The Seeds of a Crisis

A theory of bank liquidity and risk-taking over the business cycle

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Motivation

"For too long, the debate has got sidetracked. Into whether we can rely on monetary policy 'mopping up' after bubbles burst. Or into whether monetary policy could be used to control asset prices as well as doing its orthodox job of steering nominal trends in the economy..." - Paul Tucker, Executive Director for Markets and Monetary Policy Committee (MPC) member at the Bank of England.

"We need a new philosophical approach...which recognises that market liquidity is beneficial up to a point but not beyond that point..." - Lord Turner, Chairman of the Financial Services Authority.

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- What are the implications of our theory for optimal monetary policy?

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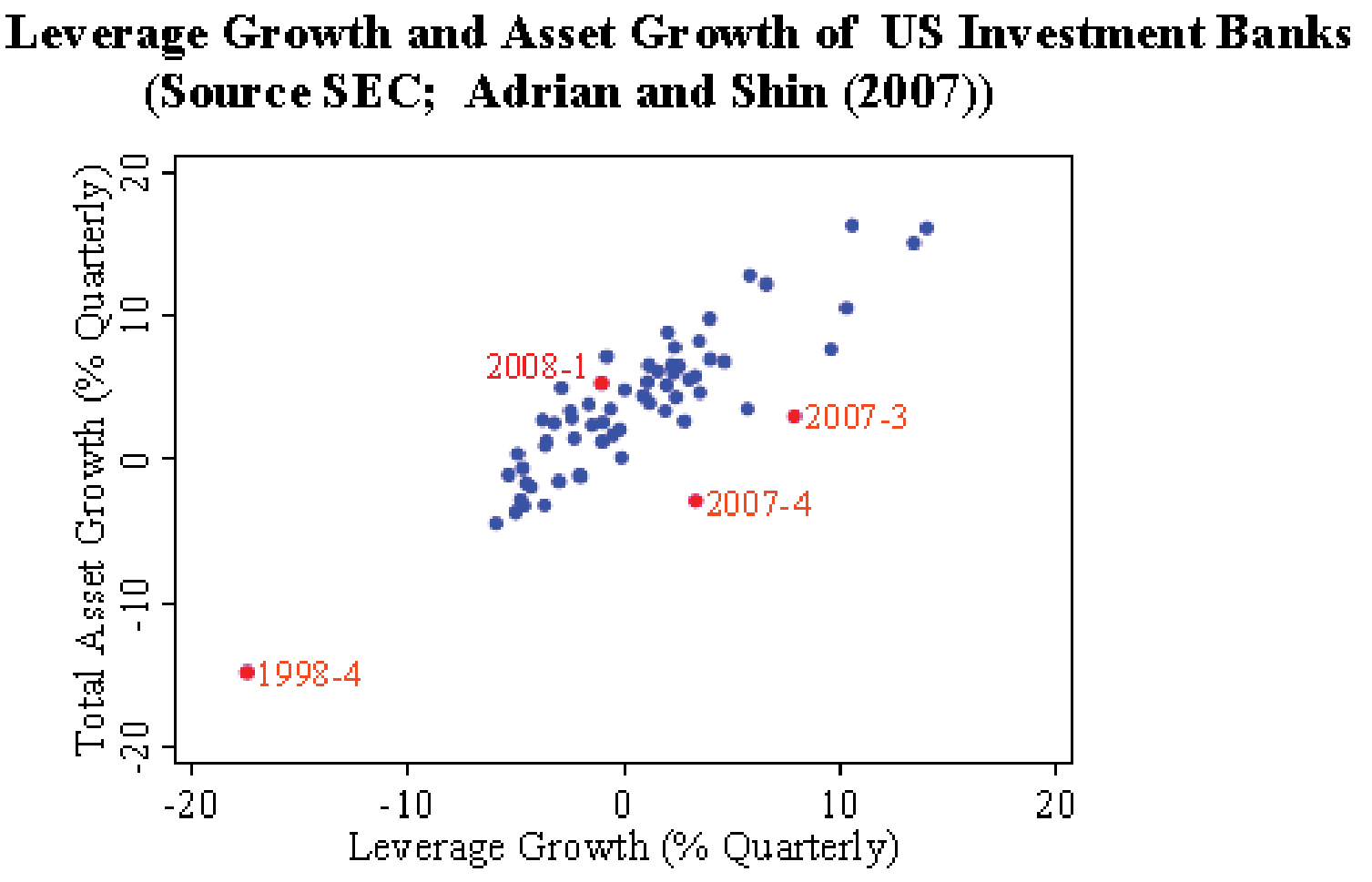
Leverage Growth and Asset Growth of US Investment Banks
(Source SEC; Adrian and Shin (2007))
Total Asset Growth (% Quarterly)
Leverage Growth (% Quarterly)
-20
-10
0
10
20
2008-1
2007-3
2007-4
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- Bubbles are more likely to be formed when the underlying macroeconomic risk is high;
- Bubbles are more likely to be formed following loose monetary policies;
- Monetary policy should "lean against liquidity".

