Stability of Funding Models: An Analytical Framework

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Introduction

- Banks perform liquidity and maturity transformation, which makes banks prone to runs.

- A bank can fail because of
  - Low asset returns
  - Loss of significant funding

- The two interact and in most cases it is difficult to separate the two reasons.

- Provide an analytical framework to analyze the reasons for failure.

Introduction

- A scenario-based approach to examine solvency of a bank:
  - Different levels of asset returns
  - Different levels of “runs” (loss of funding)

- Can be though of as a stress-testing exercise where we take the balance sheet of the bank fixed.

- Provides a simple analytical framework that illustrates the “return-loss of funding” pairings that the bank stays solvent.

- Framework can be used to analyze factors that affect bank solvency (balance sheet characteristics) and conduct analysis on the effect of policy proposals.

Outline

1. Model setup
2. Solvency conditions
3. Determinants of bank stability
4. Policy applications
5. Conclusion

Model Setup

Setup

- Three periods $t = 0,1,2$

Assets	Liabilities
m: cash, safe & liquid y: asset, risky & illiquid	s: short-term debt ℓ: long-term debt e: equity

- Cash m:
  - Earns $r_1 = 1$ between $t = 0$ and $t = 1$
  - Earns $r_s \geq 1$ between $t = 1$ and $t = 2$

- Asset y:
  - Random return θ at $t = 2$.
  - θ observed at $t = 1$.
  - Can be liquidated for $\tau\theta < \theta$ at $t = 1$.

Setup

Assets	Liabilities
m: cash, safe & liquid y: asset, risky & illiquid	s: short-term debt ℓ: long-term debt e: equity

- Short-term debt s:
  - Matures in $t = 1$ with interest rate $r_1 = 1$.
  - If rolled over $\rightarrow$ matures in $t = 2$ with $r_s \geq 1$.
- Long-term debt ℓ:
  - Matures in $t = 2$ with interest rate $r_\ell > r_s$.

Parameter Assumptions

- Two assumptions on parameters:
  1. No dominance in ST or LT debt:

$$\underset{\text{Cost of ST rolled over}}{r_s} < \underset{\text{Cost of LT}}{r_\ell} < \underset{\text{Cost of ST withdrawn}}{1/\tau}$$

  2. Cash has higher return than liquidation:

$$\underset{\text{Liquidity of asset}}{\tau\theta} < \underset{\text{Liquidity of cash}}{1}$$

Solvency Conditions

Solvency

- Bank solvency depends on:
  1. Asset shock: return on risky asset θ
  2. Funding shock: fraction of ST debt withdrawn α

- Two scenarios for insolvency:
  1. Fundamental insolvency:
     - Bank insolvent irrespective of funding shock
  2. Conditional insolvency:
     - Bank solvent/insolvent depending on funding shock

