

# Coordination and Crisis in Monetary Unions

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- ▶ Decentralized fiscal policy

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## Question

- ▶ Implications for debt dynamics and self-fulfilling debt crises?
- ▶ Potential for conflict, optimal currency area

# Results

## **Fiscal externality in a monetary union**

- ▶ Excessive debt and inflation
- ▶ Case for debt ceilings
- ▶ Lack of coordination and lack of commitment

# Results

## Decision to join monetary union for high-debt country

- ▶ Classic argument: Join union with greatest credibility to keeping inflation low
  - ▶ Union with low average debt
    - ▶ Roll-over debt at low interest rates
    - ▶ Low inflation.

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- ▶ Classic argument: Join union with greatest credibility to keeping inflation low
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    - ▶ Roll-over debt at low interest rates
    - ▶ Low inflation.
- ▶ With Roll-over risk: Join union with intermediate credibility to keeping inflation low
  - ▶ Union with intermediate average debt
    - ▶ Deliver low inflation in good times
    - ▶ Act as lender of last resort in crises
    - ▶ Reduce vulnerability to self-fulfilling crises.



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## Institutional design of monetary policy

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  - ▶ Here, preference of central banker endogenously impacted ...
    - ▶ through debt composition of union

# Literature Review

- ▶ Optimal currency areas
  - ▶ Mundell (1961, 1973), McKinnon (1963), Kenen (1969), Alesina and Barro (2002), Silva and Tenreyro (2010)
- ▶ Debt ceilings
  - ▶ Chari and Kehoe (2007)
  - ▶ Beetsma and Uhlig (1999): political economy constraints. short sighted governments.
  - ▶ Cooper, Kempf and Peled (2009,2010): monetary bailout in the presence of regional debt
- ▶ Fiscal and monetary policy in a MU
  - ▶ Gali and Monacelli (2008) (stabilization on a peg)
  - ▶ Dixit and Lambertini (2001), Dixit and Lambertini (2003) (conflicting goals for output and inflation)
  - ▶ Farhi and Werning (2012) (Fiscal Unions)

# Road Map

- ▶ No roll-over risk
  - ▶ Fiscal externality

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- ▶ No roll-over risk
  - ▶ Fiscal externality
- ▶ Roll-over risk
  - ▶ Conflicts in presence of roll-over risk

# Environment

- ▶ Continuum of SOE
- ▶ Time is continuous
- ▶ Fiscal policy determined at the country level
- ▶ Constant endowment economy,  $y_i = y$
- ▶ Monetary policy chosen by single monetary authority

$$P_t = P(t) = P(0)e^{\int_0^t \pi(t)dt}$$

- ▶ Risk neutral lenders, outside option  $r^*$

# No Roll-over Risk

## Fiscal Authority's Problem

$$V(b, \mathbf{b}) = \max_{c(t)} \int_0^{\infty} e^{-\rho t} (u(c(t)) - \psi_0 \pi(\mathbf{b}(t))) dt$$

$$\dot{b}(t) = c(t) - y + (r(\mathbf{b}(t)) - \pi(\mathbf{b}(t)))b(t)$$

$$V(b, \mathbf{b}) \geq \underline{V}$$

- ▶ Choose  $c(t)$  given schedules  $\{\pi(\mathbf{b}(t)), r(\mathbf{b}(t)), \tilde{C}(\mathbf{b}(t))\}$
- ▶  $\pi \in [0, \bar{\pi}]$



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- ▶  $\pi \in [0, \bar{\pi}]$
- ▶ Default payoff

$$\underline{V} = \frac{u((1 - \chi)y)}{\rho} - \int_0^{\infty} e^{-\rho t} \psi(\pi(t)) dt.$$

# No Roll-over Risk

## Monetary Authority's Problem

$$J(\mathbf{b}) = \int_0^{\infty} e^{-\rho t} \left( \int_i u(C_i(b_i(t), \mathbf{b}(t))) di - \psi_0 \pi(t) \right) dt$$

$$\dot{\mathbf{b}}(t) = C(b_i(t), \mathbf{b}(t)) + (r(\mathbf{b}(t)) - \pi(t))b_i(t) - y$$

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## Risk Neutral Lenders

$$r(\mathbf{b}) - \Pi(\mathbf{b}) = r^* = \rho$$

Solve for symmetric recursive competitive equilibrium

# No Roll-over Risk: Fiscal Authority

- ▶ Simple consumption-saving problem

$$\max_{c(t)} \int_0^{\infty} e^{-\rho t} u(c(t)) dt,$$

subject to  $\dot{b}(t) = c(t) - y + \rho b(t)$ .