Related literature

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- Thakor (2005) argues that banks over-lend by not invoking the MAC clause in booms given reputational concerns.

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- At $t = 2$ the proceeds from bank investments, if any, are divided among depositors and equityholders.

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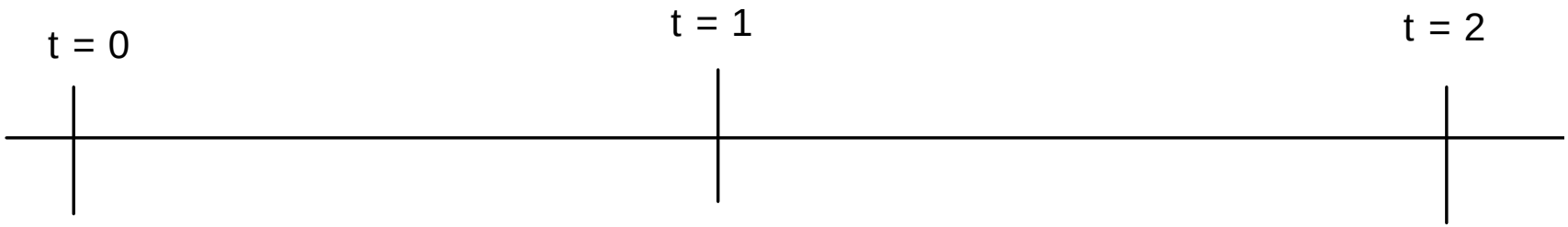

- Bank raises deposits
- Bank observes success probabilty θ and sets r_L
- Investments made and bank sets aside reserves R

- Bank suffers early withdrawals, xD
- Bank incurs a penalty cost if xD>R

- Bank projects either succeed or fail
- Payoffs divided among parties

Benchmark model

Bank's maximization problem:

$$\max_{r_L^*, r_D^*, R^*} \Pi = \pi - r_p E\left[\max\left(\tilde{x}D - R, 0\right)\right] \tag{1}$$

subject to

$$E\left(\tilde{x}\right) + \left(1 - E\left(\tilde{x}\right)\right)\left[\theta r_D + \left(1-\theta\right)\frac{E\left[\max\left(R - \tilde{x}D, 0\right)\right]}{\left(1 - E\left(\tilde{x}\right)\right)D}\right]$$

$$\geq \bar{u} \tag{2}$$

where

$$\pi = \theta\{r_L L\left(r_L\right) - r_D D\left(1 - E\left(\tilde{x}\right)\right) + E\left[\max\left(R - \tilde{x}D, 0\right)\right]$$

Benchmark model

Proposition

1. *(Risk effect)* $\frac{\partial r_L^*}{\partial \theta} < 0$, *i.e. an increase in risk* $(1-\theta)$, *ceteris paribus, will increase the equilibrium lending rate.*
2. *(Liquidity effect)* $\frac{\partial r_L^*}{\partial D} < 0$, *i.e. an increase in bank liquidity, ceteris paribus, will decrease the equilibrium lending rate.*

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- In the period preceding the crisis, traders and large profit/risk centers in many financial institutions were paying themselves bonuses based on the size of their risky positions.

