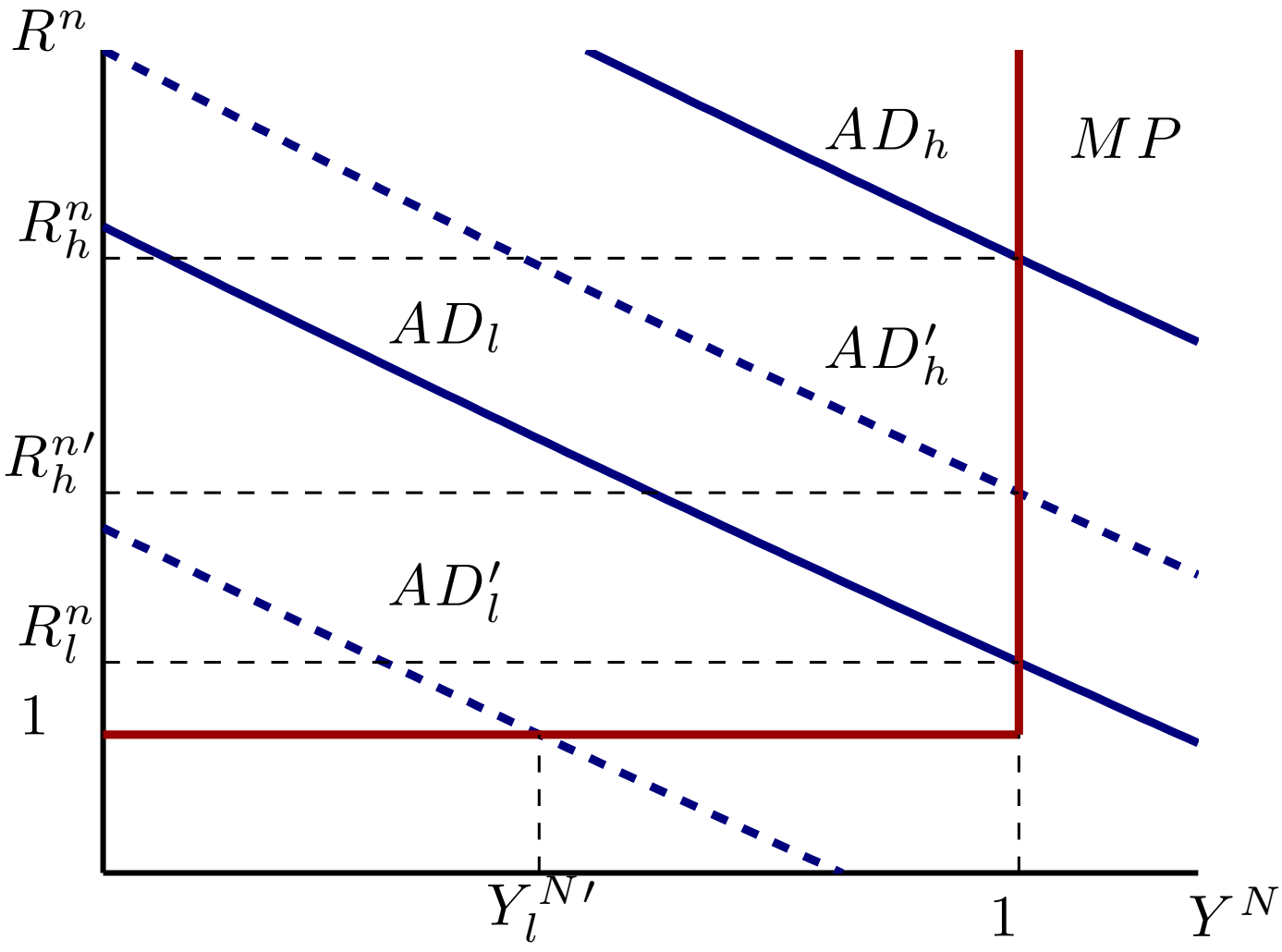
$$R_{i,t}^n = \begin{cases} \geq 1 & \text{if } Y_{i,t}^N = 1, \pi_{i,t} = \bar{\pi} \\ = 1 & \text{if } Y_{i,t}^N < 1, \pi_{i,t} = \gamma \end{cases} \qquad \text{(MP)}$$

- Equilibrium $C_{i,t}^N = Y_{i,t}^N$

Non-tradable good market



High R (solid lines) vs. low R (dashed lines)



Proposition

Define R^* *as solution to* $1 = R^* \bar{\pi} \max\left(\beta R^*, \, {Y_l}^T / {Y_h}^T\right)$. *Then*

$$\begin{cases} Y_l^N = Y_h^N = 1 & \text{if } R \geq R^* \\ Y_l^N < Y_h^N = 1 & \text{if } R < R^* \end{cases}$$

