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A Theory of Bank Liquidity Requirements

Charles Calomiris
Columbia University

Florian Heider
European Central Bank

Marie Hoerova
European Central Bank

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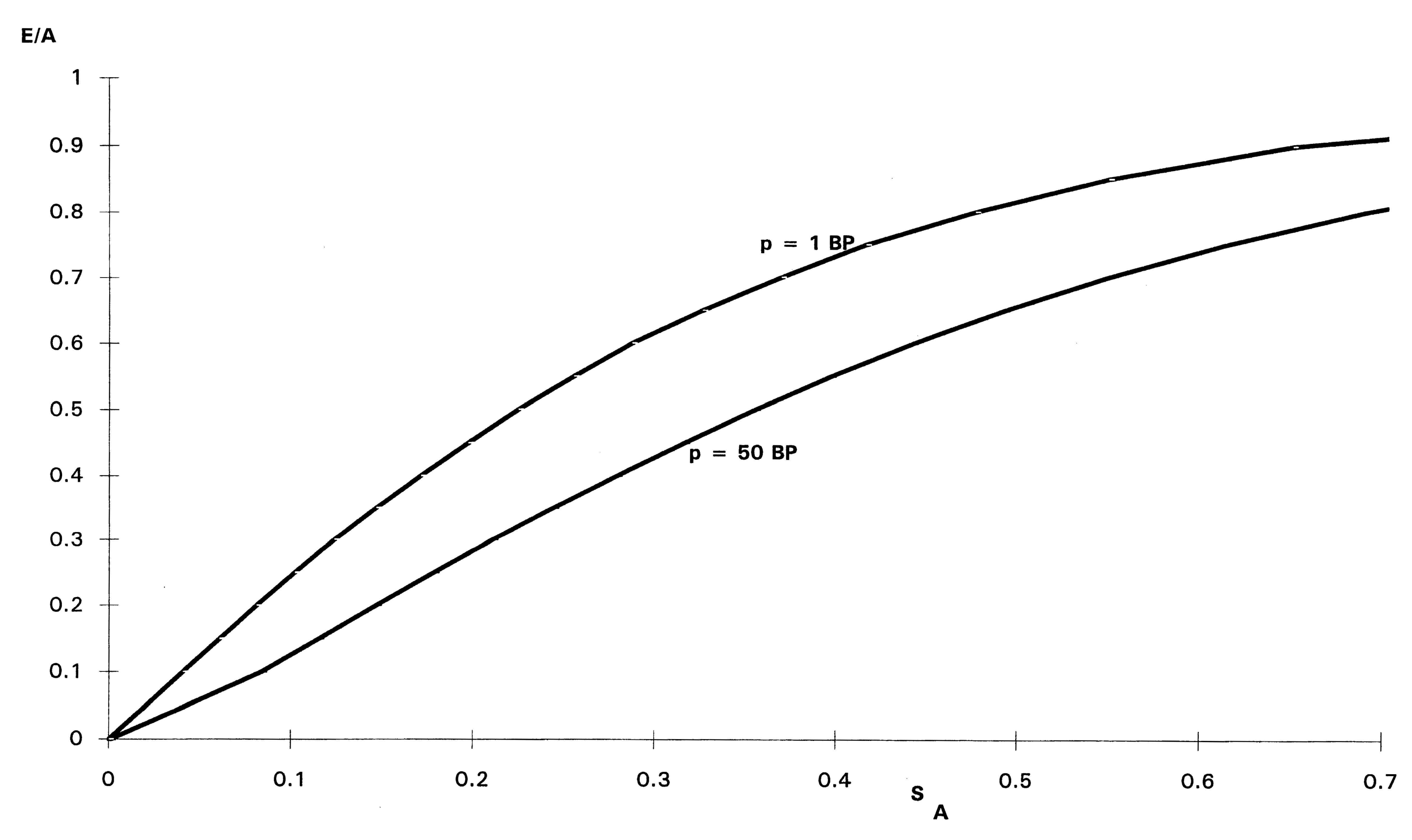
The views expressed are those of the authors, and not necessarily their employers.

Liquidity Requirements: Frictionless World

- In frictionless world (perfect information, no transaction cost) a liquidity standard would add nothing to a capital requirement (two ways to skin the cat of targeting a given default risk on bank debt).
- Black-Scholes-Merton framework: cash holdings reduce sigma of assets proportionally, and substitutability of cash vs. capital is given by deposit iso-default risk curve for the target default risk level.

