Comments by Rafael Repullo on

Endogenous Systemic Liquidity Risk

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Purpose of paper

- Construct model of systemic liquidity risk
  - Not based on Diamond and Dybvig (1983)
  - Not based on Holmström and Tirole (1998)
  - Related to Bolton, Santos, and Scheinkman (2010)
- Discuss optimal policy
  - Lender of last resort (LOLR)
  - Liquidity regulation
  - Capital regulation
  - Narrow banking

Main results

- LOLR prevents inefficient liquidation

  → But induces banks to free ride on liquidity provision

  → Too much investment in illiquid assets

- Liquidity regulation + LOLR is second best optimal

  → Dominates capital regulation

  → Dominates narrow banking

Overview of discussion

- Model setup
- Main comments
  - Need proper definition of equilibrium
  - Need proper welfare criterion
- Review of equilibrium analysis
- Review of welfare analysis
- Comments on the modeling of liquidity risk

Part 1

Model setup

Model setup

- Three dates ($t = 0, 1, 2$) – later on there will be a $t = ½$
- Three types of risk-neutral agents
  - Investors with funds and no investment projects
  - Entrepreneurs with investment projects and no funds
  - Banks that channel funds from investors to entrepreneurs

Model setup

- Investors
  - Continuum with unit endowment at $t = 0$
  - Only want to consume at $t = 1$

    → No consumption shocks à la DD
  - Deposit funds in banks that offer deposit rate d

Model setup

- Entrepreneurs
  - Large number of entrepreneurs of two types
  - Type 1 have projects with return $R_1 > 1$ realized at $t = 1$
  - Type 2 have projects with return $R_2 > R_1$ realized at
    - → either $t = 1$ (with *iid* probability p)
    - → or at $t = 2$ (with *iid* probability $1 - p$)
  - Indifferent between consumption at $t = 1$ or $t = 2$
  - Borrow from banks at rates γR_1 or γR_2 (depending on type)
    - → Keep $(1 - \gamma)R_1$ or $(1 - \gamma)R_2$

Model setup

- Banks
  - Large number that compete à la Bertrand at $t = 0$
  - Raise deposits from investors
    - → Deposit rate d payable at $t = 1$
  - Grant loans to entrepreneurs
    - → Loan rates γR_1 or γR_2 payable at either $t = 1$ or 2
  - Borrow at rate r in a market for liquidity at $t = 1$
    - → Supplied by type 1 and early type 2 entrepreneurs

Model setup

- Model with no aggregate uncertainty
  - Proportion p of early type 2 projects is fixed
- Model with aggregate uncertainty
  - Proportion p can take two values: p_L or $p_H > p_L$
  - Uncertainty resolves at $t = ½$
  - Depositors may run on the banks at $t = ½$
  - Liquidation value $c < 1$

Part 2

Main comments

Comment 1: Definition of equilibrium

- There is no formal definition of equilibrium

  → This makes analysis difficult to follow

- Start with simple model with no aggregate uncertainty (fixed p)
- Equilibrium involves triple (α, d, r)

  → Banks' share α of investment in type 1 projects

  → Deposit rate d offered to investors

  → Interest rate r in market for liquidity

Comment 2: Welfare criterion

- There is no explicit welfare criterion

  → Except to avoid inefficient costly liquidation at $t = ½$

  → This complicates discussion of optimal policy

Part 3

Equilibrium analysis

Definition of equilibrium (fixed *p*)

- A symmetric equilibrium is triple (α, d, r) such that
  - Banks' revenue maximization

$$\max_{\alpha}\left[\alpha\gamma R_1 + (1-\alpha)\left(p\gamma R_2 + \frac{(1-p)\gamma R_2}{r}\right)\right]$$

Revenue from type 1

Revenue from early type 2

Revenue from late type 2 (discounted)

  - Banks' zero profit: deposit rate d equals max. revenue
  - Interest rate r clears market for liquidity

Characterization of equilibrium

- Two possible solutions
  - Corner solution: no investment in type 1 asset ($\alpha = 0$) if

$$R_1 < pR_2 + \frac{(1-p)R_2}{r}$$

  - Interior solution: investment in both assets ($0 < \alpha < 1$) if

$$R_1 = pR_2 + \frac{(1-p)R_2}{r}$$

  → How is r determined?