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- Probability of conducting audit given by ϕ.
- Probability that manager will be penalized following an audit given by ζ.
- Audit technology imperfect but correlated to manager's choice of r_L: $\zeta > 0.5$ if $r_L < r_L^f$ but $\zeta < 0.5$ if $r_L = r_L^f$.

Agency problem

- Manager's utility: $u(w, \psi, e) = v(w) - c(\psi) - e$, where $v'(w) > 0$, $v''(w) < 0$, $c'(\psi) > 0$ and $c''(\psi) > 0$.
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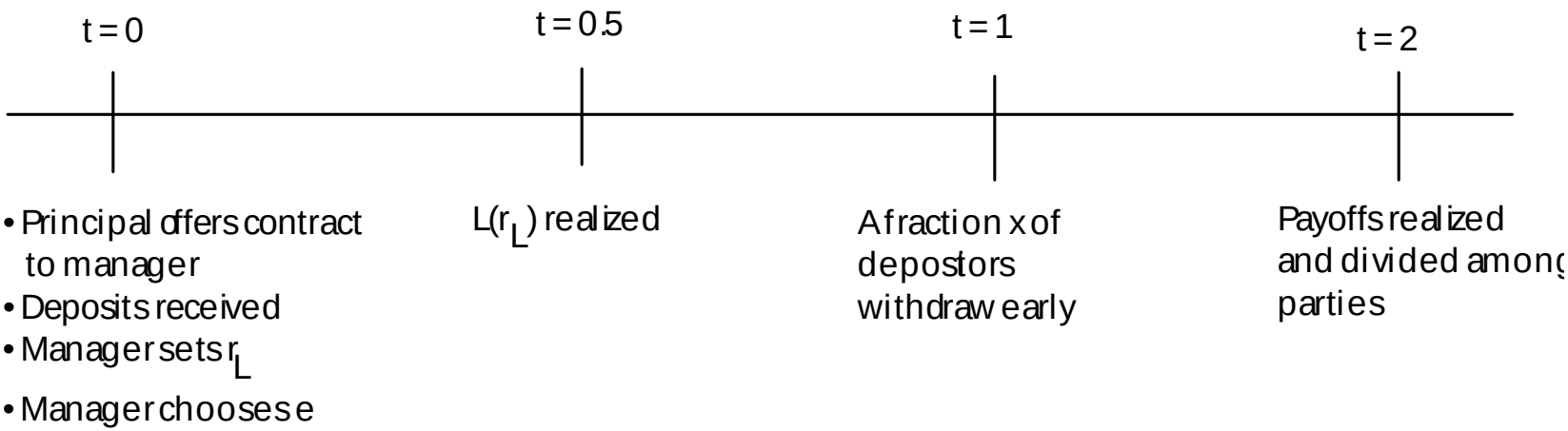
- Bank liquidity non-verifiable and principal observes distribution of bank liquidity.