Fundamental Insolvency

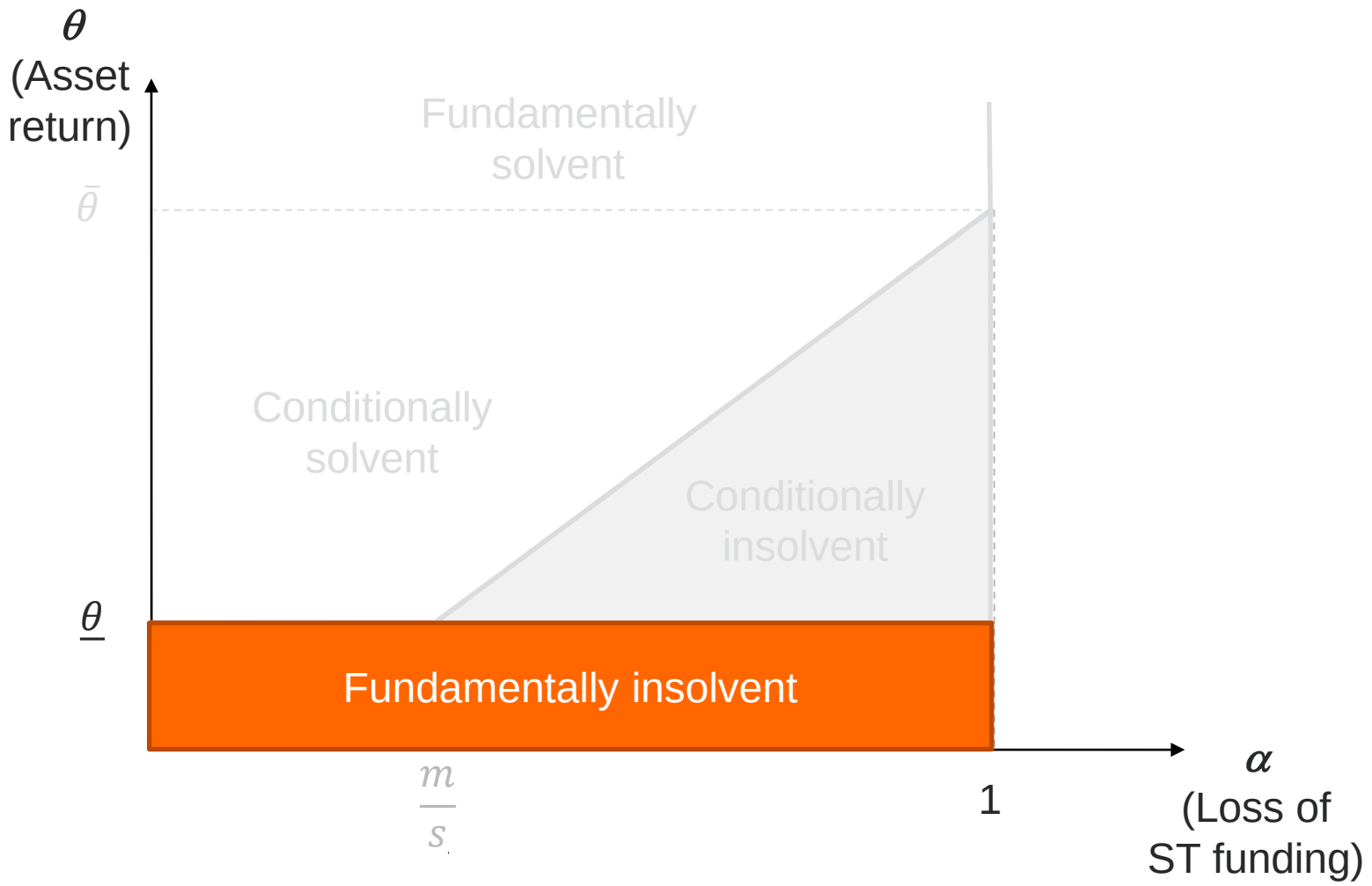
- Condition for fundamental insolvency:

$$\underbrace{\theta y + r_s m}_{\text{Value of assets}} \quad < \quad \underbrace{r_s s + r_\ell \ell}_{\text{Debt burden}}$$

  - α: fraction of short-term creditors that withdraw at *t*=1
  - $\alpha s < m$: all withdrawals paid with cash, no costly liquidation.
  - Bank fundamentally insolvent for $\theta < \underline{\theta}$:

$$\underline{\theta} = \frac{r_s s + r_\ell \ell - r_s m}{y}$$

Fundamental Insolvency



Conditional Insolvency

- For $\alpha s > m$ some assets have to be liquidated.
- Conditional insolvency:

