Financial Intermediation, Loanable Funds and The Real Sector

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Motivation

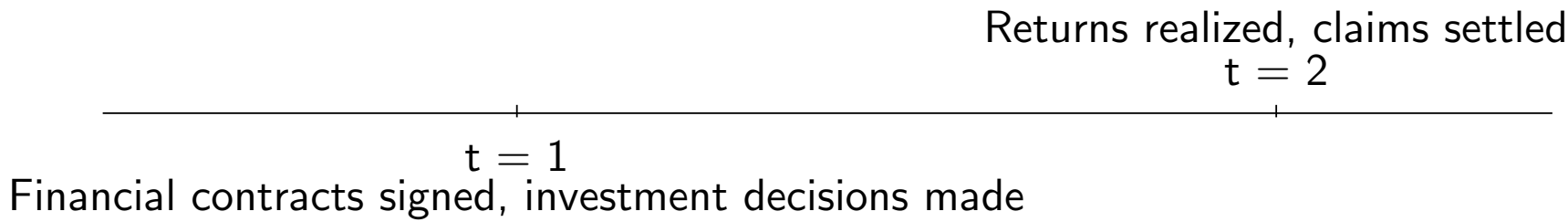
- The credit crunch hits small, collateral-poor firms the hardest. Larger firms are less affected as they either renegotiate their loans or go directly to the commercial paper or bond markets.
- Example: Late 1980s and early 1990s several OECD countries appeared to have suffered a credit crunch. The banking sectors of Sweden, Norway and Finland had to be rescued by their governments at a very high price.
- U.S 1990-91 Recession:Evidence points to role of credit crunch.
  1. Bank lending experienced significant and prolonged decline, historically exceptional.
  2. The change in bank lending within states can be well explained by the 1989 capital asset ratio of a state's banking sector, thus equity value affected lending.
  3. Flight to quality in lending indicated - decline in share of credit flowing to borrowers with high agency costs(proxied by small firms)

Introduction

- The paper sheds light on the role of different kinds of capital tightening on investments, interest rates and forms of financing. For the same an incentive model of financial intermediation with capital constrained firms and intermediaries is considered.
- Predictions of model
  1. Firms with substantial net worth rely on cheaper,less information intensive finance, highly leveraged firms demand more information intensive finance. When monitoring capital decreases capital poor firms are the first to get squeezed.
  2. If intensity of monitoring is allowed to be varied then increase in monitoring capital relative to firm capital leads to lending with intensive monitoring capital.
  3. Intermediaries must satisfy capital market determined adequacy ratios.

The Basic Model

- 3 types of agents - Firms (Real sector), Intermediaries (Financial sector), Investors
- 2 period



- Risk Neutral agents
- Protected by limited liability

The Real Sector

- Continuum of firms, access to same technology, differ in initial amount of capital A.
- Distribution of assets described by G(A). Aggregate amount of firm capital i.e $K_f = \int A dG(A)$.
- One economically viable project costing $I > 0$.If $A < I$, firm needs atleast $I - A$ externally. Verifiable, financial return of either 0(failure) or R(success) generated.
- Moral Hazard Problem: Firms run by entrepreneurs and in absence of proper incentives may deliberately reduce success probability to enjoy private benefit.
- Market rate of return $= \gamma =$ rate of return on investor capital
- Firms cannot monitor other firms. Hence surplus cash invested in open market earning γ

The Real Sector

Project	Good	Bad(low private benefit)	Bad(high private benefit)
Private Benefit	0	b	B
Probability of success	p_H	p_L	p_L

- Entrepreneur can privately choose between 3 versions of the project. $B > b > 0$, thus entrepreneur prefers the B-project over the b-project irrespective of the financial contract.

Assumptions

- $\Delta p = p_H - p_L > 0$
- Only the good project is economically viable;

$$p_H R - \gamma I > 0 > p_L R - \gamma I + B \tag{1}$$

The Financial Sector

- Many intermediaries which monitor firms and alleviate moral hazard problem. In case of bank lending - covenants are extensive. Covenant reduces the firm's OC of being diligent. Thus monitor reduces firm's OC to b from B by preventing the undertaking of B-project.
- Cost of monitoring :- $c > 0$, non verifiable.
- Moral Hazard Problem: Because of costly monitoring, to be credible monitors, intermediaries inject their own capital and thus a limit to the number of firms they can monitor.
- Aggregate intermediary capital- K_m. We assume
  1. all projects financed by intermediary are perfectly correlated
  2. capital of each intermediary is sufficiently large

  hence the exact distribution of assets among intermediaries irrelevant.
- Rate of return on intermediary capital is β.

