The Interdependence of Bank Capital and Liquidity

E. Carletti [†] I. Goldstein [‡] A. Leonello [*]

[†]Bocconi University and CEPR

[‡]University of Pennsylvania

[*]European Central Bank

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Introduction

- Liquidity played a central role in the recent financial crises (e.g., Bernanke, 2008)
  - As a result, liquidity regulation (e.g., LCR, NSFR) was introduced to complement capital regulation
- Capital and liquidity requirements are meant to serve different purposes
  - The former deals with solvency issues, the latter with liquidity ones
- (In)solvency and (il)liquidity are closely intertwined concepts in triggering financial crises
- In light of these considerations, do capital and liquidity interact in affecting bank stability? If so, how?

What we do in the paper

- We present a model to analyze the interdependent effect of capital and liquidity on financial stability
- Need a model where
  - **Solvency** (spurred by bad fundamentals) and **liquidity** crises (due to coordination failure) can be told apart
  - Crisis probabilities are **endogenously** pinned down and depend on bank's balance sheet choice (leverage and asset liquidity)
  - (Rich) debt holders' **payoffs** depend on bank's balance sheet
  - Existing models (e.g., Diamond and Kashyap, 2016; Vives, 2014; Kashyap et al., 2017) do not have **all** these ingredients
- We develop a global-games framework à la Goldstein and Pauzner (2005) and derive
  - New results on the effects of capital and liquidity on bank stability
  - Some implications for capital and liquidity regulation

Sketch of the model

- Banks raise short term debt and equity, and choose portfolio with liquidity/return trade-off
- Debt holders receive imperfect information about the long term portfolio value, and decide whether to roll over or run
- Both solvency and liquidity crises occur, with probability uniquely determined as a function of bank balance sheet composition
- Two inefficiencies
  - Runs lead to inefficient liquidation of bank portfolios
  - Liquidation may entail losses due to fire sales

Results in a nutshell

- Capital and liquidity have ambiguous effects on the likelihood of crises, depending on
  - Nature of crises, i.e., solvency or liquidity
  - Initial bank balance sheet composition
- In particular,
  - Capital is **detrimental only** for banks with **little** capital/liquidity
  - Liquidity is **beneficial only** for banks with **intermediate** levels of capital/portfolio liquidity
- Regulation should consider both sides of bank balance sheet
  - Regulation can restore efficiency, only with small cost of capital and liquidity and good market funding conditions

The baseline model: Banks and investors

- Three dates ($t = 0, 1, 2$) economy with a continuum $[0, 1]$ of banks and (risk-neutral) investors
- At date 0, banks raise a fraction k as capital and $1 - k$ as short-term debt, and invests in a risky portfolio
  - Capital entails a per unit cost $\rho > 1$
  - Debt holders are promised r_1 at date 1 and r_2 at date 2 in case of rollover, with $r_2 \geq r_1 \geq 1$, and obtain 1 in expectation
- Portfolio returns $\ell\chi \in [0, 1]$ at date 1 and $R(\theta)(1 - \alpha\ell)$ at date 2, where
  - ℓ is a choice variable capturing bank portfolio liquidity $\longrightarrow$ liquidity/return trade-off
  - $\chi \in (0, 1]$ represents market funding conditions
  - $\theta \sim U[0, 1]$, $R'(\theta) > 0$ and $0 < \alpha \leq \overline{\alpha}$ is cost of liquidity

