Deposits and Bank Capital Structure

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Motivation

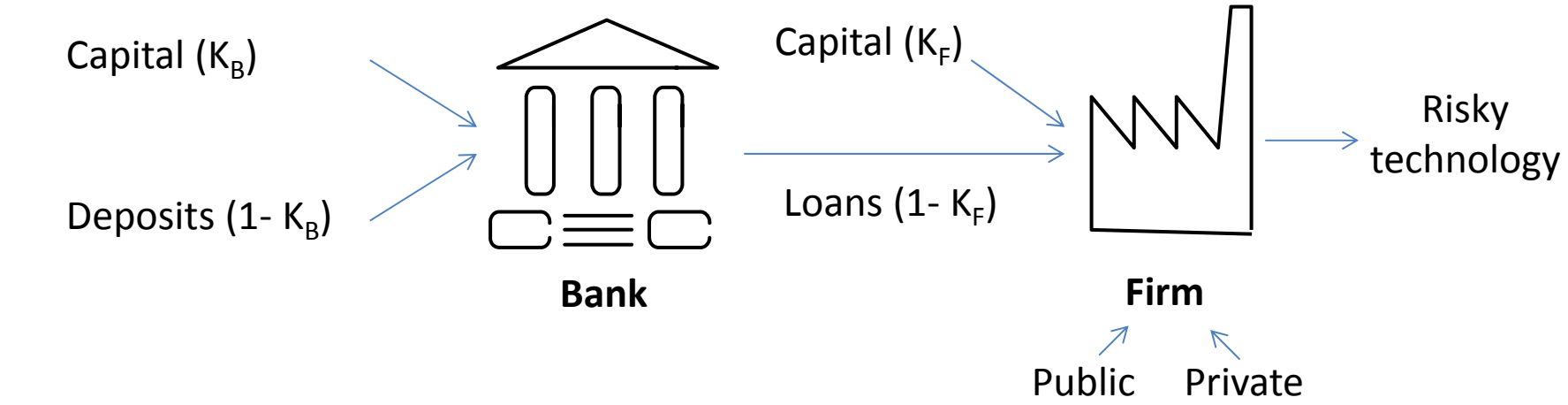
- Growing literature on the role of equity in bank capital structure focusing on equity as a buffer, liquidity, agency costs etc. (e.g., Diamond and Rajan (2000), Gale (2004), Morrison and White (2005), Hellmann, Murdock and Stiglitz(2000), Allen, Carletti and Marquez (2011))
- Typically, **partial** equilibrium models take the cost of equity capital as **given** and **higher** than for other types of finance
  - This means that banks economize on the use of capital
  - There is scope for capital regulation imposing minimum capital requirements
- Some papers have questioned whether this is justified and have stressed that the cost of equity should vary with capital structure (Miller (1995), Brealey (2006), Admati, DeMarzo, Hellwig and Pfleiderer (2010))

What we do in our paper

- We develop a **general equilibrium** model of bank and firm financing where the cost of capital is endogenized
- Our aim is to analyze
  - Optimal capital structure for banks
  - Implications for the pricing of equity and deposits
- Main take away
  - Capital is "costly" and Modigliani and Miller's irrelevance result does not hold
  - There is a unique optimal capital structure, which depends on whether
    - ★ Banks invest directly in risky investments
    - ★ Banks give loans to (either public or private) firms

