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FINANCIAL INTERMEDIATION, LOANABLE FUNDS, AND THE REAL SECTOR*

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We study an incentive model of financial intermediation in which firms as well as intermediaries are capital constrained. We analyze how the distribution of wealth across firms, intermediaries, and uninformed investors affects investment, interest rates, and the intensity of monitoring. We show that all forms of capital tightening (a credit crunch, a collateral squeeze, or a savings squeeze) hit poorly capitalized firms the hardest, but that interest rate effects and the intensity of monitoring will depend on relative changes in the various components of capital. The predictions of the model are broadly consistent with the lending patterns observed during the recent financial crises.

I. INTRODUCTION

During the late 1980s and early 1990s several OECD countries appeared to be suffering from a credit crunch. Higher interest rates reduced cash flows and pushed down asset prices, weakening the balance sheets of firms. Loan losses and lower asset prices (particularly in real estate) ate significantly into the equity of the banking sector, causing banks to pull back on their lending and to increase interest rate spreads. The credit crunch hit small, collateral-poor firms the hardest. Larger firms were less affected as they could either renegotiate their loans or go directly to the commercial paper or bond markets.

Scandinavia seems to have been most severely hit by the credit crunch. The banking sectors of Sweden, Norway, and Finland all had to be rescued by their governments at a very high

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price.[1] Yet, it is the U. S. experience that has received the closest empirical scrutiny. A lot of work has gone into characterizing, identifying, and measuring the effects of the alleged credit crunch. While the exact role of the credit crunch in the 1990–1991 recession remains unclear, there are several pieces of evidence that point to a material influence.

First, bank lending experienced a significant and prolonged decline, which from a historical perspective appears rather exceptional (see Friedman and Kuttner [1993]). Second, and most relevant to this paper, the 1990–1991 change in bank lending within states can be rather well explained by the 1989 capital-asset ratio of a state's banking sector, suggesting that the equity value of the banking sector did affect lending.[2] The sharp decline in lending in the Northeast, where real estate markets experienced the biggest drop, is particularly telling. Third, there is plenty of evidence to indicate a "flight-to-quality" in lending, defined by Gilchrist et al. [1994] as a decline in the share of credit flowing to borrowers with high agency costs (proxied by small firms). Gertler and Gilchrist [1994] offer the first such evidence, which later studies have confirmed. As indirect evidence one can point to the many studies that show that investment in financially stressed firms is more sensitive to cash flow (see subsection IIIB in Gilchrist et al. [1994]). Also, inventories and production in small firms (which presumably have the weakest balance sheets) contract the most when money is tight [Gertler and Gilchrist 1994].

The final, and most controversial, evidence on credit crunches comes from interest rate spreads. There is a significant empirical problem: because of a possible flight to quality, interest rate spreads across different periods are not comparable. The selection effect tends to reduce the observed differential (see Bernanke [1993] for a further discussion). This may explain why the findings with respect to interest rate spreads are less consistent. Friedman and Kuttner [1993] find that the commercial paper-Treasury bill spread reacts positively both to tighter money and to reductions in the capital-asset ratio of banks. However, Miron, Romer, and Weil [1994] find little supportive evidence when one goes farther back in time.[3]

The purpose of this paper is to construct a simple equilibrium

1. Vihriala [1996] contains a summary account of the Finnish experience.

2. For an extensive survey of the empirical work on the role of bank capital on the growth of lending, see Sharpe [1995].

3. Vihriala [1996] reports that in Finland the bank interest rate spread (between lending and funding) correlated positively with tightness of money.

model of credit that can reproduce some of the stylized facts reported above and thereby shed light on the role of different kinds of capital constraints. In the model a firm's net worth determines its debt capacity. Firms that take on too much debt in relation to equity will not have a sufficient stake in the financial outcome and will therefore not behave diligently. Assuming that investment projects are of fixed size, only firms with sufficiently high net worth will be able to finance investments directly. Firms with low net worth have to turn to financial intermediaries, who can reduce the demand for collateral by monitoring more intensively.[4] Thus, monitoring is a partial substitute for collateral. However, all firms cannot be monitored in equilibrium, because intermediaries, like firms, must invest some of their own capital in a project in order to be credible monitors. In the market for monitoring, the equilibrium interest premium paid on monitoring capital is then determined by the relative amounts of aggregate firm and aggregate intermediary capital.