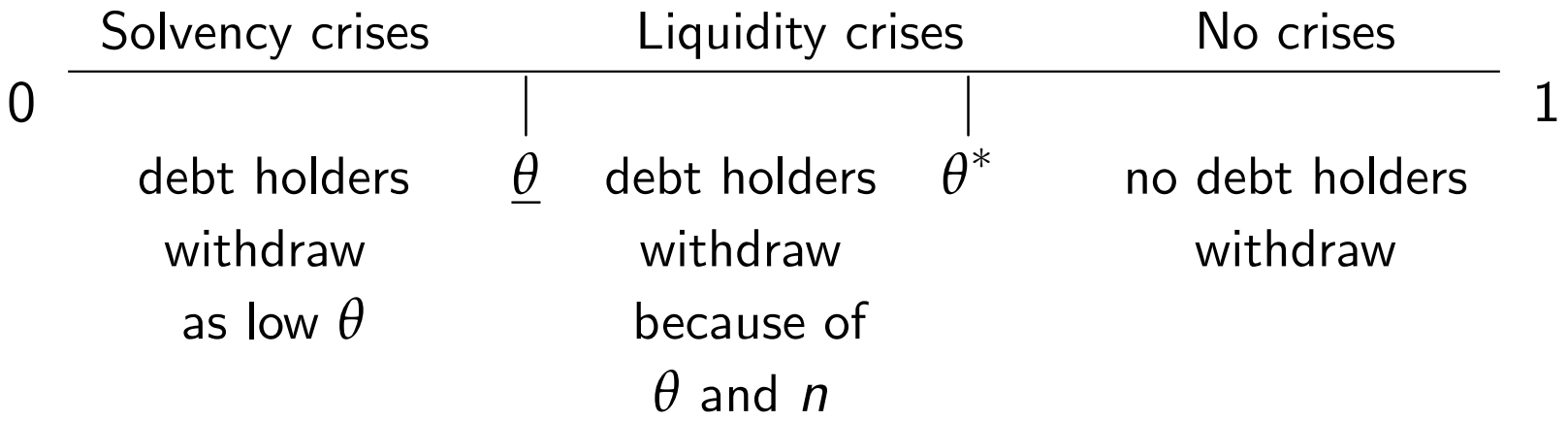
The baseline model: Debt holders' information

- At the beginning of date 1, each debt holder receives a private signal s_i on the fundamental of the economy of the form

$$s_i = \theta + \varepsilon_i$$

  with $\varepsilon_i \sim U[-\varepsilon, +\varepsilon]$ being i.i.d. across agents and $\varepsilon \longrightarrow 0$
- Based on the signal, debt holders decide whether to withdraw (run) at date 1 or roll over their debt
  - They update their beliefs about θ and the others' actions
- The bank satisfies early redemptions by liquidating its portfolio
- Debt holders receive a pro-rata share, whenever bank proceeds are not enough to repay r_1 or r_2

Debt holders' rollover decision and crises



where $\underline{\theta}$ is the solution to

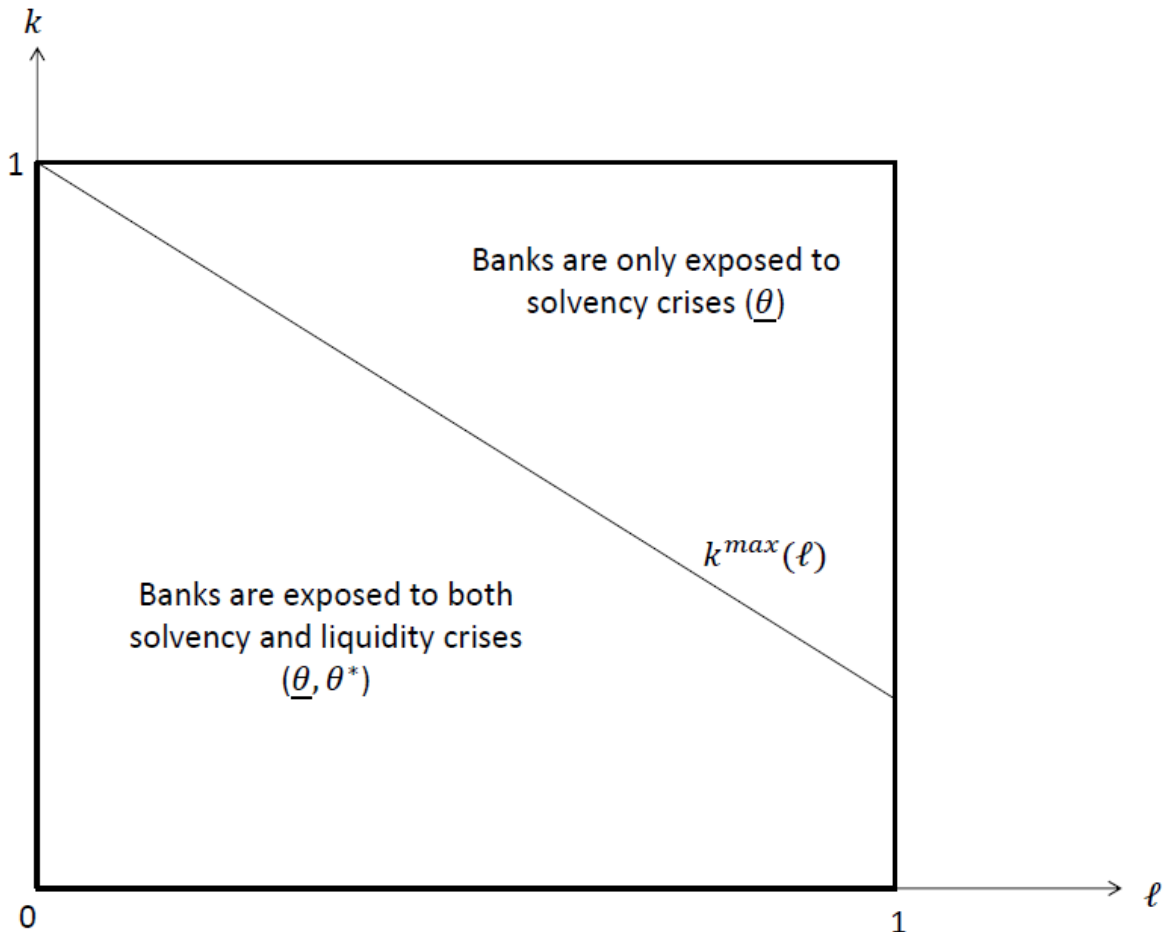
$$R(\theta)(1-\alpha\ell) = (1-k)\, r_1$$