Baseline model: Direct investment

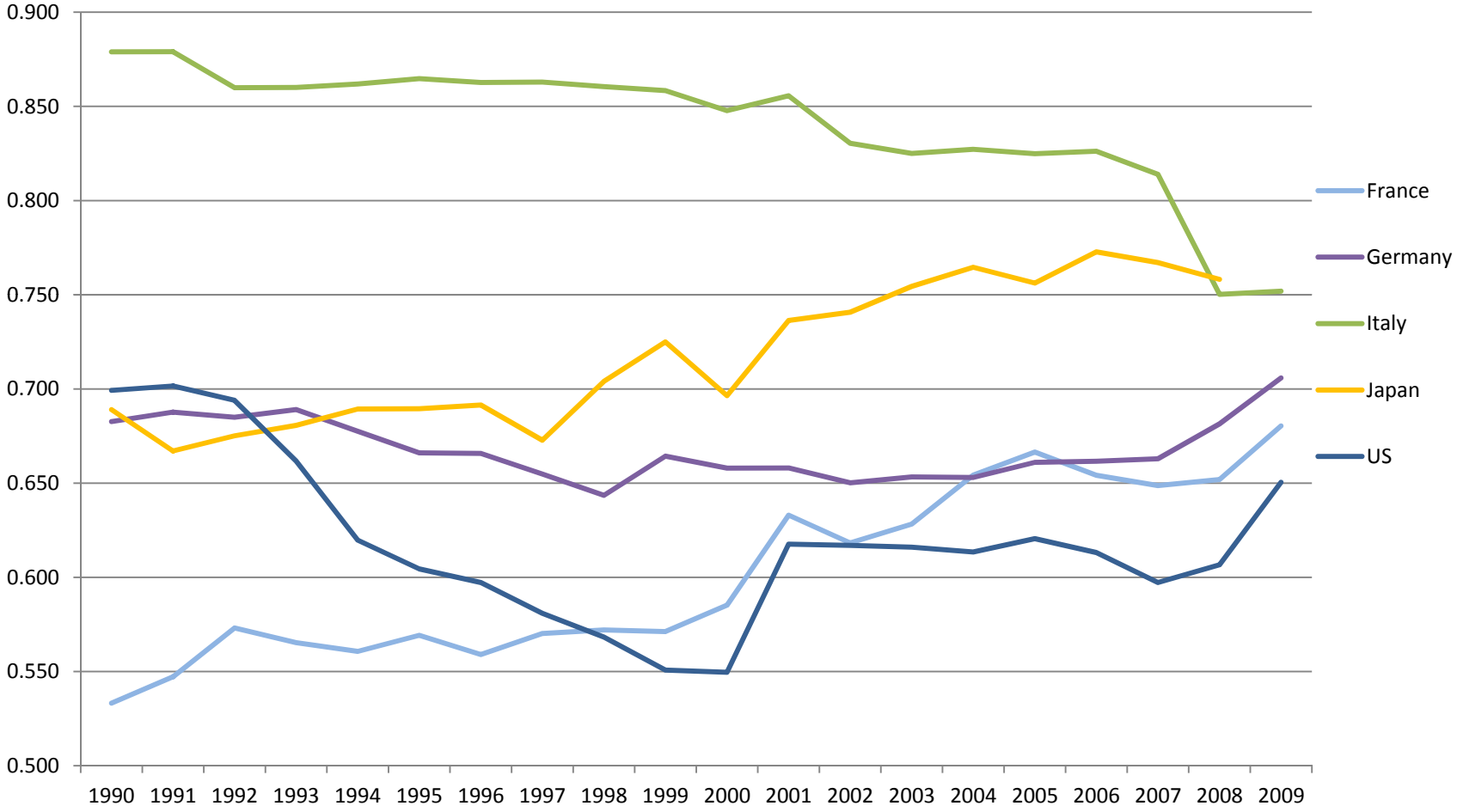
Extension: Lending to firms



Main ingredients of our analysis

- We base our analysis on two main elements
  1. Banks raise funds from deposits, while non-financial firms do not. The markets for deposit and equity finance are segmented
  2. Banks and firms incur bankruptcy costs

Figure 1: Deposits over bank liabilities



Market segmentation

- Deposit finance has played a relatively small role in the theory of bank funding, in terms of being considered to be segmented from other forms of debt and equity
- Most people in developed countries have bank accounts, **but**, with the exception of the U.S., relatively few people own stocks, bonds or other types of financial assets (see, e.g., Guiso, Halassios and Jappelli (2002), Guiso and Sodini (2013))
- Businesses hold considerable amounts in deposits for transaction purposes and reserves and there is limited substitution possibilities with other assets, particularly equity