Equilibrium on world asset market

- Equilibrium on asset market implies

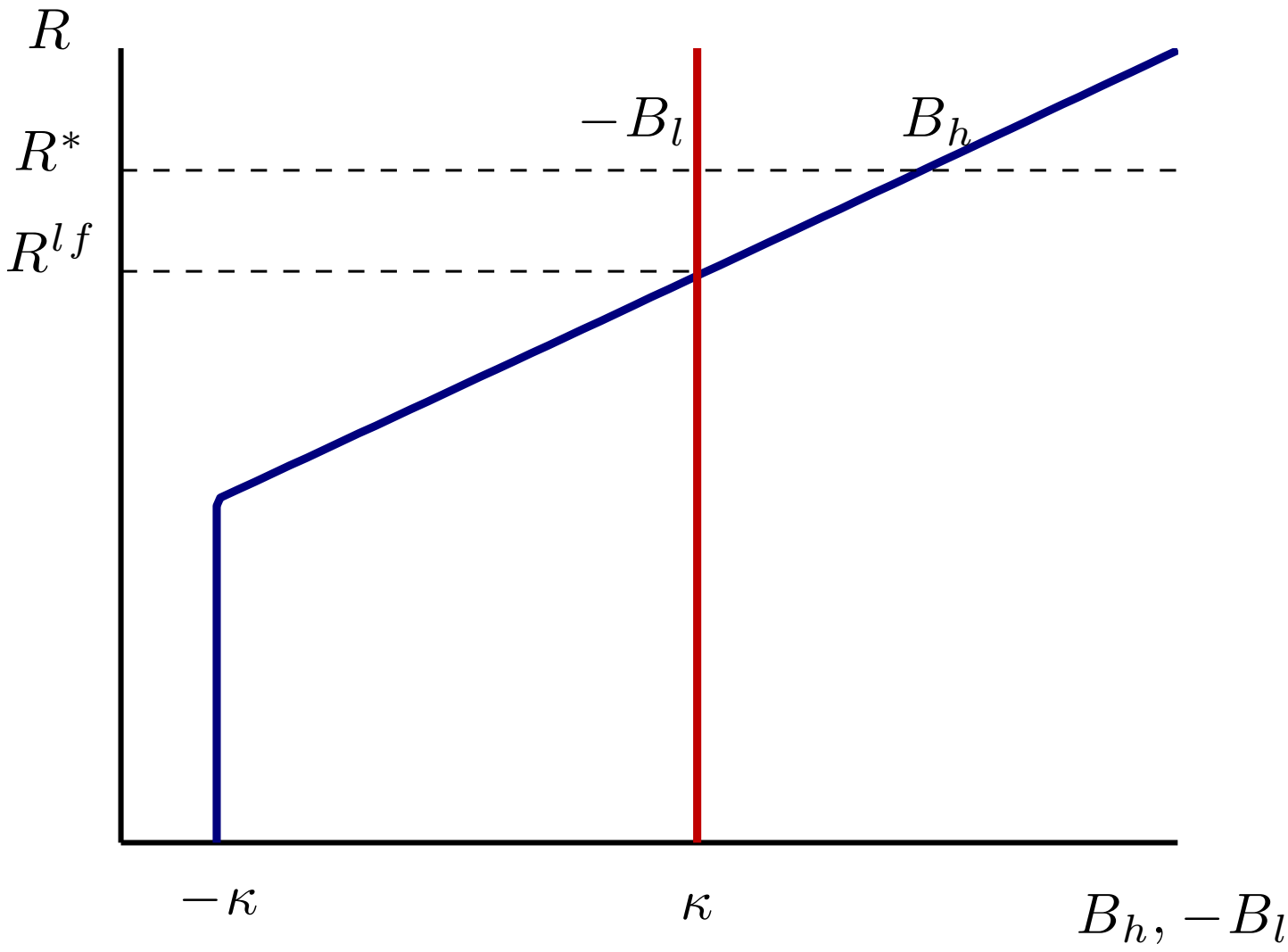
$$B_h = -B_l = \kappa \approx 0 \rightarrow C_h^T = Y_h^T, C_l^T = Y_l^T$$

- World interest rate given by

$$R = \frac{C_l^T}{\beta C_h^T} = \frac{Y_l^T}{\beta Y_h^T} \equiv R^{lf}$$

- If $R^{lf} < R^*$ world is in a global liquidity trap
  - Countries hit by negative shocks experience liquidity traps with unemployment
  - Permanent state of secular stagnation

Equilibrium on world asset market



Outline

FINANCIAL POLICY AS A STABILIZATION TOOL

- Non-tradable output in low state

$$Y_l^N = \min\left(R\bar{\pi}\, C_l^T / C_h^T, 1\right)$$

- Suppose government policy generates $\uparrow B_h$
  - $\uparrow$ current account surplus in h state
  - $\uparrow$ tradable consumption and aggregate demand in l state
  - If zlb binds, $\uparrow$ employment and non-tradable consumption in l state
- **Domestic aggregate demand externality**: atomistic agents do not internalize the impact of their saving decisions in h state on employment in l state

Optimal uncooperative policy

Domestic planner operating under discretion solves

$$\max_{C_{i,t}^T, Y_{i,t}^N, B_{i,t+1}} \sum_{t=0}^{\infty} \beta^t \left(\omega \log C_{i,t}^T + (1-\omega) \log Y_{i,t}^N\right)$$