- ▶  $C(b, \mathbf{b}) = y - \rho b, \dot{b}(t) = 0$ .

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- ▶  $C(b, \mathbf{b}) = y - \rho b, \dot{b}(t) = 0$ .

- ▶ Max sustainable debt

$$\begin{aligned} V(b, \mathbf{b}) &\geq \underline{V} \\ &\Rightarrow \\ b &\leq \frac{\chi y}{\rho}. \end{aligned}$$

# No Roll-over Risk: Monetary Authority

$$\rho J(\mathbf{b}) = \max_{\pi \in [0, \bar{\pi}]} u(y - \rho \mathbf{b}) - \psi_0 \pi + (r(\mathbf{b}) - \pi - \rho) J'(\mathbf{b}) \cdot \mathbf{b}',$$

$$\Pi(\mathbf{b}) = \begin{cases} 0 & \text{if } \psi_0 > -J'(\mathbf{b}) \cdot \mathbf{b}', \\ \in [0, \bar{\pi}] & \text{if } \psi_0 = -J'(\mathbf{b}) \cdot \mathbf{b}', \\ \bar{\pi} & \text{if } \psi_0 < -J'(\mathbf{b}) \cdot \mathbf{b}'. \end{cases}$$

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- ▶ Bang-Bang solution for inflation

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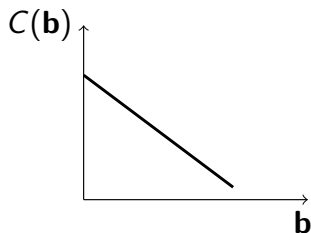
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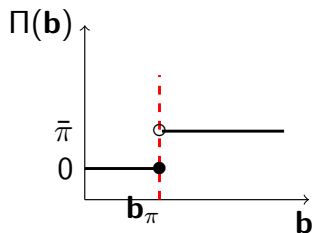
- ▶ Best Monotone Equilibrium
- ▶ Bang-Bang solution for inflation
- ▶ Assume symmetric initial debt positions,  $b = \mathbf{b}$