We are primarily interested in the effects that reductions in different types of capital have on investment, interest rates, and the forms of financing. The novelty in our analysis is that we study how these choices are influenced by the financial status of intermediaries as well as of firms. Since our model incorporates both demand factors (changes in collateral) and supply factors (changes in intermediary capital), we can identify a separate "balance sheet channel" and a "lending channel," a distinction that previously has only been discussed in the empirical literature (see Bernanke [1993]).

Our model features behavior that is broadly consistent with the earlier reported evidence: firms with substantial net worth can rely on cheaper, less information-intensive (asset-backed) finance; highly leveraged firms demand more information-intensive finance (monitoring); when monitoring capital decreases, capital-poor firms are the first to get squeezed; and credit crunches increase the interest rate spread between intermediated debt and market debt. However, note that if both intermediary capital and firm capital contract, as they appear to have done in the recent recession, then the sign of the change in the interest rate spread depends crucially on the change in the relative amounts of capital.

4. Since our model is a principal-agent model, it cannot distinguish between different monitoring institutions. In subsection III.3 we discuss in some depth two equivalent interpretations of monitoring: intermediation and certification.

We also find that if we allow intermediaries to vary the intensity of monitoring, then an increase in monitoring capital relative to firm capital leads to lending that involves more intensive monitoring. This is consistent with the recent Scandinavian experience, where banks have begun to invest in more information-intensive lending technologies in the wake of reduced firm collateral.

Another implication of our model is that intermediaries must satisfy market-determined capital adequacy ratios. Interestingly, these capital adequacy ratios are procyclical, suggesting a possible rationale for looser banking norms in recessions.

Our model builds on the previous literature on capital-constrained lending, borrowing extensively from its insights.[5] The papers most closely related to ours are by Hoshi, Kashyap, and Scharfstein [1992] and Repullo and Suarez [1995], who employ the same basic moral hazard model as we do to analyze how the firm's net worth determines its choice between direct and indirect financing, and by Diamond [1991], who studies this choice as a function of the firm's reputation for repaying debt (its reputation capital). However, in neither paper are intermediaries capital constrained, which is the main feature we are interested in. The paper by Besanko and Kanatas [1993] is related in that it investigates the choice of financing and monitoring intensity in an equilibrium model like ours. However, collateral plays no role in their model. Intermediary capital is plentiful, and the firms finance part of their investment from uninformed capital in order not to be monitored too carefully by intermediaries.[6]

The next section describes the basic model, which features fixed-size investment projects. The equilibrium of this model is analyzed in Section III. Section IV moves on to a model with variable investment size, in order to avoid some of the technical complications that stem from fixed-size investment. The variable investment model is highly tractable and delivers preliminary

5. See Jaffee and Russell [1976], Stiglitz and Weiss [1981], and Bester and Hellwig [1987] on credit rationing; Bester [1985, 1987], Diamond [1991], and Hoshi, Kashyap, and Scharfstein [1992] on capital-constrained borrowing; Diamond [1984] and Besanko and Kanatas [1993] on intermediation; and Holmstrom and Weiss [1985], Williamson [1987], Bernanke and Gertler [1989], and Kiyotaki and Moore [1993] on agency costs that amplify the business cycle.

6. In independent work Cantillo [1994] develops an equilibrium model with limited intermediary capital, which is used to address many of the same questions as we do. Cantillo's model is one with costly state verification, but the conclusions are rather similar to ours.

answers to most of the questions raised above. Several variations of it are discussed to illustrate its versatility. Section V concludes with caveats and some future research directions.

II. The Basic Model

The model has three types of agents: firms, intermediaries, and investors. There are two periods. In the first period financial contracts are signed, and investment decisions made. In the second period investment returns are realized, and claims are settled. All parties are risk neutral and protected by limited liability so that no one can end up with a negative cash position.