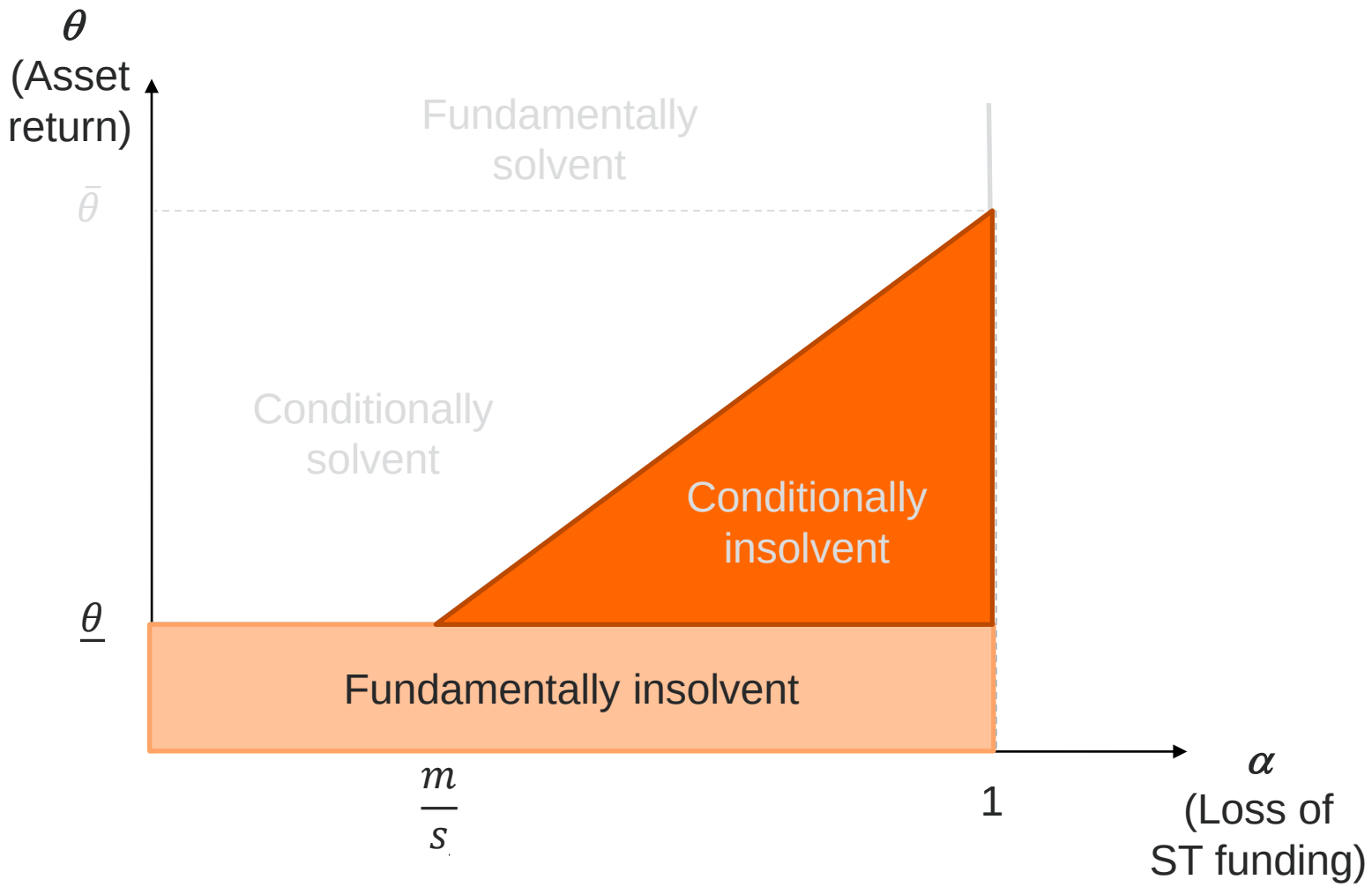
$$\underbrace{\theta y}_{\text{Value of assets}} < \underbrace{{}^{1}/_{\tau}\,(\alpha s - m)}_{\text{ST withdrawn}} + \underbrace{(1-\alpha) r_s s}_{\text{ST rolled over}} + \underbrace{r_\ell \ell}_{\text{LT}}$$

- Solvency threshold for asset & funding shocks:

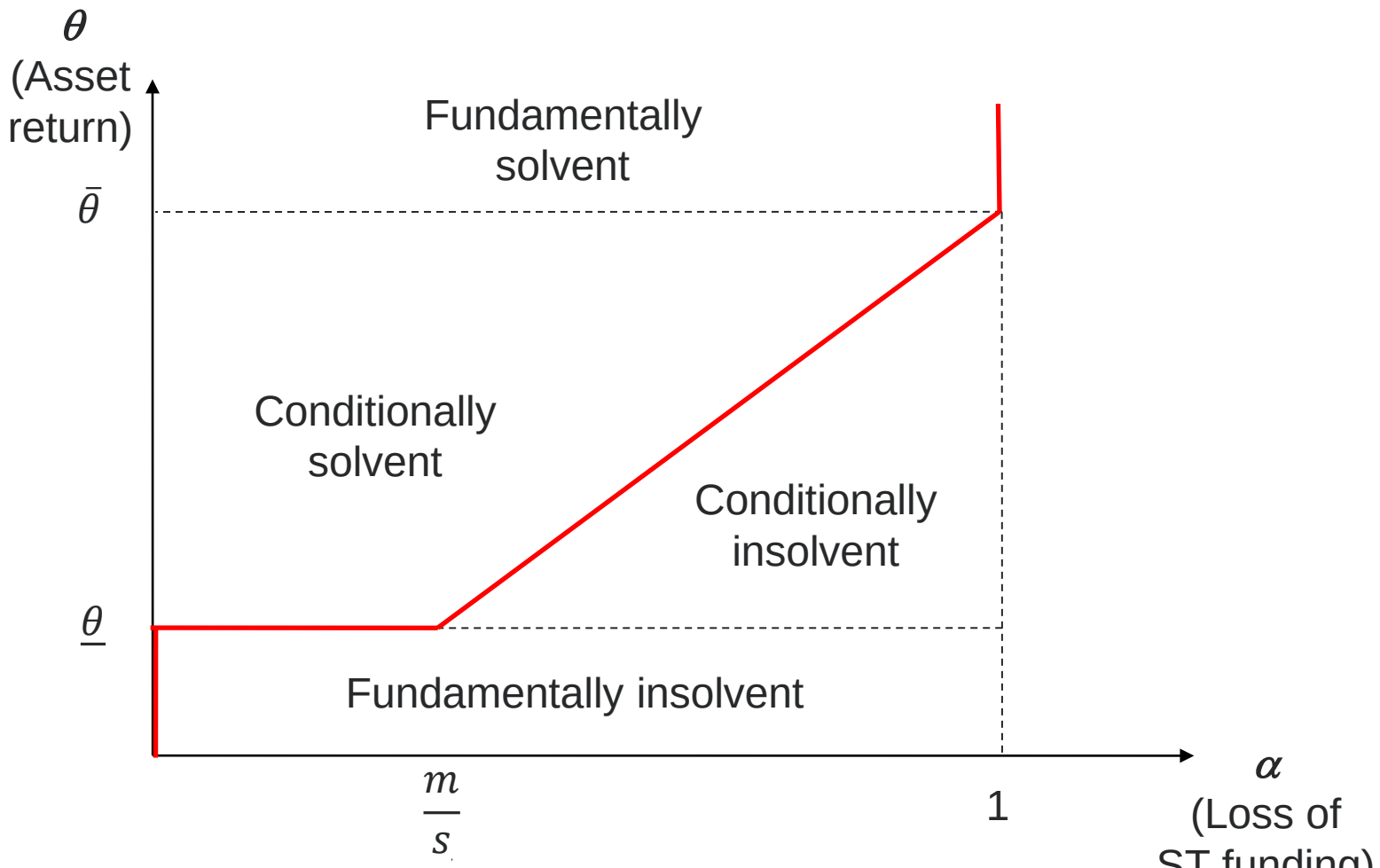
$$\theta(\alpha) = \frac{{}^{1}/_{\tau}\,(\alpha s - m) + (1-\alpha) r_s s + r_\ell \ell}{y}$$