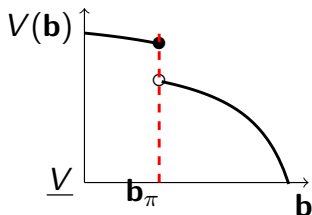
# Monetary Union with No Crisis



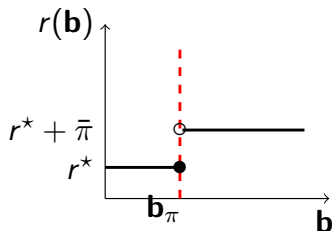
(a) Consumption Policy



(b) Inflation Policy

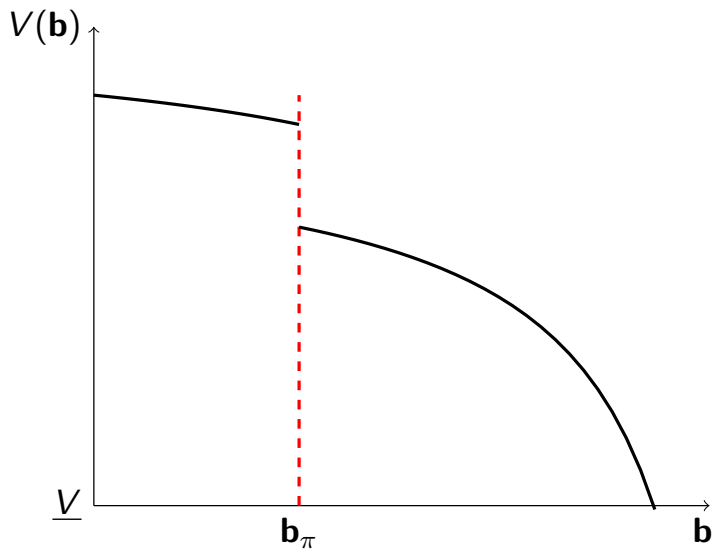


(c) Value Function

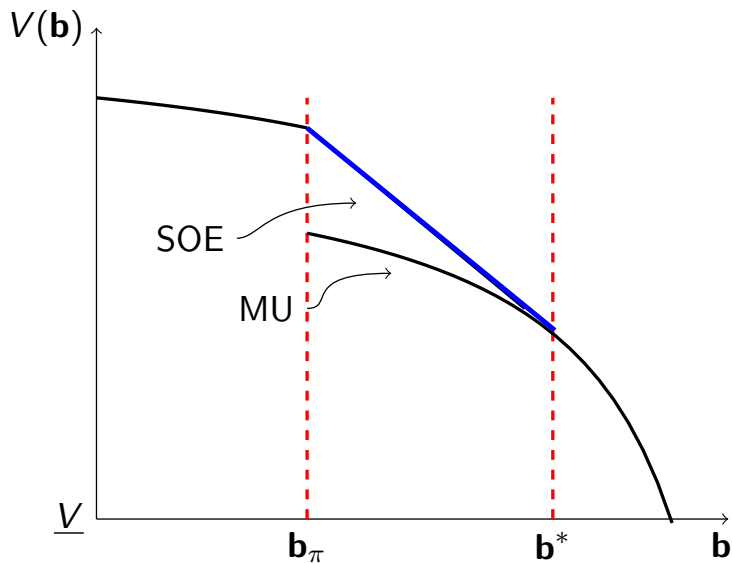


(d) Interest Rates

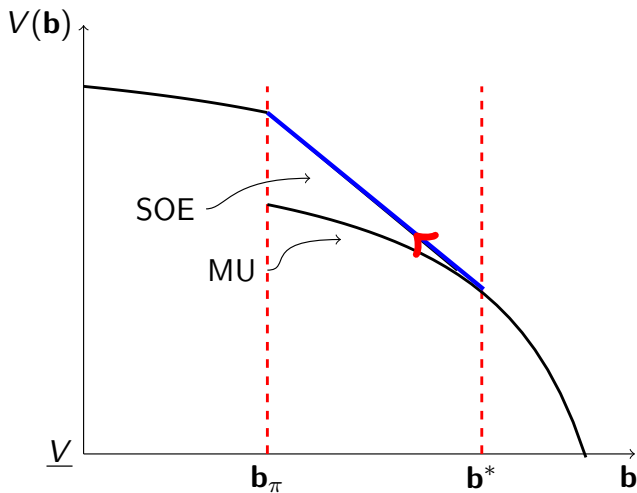
# Fiscal Externality: MU



# Fiscal Externalities: Role of Coordination

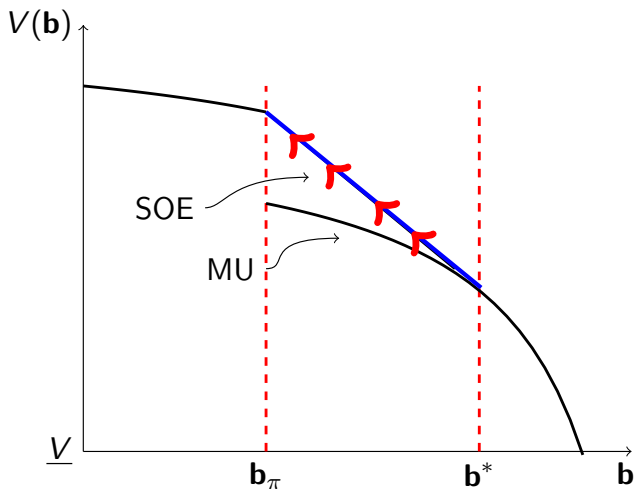


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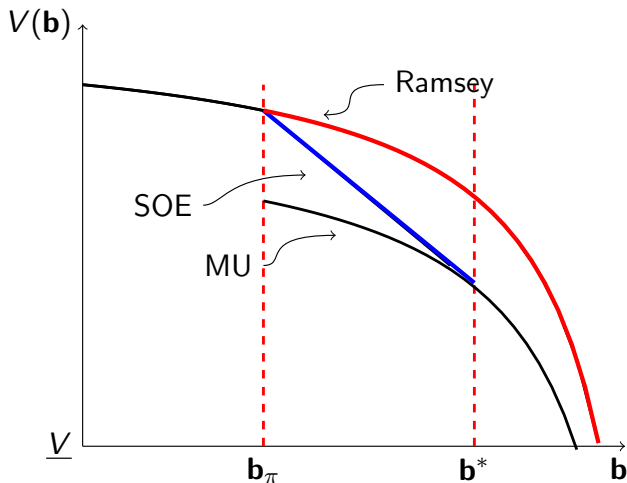
- ▶ Aguiar et al (2012)
- ▶ Higher LR debt and inflation in MU relative to SOE.
- ▶ Debt Ceiling:  $b(t) \leq \mathbf{b}_t^{\text{SOE}}$

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# Fiscal Externalality: Role of Commitment



- ▶ Consumption  $c^{Ramsey} = c^{MU} = y - \rho b$
- ▶ Higher inflation in a MU
- ▶ Chari, Kehoe (07)

# Heterogeneity Absent Crises

- ▶ Suppose fraction  $\eta$  have debt  $\mathbf{b} > 0$  and  $(1 - \eta)$  have  $\mathbf{b} = 0$
- ▶ Do members disagree about the debt choices of other members (or potential new members)?

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- ▶ **No longer true when have roll-over crises.**

# Roll-over Crises

- ▶ Builds on Cole and Kehoe (00), Aguiar et al (12)
- ▶ Equilibrium interest rate schedule of lenders

$$r(\mathbf{b}) = r^* + \pi(\mathbf{b}) + \lambda(\mathbf{b})$$

- ▶ where  $\pi(\mathbf{b})$  is the inflation strategy of the government
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## Coordination problem of the lenders

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- ▶ Run is a common shock for all positive debtors.

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  - ▶ roll-over crisis is self-fulfilling: vulnerable to crisis
- ▶ Monetary Authority: More likely to inflate the higher is  $\eta$



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- ▶ Vulnerability cutoff level  $\mathbf{b}_\lambda$ : Safe for  $\mathbf{b} \leq \mathbf{b}_\lambda$ , vulnerable  $\mathbf{b} > \mathbf{b}_\lambda$