Bankruptcy costs

- Bankruptcy costs are significant for both banks and firms
  - James (1991) finds bankruptcy costs for banks are 30 cents on the dollar
  - For non-financial firms, Andrade and Kaplan (1998) and Korteweg (2010) find 10-23% for the ex post bankruptcy costs and 15-30% for firms in or near bankruptcy
- These estimates seem to underestimate the real cost of bankruptcy (e.g., Almeida and Philippon (2007), Acharya, Bharath and Srivasan (2007))

The baseline model

- One-period model where limited-liability banks raise capital k_B and deposits $1 - k_B$, and invest in a risky technology with return $r \sim U[0, R]$ at date 1, with $Er = \frac{R}{2} > 1$
- There are two groups of risk neutral investors (each with endowment of 1):
  - Shareholders supply capital or deposits to banks with opportunity cost ρ or invest directly in the risky technology so that $\rho \geq R/2$
  - Depositors supply deposits to the banks for the promised per unit rate r_D and opportunity cost u or store so that $u \geq 1$
- The two markets are segmented

- The total supply of capital is K and of deposits is D with

$$\frac{K}{D} = \eta > 0 \tag{1}$$

- Since banks invest with risky return r, they repay depositors r_D if $r \geq \bar{r}_B$, where

$$\bar{r}_B = r_D(1 - k_B), \tag{2}$$

and go bankrupt otherwise

- Liquidation proceeds are $h_B r$, with $h_B \in [0, 1]$, and are distributed pro rata to depositors so that each depositor obtains $\frac{h_B r}{1-k_B}$

The equilibrium with direct investment

1. Banks choose k_B and r_D to maximize expected profits
2. Capital providers maximize expected utility
3. Depositors maximize expected utility
4. Banks make zero expected profits in equilibrium
5. The equity market clears: $N_B k_B \leq K$
6. The deposit market clears: $N_B(1 - k_B) \leq D$

Each bank's optimization problem

$$\max_{k_B, r_D} E\Pi_B = \int_{\bar{r}_B}^{R} \left(r - r_D(1 - k_B)\right) \frac{1}{R} dr - \rho k_B$$

subject to

$$EU_D = \int_0^{\bar{r}_B} \frac{h_B r}{1 - k_B} \frac{1}{R} dr + \int_{\bar{r}_B}^{R} r_D \frac{1}{R} dr \geq u$$

$$E\Pi_B \geq 0$$

$$0 \leq k_B \leq 1$$

Proposition

In the unique equilibrium with $h_B = 0$, $k_B \in (0,1), \rho > \frac{R}{2}$, $E\Pi = 0$, $N_B k_B = K$ *and:*
i) For $R < \overline{R} = \frac{4(1+\eta)}{1+2\eta}$, $EU = u = 1$ *and* $N_B(1-k_B) < D$;
ii) For $R \geq \overline{R}$, $EU = u \in [1, \frac{R}{2})$ *and* $N_B(1-k_B) = D$.

- Banks hold a positive amount of capital and there is a **unique** capital structure
- The opportunity cost ρ is bid up above $\frac{R}{2}$ (and above u) so **capital is more costly** than deposits
  - Capital allows bankruptcy costs to be reduced and is scarce
  - Capital is always fully included in in the banking sector, while deposits are not
- Similar results hold for $0 < h_B < 1$ but with more complicated expressions
- Only with $h_B = 1$ or $\eta = \infty$ does an MM-type result hold so that $\rho = \frac{R}{2}$

Corollary

The following comparative statics results hold:

i) $\frac{\partial k_B}{\partial R} \leq 0$, *with the inequality strict for* $R < \overline{R}$

ii) $\frac{\partial \rho}{\partial R} > 0$

iii) $\frac{\partial u}{\partial R} \geq 0$, *with the inequality strict for* $R > \overline{R}$

iv) $\frac{\partial \overline{R}}{\partial \eta} < 0$.