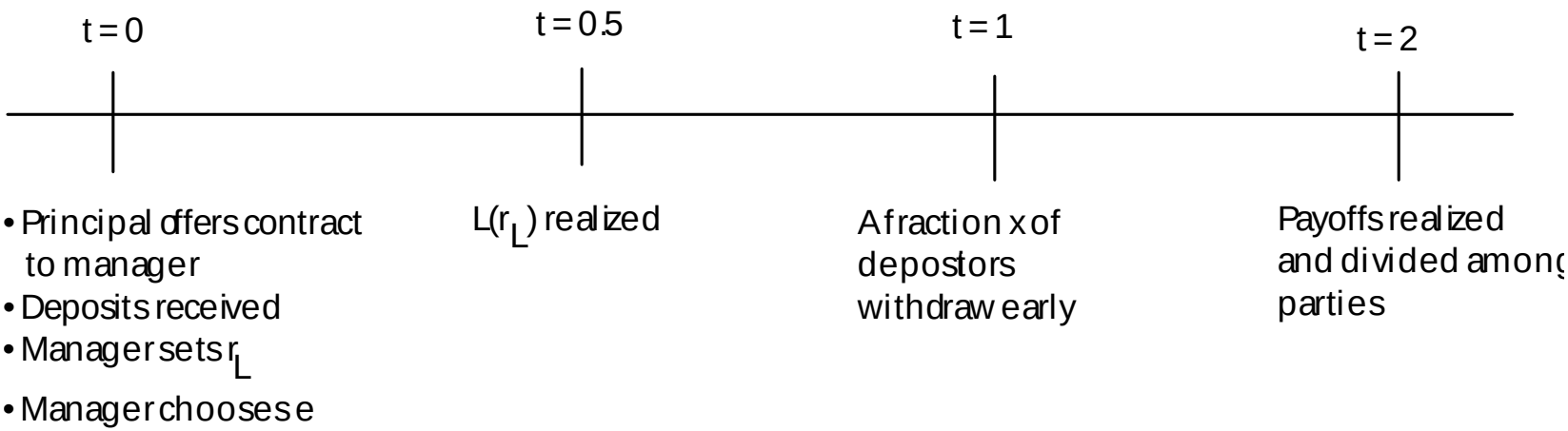
Timeline

- At $t = 0$ principal offers contract to manager, manager then receives deposits, chooses effort and manager sets r_L.



Timeline

- At $t = 0$ principal offers contract to manager, manager then receives deposits, chooses effort and manager sets r_L.
- At $t = 0.5$, $L(r_L)$ is realized; at $t = 1$ early withdrawals and at $t = 2$ payoffs consumed.



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Symmetric information problem:

$$\max \Pi = \pi - r_p E\left[\max\left(\tilde{x}D - R, 0\right) | e = e_H\right] \tag{3}$$

s.t.

$$E\left(\tilde{x}\right) + \left(1 - E\left(\tilde{x}\right)\right)\left[\theta r_D + \left(1-\theta\right)\frac{E\left[\max\left(R - \tilde{x}D, 0\right) | e = e_H\right]}{\left(1 - E\left(\tilde{x}\right)\right)D}\right]$$

$$\geq \bar{u} \tag{4}$$

where

$$\begin{aligned} \pi &= \theta\{r_L E\left[L\left(r_L\right) | e_H\right] - r_D D\left(1 - E\left(\tilde{x}\right)\right) \\ &\quad + E\left[\max\left(R - \tilde{x}D, 0\right) | e = e_H\right]\} \end{aligned} \tag{5}$$

Agency problem

Contractual problem under asymmetric information:

$$\max_{w(L),\psi(S),\phi(S)} \Pi - (E[w(L)] - E[\psi(S)]) - E(z) \tag{6}$$

subject to

$$E[v(w(L))] - E[c(\psi(S))] - e \geq u^o \tag{7}$$

$$E[v(w(L)|e_H)] - e_H \geq E[v(w(L)|e_L)] - e_L \tag{8}$$

$$E\left[c\left(\psi(S)|r_L = r_L^f\right)\right] \leq E\left[c\left(\psi(S)|r_L < r_L^f\right)\right] \tag{9}$$

where $S = \max(xD - R, 0)$ represents the liquidity shortfall of the bank, if any.

Agency problem

Proposition

Managerial wages, w, are increasing in loan volume, L. However, if an audit is conducted and it is inferred that the manager had acted over-aggressively then he is penalized where the managerial penalty, ψ, is such that it is increasing in the bank's liquidity shortfall, S.