Characterization of equilibrium

- Equilibrium in market for liquidity
  - Consider the simple case $R_1 < pR_2$

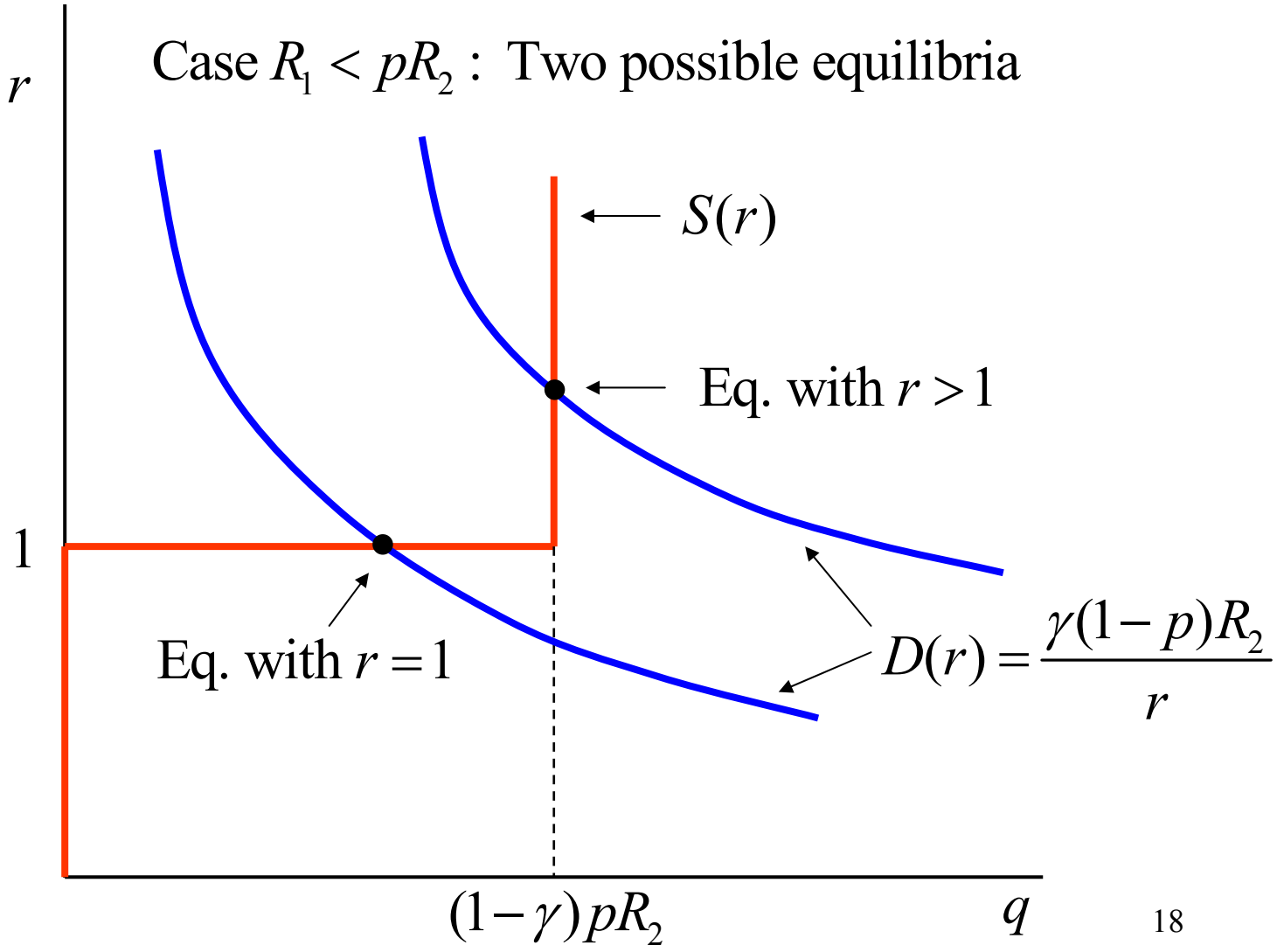
    → Banks only invest in type 2 projects ($\alpha = 0$)
  - Supply of liquidity (by early type 2 entrepreneurs)

$$S(r) = \begin{cases} (1-\gamma)\,pR_2, & \text{if } r > 1 \\ 0, & \text{if } r < 1 \end{cases}$$