- Capital is (weakly) decreasing in R
- Shareholders capture all surplus for $R \leq \overline{R}$, while surplus is split for $R > \overline{R}$
- The degree of financial inclusion increases with η

Deposit insurance and capital regulation I

- So far we have assumed that deposits are not insured so that r_D reflects bankruptcy risk
- In this context, capital has a role as a way to reduce bankruptcy costs and the market solution is efficient
- If deposits are insured and r_D is fixed, banks have no longer incentives to hold capital
- Thus, there is a scope for capital regulation
  - Planner chooses a lower level of capital than in the market solution with uninsured deposits and social welfare is higher

Deposit insurance and capital regulation II

- Depositor's participation constraint was

$$EU_D = \int_0^{\bar{r}_B} \frac{h_B r}{1 - k_B} \frac{1}{R} dr + \int_{\bar{r}_B}^{R} r_D \frac{1}{R} dr \geq u$$

- while with deposit insurance it becomes

$$EU_D = \int_0^{R} r_D \frac{1}{R} dr \geq u \text{ and thus } r_D = u.$$

- Social planner to chooses k_B to maximize

$$SW = N_B \left(\frac{1}{2} R - \int_0^{\bar{r}_B} (1 - h_B) \, r \frac{1}{R} dr \right) + \max\{ (D - (1 - k_B) \, N_B) \, , 0 \}$$

Deposit insurance and capital regulation III

Proposition

The regulatory solution with insured deposits always entails a higher level of social welfare than the market solution with uninsured deposits: $SW^{reg} > SW$. *Moreover, it also entails a lower level of capital,* $k_B^{reg} \leq k_B$, *with the inequality strict whenever* $u = 1$ *in the market solution*

- The allocation with deposit insurance and capital regulation is similar to the market allocation ($\rho^{reg} > \frac{R}{2} > u^{reg} \geq 1$) but welfare superior
  - It achieves a greater surplus through a greater number of banks and through a lower bankruptcy probability because of a lower r_D

Lending to firms

- So far we have considered the case of direct investment
- The more common view is that banks channel funds to firms through the allocation of credit. We consider two cases:
  - **Public firms**: they have no inside equity but can attract funds both from banks and outside equity investors
  - **Private firms**: they have an initial endowment of inside equity but can only raise external funds in the form of bank loans
- Main take away
  - Results on the pricing of capital and deposits remain valid
  - Capital structure of banks and firms change significantly in the two cases

Public firms

- A continuum of publicly traded firms hold the risky technology with return $r \sim U[0, R]$
- Each firm raises 1 unit with outside equity k_F at cost ρ and loans $1 - k_F$ from banks at promised rate r_L. The firm is solvent if

$$r \geq \bar{r}_F = r_L(1 - k_F)$$

- If $r < \bar{r}_F$, the firm goes bankrupt and each bank obtains $\frac{h_F r}{1-k_F}$
- The bank has to repay $r_D(1 - k_B)$ as before and goes bankrupt for

$$r < \bar{r}_B \leq \bar{r}_F$$

Given $h_B, h_F \in [0,1)$, the problem is to choose k_F,r_L, k_B and r_D to maximize

$$E\Pi_B = \int_{\bar{r}_B}^{\bar{r}_F} \left(\frac{h_F r}{1-k_F} - r_D(1-k_D) \right) \frac{1}{R} dr + \int_{\bar{r}_F}^{R} \left(r_L - r_D(1-k_D) \right) \frac{1}{R} dr - \rho k_B$$

subject to

$$E\Pi_F = \int_{\bar{r}_F}^{R} \left(r - r_L(1-k_F) \right) \frac{1}{R} dr - \rho k_F \geq 0$$

$$EU_D = \int_{0}^{\bar{r}_B} \frac{h_B h_F r}{(1-k_B)(1-k_F)} \frac{1}{R} dr + \int_{\bar{r}_B}^{R} r_D \frac{1}{R} dr \geq u$$

$$E\Pi_B \geq 0$$

Proposition

In the unique equilibrium with $0 \leq h_B, h_F < 1$, $k_B = 0, r_D = r_L$ *and* $k_F > 0$. *The equilibrium is similar to the one in baseline model with the difference that firms hold the same capital as banks there.*