Uninformed Investors

- Individual investors are small and demand an expected rate of return, γ.
- Supply of uninformed capital - either exogenously given or determined by standard increasing supply function

Fixed Investment Scale - Direct Finance

- Firm borrows only from uninformed investors. A contract specifies the investment and the repayment from outcome for each side.One optimal contract is
  1. Firms invest all A, investors put up the remaining I-A
  2. Failed project - Neither party is paid
  3. Successful Project - firm receives $R_f > 0$, investor receives $R_u > 0$

$$R_f + R_u = R$$

- Given economical viability, necessary condition for direct finance is that the firm prefers to be diligent:

$$p_H R_f \geq p_L R_f + B$$

$$\Downarrow$$

$$R_f \geq B/\Delta p \qquad (IC_f)$$

Fixed Investment Scale - Direct Finance

- Thus at most $R_u = R - B/\Delta p$ to compensate investors. **Pledgeable Expected Income** $= p_H[R - (B/\Delta p)]$ i.e the maximum expected income that can be promised to investors.
- Necessary and Sufficient condition for firms to have access to direct finance is

$$\gamma[I - A] \leq p_H[R - (B/\Delta p)]$$

- Define $\bar{A}(\gamma)$ as,

$$\bar{A}(\gamma) = I - p_H/\gamma[R - (B/\Delta p)] \tag{2}$$

we have that only firms with $A \geq \bar{A}(\gamma)$ invest using direct finance.

Fixed Investment Scale - Direct Finance

- Assumption so that firms without own capital cannot invest:

$$p_H R - \gamma I < -p_H B/\Delta p \tag{3}$$

- Condition (3) states that the total surplus from a project is less than the minimum share a firm must be paid to behave diligently. To get external financing, therefore, total surplus must be redistributed. But given limited liability, the only way a firm can transfer some of the surplus back to investors is by investing its own capital. Capital-poor firms will be unable to invest, because they do not have the means to redistribute surplus.
- Efficiency not defined by total surplus maximization because of liquidity constraints. Therefore even though aggregate surplus could be increased by reallocating funds, the transfers are not Pareto Improving. No externalities and hence social planner solution also same.

Fixed Investment Scale - Indirect Finance

- Monitoring reduces firm's opportunity cost by eliminating the B-project and thus allowing more external capital raise.
- 3 parties in financial contract - investor, intermediary and firm. Optimal contract form
  1. Firms invest all A, intermediary provides $I_m(\beta)$ and investors put up the remaining $I - A - I_m(\beta)$
  2. Failed project - Neither party is paid
  3. Successful Project - firm receives $R_f > 0$,intermediary receives $R_m > 0$ and investor receives $R_u > 0$

$$R_f + R_u + R_m = R$$

Fixed Investment Scale - Indirect Finance

- B-project is eliminated hence the firm's incentive constraint is,

$$B/\Delta p > R_f \geq b/\Delta p \qquad (IC_f)$$

- Intermediary incentive constraint -

$$R_m \geq c/\Delta p \qquad (IC_m)$$

The condition implies that monitors earn positive net return in 2^{nd} period and competition will reduce the surplus by forcing monitors to contribute in 1^{st} period.Thus assumed that monitoring capital is scarce and monitors make a strictly positive profit.

- $$\textit{Pledgeable Expected Income} = p_H[R - (b + c)/\Delta p] \qquad (4)$$

- Intermediary capital entirely invested in monitoring thus

$$\beta = p_H R_m / I_m$$

Fixed Investment Scale - Indirect Finance

- $\beta > \gamma$, since monitoring is costly. Thus firms prefer uninformed capital to informed.
- IC_m implies that intermediary be paid atleast $R_m = c/\Delta p$ and thus intermediary contributes atleast

$$I_m(\beta) = p_H c/(\Delta p)\beta \tag{5}$$

- The capital does not provide the incentive but the return does. The required investment makes sure that the market for informed capital clears.