subject to

$$C_{i,t}^T = Y_{i,t}^T - B_{i,t+1} + RB_{i,t}$$

$$B_{i,t+1} \geq -\kappa$$

$$Y_{i,t}^N \leq 1$$

$$Y_{i,t}^N \leq R\pi_{t+1} \frac{C_{i,t}^T}{C_{i,t+1}^T} Y_{i,t+1}^N,$$

Optimal uncooperative policy

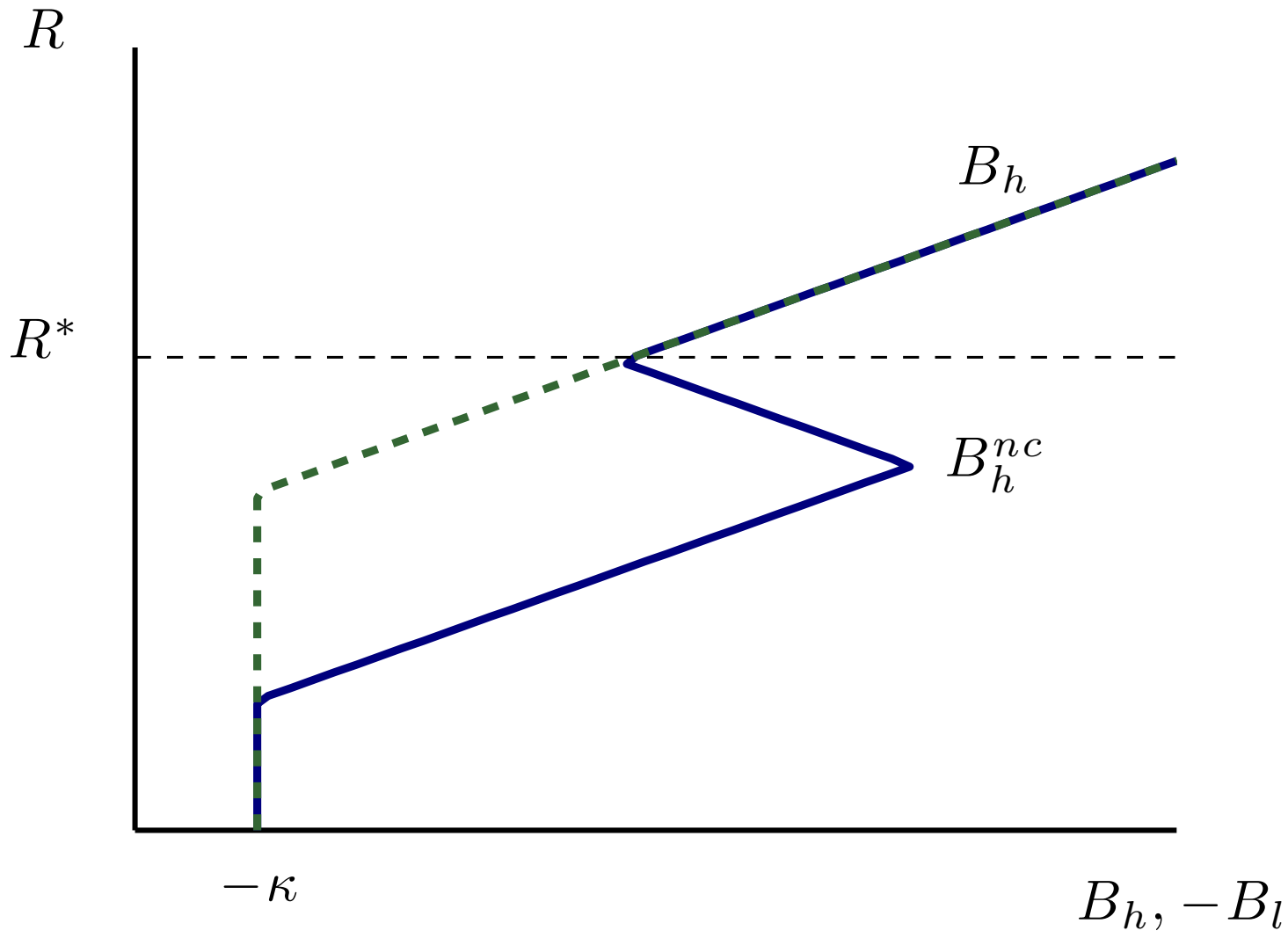
- Domestic planner Euler equation

$$\frac{1}{C_h^T} \geq \frac{\beta R}{C_l^T}\left(1 + \frac{\bar{v}_l\, Y_l^N}{\omega}\right)$$