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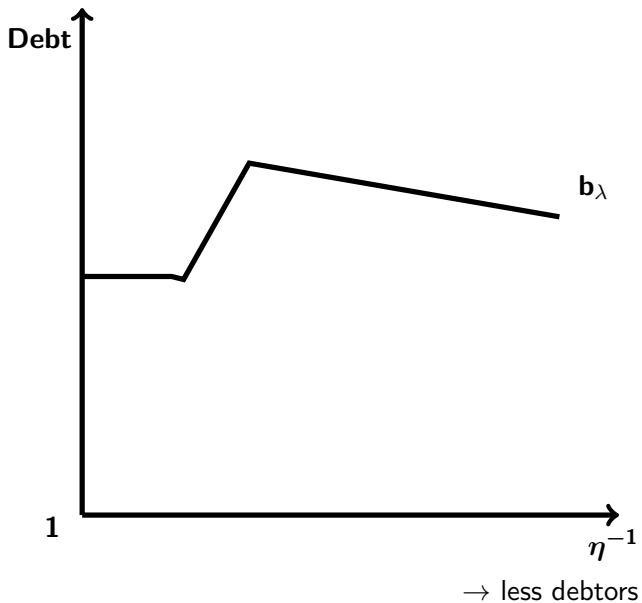
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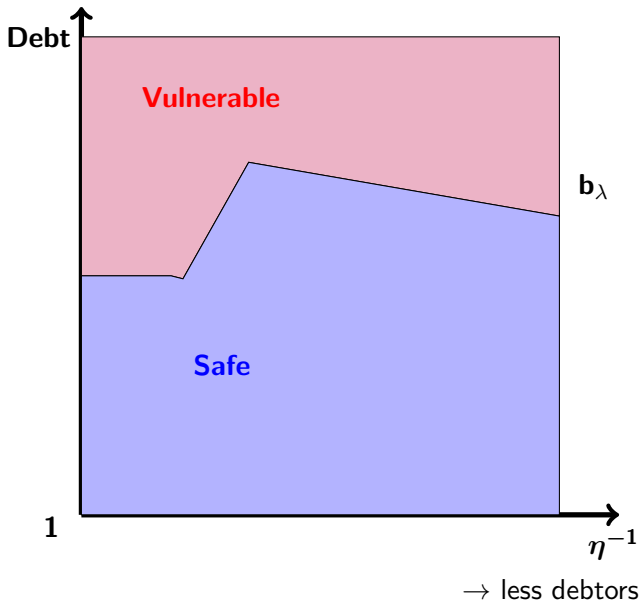
## Question

- ▶ How does the vulnerability cutoff ( $\mathbf{b}_\lambda$ ) depend on the fraction of members,  $\eta$ , with high debt?

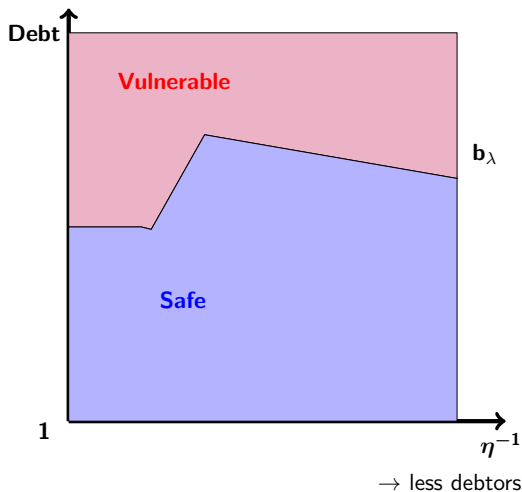
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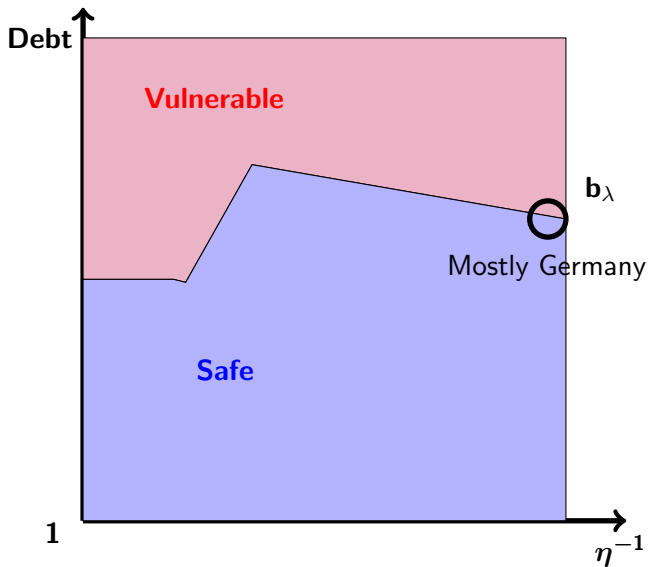