Fixed Investment Scale - Indirect Finance

- Investors supply $I_u = I - A - I_m(\beta)$ if > 0.
- Necessary and Sufficient condition for firm to be financed is,

$$\gamma[I - A - I_m(\beta)] \leq p_H[R - (b + c)/\Delta p]$$

$$\Downarrow$$

$$A \geq \underline{A}(\gamma, \beta) = I - I_m(\beta) - (p_H/\gamma)[R - (b + C)/\Delta p] \qquad (6)$$

- Even if the firm demanded more than $I_m(\beta)$, capital poor firms cannot invest. Because, each additional dollar of informed capital reduces pledgeable expected income by β. $\beta > \gamma$, thus total amount of capital that firm can raise does not increase.
- From (5) and (6), $\underline{A}(\gamma, \beta)$ is increasing in both β and γ

Fixed Investment Scale - Indirect Finance

- If for some combination of β and γ, $\underline{A}(\gamma, \beta) > \bar{A}(\gamma)$, β has to come down. But β has to be high enough to make intermediary prefer monitoring than investing in open market. Thus at minimum acceptable return rate $\underline{\beta}$ we have,

$$p_H c/\Delta p - c = \gamma I_m(\underline{\beta}) = \gamma p_H c/(\Delta p \underline{\beta})$$

$$\Downarrow$$

$$\underline{\beta} = p_H \gamma / p_L > \gamma$$

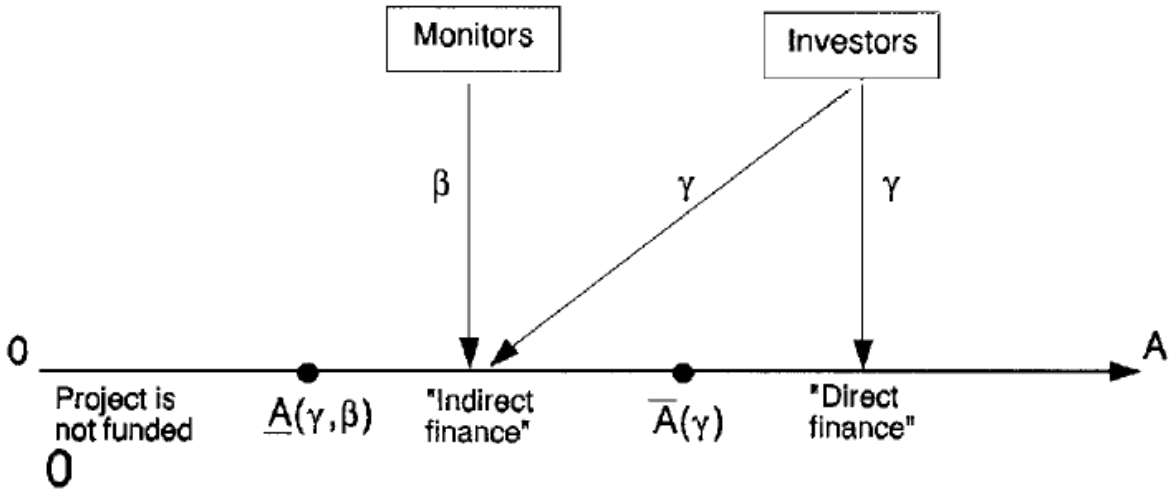
- Ruling out the case that even at $\underline{\beta}$, monitoring is too costly to be socially useful, we have