  - Given θ, insolvent if α too high
  - Given α, insolvent if θ too low

Conditional Insolvency

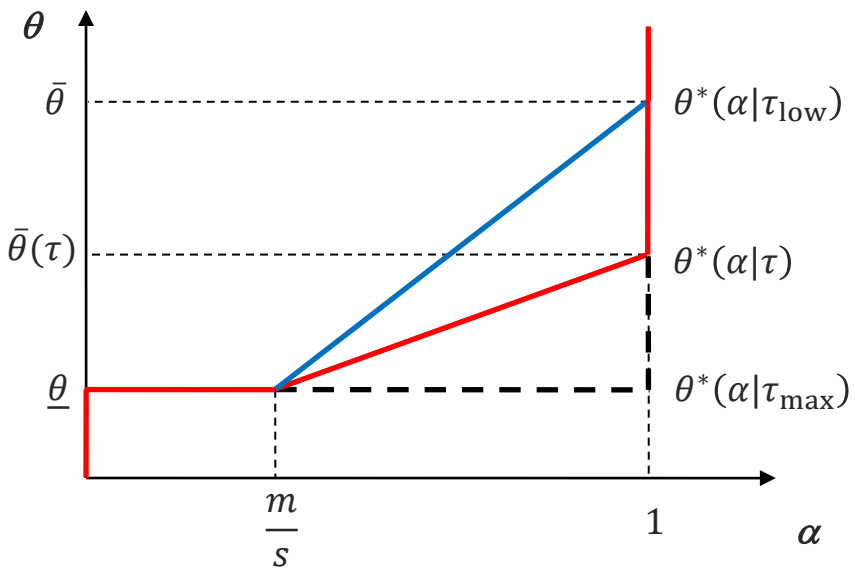


Solvency Regions



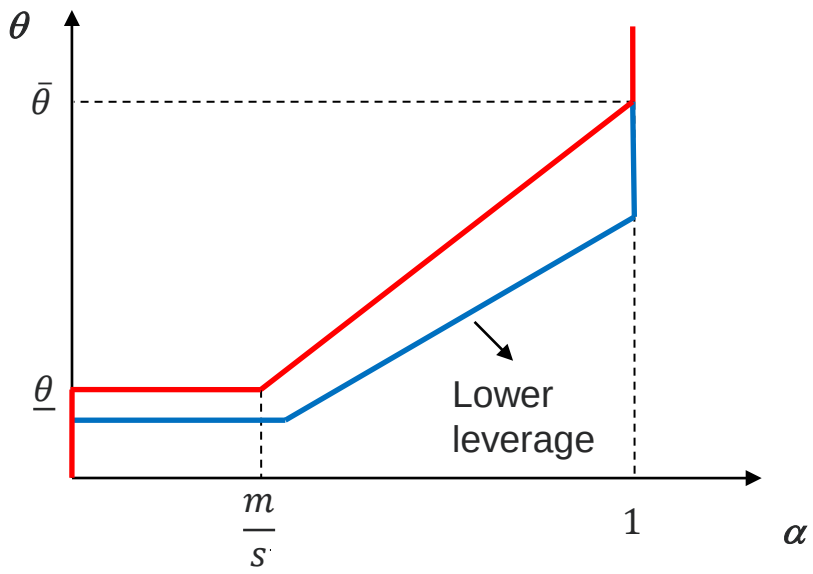
Determinants of Bank Stability

Asset Liquidity



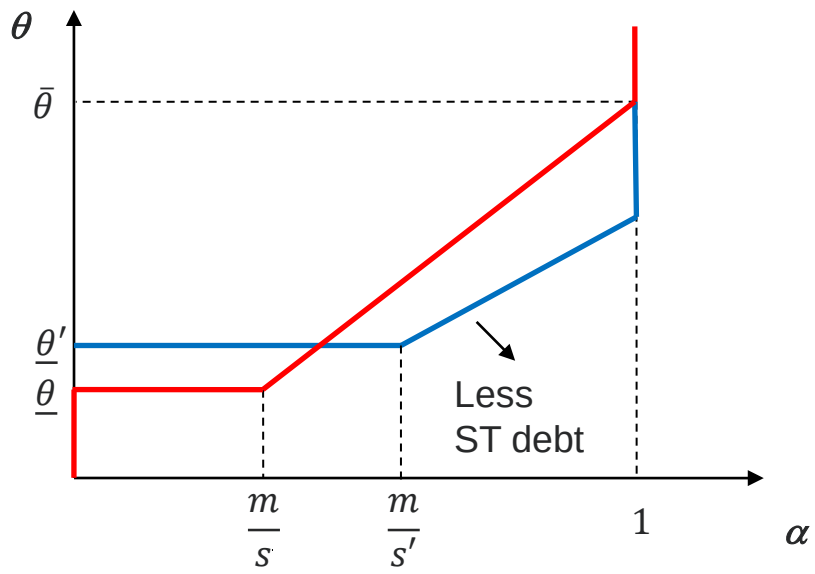
- Higher liquidation value:
  - Doesn't affect risk of fundamental insolvency
  - Reduces risk of conditional insolvency
  - Reduces sensitivity to withdrawals