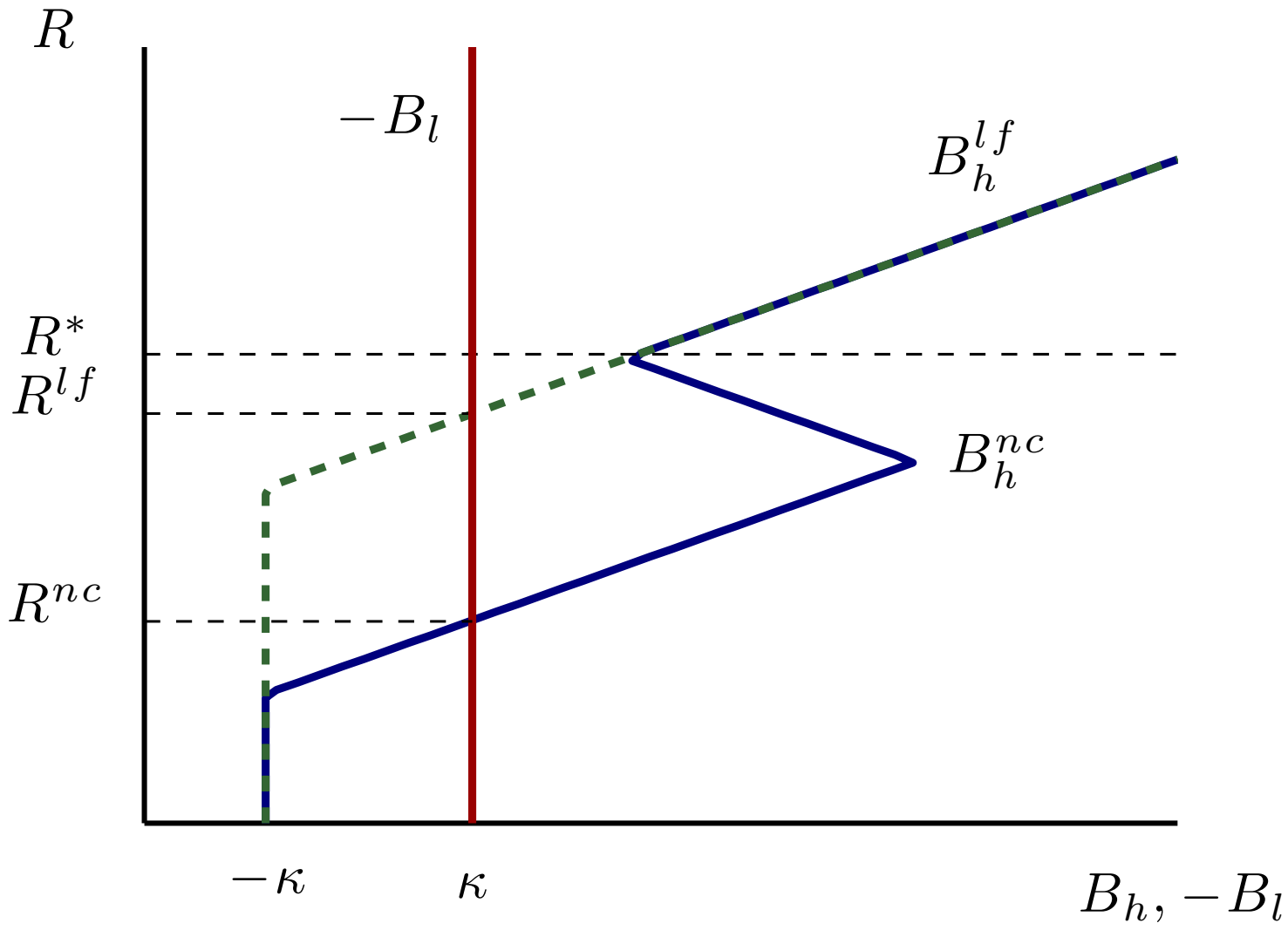
- If $\bar{v}_l > 0$ planner saves more during booms compared to financial laissez faire

- Planning allocation can be decentralized by imposing tighter borrowing limit than the market one, or through subsidies to savings

