# Optimal Lender of Last Resort Policy in Different Financial Systems

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# 1 Motivation

- In the last 20 years financial crises reemerged as a phenomenon in many countries $\Rightarrow$ demanding role for a lender of last resort
- But principles of lender of last resort policy still captured well by the Bagehot doctrine formulated in 1873: *In a crisis, the lender of last resort should lend freely, at a penalty rate, on the basis of collateral that is marketable in the ordinary cause of business when there is no panic*
- Nowadays common wisdom that financial systems of various countries differ substantially
- Thus the question of the paper: Is a one size fits all-approach with respect to lender of last resort policy appropriate having in mind the differences between financial systems of various countries?

## 2 Structure of the presentation

- The basic framework
- Description of different liquidity crises depending on the degree of aggregate liquidity shortage 3 cases
- Optimal LOLR-policies in the different crises
- Conclusion and further research

# 3 The framework

- Three dates $t = 0, 1, 2$ and two type of goods: consumption goods and machinery
- Large number of risk-neutral entrepreneurs, bankers and small investors; investors and bankers almost only value consumption at date $t = 1$, entrepreneurs value consumption at either date equally
- Project returns $C > 1$ but ex ante uncertainty about *when* this amount will arise: early ($t = 1$) or late ($t = 2$)
- Original project with specific human capital of initial entrepreneur but two alternatives which result in loss of surplus
  - (1) *Restructuring*: at any time *until* date 1 $\Rightarrow$ generates return of $c_1 < 1$ directly $\Rightarrow$ secondary market value of project
  - (2) *Replacement* of the entrepreneur: $\gamma C$ with $\gamma < 1$ but $\gamma C > 1 \Rightarrow$ bank's project value
- Incomplete contracts approach: Financial contracts specify who owns the physical assets conditional on the payments made

- Parametrization of financial systems in our framework
  - Bank-based financial system: Relatively high $\gamma$ and low $c_1 \Rightarrow$ differences between $\gamma$ and $c_1$ large $\Rightarrow$ banks with much insider information $\Rightarrow$ loans are illiquid
  - Market-based financial system: Relatively low $\gamma$ and high $c_1 \Rightarrow$ differences between $\gamma$ and $c_1$ rather small $\Rightarrow$ higher level of information in the market $\Rightarrow$ loans are more liquid
- Banks financed with deposits as *hard* claim and capital as *soft* claim $\Rightarrow$ bank's project value not fully pledgeable to depositors and capital owners $\Rightarrow$ banker gets rents
  - capital as a fraction $k$ of the bank's pledgable assets: Thus, $k = \frac{\frac{1}{2}(\gamma C - D)}{\frac{1}{2}(\gamma C + D)} \iff D = \frac{1-k}{1+k}\gamma C \Rightarrow$ bank absorbs $\frac{k}{1+k}\gamma C$ in rent and capital owners gets the same $\Rightarrow$ total value pledgable to investors is $\frac{\gamma C}{1+k}$

- Our structure of lending markets: Two ex ante identical "regions" hit by a differing macroeconomic shock $\Rightarrow$ influences the fraction of early projects
  - With probability $1 - p_1$ only the fraction $\overline{\alpha}$ resp. $\underline{\alpha}$ of the projects in the regions early, with $\overline{\alpha} \geq \underline{\alpha}$ and symmetric uncertainty about which region is hit by a stronger shock
- Time structure of the model
  - $t = 0$: Banks competing for endowments; bank lending to entrepreneurs
  - Shortly before $t = 1$: Entrepreneurs learn state of their projects and inform their banks; banks try to renegotiate deposit repayment in case the fraction of early projects is too low; renegotiation triggers immediately bank run and restructuring of *all* late projects
  - $t = 1$: Early entrepreneurs repay $\gamma C$ to surviving banks and have $(1-\gamma)C$ at their disposal for consuming or investing; late entrepreneurs default; banks decide how to deal with late projects $\Rightarrow$ depends on prevailing interest rate and need for funds: market for liquidity is open; banks repay investors; investors and bankers consume
  - $t = 2$: Repayments from late projects; entrepreneurs consume