Leverage



- Lower leverage
  - Reduces risk of fundamental insolvency
  - Reduces risk of conditional insolvency
  - Reduces sensitivity to withdrawals (slope)

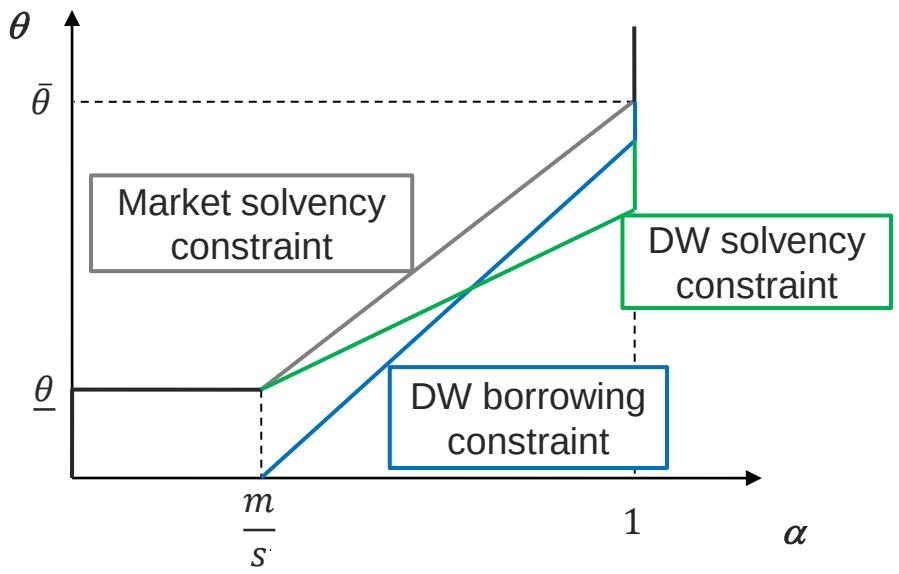
Maturity Structure of Debt



- Less short-term debt:
  - Reduces risk of conditional insolvency
  - Increases risk of fundamental insolvency
  - Reduces sensitivity to withdrawals (slope)

Applications

Discount Window



- DW borrowing constraint in $t = 1$:

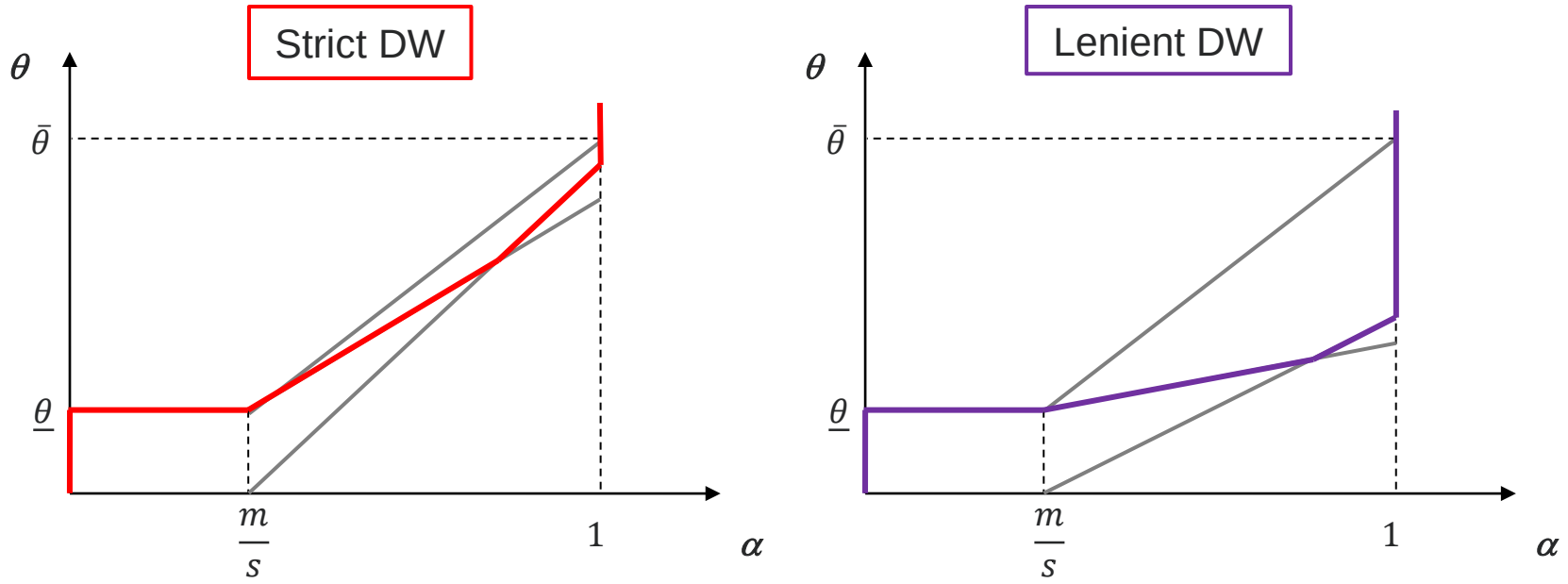
$$\underbrace{\alpha s - m}_{\text{DW borrowing}} \leq \underbrace{(1 - h_d)\theta y}_{\text{Value of collateral}}$$

- DW solvency constraint in $t = 2$:

$$\underbrace{\theta y}_{\text{Value of assets}} \geq \underbrace{r_d(\alpha s - m)}_{\text{DW loan}} + \underbrace{(1 - \alpha) r_s s}_{\text{ST rolled over}} + \underbrace{r_\ell \ell}_{\text{LT}}$$

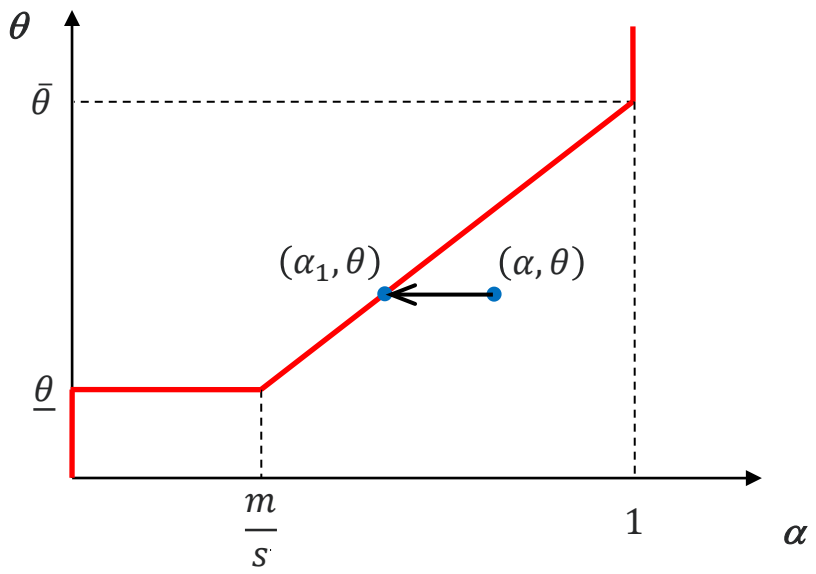
Debt burden

Discount Window



- Discount window reduces risk of conditional insolvency
  - With low haircut in $t = 1$ and
  - With low interest rate in $t = 2$