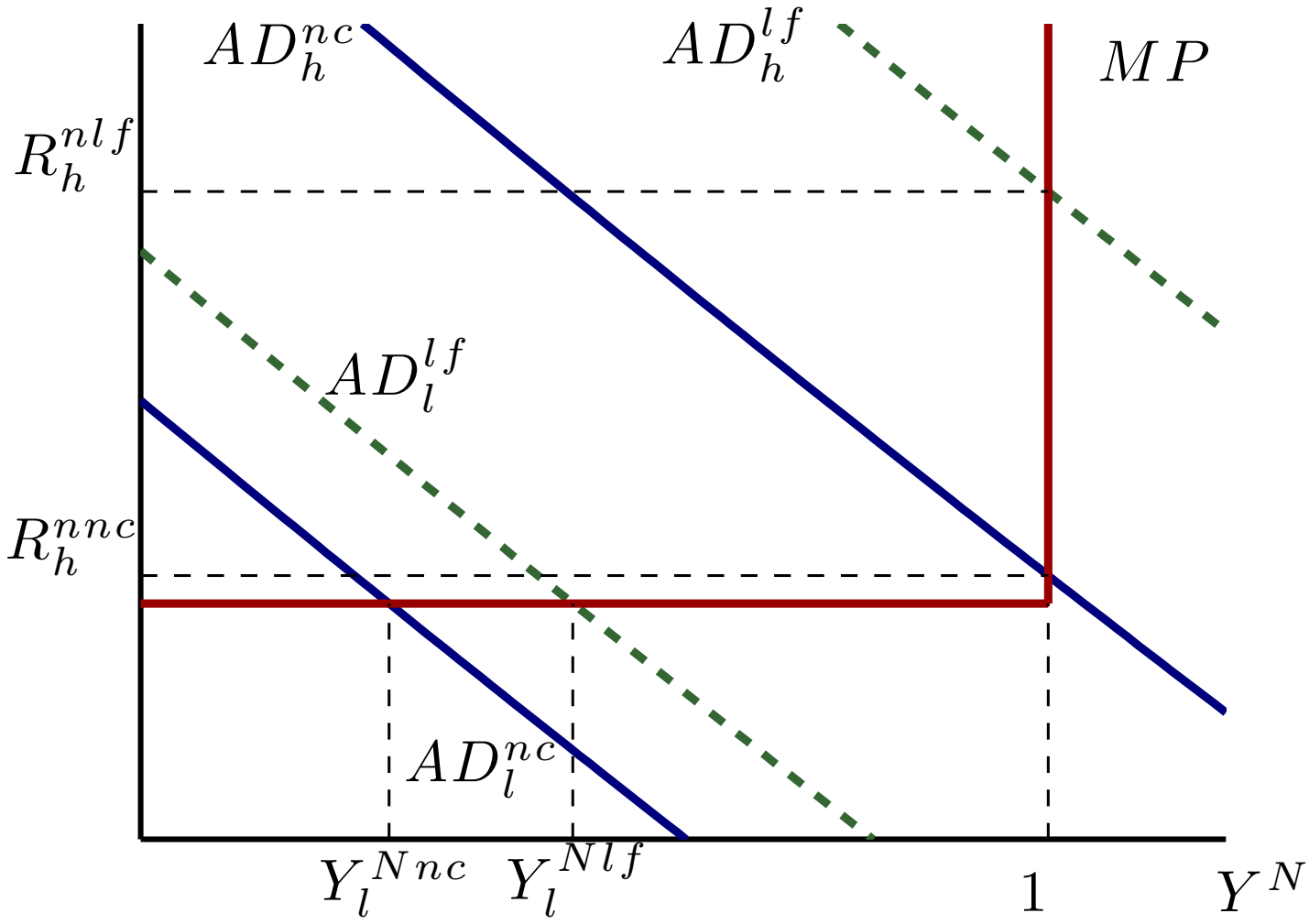
Uncooperative policy



Global impact of uncooperative policy



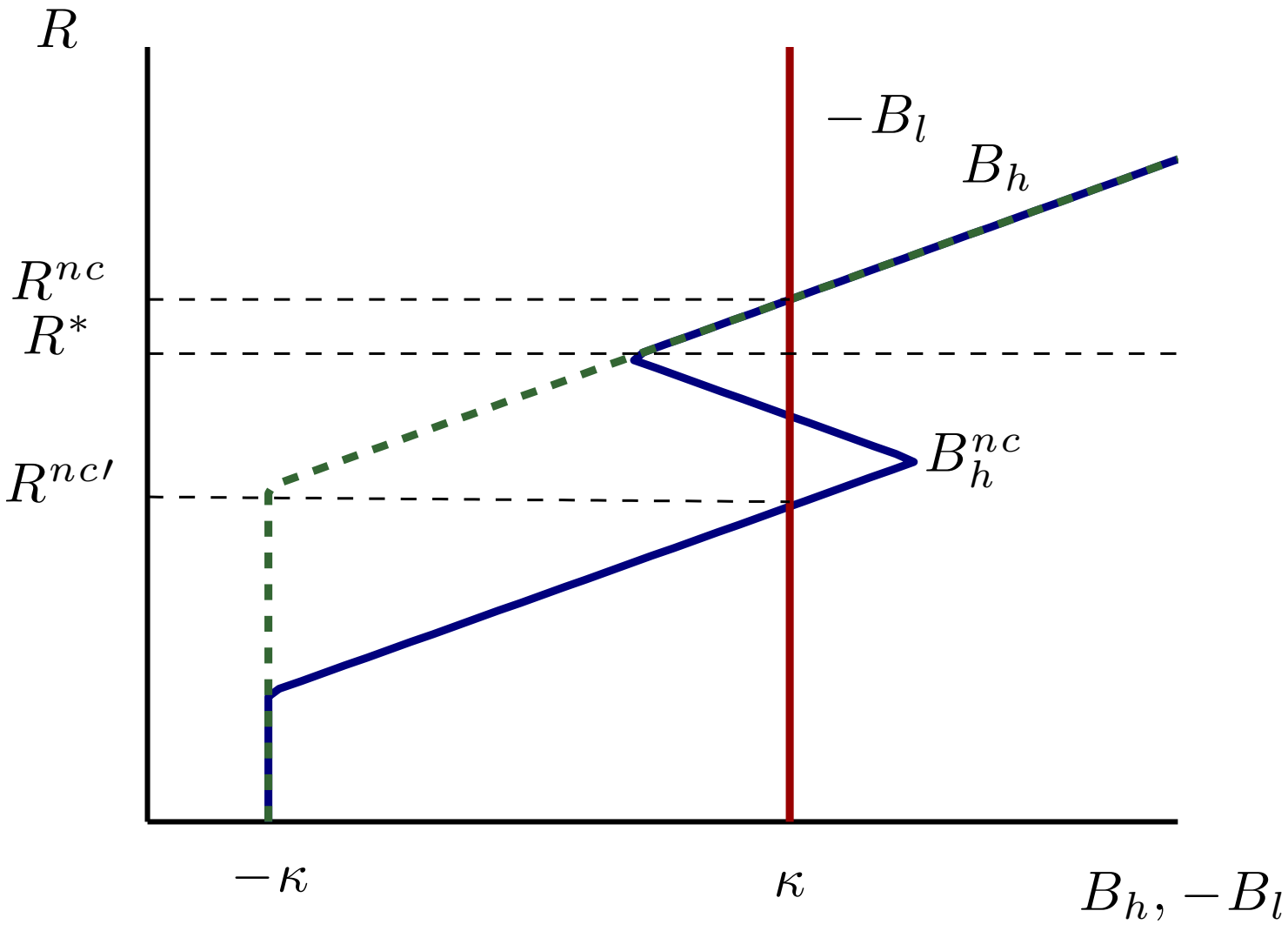
Global impact of uncooperative policy



Global impact of uncooperative policy

- When governments in booming countries intervene to improve current account
  - Rise in global supply of savings
  - World interest rate falls
  - Fall in global demand for non-tradables
  - Rise in unemployment in countries currently at zlb
- **International aggregate demand externality**: governments in booming countries do not internalize the impact of their policies on global demand and unemployment in bust countries