# 4 Stability of an individual bank (1)

- Bankers always prefer to continue late projects in $t = 1$
- Capital owners try to maximize $t = 1$ consumption goods available to the bank $\Rightarrow$ decision depends on $t = 1$ interest rate $r$
  - Restructure if $c_1 > \frac{\gamma C}{(1+k)r}$, thus $\tilde{r} = \frac{\gamma C}{(1+k)c_1}$, continue otherwise, but restructuring socially inefficient as long as $c_1 < \frac{\gamma C}{r}$
- Depositors will run if repayment too low
  - Given capital owners force bankers to restructure late projects, depositors run if $\alpha\gamma C + (1-\alpha)\, c_1 < D = \frac{1-k}{1+k}\gamma C \Rightarrow$ critical level of late projects too high
  - Given that capital owners will continue late projects, depositors will run if

$$\alpha\gamma C + (1-\alpha)\,\frac{\gamma C}{(1+k)\,r} < D = \frac{1-k}{1+k}\gamma C$$

$\Rightarrow$ defines critical interest rate level:

$$r > \frac{1}{1 - k\frac{1+\alpha}{1-\alpha}} \geq 1$$

# 5 Stability of an individual bank (2)

- Optimal decision of depositors
  - Given capital owners force bankers to restructure late projects
    - Depositors run, if $\alpha\gamma C + (1-\alpha)\, c_1 < D = \frac{1-k}{1+k}\gamma C$
      $\Rightarrow$ Critical level of late projects:

$$1 - \alpha > \frac{2k}{1+k}\frac{\gamma C}{\gamma C - c_1}$$

  - Given that capital owners will continue late projects
    - Depositors will run, if

$$\alpha\gamma C + (1-\alpha)\frac{\gamma C}{(1+k)\, r} < D = \frac{1-k}{1+k}\gamma C$$

      $\Rightarrow$ Critical interest rate level:

$$r > \frac{1}{1 - k\frac{1+\alpha}{1-\alpha}} \geq 1$$

# 6 Equilibrium in the liquidity market (1)

- Parameter space for the macroeconomic shock: $\overline{\alpha} > \frac{1-k}{1+k} > \underline{\alpha}$
  - Strong region $\overline{\alpha} \Rightarrow$ liquidity inflow sufficient to repay depositors
  - Weak region $\underline{\alpha} \Rightarrow$ liquidity inflow from financial market transactions needed
  - Accordingly: $\widehat{r} = \frac{1}{1-k\frac{1+\underline{\alpha}}{1-\underline{\alpha}}}$ and $\widehat{\widehat{r}} = \frac{1}{1-k\frac{1+\overline{\alpha}}{1-\overline{\alpha}}}$
- Aggregate liquidity supply: $L^S = (\overline{\alpha} + \underline{\alpha})(1-\gamma)C$
- Aggregate liquidity demand

$$L^D = \begin{cases} 0 & r > \widetilde{r} \\ \left[0; (1-\overline{\alpha})\frac{\gamma C}{(1+k)r}\right] & r = \widetilde{r} \\ (1-\overline{\alpha})\frac{\gamma C}{(1+k)r} & \widehat{r} < r < \widetilde{r} \\ (2-\overline{\alpha}-\underline{\alpha})\frac{\gamma C}{(1+k)r} & r \leq \widehat{r} \end{cases}$$

# 7 Equilibrium in the liquidity market (2)

- Intuition for liquidity demand
  - Banks in need for funds to repay depositors bid up interest rate in the liquidity market
    - First case $r \leq \widehat{r}$: Only slight increase of $r \Rightarrow$ banks in both regions are stable $\Rightarrow$ no restructuring $\Rightarrow L^D = (2 - \overline{\alpha} - \underline{\alpha}) \frac{\gamma C}{(1+k)r}$
    - Second case $\widehat{r} < r < \widetilde{r}$: Run on banks in weaker region $\Rightarrow$ restructuring of late projects; banks in stronger region not inflicted $\Rightarrow L^D = (1 - \overline{\alpha}) \frac{\gamma C}{(1+k)r}$
    - Third case $r = \widetilde{r}$: $\widetilde{r} = \frac{\gamma C}{(1+k)c_1} \Rightarrow$ banks in strong region also in trouble $\Rightarrow$ no run on these banks but (partial) restructuring of late projects
    - Fourth case $r > \widetilde{r}$ : return of restructuring is higher for capital owner $\Rightarrow$ no refinancing of late projects $\Rightarrow L^D = 0$
- Accordingly *three* qualitatively very different equilibria in the liquidity market possible: *slight*, *moderate* and *severe* liquidity crises