  - Demand for liquidity (by banks)

$$D(r) = \frac{\gamma(1-p)R_2}{r}$$

Characterization of equilibrium



Characterization of equilibrium

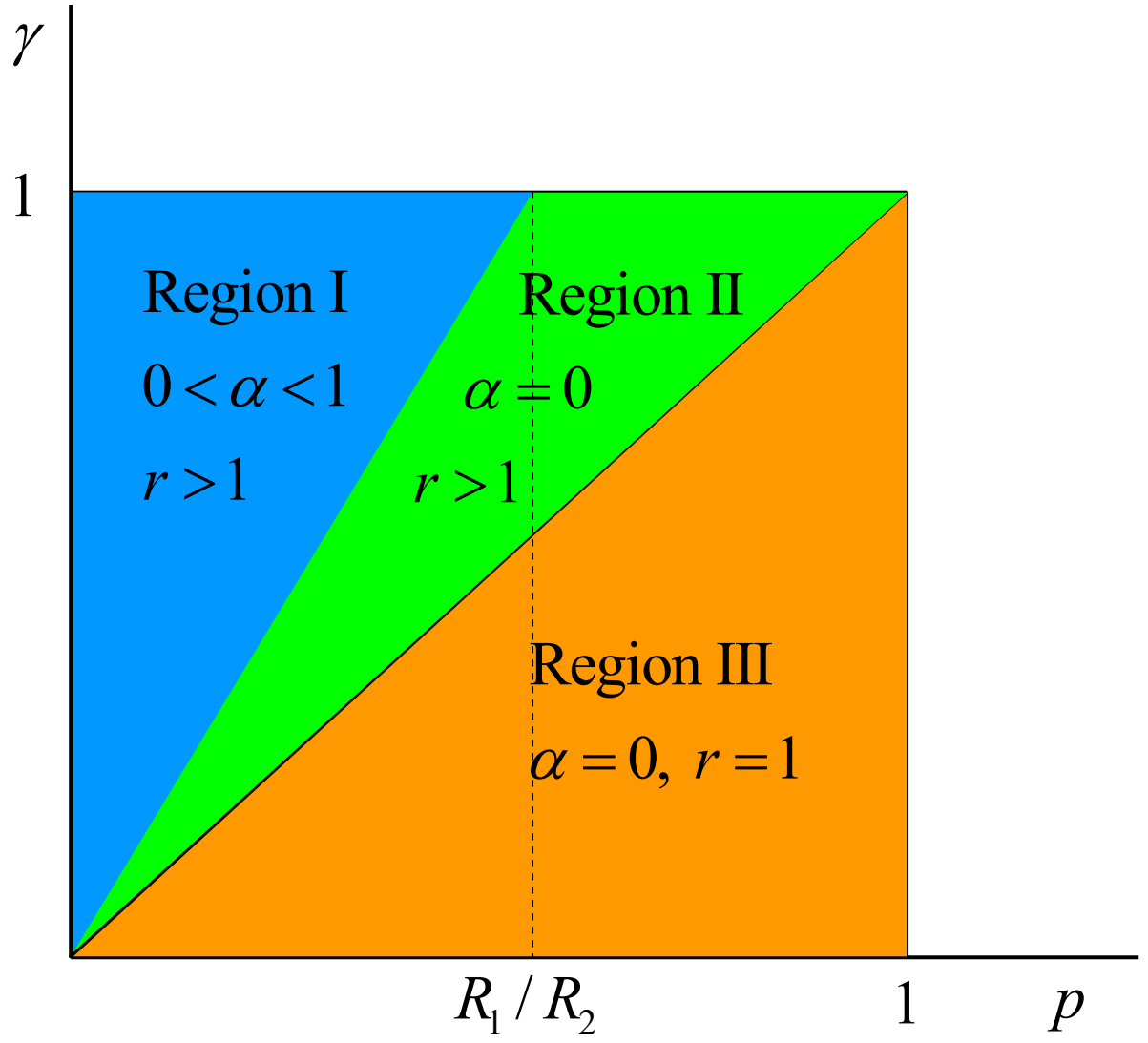
- Three regions
  - Region I: $\gamma \geq pR_2/R_1$

    $\rightarrow$ Equilibrium: $0 < \alpha < 1, \quad d = \gamma R_1, \quad r > 1$
  - Region II: $p \leq \gamma \leq pR_2/R_1$