Agency problem

Proposition

The principal will conduct an audit if and only if the liquidity shortfall suffered by the bank exceeds some threshold S^*. Thus the optimal audit timing as defined by the audit probability, ϕ, is given by

$$\phi = \begin{cases} 1 & \text{if } S > S^* \\ 0 & \text{otherwise} \end{cases}. \tag{10}$$

Agency problem

Summary of results:

- Managerial wages increasing in loan volume.
- An audit is triggered if liquidity shortfall exceeds a threshold.
- If it is inferred that manager had acted over-aggressively he is penalized a fraction of the bank's penalty cost.

Proposition

The manager will engage in overly-aggressive behavior if and only if bank liquidity is sufficiently high.

Intuition: The manager is penalized a proportion of the penalty costs but in the presence of substantial liquidity the probability of experiencing liquidity shortages is low and hence audit probability is low. This encourages excessive lending.

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- Let P be the asset price.
- Let $b(X_d)$ represent a non-pecuniary investment cost such that: $b(0) = b'(0)$, $b'(X_d) > 0$ and $b''(X_d) > 0$ for all $X_d > 0$.

Asset pricing

Problem faced by representative borrower:

$$\max_{X_d} \theta \left[CX_d - r_L PX_d \right] - b\left(X_d\right).$$

s.t.

$$nX_d = X_s.$$

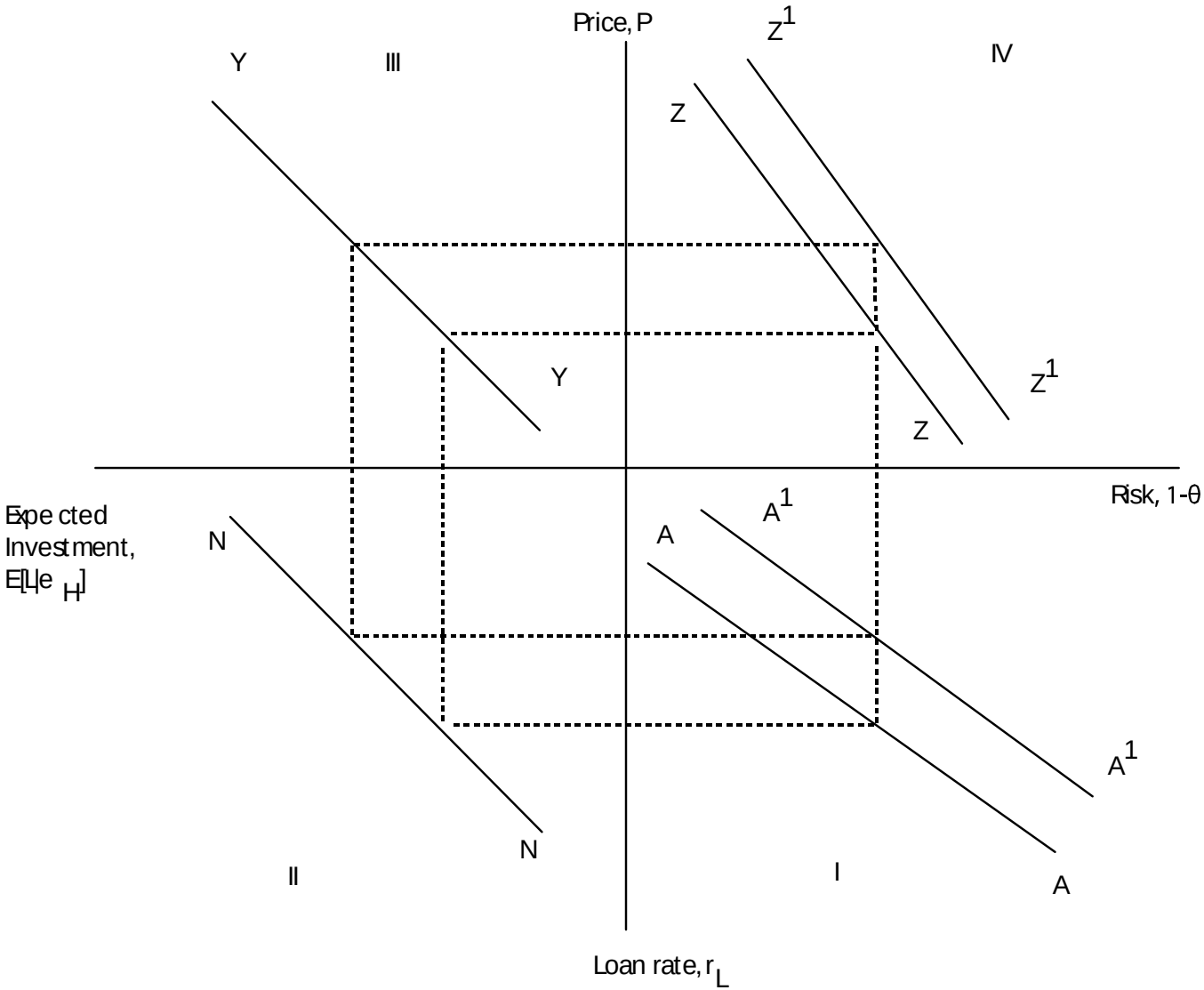
Solution: $P = \frac{\theta C - b'(X_d)}{\theta r_L}$, where r_L is the loan rate set by bank manager.
But $P^f = \frac{\theta C - b'(X_d)}{\theta r_L^f}$, where r_L^f is the loan rate in the absence of agency problems.