Orderly Liquidation Authority



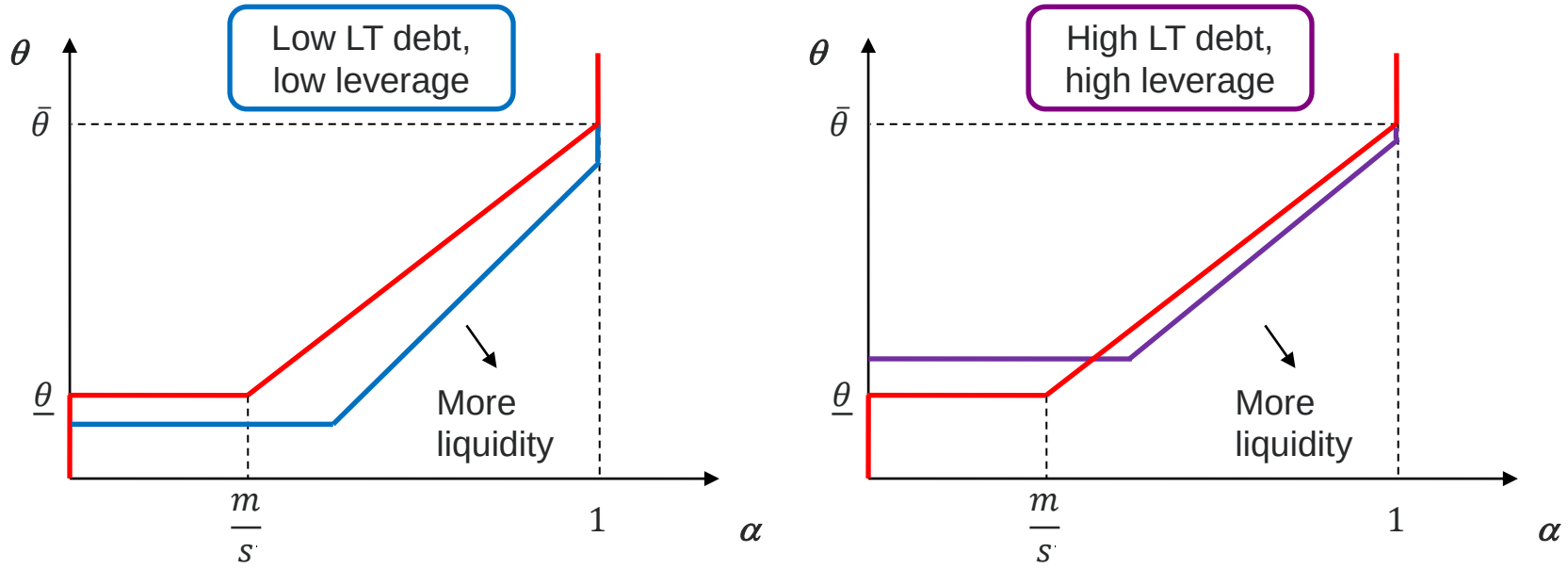
- Regulator triggers OLA
- OLA restricts withdrawals to α_1 given by $\theta = \theta^*(\alpha_1)$
- Remaining $\alpha_2 = \alpha - \alpha_1$ forced to wait until $t = 2$
- OLA eliminates risk of conditional insolvency

Conclusion

Conclusion

- The question “Is the bank solvent or insolvent?” is not always a well-posed question.
- In many cases a bank is only “conditionally solvent,” that is, solvent only if sufficiently many of its short-term debt holders roll over their debt.
- Lower leverage and higher asset liquidation values unambiguously reduce the region of conditional insolvency for the bank.
- Higher long-term debt requirements and higher holdings of liquid cash assets have ambiguous effects on the bank’s conditional solvency.

Liquidity Holdings



- Higher cash holdings:
  - Ambiguous effect on risk of fundamental insolvency
    - Decreases risk for low LT debt, low leverage
    - Increases risk for high LT debt, high leverage
  - Reduces risk of conditional insolvency
  - Increases sensitivity to withdrawals $\frac{d}{d\alpha}\theta^*(\alpha)$

Liquidity Regulation

- Liquidity coverage ratio / Net stable funding ratio
- Link liquidity holdings and ST debt: $m \geq \gamma s$
- Our framework:
  - Strengthening regulation (higher γ)
  - Equivalent to increasing liquidity holdings (higher m)