and θ^* to

$$\int_{n=0}^{\widehat{n}(\theta)} r_2 + \int_{n=\widehat{n}(\theta)}^{\bar{n}} \frac{R(\theta)(1-\alpha\ell)\left[1-\frac{(1-k)nr_1}{\ell\chi}\right]}{(1-k)(1-n)} = \int_{n=0}^{\bar{n}} r_1 + \int_{n=\bar{n}}^{1} \frac{\ell\chi}{(1-k)\, n}$$

Capital, liquidity and stability

- When $(1-k)r_1 = \ell\chi$ (i.e., for $k = k^{\max}(\ell)$), there are no strategic complementarities and $\theta^* \longrightarrow \underline{\theta}$



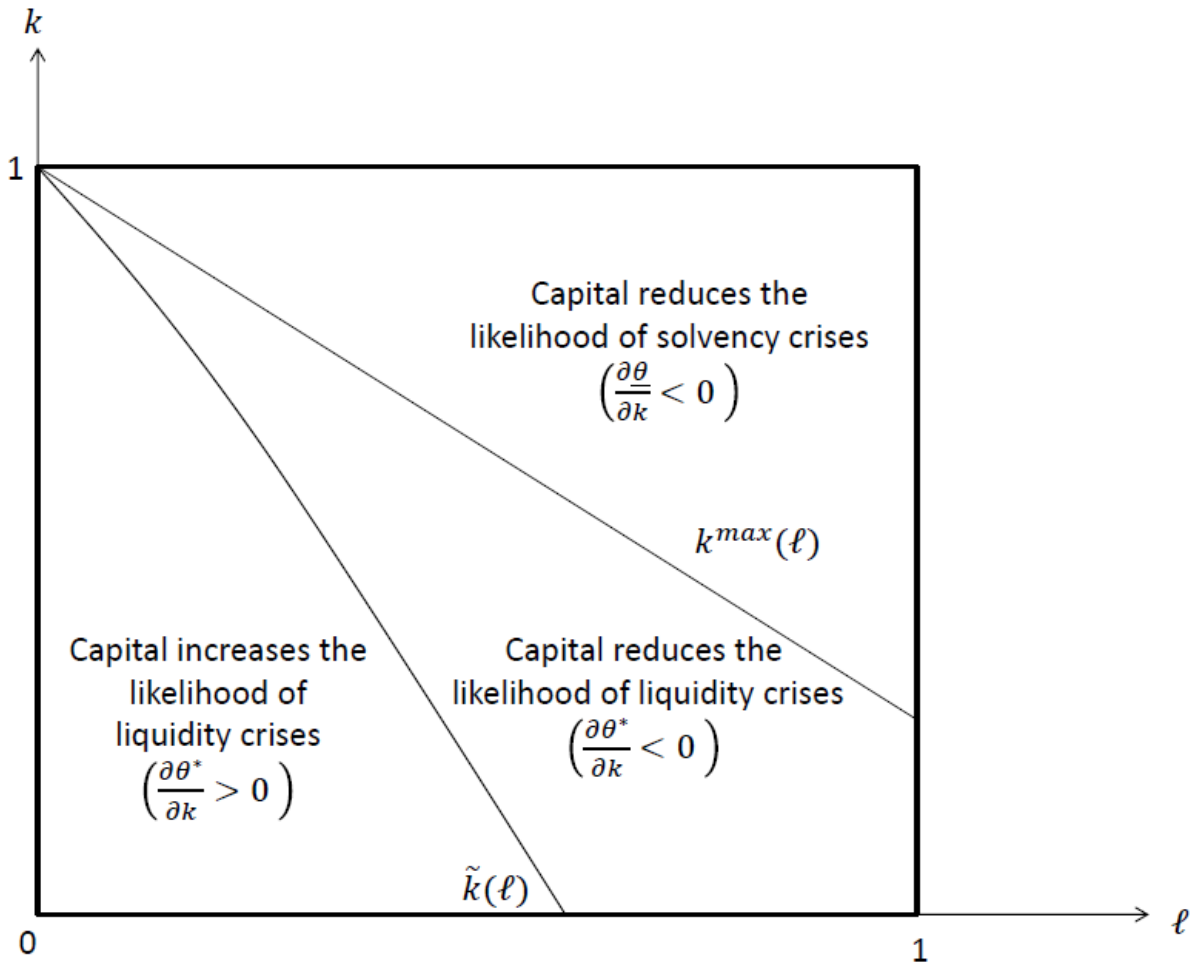
Capital and bank fragility

- Capital is always **beneficial** for **solvency** crises
  - More capital $\longrightarrow$ more resources to pay debt holders at $t = 2$
- **But** it is **ambiguous** for **liquidity** crises due to two opposing effects

$$\underbrace{-\int_{\widehat{n}(\theta)}^{\overline{n}} \frac{R(\theta)(1-\alpha\ell)}{(1-k)(1-n)}dn}_{\text{Higher repayment at date 2}} \underbrace{+\int_{\overline{n}}^{1} \frac{\ell\chi}{(1-k)n}dn}_{\text{Higher repayment at date 1}}$$

- Initial balance sheet composition (i.e., k and ℓ) determines which effect dominates