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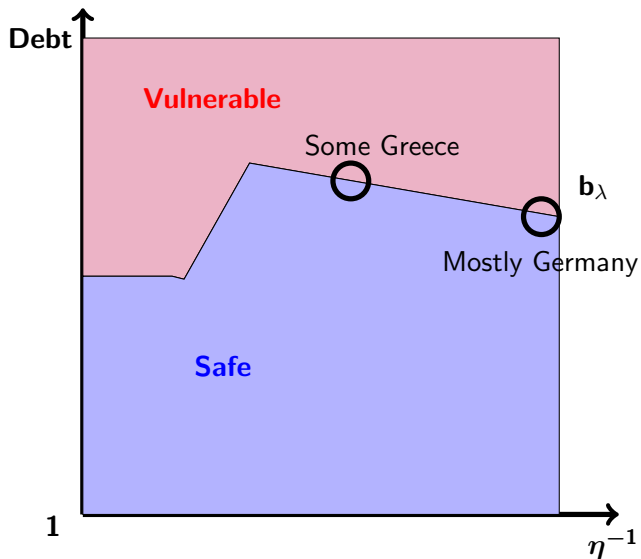


- ▶ Reduce ECB incentive to inflate in run → More costly to repay
- ▶ Reduce ECB incentive to inflate in normal → Reduce equilibrium interest rate → Reduce cost of repaying in case of

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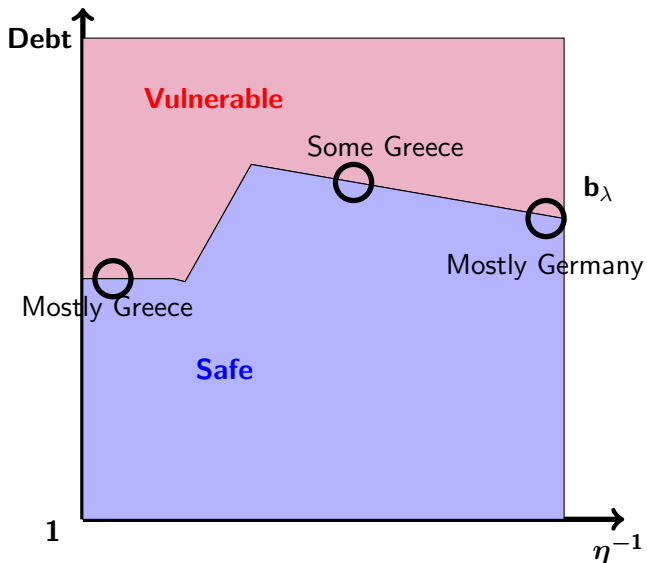


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- ▶ In vulnerable region have probability  $\lambda$  of default (sunspot)
- ▶ Fiscal authority may desire to save out of the crisis zone.

# Full Solution for Crisis Equilibria

- ▶ HJB for fiscal authority in the crisis zone:

$$(\rho + \lambda)\hat{V}(b) = \max_c u(c) + \hat{V}'(b)[(\rho + \lambda)b + c - y] + \lambda\underline{V}.$$

- ▶ FOC

$$u'(c) = -\hat{V}'(b),$$
$$\hat{V}''(b)[(\rho + \lambda)b + c - y] = 0.$$

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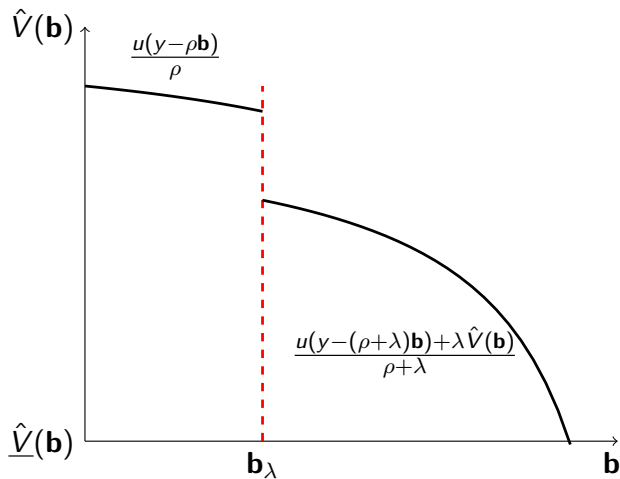
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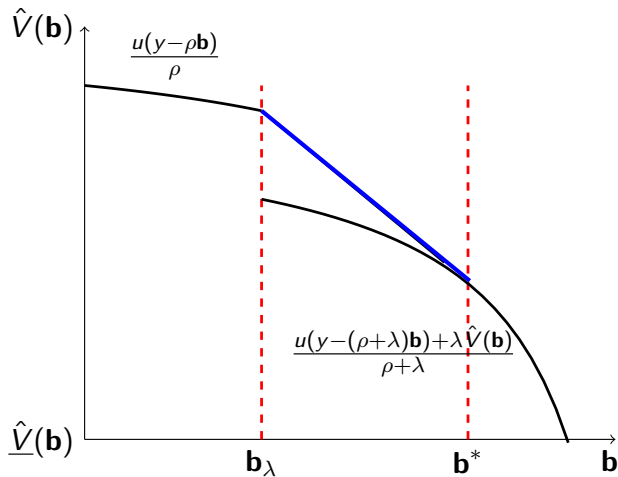
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- ▶ Unique Viscosity Solution