- Banks hold no capital now and are a conduit between depositors and firms
- Only firms hold positive amounts of capital
- This minimizes the deadweight costs associated with the bankruptcy because it aligns the bankruptcy points, i.,e, $\overline{r}_B = \overline{r}_F$
- Note: firms' returns are perfectly correlated and banks' income only comes from firm loans

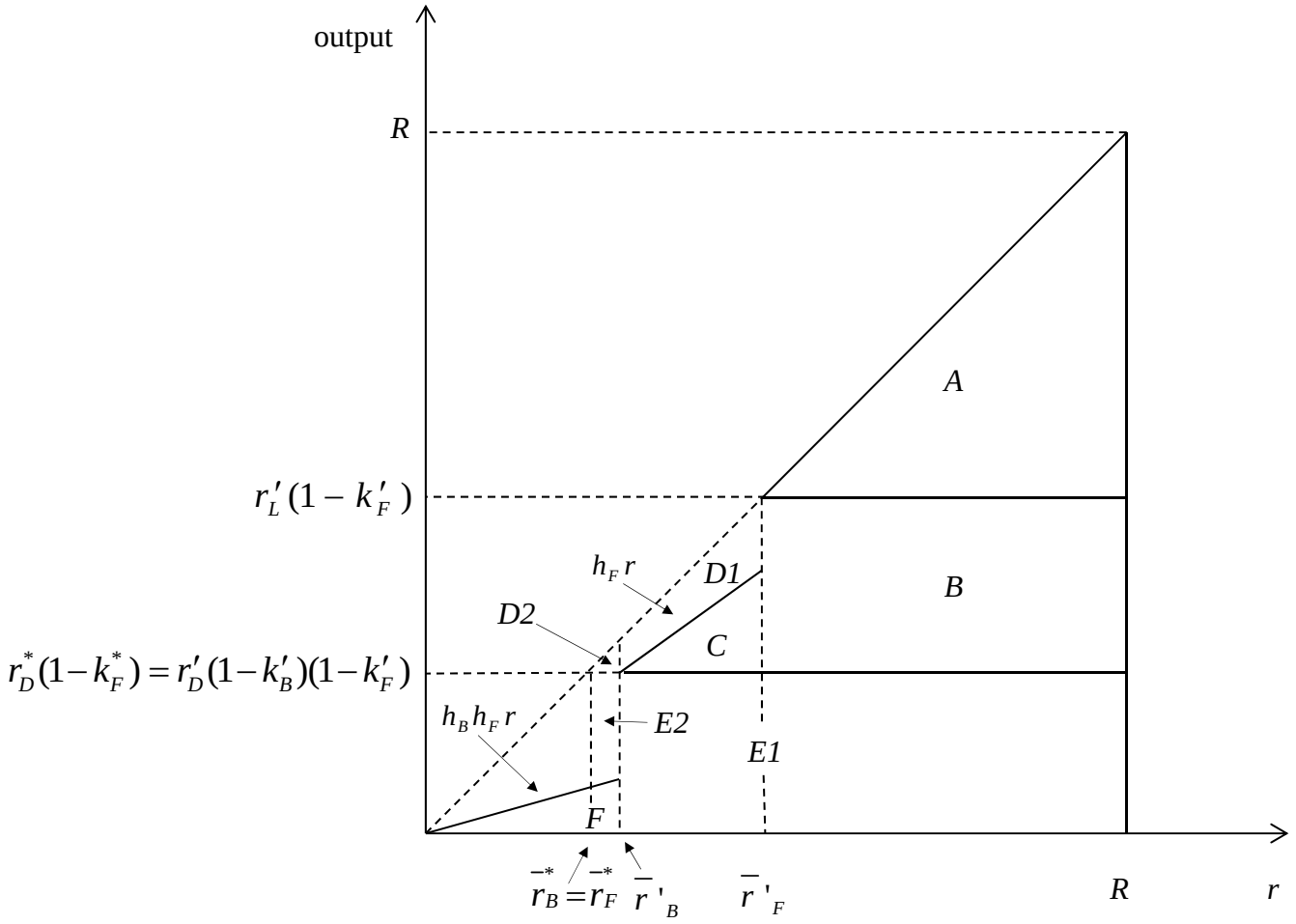


Figure 3: Output of a single firm and returns to shareholders and depositors as a function of the return r in the case of a single productive sector.