Two Ways to Skin Cat of Default Risk



Theories with Frictions: Cash's Unique Roles

- **1. Lack of substitutability of debt capacity for cash during times of need.** Under asymmetric information cash is not a perfect substitute for debt capacity. During crises, debt capacity shrinks as an endogenous response to opacity. **This is especially true of banks (ABCP, repos, Libor).** Almeida, Campello and Weisbach 2004, Acharya, Almeida and Campello 2006, Denis and Sibilkov 2007, provide empirical evidence that this is true for corporations. **Lack of cash can lead to costly liquidation.**
- **2. Buffer against noisy signals** (Calomiris and Kahn 1991). Again, costliness of liquidation is key motive. LLN benefits.
- **3. Reduce dependence on LOLR** by having banks self-insure against liquidity risk.

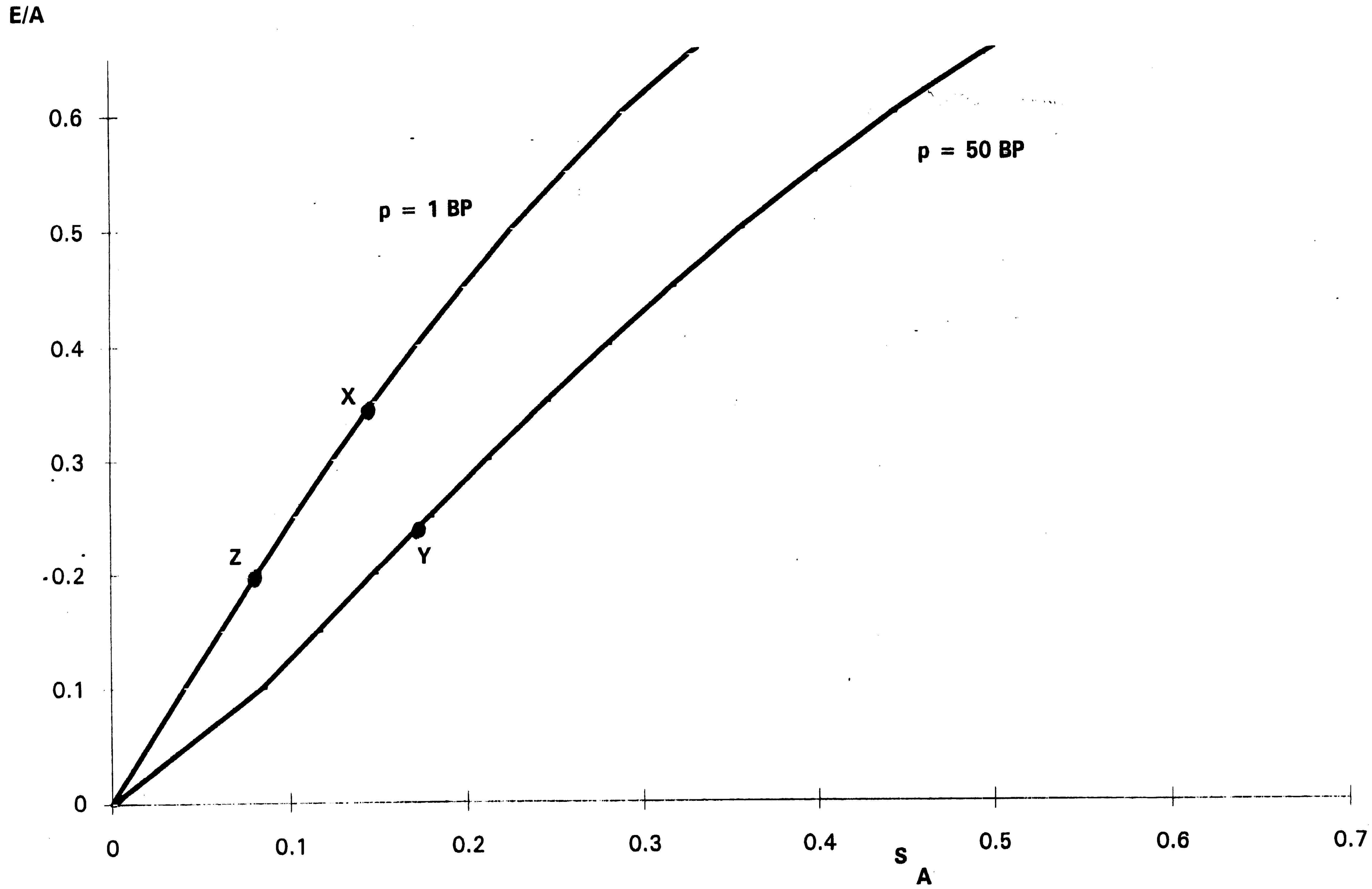
Theories with Frictions (Cont'd)

- **4. Narrow banking models** emphasize risklessness of cash and observability of its value, which matters especially when banks and supervisors hide losses. 100% cash banking proposals were advocated, in large part, to avoid abuse of the safety net. But banks specialize in investing in information about opaque risks. Higher cash means reduced ability to earn quasi rents (Rajan 1992), which means increase cost of lending and second-best shadow banking.
- 5. **Biais, Heider and Hoerova (2010) show that risk-management incentives of margin requirements** can be superior to capital in derivatives contracting.