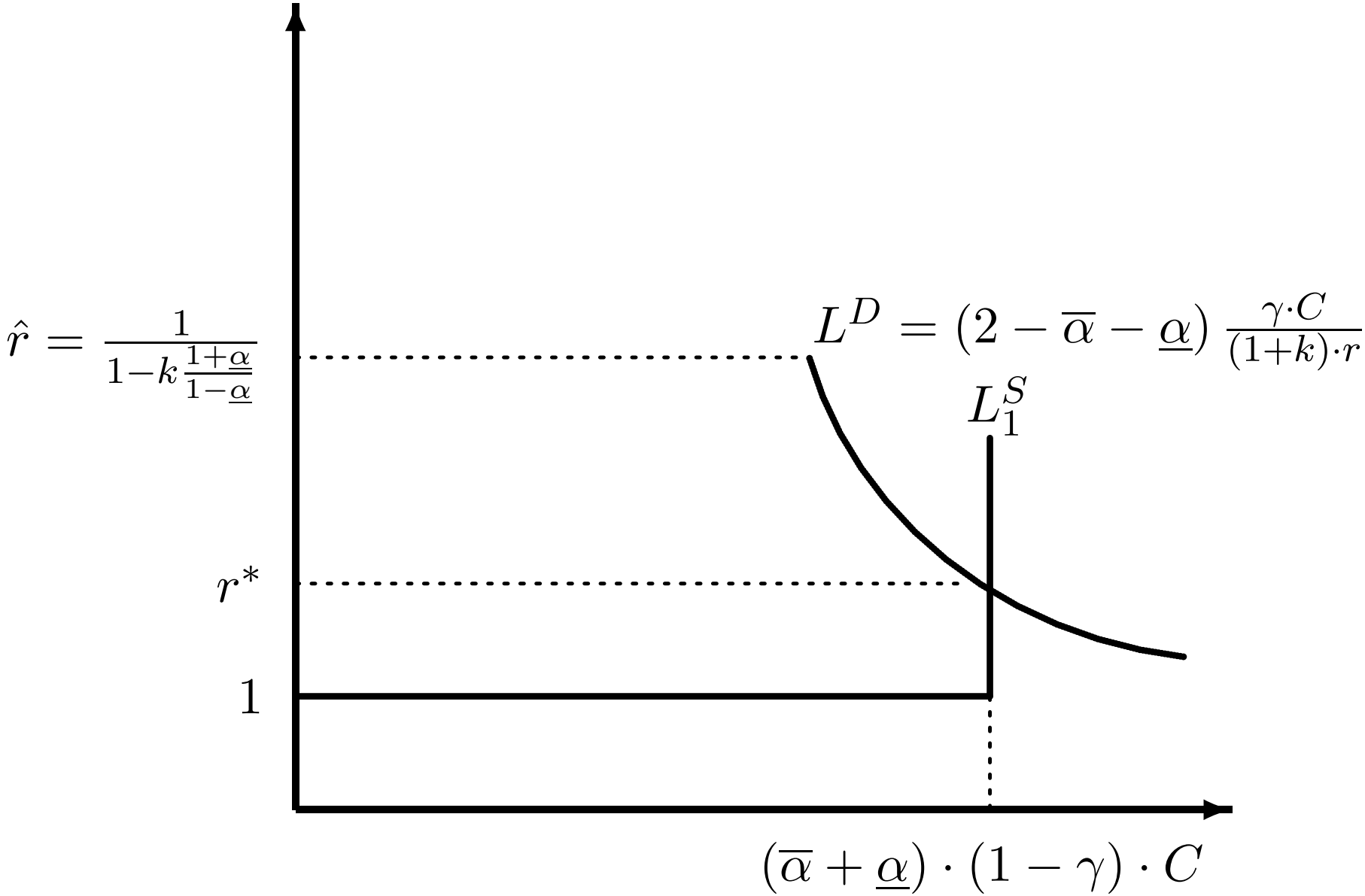


Figure 1: Equilibrium in a slight liquidity crisis

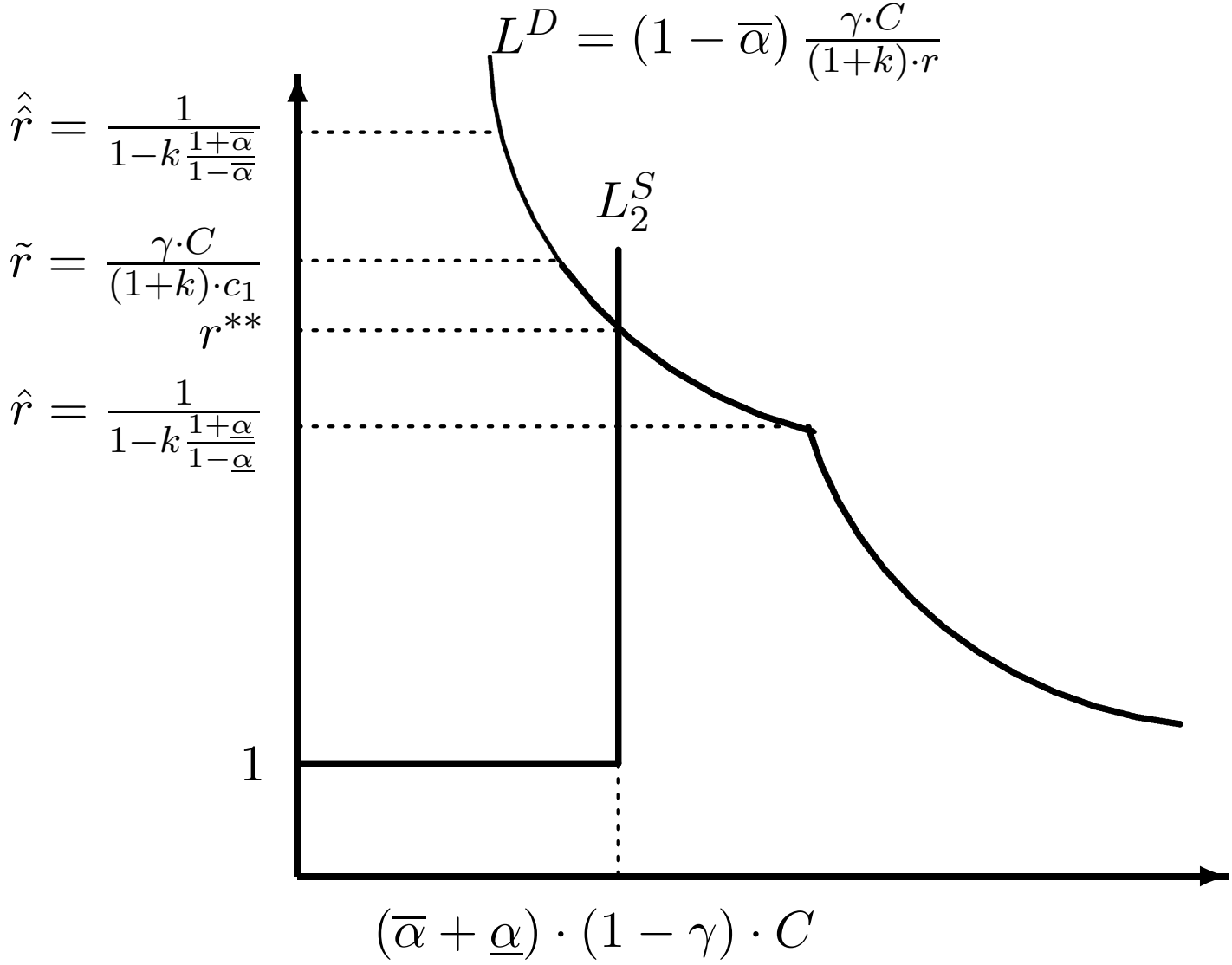


Figure 2: Equilibrium in a moderate liquidity crisis

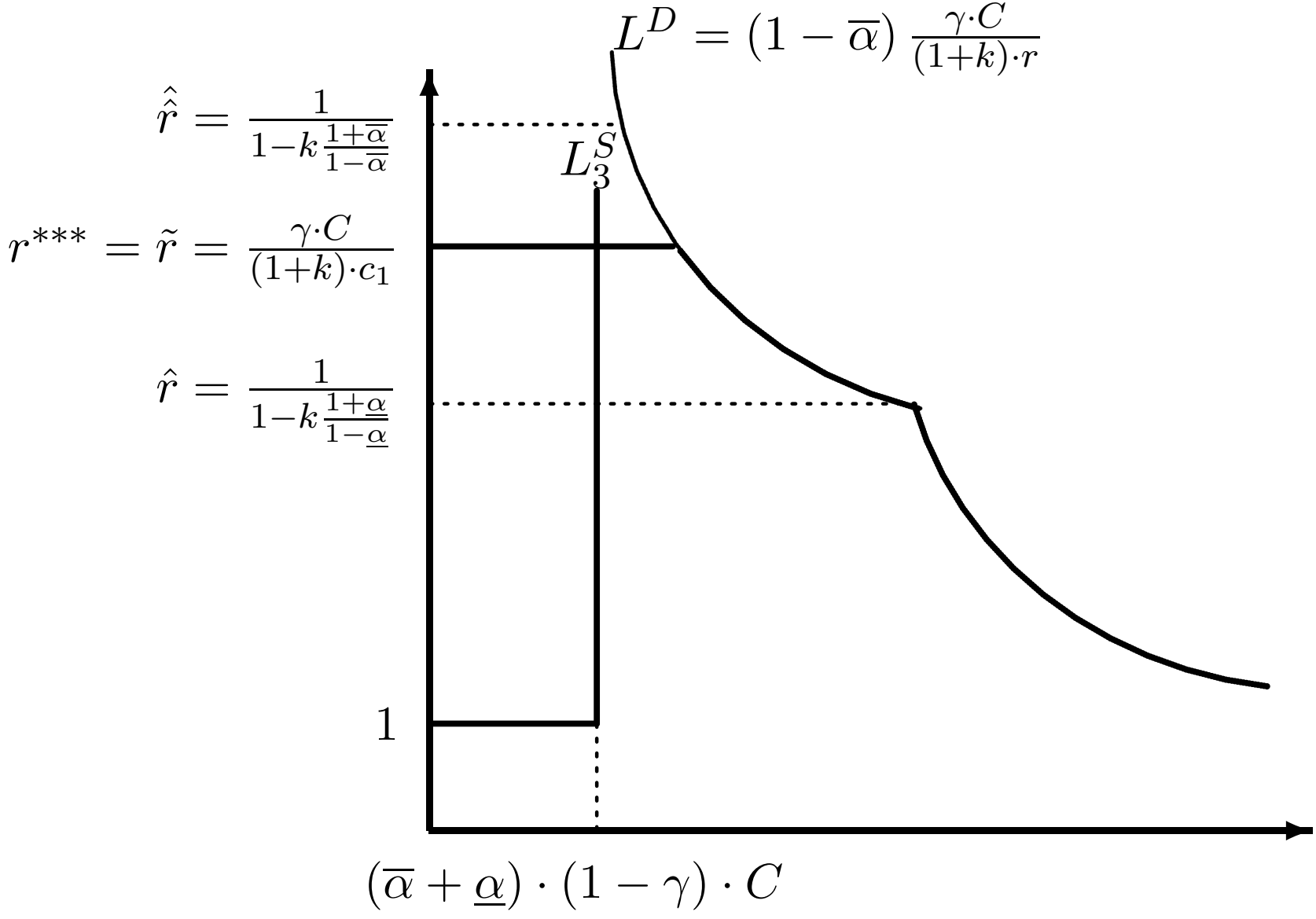


Figure 3: Equilibrium in a severe liquidity crisis

# 8 Equilibrium in the liquidity market (3)

- Influence of financial system configuration on liquidity crises
  - Higher fraction of pledgable income $\gamma \Rightarrow$ shift of liquidity demand to the right and liquidity supply to the left $\Rightarrow$ higher interest fluctuations in bank-dominated than in market-oriented systems
  - Lower return on restructured projects $c_1 \Rightarrow$ raises equilibrium interest rate in severe crisis $\Rightarrow$ Again higher interest fluctuations in bank-dominated systems
  - Threshold level for different crises dependent on financial system
    - Market-based systems end up more likely in a severe crisis
    - Bank-dominated systems end up more often in a moderate crisis