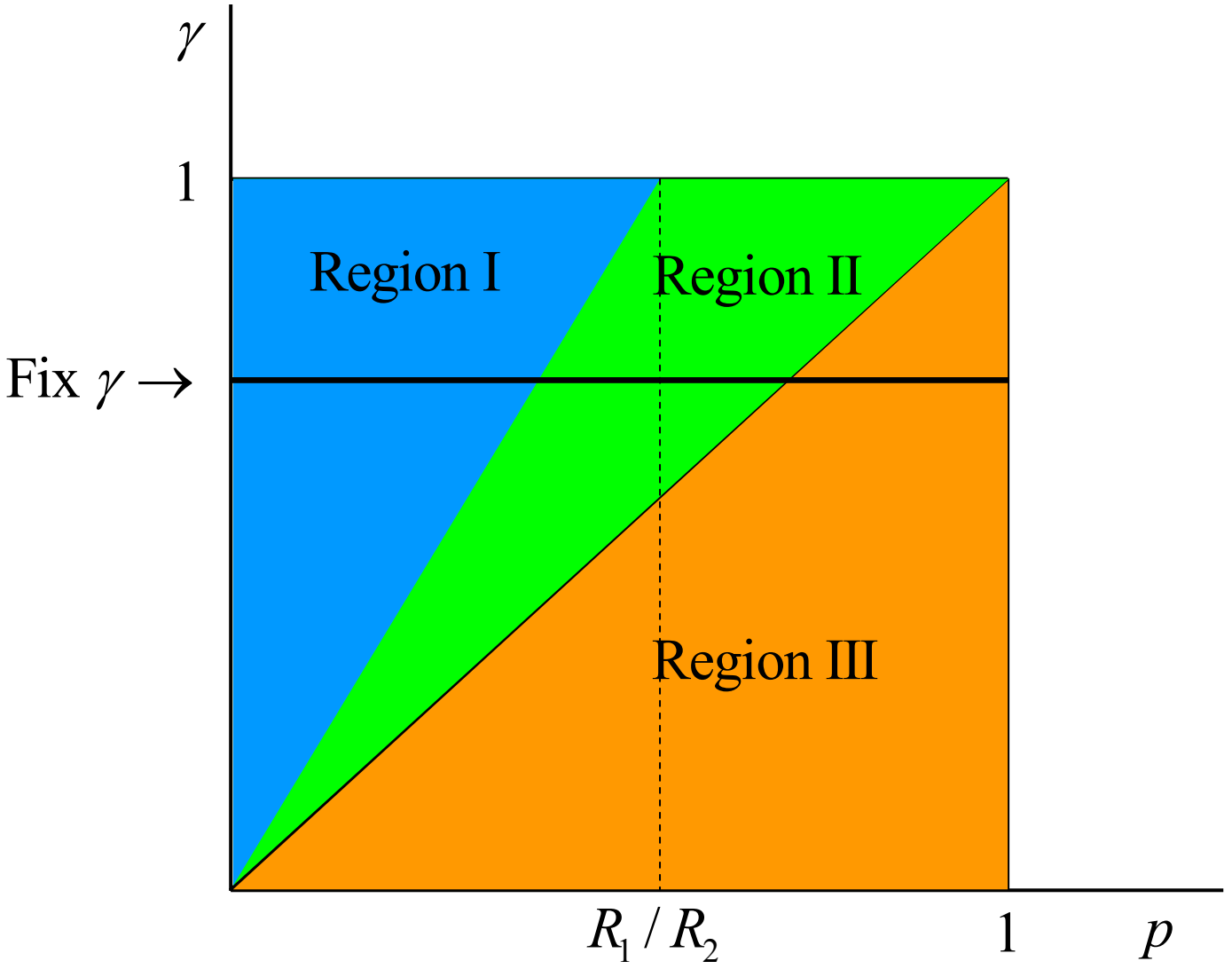
    $\rightarrow$ Equilibrium: $\alpha = 0, \quad d = pR_2, \quad r > 1$
  - Region III: $p \geq \gamma$