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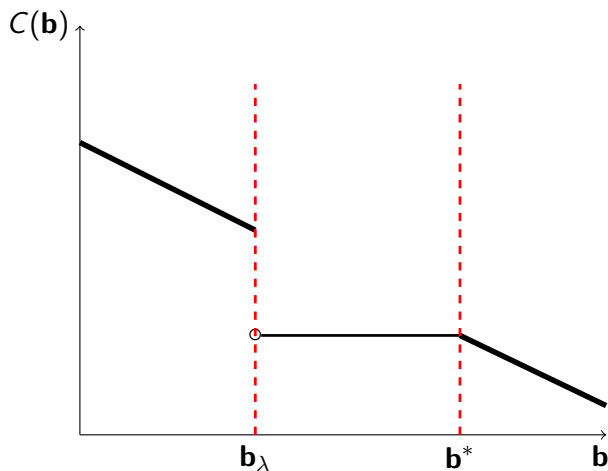


Figure: Consumption policy

- ▶ Consumption policy depends indirectly on  $\eta$  through its impact on equilibrium  $b_\lambda$ .



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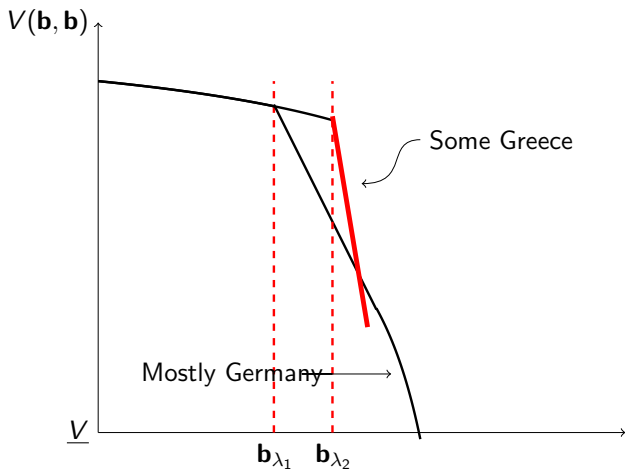
$$(\rho + \lambda)J(\mathbf{b}) = \max_{\pi} \eta u(c(\mathbf{b})) + (1 - \eta)u(y) - \psi_0 \pi + J'(\mathbf{b})[(r(\mathbf{b}) - \pi)\mathbf{b} + c(\mathbf{b}) - y] + \lambda V$$

$$\Pi(\mathbf{b}) = \begin{cases} 0 & \text{if } \psi_0/\eta \geq -J'(\mathbf{b})\mathbf{b}, \\ \bar{\pi} & \text{if } \psi_0/\eta < -J'(\mathbf{b})\mathbf{b}. \end{cases}$$

$$J'(\mathbf{b})\Pi'(\mathbf{b})\mathbf{b} + J''(\mathbf{b})((\rho + \lambda)\mathbf{b} + c - y) = 0.$$

- ▶  $\eta$  determines whether jump in inflation takes place in the safe zone or the vulnerability zone.