Multiple equilibria with uncooperative policy



Multiple equilibria with uncooperative policy

- Suppose that fundamentals are such that without credit market interventions the world is not in a global liquidity trap
- If governments intervene unilaterally on the credit markets multiple equilibria are possible
  - Governments expect interventions in the future
  - Expected interest rates are low
  - High savings in the present
  - Low interest rates in the present
- In absence of cooperation, expectations of future low rate can generate a liquidity trap in the present

Outline

Optimal cooperative policy

World planner solves

$$\max_{C_{i,t}^T,\, Y_{i,t}^N, B_{i,t+1}, R} \sum_{t=0}^{\infty} \beta^t \int_0^1 \left(\omega \log C_{i,t}^T + (1-\omega) \log Y_{i,t}^N\right) di$$

subject to

$$C_{i,t}^T = Y_{i,t}^T$$

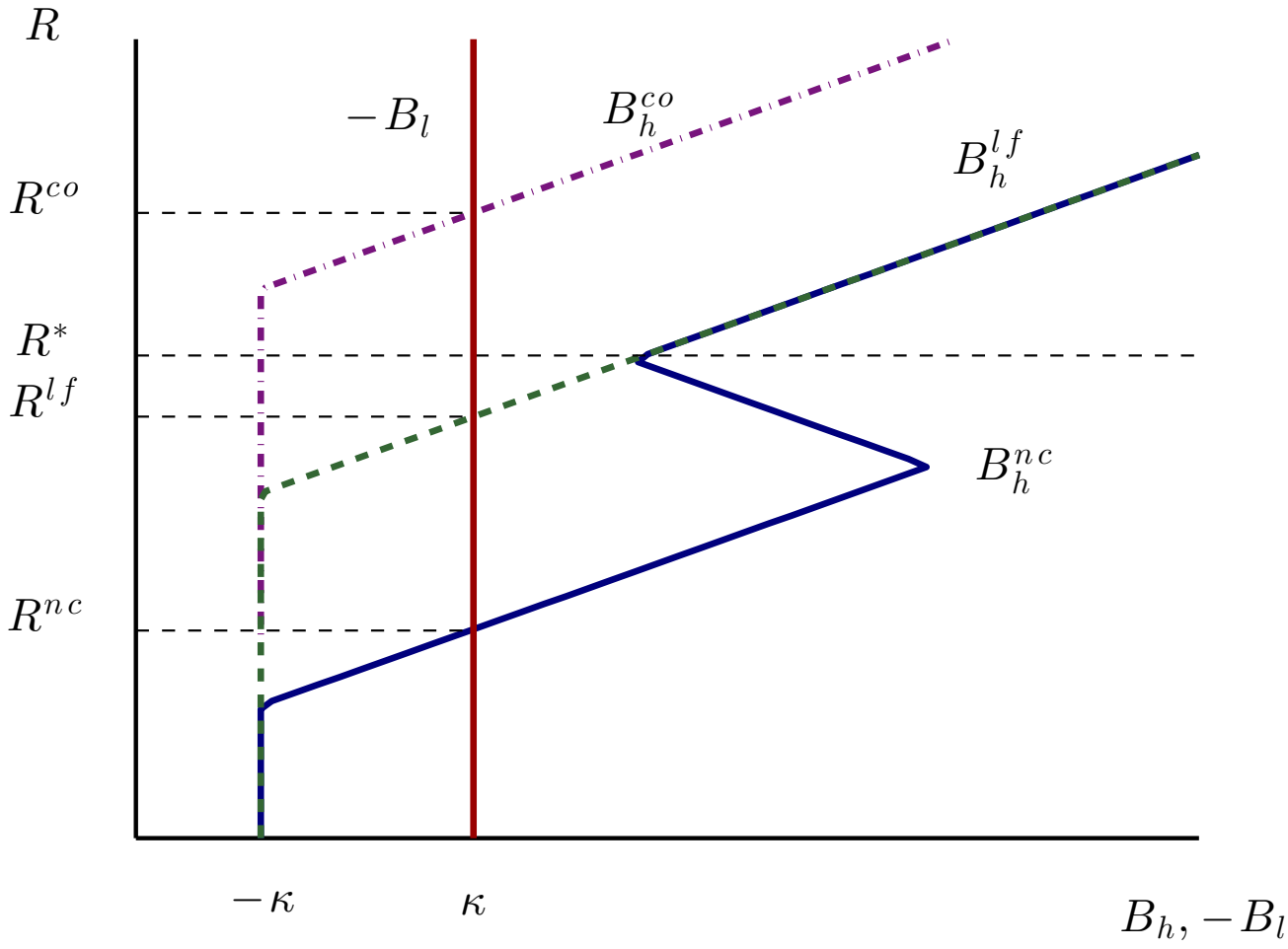
$$Y_{i,t}^N \leq 1$$

$$Y_{i,t}^N \leq R\pi_{t+1} \frac{C_{i,t}^T}{C_{i,t+1}^T} Y_{i,t+1}^N,$$

Optimal cooperative policy

- Global planner sets $R \geq R$ so that full employment is reached in every country ($Y_h^N = Y_l^N = 1$)
- This can be achieved by subsidizing borrowing in booming countries
- Pareto improvement with respect to laissez faire and uncooperative optimal policy
- Caveat: with $\kappa >> 0$ it might not be optimal to restore full employment. Still savings from booming countries under cooperation are smaller than in the uncooperative equilibrium

Global equilibrium with cooperative policy



Cooperation in a global liquidity trap

- Uncooperative interventions on capital markets exacerbate the global liquidity trap
- Cooperative policy calls for lower subsidies, or even for policies that subsidize consumption
- Crucial to take into account global impact of credit market interventions
- How big are the gains from coordination?