$$c\Delta p < p_H[B - b]$$

Wealth Dependent Categories

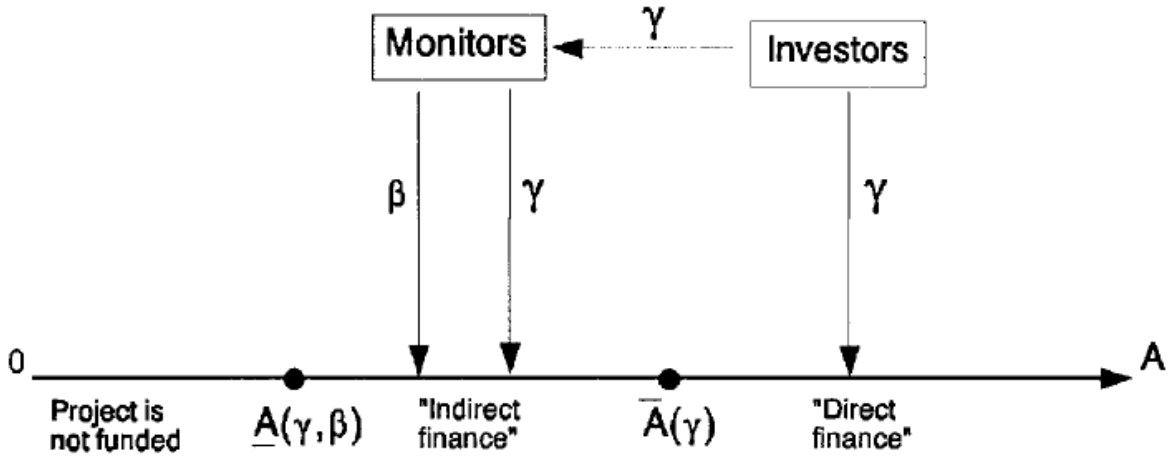
Wealth Level	Loan Amount	Finance Type
$A \geq \bar{A}(\gamma)$	$I_f = A, I_u = I - A, I_m = 0$	Direct Finance
$\underline{A}(\gamma, \beta) \leq A < \bar{A}(\gamma)$	$I_f = A, I_u = I - A - I_m, I_m > 0$	Mixed Finance
$A < \underline{A}(\gamma, \beta)$	$I_f = 0, I_u = 0, I_m = 0$	No Finance

Certification



- Monitor resembles a venture capitalist, a lead investment bank etc. whose stake in borrower *certifies* soundness of borrower.
- Example - bank providing a loan guarantee or originating a secured loan.

Intermediation



- Monitor resembles *intermediary* such as commercial bank.
- Amount of uninformed capital intermediary attracts depends on the equity of it as well as the return rates in both capital markets.
- Investors demand that intermediaries meet the solvency conditions.

Equilibrium in Credit Market- Exogenous γ

- Aggregate demand for informed capital is,

$$D_m(\gamma, \beta) = [G(\bar{A}(\gamma)) - G(\underline{A}(\gamma, \beta))]I_m(\beta)$$

- Assuming no excess supply at $\underline{\beta}$, equilibrium satisfies,

$$K_m = D_m(\gamma, \beta) = [G(\bar{A}(\gamma)) - G(\underline{A}(\gamma, \beta))]I_m(\beta) \tag{7}$$

- D_m is decreasing in β and ambiguous with respect to γ.

Equilibrium in Credit Market - Endogenous γ

- Aggregate Demand for uninformed capital

$$D_u(\gamma,\beta) = \int_{\underline{A}(\gamma,\beta)}^{\bar{A}(\gamma)} [I - A - I_m(\beta)]dG(A) + \int_{\bar{A}(\gamma)}^{\infty} [I - A]dG(A) \quad (8)$$

- D_u is decreasing in γ and ambiguous with respect to β.
- Market clears when demand $=$ supply i.e

$$D_u(\gamma,\beta) = S(\gamma) \quad (9)$$

- Thus substituting (7) into (9) to get (10), which equates aggregate demand for capital by firms to total supply of external capital.

$$\int_{\underline{A}(\gamma,\beta)}^{\infty} (I - A)dG(A) = S(\gamma) + K_m \quad (10)$$

Changes in Supply of Capital

- 3 types of capital tightening considered-
  1. Credit Crunch - K_m is reduced
  2. Collateral Squeeze - K_f is reduced
  3. Savings Squeeze - $S(\gamma)$ is shifted inwards

Proposition 1

In either type of capital tightening, aggregate investment will go down and $\underline{A}(\gamma, \beta)$ will increase. Consequently, poorly capitalized firms will be the first to lose their financing in a capital squeeze.