# Welfare and Debt Composition



# Conclusions

## Fiscal Externality

- ▶ Limits countries incentives to reduce debt
- ▶ Higher long-run inflation. Lower Welfare.

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- ▶ Different from conflicts arising from asynchronous fundamentals and output stabilization.

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## Institutional design in a monetary union

- ▶ Debt composition of members

# Grace period problem: Fiscal Authority

$$V^G(b_0, \mathbf{b}_0, r_0, \mathbf{r}_0) = \max_{c(t)} \int_0^\delta e^{-\rho t} (u(c(t)) - \psi_0 \pi^G(\mathbf{b}, \mathbf{r}_0, t)) dt + e^{-\rho \delta} V(0, 0),$$

$$\dot{b}(t) = c(t) - y + (r_0 - \pi^G(\mathbf{b}, \mathbf{r}_0, t))b(t),$$

$$b(0) = b, \quad b(\delta) = 0, \quad \text{and} \quad \dot{b}(t) \leq -\pi^G(\mathbf{b}, \mathbf{r}_0, t)b(t),$$

$$\dot{\mathbf{b}}(t) = c^G(\mathbf{b}, \mathbf{r}_0, t) - y + (\mathbf{r} - \pi^G(\mathbf{b}, \mathbf{r}_0, t))\mathbf{b}(t)$$

$$\mathbf{b}(0) = \mathbf{b}, \quad \mathbf{b}(\delta) = 0.$$

- ▶ Value net of inflation costs,

$$\hat{V}^G(b_0, \mathbf{b}_0, r_0, \mathbf{r}_0) = V^G(b_0, \mathbf{b}_0, r_0, \mathbf{r}_0) + \int_0^\delta e^{-\rho t} \psi_0 \pi^G(\mathbf{b}, \mathbf{r}_0, t) dt.$$

- ▶ Repay instead of defaulting if and only if

$$\hat{V}^G(b_0, \mathbf{b}_0, r_0, \mathbf{r}_0) \geq \underline{\hat{V}},$$

$$\underline{\hat{V}} = u(\chi y) / \rho$$

▶ back to slides

## Grace period problem: Fiscal Authority

- ▶  $\hat{V}^G(b_0, \mathbf{b}_0, r_0, \mathbf{r}_0)$  is decreasing in  $b_0$  and  $r_0$ .
- ▶ Assume that the rollover crisis is an equilibrium possibility only if  $\hat{V}^G(b_0, \mathbf{b}_0, r_0, \mathbf{r}_0) < \underline{\hat{V}}$ .
- ▶ Indicator function  $I(b_0, \mathbf{b}_0, r_0, \mathbf{r}_0)$  which takes the value of one if a rollover crisis leads to a default, and zero otherwise.
- ▶ Assume that, as long as  $\hat{V}^G(b_0, \mathbf{b}_0, r_0, \mathbf{r}_0) < \underline{\hat{V}}$ , a rollover crisis occurs with a Poisson arrival probability equal to  $\lambda$ .



# Grace period problem: Monetary Authority

$$J^G(\mathbf{b}_0, \mathbf{r}_0) = \max_{\pi(t)} \int_0^{\delta} e^{-\rho t} (\eta u(C^G(\mathbf{b}_0, \mathbf{r}_0, t)) + (1 - \eta)u(y) - \psi_0 \pi(t)) dt + \frac{e^{-\rho \delta}}{\rho}$$

subject to

$$\dot{\mathbf{b}}(t) = C^G(\mathbf{b}_0, \mathbf{r}_0, t) - y + (\mathbf{r}_0 - \pi(t))\mathbf{b}(t) \quad \text{and} \quad \mathbf{b}(0) = \mathbf{b}.$$

- ▶  $J^G(\mathbf{b}_0, \mathbf{r}_0)$  is decreasing in  $\mathbf{b}_0$  and  $\mathbf{r}_0$ .
- ▶ For a given  $(\mathbf{b}_0, \mathbf{r}_0)$ , the monetary authority is more likely to inflate the larger the fraction of countries with positive debt, i.e. the higher is  $\eta$ . There is no fiscal externality in the grace period problem.