Effect of capital on crisis probabilities



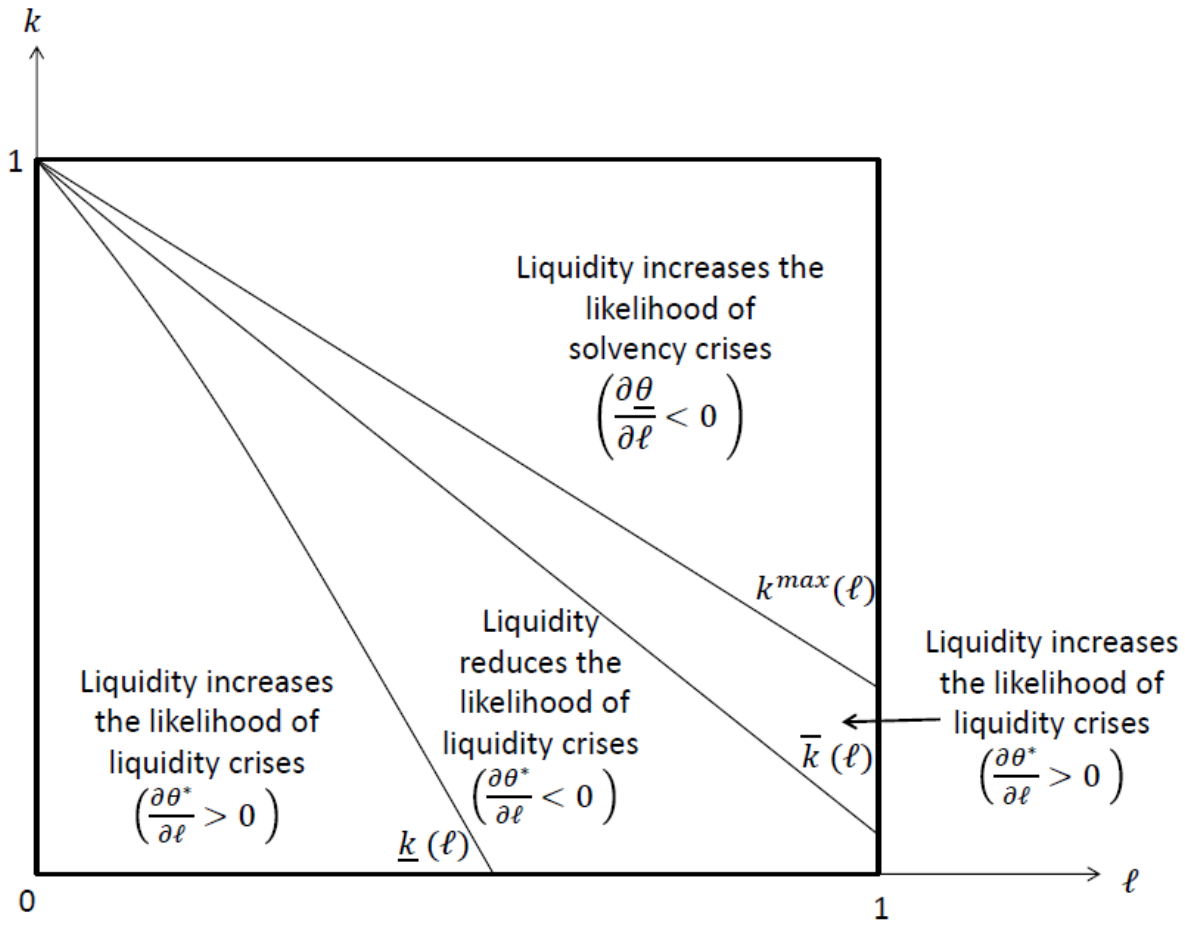
Liquidity and bank stability

- Liquidity is always **detrimental** for **solvency** crises
  - More liquidity $\longrightarrow$ lower portfolio profitability at date 2
- **But** it is **ambiguous** for **liquidity** crises due to three different effects

$$\underbrace{-\int_{\widehat{n}(\theta)}^{\overline{n}} \frac{R(\theta)\, n r_1}{\ell^2 \chi (1-n)} dn}_{\text{Higher repayment at date 2 due to less liquidation at date 1}} + \underbrace{\int_{\widehat{n}(\theta)}^{\overline{n}} \frac{\alpha R(\theta)}{(1-k)(1-n)} dn}_{\text{Lower repayment at date 2 due to lower profitability}} + \underbrace{\int_{\overline{n}}^{1} \frac{\chi}{(1-k)\, n} dn}_{\text{Higher repayment at date 1}}$$

- Again, initial balance sheet composition (i.e., k and ℓ) determines which effect dominates

Effect of liquidity on crisis probabilities



The market equilibrium: The bank's choice

- Given debt holders' rollover decisions, at date 0 each bank chooses k, ℓ, r_1 and r_2 to maximize

$$\Pi^B = \int_{\theta^*}^{1} \left[R(\theta)(1 - \alpha\ell) - (1-k) r_2 \right] d\theta - k\rho$$

subject to

$$\int_0^{\theta^*} \frac{\ell\chi}{(1-k)} d\theta + \int_{\theta^*}^{1} r_2 d\theta \geq 1 \text{ and } \Pi^B \geq 0$$

- The solution entails two inefficiencies
  - Liquidity crises occur in equilibrium since $\left(1 - k^B\right) r_1^B > \ell^B \chi$ holds