    $\rightarrow$ Equilibrium: $\alpha = 0, \quad d = \gamma R_2, \quad r = 1$

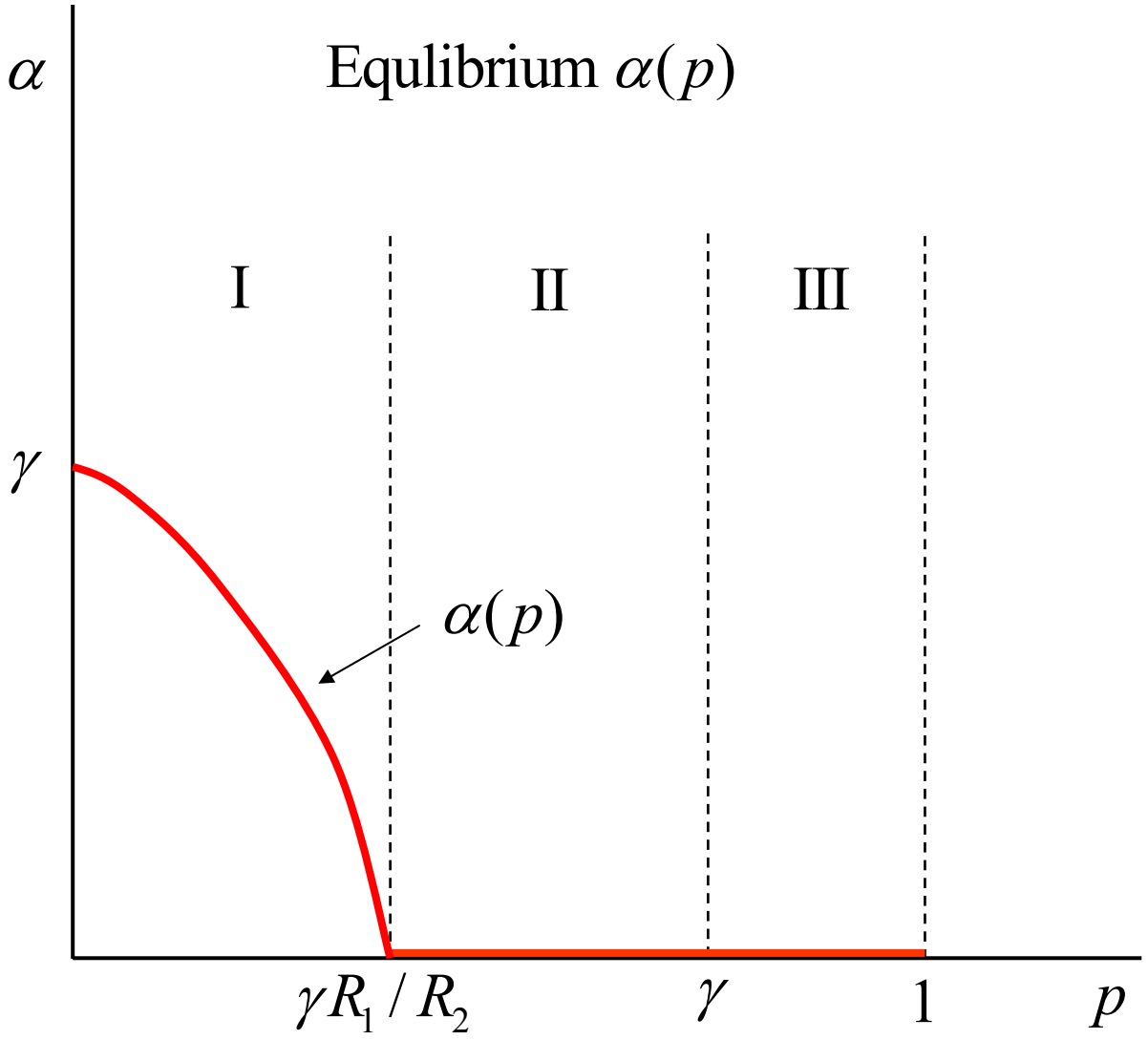
Characterization of equilibrium



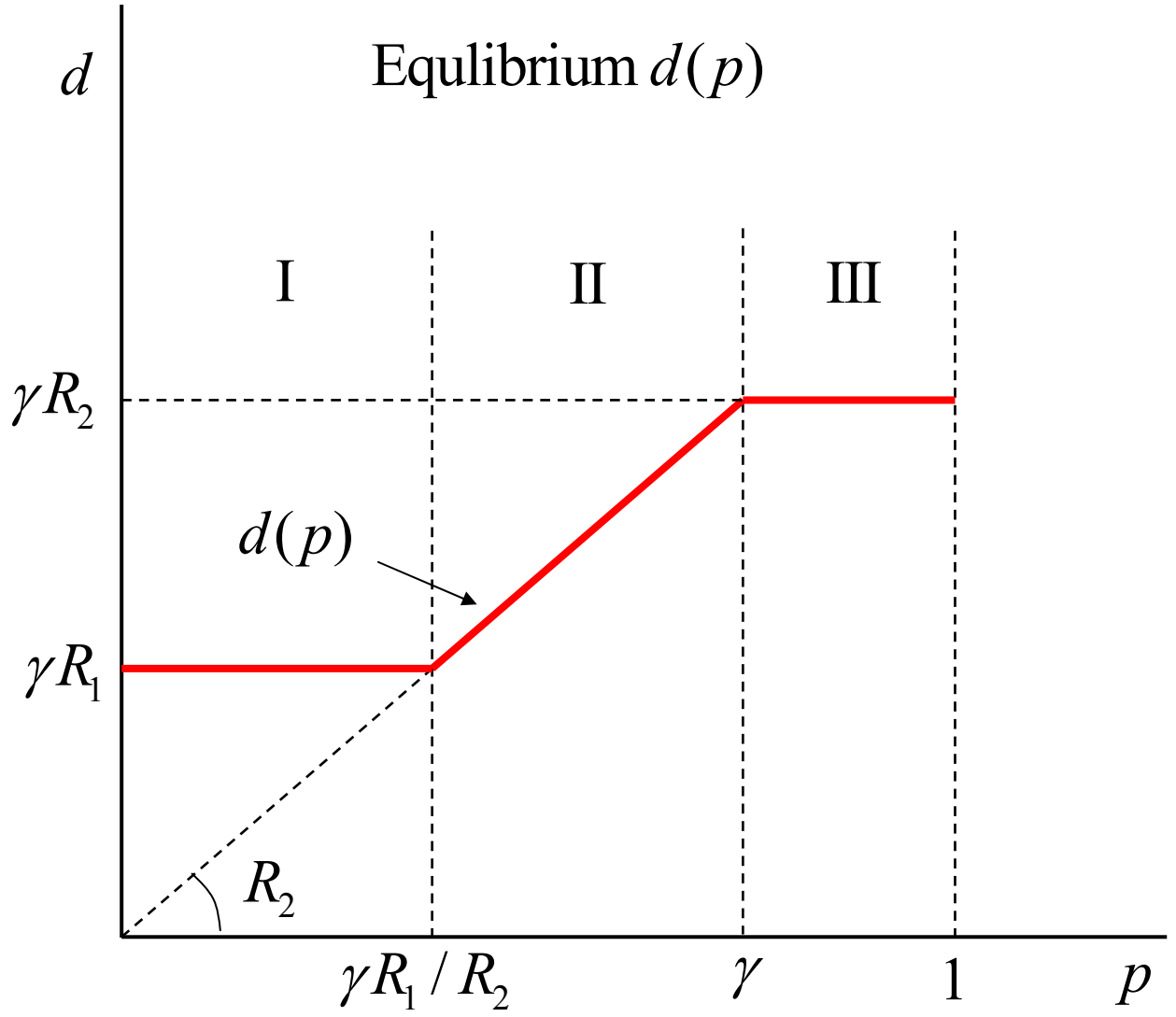
Characterization of equilibrium



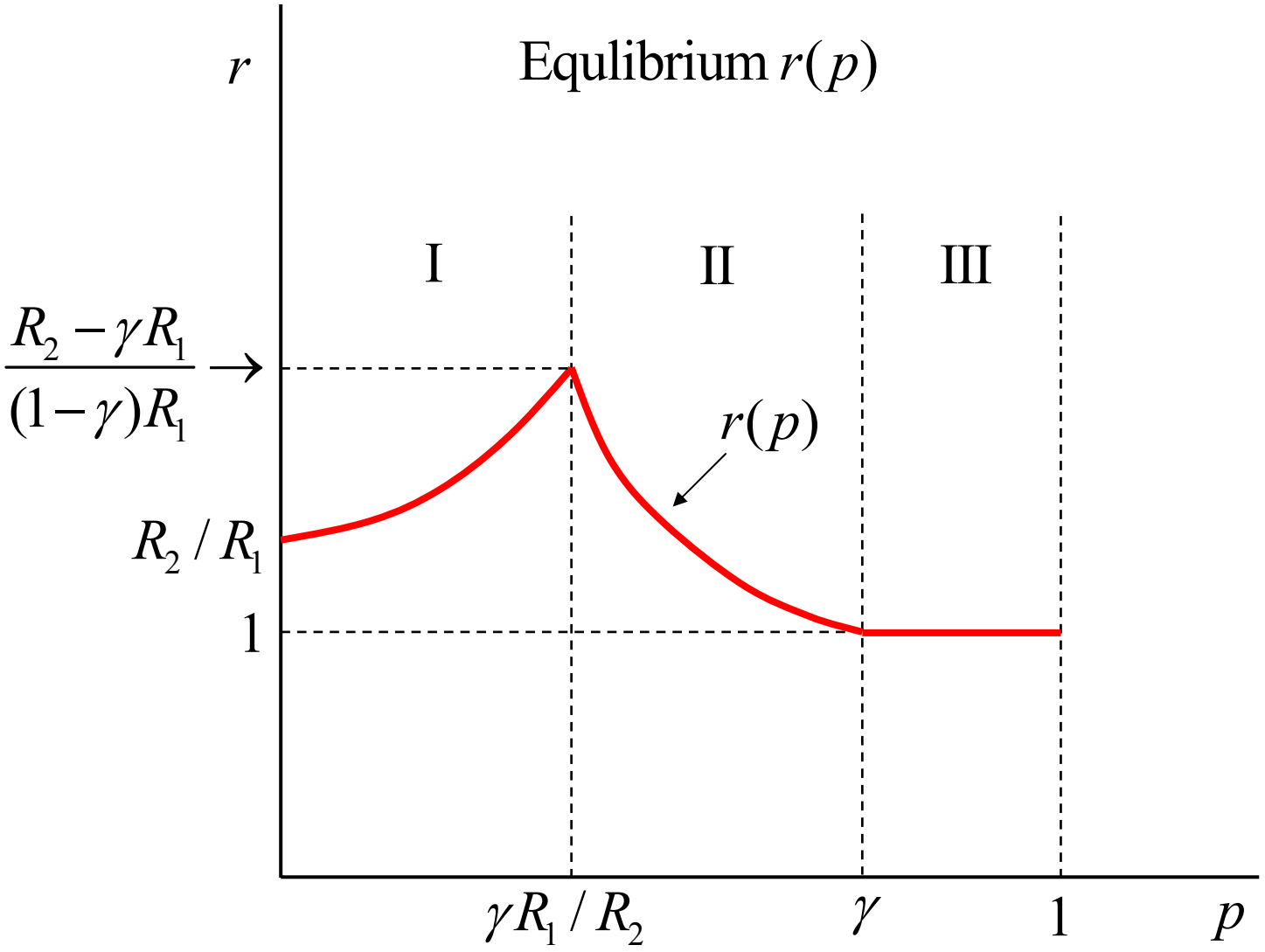
Characterization of equilibrium



Characterization of equilibrium



Characterization of equilibrium



The model with aggregate uncertainty

- Suppose that $p = \begin{cases} p_H & \text{with prob. } \pi \\ p_L & \text{with prob. } 1-\pi \end{cases}$
- Suppose that both with p_H and p_L are in Region I

  $\rightarrow$ By our previous results

$$\alpha_L = \alpha(p_L) > \alpha(p_H) = \alpha_H$$

- If banks choose $\alpha = \alpha_L \rightarrow$ excess supply of liquidity in H
- If banks choose $\alpha = \alpha_H \rightarrow$ excess demand for liquidity in L

  $\rightarrow$ What is the equilibrium?