Proof of Proposition 1

- If supply is inelastic, a firm with more assets can always do as well as a firm with fewer assets.
- If supply is imperfectly elastic - By Contradiction. Suppose $\underline{A}(\gamma, \beta)$ goes down $\Longrightarrow$ Aggregate investment increases $\Longrightarrow$ $S(\gamma)$ goes up $\Longrightarrow$ γ increases $\Longrightarrow$ $\bar{A}(\gamma)$ goes up $\Longrightarrow$ Intermediation spans larger set of firms $\Longrightarrow$ I_m decreases $\Longrightarrow$ β is pushed up $\Longrightarrow$ Both uninformed and informed capital have become more expensive and hence contradicts our initial assumption.

Implications of Proposition 1

1. **Atleast one of the interest rates must go up**. One of the two may decrease, for example with a rise in γ both $\underline{A}$ and $\bar{A}$ move up, then I_m can be increased leading to a fall in β.
2. **Equilibrium in fixed investment model is unique**. If 2 equilibria, $\underline{A}$ same in both and hence $\bar{A}$ same and hence interest rates same.
3. All forms of capital tightening result in same outcome, hence effect stronger when tightening occurs on all fronts.
4. **Small firms abandoned because of scale economies in monitoring**. Both large and small firms pay same fixed cost so per unit of net worth, monitoring costs fall. In credit crunch, banks sort good risks from bad and small firms are not worth the fixed cost of getting informed.
5. Neither D_u nor D_m is monotone, thus effect on interest rates cannot be pinned down. Because of our assumption of fixed investment, individual firm demands is discontinuous and hence G(A) plays critical role.

Variable Investment Model

- **Investments undertaken at any scale I**. Helps to avoid problem with discontinuities in individual demand for capital.
- All benefits, costs and returns are proportional to I. Thus investment technology is **Constant Returns to Scale.**
- $B(I) = BI, b(I) = bI, c(I) = cI$ *and* $R(I) = RI$. Probability of success remains same as before.

The Firm's Program

- Given the β and γ, firm with initial assets A_0 chooses I, A (own contribution) and variables - R_f, R_m, R_u, I_m, I_u, to maximize utility.

Maximize $U(A_0) = p_H RI - p_H R_m - p_H R_u + \gamma(A_0 - A)$ subject to

i $A \leq A_0$,

ii $A + I_m + I_u \geq I$,

iii $p_H R_m \geq \beta I_m$,

iv $p_H R_u \geq \gamma I_u$,

v $R_m \geq cI/\Delta p$,

vi $R_f \geq bI/\Delta p$, *and*

vii $R_f + R_m + R_u \leq RI$.

Dividing all equations by A_0, leads to scaling of choice variables by A_0. Firms with different level of assets use the same optimal policy scaled by their assets.

The Firm's Program

- All the constraints are binding. Thus firm maximizes the leverage and return on its own assets.
- Solving the equality constraints by substitution. We get,

$$A_0 + \frac{I p_H c}{\beta \Delta p} + I(\frac{p_H}{\gamma})[R - (\frac{b+c}{\Delta p})] \geq I \tag{11}$$

- The highest sustainable level of investment is,

$$I(A_0) = A_0 / A_1(\gamma, \beta), \tag{12}$$

$$\textit{where}, A_1(\gamma, \beta) = 1 - \frac{p_H c}{\beta \Delta p} - (\frac{p_H}{\gamma})[R - (\frac{b+c}{\Delta p})] \tag{13}$$

- $A_1(\gamma, \beta) < 1$, reflecting firm's ability to lever its own capital. Further, $A_1(\gamma, \beta) > 0$, else firm would want to invest without limit.

The Firm's Program

- Substituting the constraints in objective function, gives us the maximum payoff as follows,

$$U(A_0) = p_H b I(A_0)/\Delta p \tag{14}$$

- Net value of leverage to the firm is,

$$[p_H b/(\Delta p A_1(\gamma, \beta)) - \gamma]A_0 \tag{15}$$

- Assuming, monitoring is valuable, the term in brackets is positive, representing the difference between internal and external rate of return on firm capital.