  - Banks sell assets to outside investors with finite wealth w
  - Liquidation can be inefficient and entail losses due to fire sales (i.e., $\chi(\ell, k, w) < 1$) if market conditions are tight (i.e., w small)

Regulatory intervention

- Regulator sets capital and liquidity requirements $\left\{k^R, \ell^R\right\}$ to maximize

$$\int_0^{\theta^*} \ell\chi\left(Q\right) d\theta + \int_{\theta^*}^1 R\left(\theta\right)\left(1-\alpha\ell\right) d\theta$$

subject to

$$r_1^B, r_2^B = \arg\max \Pi^B$$

$$\Pi^B \geq 0$$

- Eliminating both inefficiencies may **not** be feasible for given α, ρ and w
  - Limited investors' wealth w associated with severe fire sales
  - Binding constraint $\Pi^B = 0$ when α and ρ are large

Conclusions

- Capital and liquidity present complicated intertemporal trade-offs, which affect solvency and liquidity crises differently
- Understanding all of them requires endogenizing crises probability and bank behavior, and distinguish between crises of different nature
- Higher capital and liquidity are not always beneficial, in particular for banks that are highly leveraged and hold illiquid portfolios
- Regulation should be based on both side of balance sheet
  - Joint capital and liquidity regulation can correct market inefficiencies, but this may not be feasible if market funding conditions are tight