Outline

Extended model

- CRRA utility and CES consumption aggregator
- Stochastic endowment

$$\log\left(Y_{i,t}^{T}\right) = (1-\rho)\mu_{i,t} + \rho\log\left(Y_{i,t-1}^{T}\right) + \epsilon_{i,t}$$

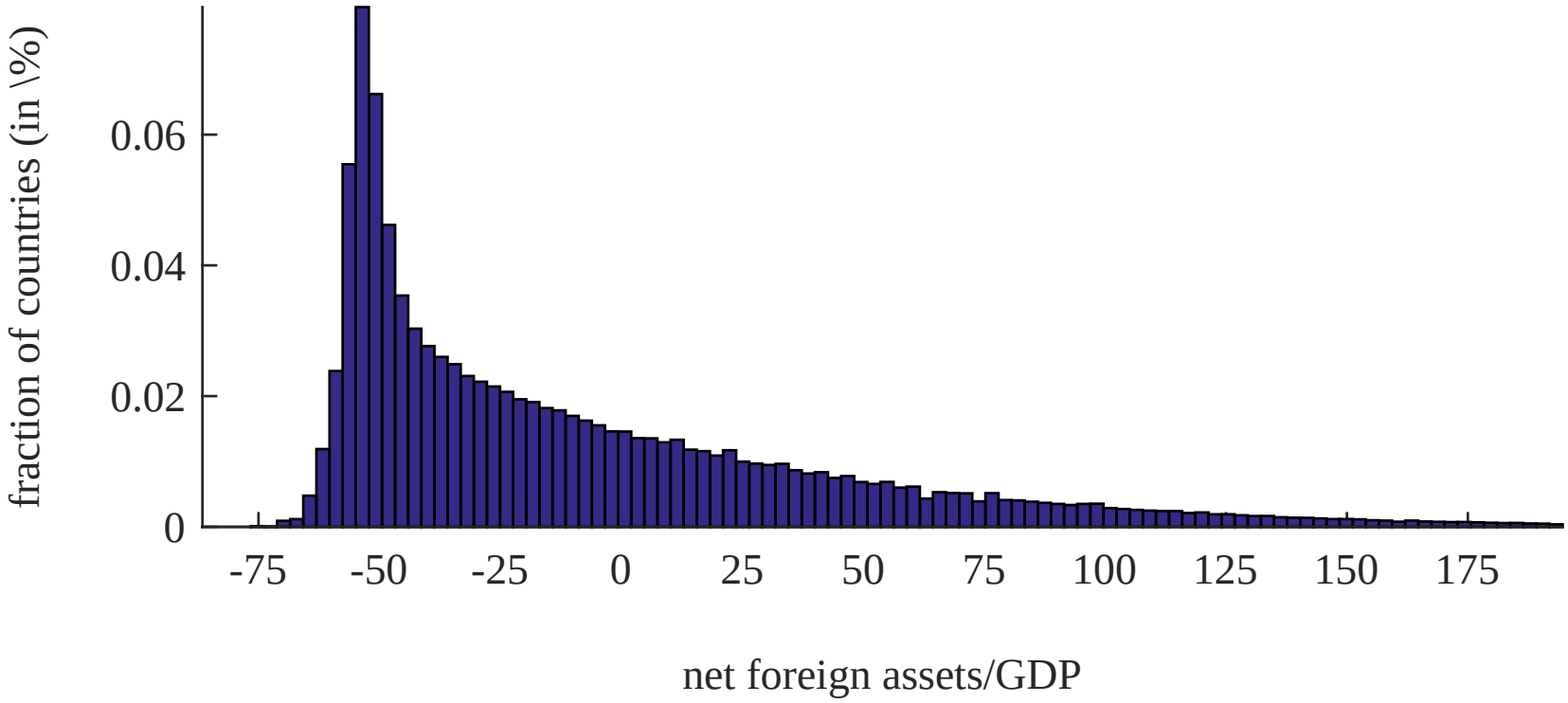
- Borrowing limit

$$B_{i,t+1} + \frac{B_{i,t+1}^{n}}{P_{i,t}^{T}} \geq -\kappa_{i,t}$$

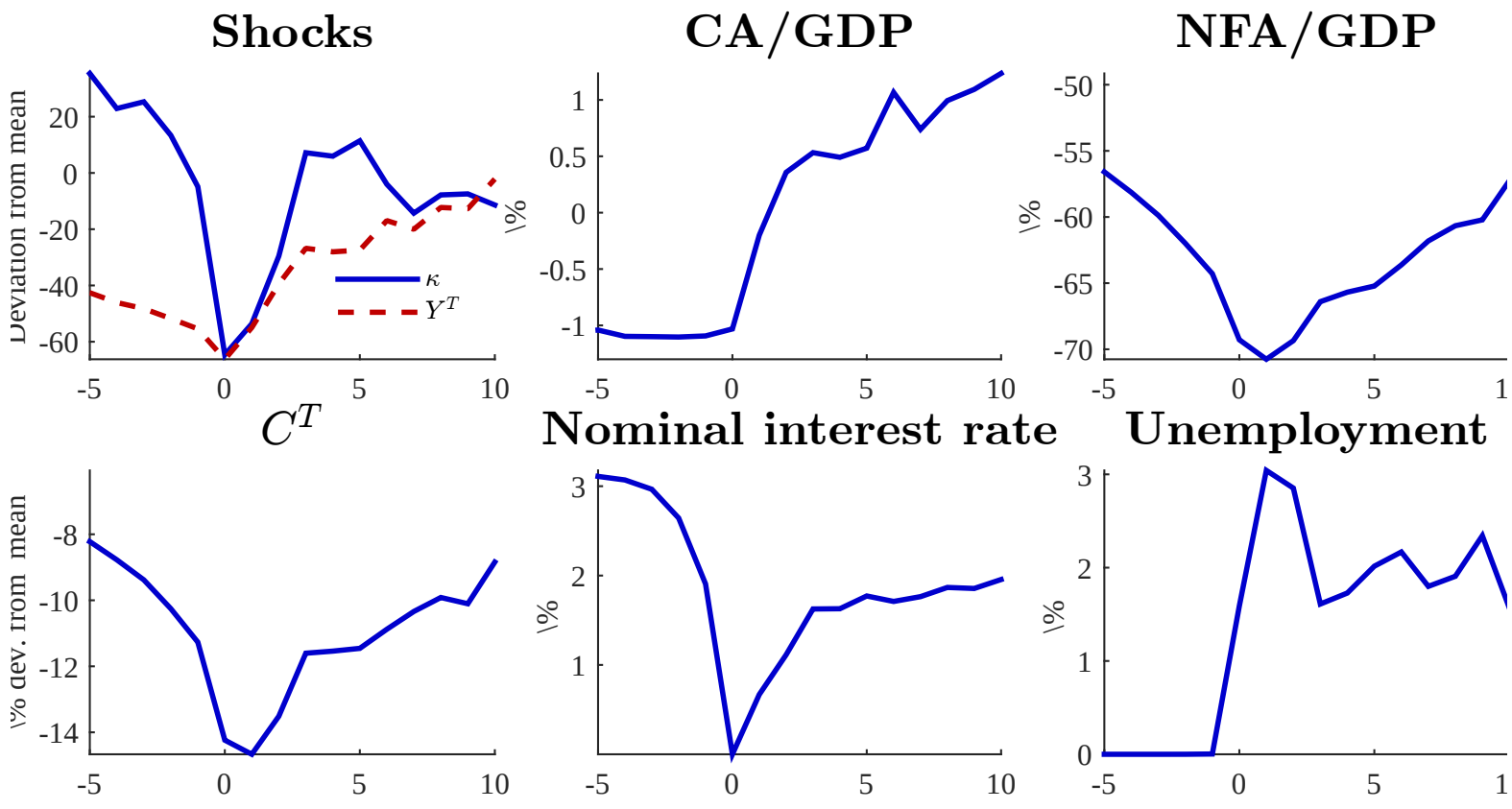
- Shocks to borrowing limit $\kappa_{i,t}$

Deleveraging shocks Parameters

Net foreign asset distribution (% of GDP)



Typical liquidity trap



Conclusions

- We provide a framework of financial integration and low interest rates
- Governments have an incentive to implement policies that improve the current account during booms, to mitigate future recessions
- These policies lower global demand for consumption and aggravate the recession in countries currently stuck in a liquidity trap
- Need to coordinate capital market interventions in a low interest rate world

Thank you!

Deleveraging shock

- Normal times $\kappa_{i,t} = \kappa_h$
- Deleveraging shock

$$\log(\kappa_{i,t}) = \rho_\kappa \log(\kappa_{i,t}) + (1 - \rho_\kappa) \log(\kappa_l), \text{ where } \kappa_h > \kappa_l$$

- Fixed probabilities of transiting between states