Equilibrium in Capital Market

- Since firms choose the same optimal policy per unit of own investment, the equilibrium is found by aggregating.
- K_f and K_m are fixed, K_u is determined by by equating the demand to supply i.e $S(\gamma)$. Letting, $\gamma = \gamma(K_u)$ be the inverse supply function.
- The equilibrium in informed capital is found by equating the demand and supply i.e $I_m(\beta) = K_m$ i.e

$$\beta = p_H cK/(\Delta p)K_m \tag{16}$$

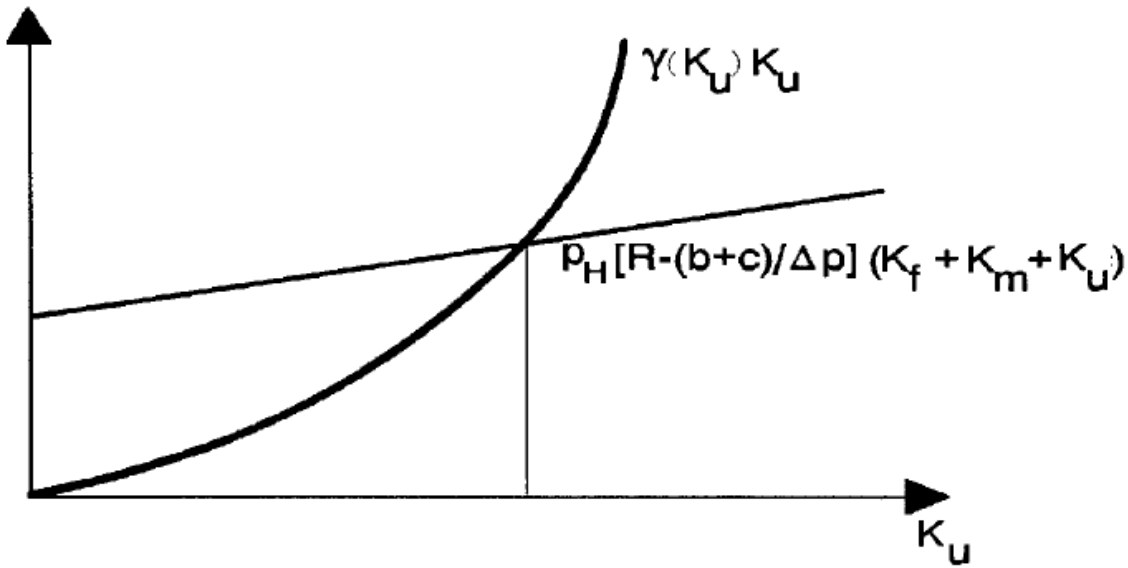
Equilibrium in Capital Market

- The equilibrium in uninformed capital is obtained when,

$$p_H(K_f + K_m + K_u)[R - (b+c)/\Delta p] = \gamma(K_u)K_u \tag{17}$$

$$\Downarrow$$

$$\gamma = p_H K[R - (b+c)/\Delta p]/K_u \tag{18}$$



- In order to have finite investment, γ must exceed the pledgeable expected income per unit of investment.

Equilibrium in Capital Market

- Equation (17) shows that the aggregate investment depends only on the sum of firm and intermediary capital. This is because we have assumed that only uninformed capital responds to changes in the rate of return.
- If the firms had option of more than one type of investment opportunity, optimal choice would depend on the relative costs of capital and hence overall investment would be dependent on relative supplies of firm and intermediary capital.
- Definition: Solvency Ratio firm, $r_f = K_f/K$. Solvency Ratio intermediary, $r_m = K_m/(K_m + K_u)$

Changes in Supply of Capital

Proposition 2

A. A decrease in K_m(credit crunch)

i. decreases γ,
ii. increases β,
iii. decreases r_m,
iv. increases r_f.

B. A decrease in K_f(collateral squeeze)

i. decreases γ,
ii. decreases β,
iii. increases r_m,
iv. decreases r_f.

C. A decrease in K_u(savings squeeze)

i. increases γ,
ii. decreases β,
iii. increases r_m,
iv. increases r_f.

In all cases K and the supply of uninformed capital (K_u) decline.

Proof of Proposition 2

- Using the example of credit crunch:- We have, when K_m contracts, less uninformed capital can be attracted $\Longrightarrow K_u, \gamma$ falls $\Longrightarrow K_m/K_u$ must decrease from equation (17) $\Longrightarrow$ contraction in K_u is less than proportional to contraction in $K_m \Longrightarrow$ informed capital is relatively more scarce $\Longrightarrow \beta$ increases and r_m falls. Further both informed and uninformed capital contracts, thus r_f increases.
- The effect of other capital tightening can be found in similar manner.