Corollary

An asset price bubble is formed for high enough bank liquidity.

Intuition: Bank managers set the loan rate. For high enough liquidity, the loan rate is underpriced due to agency problems. This increases the asset price for the same level of risk.

Mechanics of the formation of asset price bubbles



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- Quadrant IV depicts the inverse relationship between asset prices and risk.
- A bubble is formed if an increase in liquidity induces managers to underprice risk thereby shifting the AA curve in quadrant I to the right.

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  - BOJ lowered rates to 2.5% between 1986 and 1987 following the Plaza accord
  - Fed lowered rates to 1% in 2003, lowest since 1958. In fact, Fed Funds rate was even below the target in the period preceding the crisis.
  - Loose monetary policy adopted by People's Bank of China in 2009 $\Rightarrow$ Bank deposits are now 150% of GDP and house prices are increasing.

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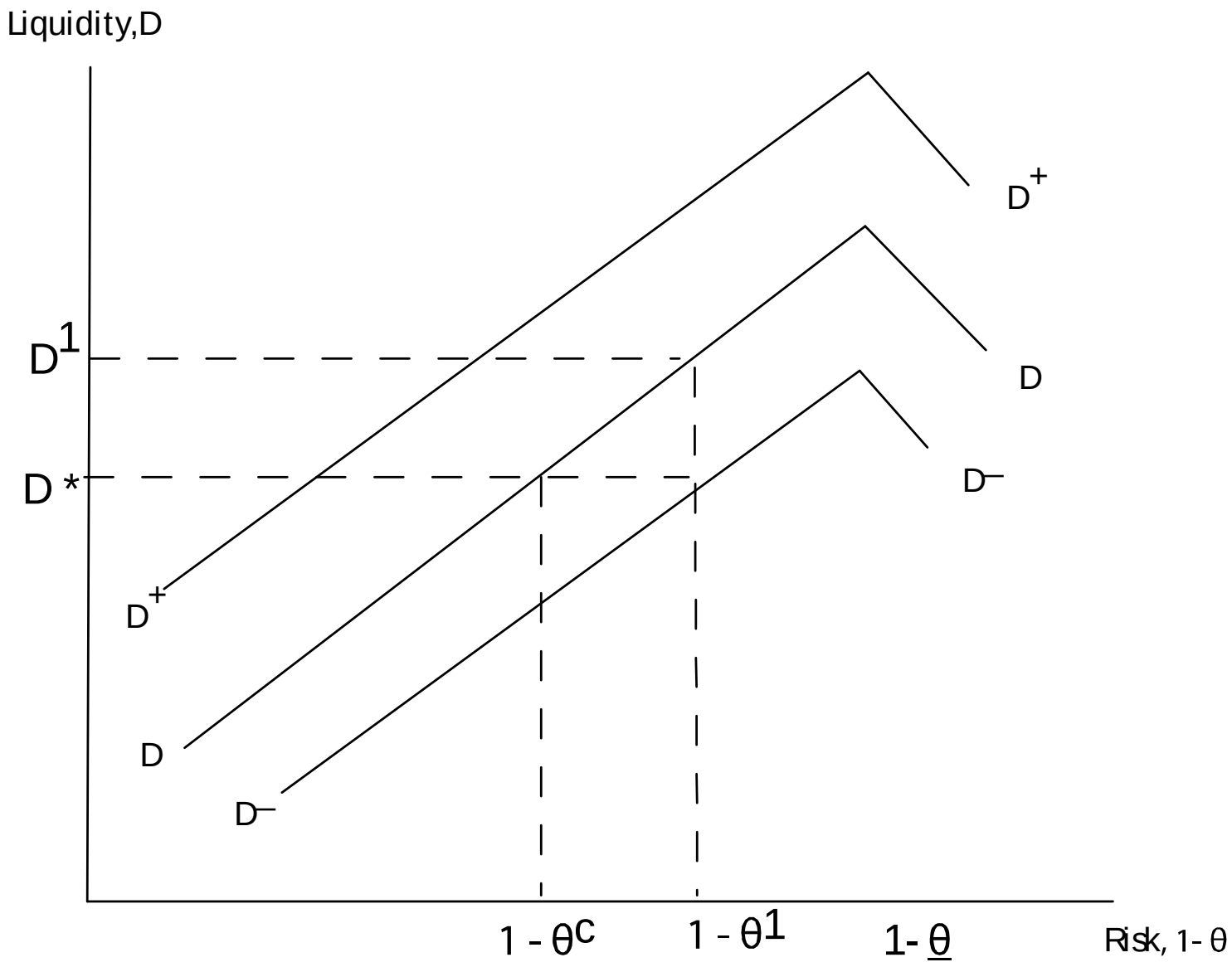

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- The figure shows that during times of excess liquidity the central bank can avoid bubbles by adopting a contractionary monetary policy. (The liquidity-risk curve shifts downwards)
- However, if during these times an expansionary monetary policy is adopted this will further fuel asset prices. (The liquidity-risk curve shifts upwards)

Optimal Monetary policy