Today's Paper Combines Several Points

- Costly liquidation (Diamond-Dybvig or Calomiris-Kahn).
- Costly state verification => deposit contracting, cash verifiability advantage. (Not in first models, current draft.)
- Benefits to pooling liquidity risk in an interbank clearing house (Calomiris-Kahn, Gorton, etc.).
- Opportunity cost from holding cash (lost rents).
- Risk-management incentive gains from holding cash, because it is observable, verifiable, riskless and not subject to risk shifting.
- In "bad" states of the world, cash ratios rise as a commitment device to good risk management, spurred by threat of early withdrawal.
- Safety net subsidy reduction: There is substitutability between cash and market discipline: When discipline is lacking due to deposit insurance, more cash is needed.

NYC Bank Capital and Risk 1920-1936



NYC Banks’ Loans/Cash, Equity, Dividends

	Loans/Cash	Equity/Assets	Dividends
1922	2.1	0.18	
1929	3.3	0.33	$392m
1933	1.0	0.15	
1940	0.3	0.10	$162m

Source: Calomiris-Wilson JB 2004.

Physical Setup of the Model

- Five dates: t=0, 1, 2, 3, and 4
- Two types of agents: competitive banks and depositors
- Bankers are risk-neutral. At t=0, each banker is endowed with knowledge about a limited amount of prospective loan projects, and with own equity E. Each loan requires 1 unit of investment, and pays off Y>1 or zero. The banker has a possibility to invest his equity in the bank, or get 1 without the bank.
- The banker accepts "deposits" D at t=0. The supply of deposits is perfectly elastic to any banker. Depositors are risk-neutral but require a reservation expected return of 1.

Physical Setup (Cont'd)

- At t=0, the banker can invest the bank's resources, D+E, in cash (amount C_0) or in loans (amount L_0 = number of loans): $C_0+L_0=D+E$
- Maximum size of bank is limited ($\overline{D}$).
- At t=3, the banker can exert costly **unobservable** risk-management effort which increases the probability of Y to certainty, otherwise probability p of Y, and (1-p) of 0.
- When no effort, the banker derives private benefit B per loan. B is higher in bad state (risk management is harder during a recession).

Physical Setup (Cont'd)

- At t=1, two possible states: good state g (with prob. q) or bad state b (with prob. 1-q)
- State observed for free by the banker; at a cost m by depositors
- At t=2, the banker can convert ΔL loans into cash at a cost l<1
- The purpose of increasing cash holdings is to commit to risk-management effort at t=3, even if state is bad
- At t=4, the loan payoff Y or 0 can (for now) be costlessly verified.

Timeline

t=0	t=1	t=2	t=3	t=4
E and D invested in L_0 and C_0.	State s observed by the banker.	Cash can be ↑ to $C_2(s)$ by liquidating loans (liquidation cost *l*).	Banker chooses whether to exert effort.	If outcome Y, depositors get R and banker keeps $YL_2(s)+C_2(s)-R$.
Contract promises R.	Depositors choose whether to pay m to observe s.	Depositors choose whether to shut down the bank (liquidation cost *v*).		If 0, depositors get $C_2(s)$ and the banker gets nothing.

First-best Equilibrium

- Risk-management effort is **observable and contractible**
- The participation constraint for depositors: R ≥ D
- The banker's participation constraint: YE +(Y-1)D ≥ YE
- Banker's surplus is increasing in D → raise maximum $\overline{D}$
- Depositors do not run as long as: $\overline{D} \geq \frac{1-v}{v}E$
- Proposition 1: In the first-best, the banker exerts effort, cash is never used, and depositors do not invest in the signal about the aggregate state

Equilibrium under Moral Hazard

- At t=4, if outcome is Y, depositors get R and the banker keeps $YL_2(s) + C_2(s) - R$.
- If outcome is 0, depositors get $C_2(s)$ and the banker gets nothing.
- As long as **unobservable** effort is expanded, depositors get R
- For that to happen, the banker's incentive constraint (IC) must be satisfied: $\mathcal{P}(s)L_2(s) + C_2(s) \geq R$
- $\mathcal{P}(s) = Y - \frac{B_s}{1-p}$ is pledgeable income (Tirole, 2006), the share of the return that can be pledged to depositors without jeopardizing the banker's incentives
- Note: $\mathcal{P}(g) > \mathcal{P}(b) \rightarrow$ less can be pledged in the bad state
- If $\mathcal{P}(s) \geq 1$, the first-best is always reached