Characterization of equilibrium

- Fraction θ of banks set $\alpha = 1$ and always survive

  → Deposit rate $d_1 = \gamma R_1$

- Fraction $1 - \theta$ of banks set $\alpha = 0$ and fail in state L

  → Deposit rate d_0 such that

$$\pi d_0 + (1-\pi)c = d_1$$

- Equilibrium θ is decreasing in π with $\lim_{\pi \to 0} \theta = 1$

  → If state L is very likely almost all banks survive

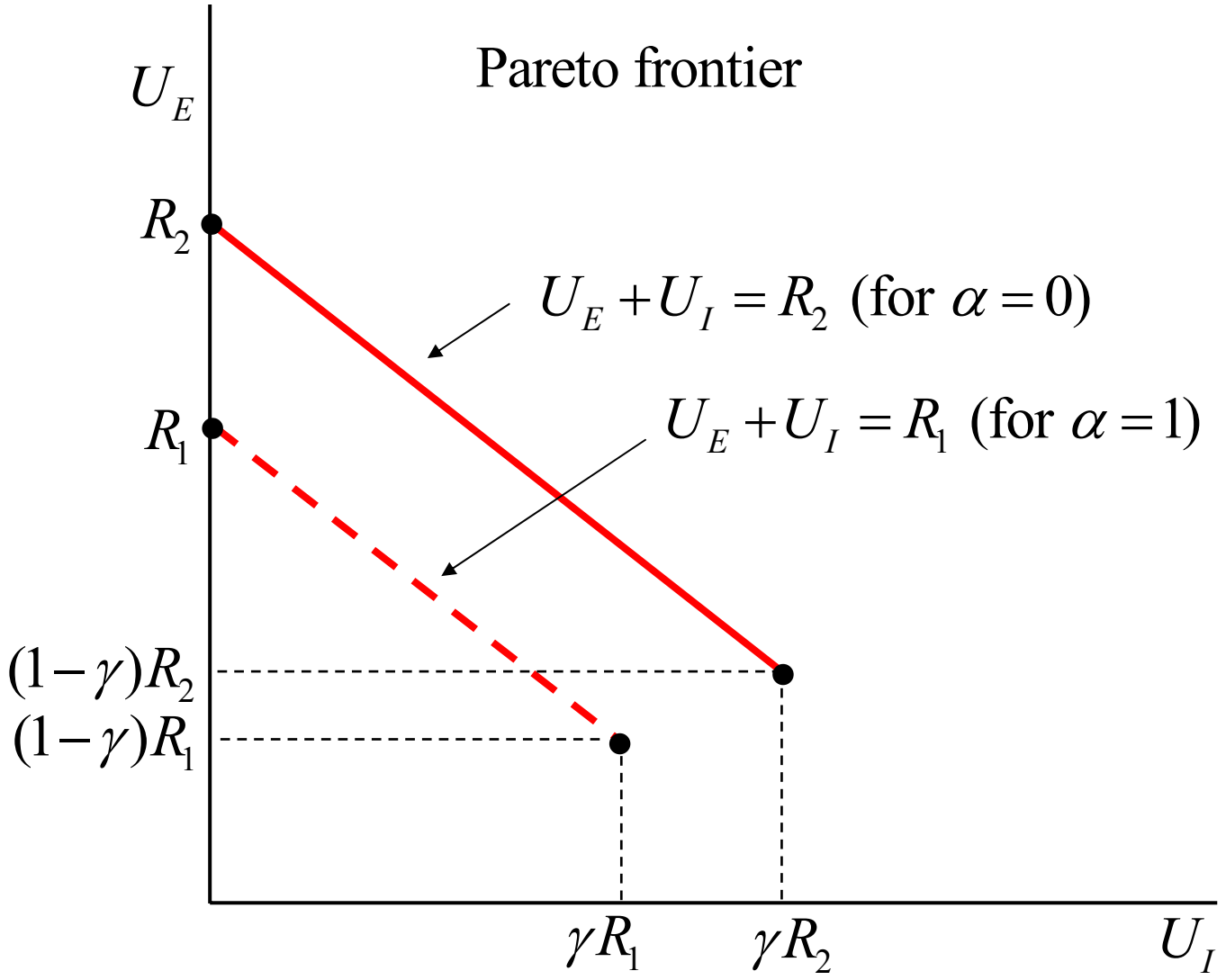
Part 4

Welfare analysis

Welfare analysis

- Consider a social planner that chooses
  - Share α of wealth invested in type 1 projects
  - Share δ of output at $t = 1$ given to investors
- Output at $t = 1$: $y_1 = \alpha R_1 + (1-\alpha) p R_2$
- Output at $t = 2$: $y_2 = (1-\alpha)(1-p) R_2$
- Investors' utility: $U_I = \delta y_1$
- Entrepreneurs' utility: $U_E = (1-\delta) y_1 + y_2$
  - Constraint: $U_E \geq (1-\gamma)\left[\alpha R_1 + (1-\alpha) R_2\right]$
  - Otherwise they would not work

Welfare analysis



Welfare analysis

- Investing everything in type 2 (illiquid) assets is efficient

  → Why may the market allocation be inefficient?

  → What are constraints associated with policy instruments?

  → Look at LOLR operations, liquidity requirements, etc.

Part 5

Modeling liquidity risk

Comments on the modeling liquidity risk

- General approach in literature
  - Liquidity shock that involves shortage of real resources
    → Early consumption that requires current output
  - Intermediaries with no capital: focus on **market liquidity**
- What would be desirable
  - Liquidity shocks involving portfolio reallocations
    → From one asset to another asset
  - Intermediaries with capital: focus on **funding liquidity**

Comments on the modeling liquidity risk

- Two types of models of liquidity risk
  - Models with real (consumption or production) shocks
  - Models with reallocation (of financial claims) shocks
- Central banks can create liquidity "at the drop of a hat"
  - This works in models with reallocation shocks
  - But does not work in models with real shocks
    - → Central banks cannot produce more output
    - → Central banks can reduce value of nominal claims
    - → This is what LOLR does in the paper

Comments on the modeling liquidity risk

- Need models of reallocation shocks
  - Related to solvency concerns → information-based runs
  - Role of funding liquidity (ability to borrow)
  - Role of bank capital
- My (relatively uninformed) guess is that in such models
  - Liquidity requirements would probably be suboptimal
  - Penalize investments with higher expected returns
  - Capital charges for liquidity risk could be better

Concluding remark

- Paper constructs model of systemic liquidity risk
  - → Interesting novel setup
  - → Liquidity shocks are exogenous
  - → Supply of liquidity is endogenous (as in extant literature)
  - → Not really model of "endogenous" systemic liquidity risk
- More work needs to be done
  - → Characterization of equilibrium
  - → Policy analysis