- Aggressive behavior of managers results in a worsening of the quality of bank loans $\Rightarrow$ Bubbles are costly.
- Trade-off faced by central bank: Money supply $(M) \uparrow \Rightarrow D \uparrow \Rightarrow$ Investment $\uparrow$ (Greenspan put)
  However, $M \uparrow \Rightarrow D \uparrow \Rightarrow$ Bubbles more likely

Proposition

The optimal monetary policy implies a leaning against liquidity approach, i.e., tightening monetary policy in times of excessive bank liquidity and loosening monetary policy in times of falling bank liquidity. More formally, $\frac{dM^*}{dD} < 0 \ \forall \theta$.

- Intuition: In times of excessive bank liquidity, central banks can avoid the formation of bubbles by a contractionary monetary policy.
  But in times of falling bank liquidity, investment is low as banks raise loan rates. Central banks can offset this effect via an expansionary monetary policy.

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- Cost of default can take several forms: Cost suffered by banks, cost suffered by taxpayers, (political) cost suffered by regulators, etc.

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  - Charles Bean, Financial Times, 16 May '08

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- bubbles are more likely to be formed following loose monetary policies;
- monetary policy should "lean against liquidity".
- Other measures that can complement the "leaning against liquidity" policy: Minimum Liquidity requirements, Bank Supervision (especially in times when banks are flush with liquidity).