Private firms

- The difference is that now each firm has a given level of capital k_F, which returns $\rho_F = \frac{R}{2}$
- Banks have $k_B = 0$ or $k_B > 0$ depending on the asset return R and the recovery rate h_F

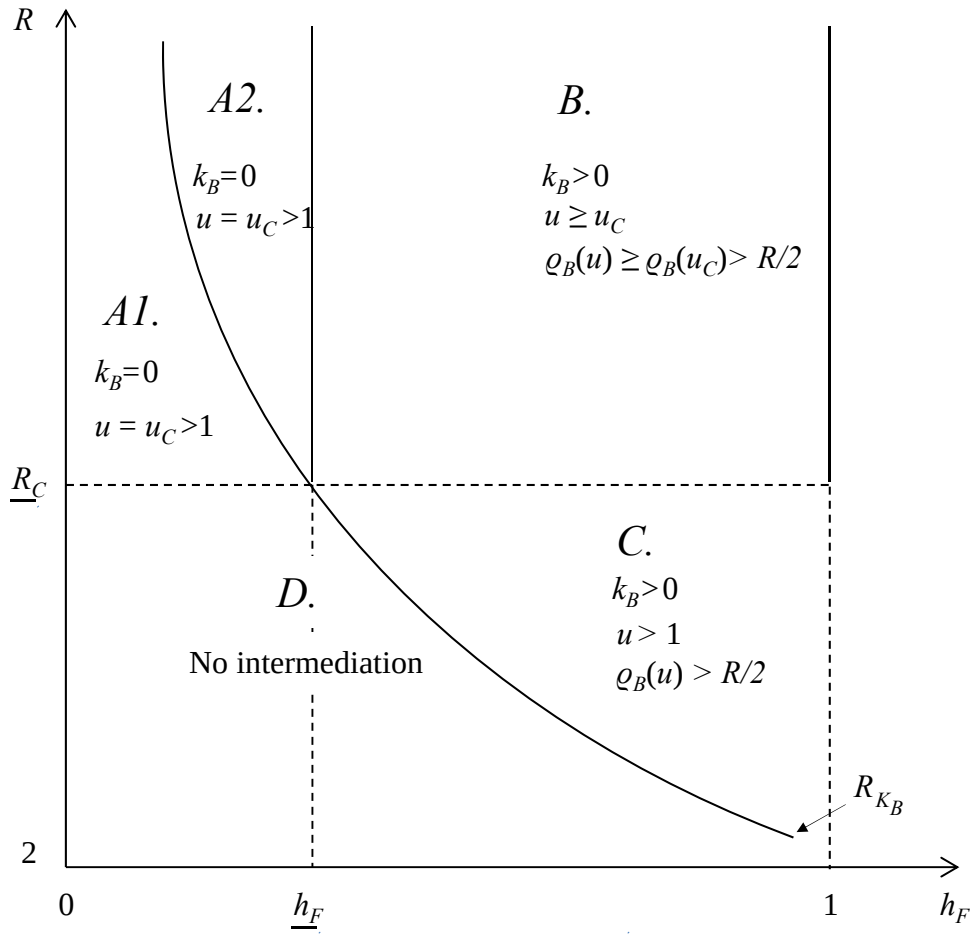


Figure 4: The case of private firms as a function of the recovery rate h_F and the asset return R.

Concluding remarks

We have provided a theory of the corporate finance of banks and firms based on

- Segmentation of deposit and equity markets
- Bankruptcy costs for banks and firms
  This provides
- A theory of "expensive" equity capital
- A theory of when banks hold positive capital and when not
- An important extension would be to endogenize the supply of capital and the supply of deposits