Equilibrium under Moral Hazard (Cont'd)

- If $\mathcal{P}$(s) < 1, the IC can be written as:

$$\frac{\mathcal{P}(\mathrm{s})}{1-\mathcal{P}(\mathrm{s})}E+\frac{1\text{-}l\text{-}\mathcal{P}(\mathrm{s})}{1\text{-}l\text{-}\mathcal{P}(\mathrm{s})+l\mathcal{P}(\mathrm{s})}\Delta C(s)+C_0\geq D$$

- Both cash at t=0 and extra cash at t=2 can relax the IC: C_0 relaxes the IC at rate one but is not contingent on the state, while $\Delta C(s)$ relaxes the IC at rate <1 but is flexible
- → Tradeoff between saving on liquidation cost and flexibility (adjusting cash once $\mathcal{P}$(s) is known): moral hazard is more severe in the bad state since $\mathcal{P}$(b) < $\mathcal{P}$(g)
- Extra cash at t=2 only helps if $\mathcal{P}$(s) < 1-*l*
- Cash is less productive than loan-making under effort: IC binds in the optimum

Equilibrium under Moral Hazard (Cont'd)

- Suppose the state (good/bad) can be observed at no cost
- For simplicity, suppose moral hazard problem in the bad state only ($\mathcal{P}$(g) ≥ 1)
- Depending on parameters, two possible equilibrium outcomes:
- 1. $C_0 = 0$ and $\Delta C(b) > 0$ [e.g., when liquidation cost is low]
- 2. $C_0 > 0$ and $\Delta C(b) = 0$ [e.g., when liquidation cost is high]
- Note: Outcome 1 is due to our simplifying assumption that there is no moral hazard problem in the good state. If there was, then $C_0 > 0$ and $\Delta C(b) > 0$ possible

Equilibrium under Moral Hazard (Cont'd)

- Condition (C) for raising extra cash at t=2 in the bad state:

$$\frac{\mathcal{P}(\mathrm{b})}{1-\mathcal{P}(\mathrm{b})} < q\frac{1\text{-}l}{l} - (1-q)\frac{Y}{Y-1}$$

- Proposition 2: If condition (C) holds and $\frac{\mathcal{P}(\mathrm{b})}{1-\mathcal{P}(\mathrm{b})} \geq \frac{1\text{-v}}{\mathrm{v}}$, then the banker increases his cash holdings at t=2 if the bad aggregate state is realized. If condition (C) does not hold, then adjusting cash at t=2 is too costly and the banker builds incentive-compatible cash holdings at t=0. For $\frac{\mathcal{P}(\mathrm{b})}{1-\mathcal{P}(\mathrm{b})} < \frac{1\text{-v}}{\mathrm{v}}$, the banker will not raise deposits and will run the bank using his own equity only.

Equilibrium under Moral Hazard (Cont'd)

- Suppose the state (good/bad) can be observed by depositors at cost $m>0$
- Proposition 3: If the cost of acquiring the signal about the aggregate state m is low, depositors invest in the signal and the banker increases his cash holdings if the bad aggregate state realizes, as long as the liquidation is not too costly. If the cost m is high, depositors do not invest in the signal and the banker only uses cash at $t=0$ as a commitment for proper risk management.

Clearing House Equilibrium

- If state shocks are diversifiable across banks, then they can be reduced in the aggregate by forming a banking coalition, where banks in the "clearing house" agree to lend cash to one another as needed.
- Reserve requirements are necessary to prevent free riding on collective protection.

Deposit Insurance Equilibrium

- Assume that supervisors don't monitor to discover bank states.
- Cash needs be set higher initially to prevent bad risk management abuse of the safety net (since there is no credible contingent response of cash to the state).
- Note: Even in a model with zero liquidity risk (because of deposit insurance), the risk-management incentive motive for cash can result in a higher cash requirement than under autarky, or clearing house coinsurance.

Conclusion

- First-best requires risk-management effort, which is unobservable.
- Unobservable effort can be induced by cash holdings, though it is costly (foregone return, liquidation).
- Cash holdings do not just affect risk mechanically, but they also affect the riskiness of risky assets.
- Cash holdings must be mandated in clearing house coinsurance.
- With deposit insurance, cash requirement can be higher than under autarky, or clearing house coinsurance, even with zero liquidity risk.