$$P(\kappa_{i,t} = \kappa_h | \kappa_{i,t-1} = \kappa_h) > .5$$

$$P(\kappa_{i,t} = \kappa_h | \kappa_{i,t-1} < \kappa_h) < .5$$

Back

Table 1: Parameters

	Value	Source/Target
Risk aversion	$\sigma = 2$	Standard value
Elasticity consumption aggr.	$\xi = 0.5$	Standard value
Tradable share in expenditure	$\omega = 0.25$	Standard value
Discount factor	$\beta = 0.985$	$R = 1.01$
Downward wage rigidities	$\gamma = 1$	Schmitt-Grohe and Uribe (2013)
Inflation target	$\bar{\pi} = 1.02$	Standard value
Endowment process	$\sigma_\epsilon = 0.041$, $\rho = 0.78$	Estimate for advanced economies
Tradable output high mean	$\mu_l = \log(1.7)$	Estimate for the advanced economies
Tradable output low mean	$\mu = 0$	Normalization
Fraction of very rich countries	$\pi_{l,l} = 0.96$	Estimate for the advanced countries
Prob. of remaining in high mean	$\pi_{h,h} = 0.78$	Standard deviation NFA/GDP =0.55
Bond supply r.o.w.	$B_{rw} = 0.28$	$B_{rw} / \int_0^1 GDP_{i,t}\, di = 7\%$
High borrowing limit	$\kappa_h = 0.2.75$	
Low borrowing limit	$\kappa_l = 2.27$	
Persistence deleveraging	$\rho_\kappa = 0.7$	
Prob. entry deleveraging	$P_{entry} = 0.08$	
Prob. exit deleveraging	$P_{exit} = 0.51$	

Back