# 9 Optimal LOLR-policy (1)

- Restructuring late projects always welfare reducing $\Rightarrow$ is a consequence of refinancing through deposits $\Rightarrow$ banks cannot bargain in a crisis situation
- Role of LOLR in providing additional liquidity $\Rightarrow$ financed by taxing $t_1$-consumption $\Rightarrow$ shortcut for inflation tax: Money supply increases $\Rightarrow$ banks can fulfill their *nominal* obligations $\Rightarrow$ real value of money reduced
- Assumption: Inflation tax causes welfare losses as costs $\Rightarrow$ proportional to volume of liquidity assistance (LA)
- *Two* possibilities of providing liquidity considered
  - Market interventions (MI): Supplying liquidity to the market by buying financial assets
  - Individual assistance (IA): Providing liquidity to individual banks

# 10 Optimal LOLR-policy (2)

- Moderate liquidity crisis
  - Individual assistance: Only to weak banks: $LA_m^{IA} = D - \underline{\alpha} \cdot \gamma \cdot C$
  - Welfare gains:

$$WG_m^{IA} = (1 - \underline{\alpha}) \left[ D - c_1 + (1 - \gamma) C + \frac{2k}{1+k} \cdot \frac{\gamma C}{\rho} \right] - \beta \left[ D - \underline{\alpha} \gamma C \right]$$

  - Market intervention: has to reduce interest rate to $\widehat{r} \Rightarrow$ not only weak but also strong banks demand liquidity because of interest rate reduction

$$LA_m^{MI} = LA_m^{IA} + (1 - \overline{\alpha}) \cdot \left[ \frac{\gamma C}{(1+k) \cdot \widehat{r}} - \frac{\gamma C}{(1+k) \cdot r^{**}} \right]$$

  - No welfare gain at strong banks $\Rightarrow$ only consumption reshuffling
  - Overall a welfare loss from using market interventions

$$WG_m^{IA} - WG_m^{MI} = \beta (1 - \overline{\alpha}) \left[ \frac{(1 - \underline{\alpha}) - k (1 + \underline{\alpha})}{(1 - \underline{\alpha})} \cdot \frac{\gamma C}{(1+k)} - \frac{(\overline{\alpha} + \underline{\alpha}) (1 - \gamma) C}{(1 - \overline{\alpha})} \right]$$

# 11 Optimal LOLR-policy (3)

- Severe liquidity crisis
  - Similar effects as in moderate crisis at work
  - Liquidity provision through market intervention will be (partially) wasted because of liquidity demand

$$WG_s^{IA} - WG_s^{MI} = \beta\,(1-\overline{\alpha})\left[\frac{(1-\underline{\alpha}) - k\,(1+\underline{\alpha})}{(1-\underline{\alpha})} \cdot \frac{\gamma C}{(1+k)} - c_1\right]$$

- Not only $\gamma$ but also $c_1$ influences the welfare loss of market intervention $\Rightarrow$ efficiency loss of market intervention higher in bank-dominated financial systems
- *Preliminary* result: Individual liquidity assistance strictly preferable and welfare gains higher in bank-dominated financial systems

# 12 Optimal LOLR-policy (4)

- But one big disadvantage of individual liquidity assistance: *Higher* informational requirements
  - Precise information about liquidity needs of every single bank required $\Rightarrow$ no incentives of banks to report honestly their liquidity needs $\Rightarrow$ information costs higher with individual assistance
- Bearing of these additional costs more preferable for a LOLR in bank-dominated systems because of the higher welfare gains
- *Overall* result: LOLR-policy based on individual liquidity assistance *may* be preferable in bank-based but not in market-oriented financial systems

# 13 Conclusion

- Connection between financial system configurations and optimal LOLR-policy drawable
- Market interventions (Bagehot) more favourable in market-oriented systems
- Important caveats
  - Incorporate ex ante decision of investment vs cash holding of the bank
  - Elaborate the incentives for bank moral hazard
  - Monitoring decision of the LOLR