Endogenous Monitoring Modeling

- Assumption - the opportunity cost **b** is a continuous variable.Thus can be interpreted as firm having continuum of bad projects with differing private benefit.
- Monitoring at intensity **c** eliminates all bad projects with private benefit higher than b(c).

Fixed Investment Endogenous Monitoring

- Earlier all firms demanded same amount of I_m because monitor had to be paid a minimum return. But if firm could reduce the intensity of monitoring, everyone except the poorest capitalized firm would do so.
- Thus, all firms with $A > \underline{A}(\gamma, \beta)$, reduce c by allowing b to rise $\Longrightarrow$ (IC_m) relaxes and thus the R_m) and (I_m) falls. Firm replaces the lost (I_m) with cheaper uninformed capital for net gain.
- Thus the relation between intensity and level of firm asset declines continuously. Further it suggests a positive relation between intensity of monitoring and intermediary capital amount that has to be put up. Intermediaries monitoring more intensively are required to have higher solvency ratio.

Variable Investment Model Endogenous Monitoring

- Because of our specification of the maximization problem, all firms would be monitored at same intensity, since choice of b is independent of A_0. But the b would vary with relative amounts of intermediary and firm capital.
- Using (12)-(14), we find that firm would choose b to minimize $A_1(\gamma, \beta)/b$. Thus b increases in response to an increase in β.
- Hence with scarcer informed capital, less intensive monitoring is adopted and vice versa.

Equilibrium with Variable Investment and Endogenous Monitoring

- Aggregate investment will now depend on both sum of firm and intermediary capital as well as relative amounts.
- An extra dollar of informed capital will expand investment by more than an extra dollar of firm capital. Thus gives the rationale for subsidizing intermediaries rather than firms.

Continuous Investment but Decreasing Returns to Scale

- Continuous investment, DRS. Let R(I) denote firm's gross profit in case of success, $R' > 0$, $R'' < 0$, $R'(0) = \infty, R'(\infty) = 0$.
- For given β and γ, firm's net utility is equal to expected net profit minus the extra cost of using intermediary capital.

$$U(I) = p_H R(I) - \gamma I - [\beta - (\gamma/\beta)(p_H c/\Delta p]I$$

- Utility therefore depends on its asset level only through borrowing capacity, which is obtained from (12) and (13). Incentive compatibility for the firm requires that $I \leq I(A_0)$, where $I(A_0)$ satisfies,

$$\Delta p[R(I) - \frac{cI}{\Delta p} - \frac{\gamma}{p_H}(I - \frac{p_H cI}{\beta \Delta p}) - A_0] = bI \qquad (19)$$

- Investment capacity $I(A_0)$ is an increasing and concave function of assets. Let I^* be the maximizing investment. Firms with assets such that $I(A_0) > I^*$ invest at I^* and others are credit constrained.

Continuous Investment but Decreasing Returns to Scale

- Thus here investment over asset multiplier is a decreasing function of assets and hence firms with more assets will have a higher solvency ratio.
- Hence distribution of capital across firms as well as between firms and intermediaries would influence aggregate investment.
- The exact effect of capital tightening would depend on the shape of R(I), because of 2 opposing effects to rise in β -
  1. lower leverage makes large firms less sensitive
  2. lower marginal returns makes them more sensitive

Conclusion

- Understanding the role played by the distribution of capital across differently informed sources of capital.
- Because of limited borrowing capacity, distribution of wealth across firms and intermediaries impacts the investment, monitoring and interest rates.
- All types of credit tightening hit poorly capitalized firms the hardest but with different effects on interest rates and solvency ratios.

Limitations

- K_f and K_m are assumed exogenous. The feedback from interest rates to capital values should be taken.
- Alternative forms of monitoring institutes and their emergence and their relative role has been ignored.
- Intermediary's projects perfect correlation not a very reasonable assumption.
- Role of own capital, makes sense only in entrepreneurial firms whereas most of the firms today are agency firms.