II.1. The Real Sector

There is a continuum of firms. All firms have access to the same technology; the only difference among them is that they start out with different amounts of capital A. For simplicity, we assume that all initial capital is cash. More generally, it could be any type of asset that can be pledged as collateral with first-period market value A.[7] The distribution of assets across firms is described by the cumulative distribution function $G(A)$, indicating the fraction of firms with assets less than A. The aggregate amount of firm capital is $K_f = \int A dG(A)$.

In the basic version of the model, each firm has one economically viable project or idea. It costs $I > 0$ (in period 1) to undertake a project. If $A < I$, a firm needs at least $I - A$ in external funds to be able to invest. In period 2 the investment generates a verifiable, financial return equaling either 0 (failure) or R (success).

Firms are run by entrepreneurs, who in the absence of proper incentives or outside monitoring may deliberately reduce the probability of success in order to enjoy a private benefit. We formalize this moral hazard problem by assuming that the entrepreneur can privately choose between three versions of the project as described in Figure I.

We assume that

$$\Delta p = p_H - p_L > 0.$$

7. To the extent that the first-period value of collateral depends on the market interest rate, this distinction between cash and real collateral becomes important.

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

FIGURE I

Furthermore, in the relevant range of the rate of return on investor capital, denoted by γ, only the good project is economically viable; that is,

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

We introduce two levels of shirking (two bad projects) in order to have a sufficiently rich way of modeling monitoring (see below). Private benefits are ordered $B > b > 0$ and can, of course, be interpreted alternatively as opportunity costs from managing the project diligently. Note that either level of shirking produces the same probability of success. This has the convenient implication that the entrepreneur will prefer the high private benefit project (B-project) over the low private benefit project (b-project) irrespectively of the financial contract.

II.2. The Financial Sector

The financial sector consists of many intermediaries. The function of intermediaries is to monitor firms and thereby alleviate the moral hazard problem. In practice, monitoring takes many forms: inspection of a firm's potential cash flow, its balance sheet position, its management, and so on. Often monitoring merely amounts to verifying that the firm conforms with covenants of the financial contract, such as a minimum solvency ratio or a minimum cash balance. In the case of bank lending, covenants are particularly common and extensive. The intent of covenants is to reduce the firm's opportunity cost of being diligent. With that in mind, we assume that the monitor can prevent a firm from undertaking the B-project. This reduces the firm's opportunity cost of being diligent from B to b.

A key element in our story is the assumption that monitoring is privately costly; the intermediary will have to pay a nonverifiable amount $c > 0$ in order to eliminate the B-project. Thus, intermediaries also face a potential moral hazard problem. While we assume that each intermediary has the physical capacity to monitor an arbitrary number of firms, the moral hazard problem puts a limit on the actual amount of monitoring that will take place. Moral hazard forces intermediaries to inject some of their own capital into the firms that they monitor, making the aggregate amount of intermediary (or "informed") capital K_m one of the important constraints on aggregate investment.

It turns out that the exact distribution of assets among intermediaries is irrelevant if we assume that all projects financed by an intermediary are perfectly correlated and that the capital of each intermediary is sufficiently large relative to the scale of a project (allowing us to ignore integer problems).[8] In practice, projects may be correlated because intermediaries have an incentive to choose them so, or because monitoring requires specialized expertise in a given market or instrument, or because of macroeconomic shocks. Nevertheless, assuming perfect correlation is obviously unrealistic. We make this assumption only because we know that, without some degree of correlation, intermediaries would not need to put up any capital (see Diamond [1984] and the concluding section for further discussion). While perfect correlation is an extreme case, it greatly simplifies the analysis.

II.3. Investors

Individual investors are small. We will often refer to them as uninformed investors, to distinguish them from intermediaries, who monitor the firms that they invest in. Uninformed investors demand an expected rate of return γ. We sometimes assume that γ is exogenously given (there is an infinite supply of outside investment opportunities that return γ) and sometimes that the aggregate amount of uninformed capital invested in firms is determined by a standard, increasing supply function $S(\gamma)$. The

8. One way to model perfect correlation is to let θ, distributed uniformly on [0,1], represent an intermediary specific random disturbance, such that if $\theta < p_L$, all the intermediary's projects succeed, if $\theta \geq p_H$, all of its projects fail and if $p_L \leq \theta < p_H$, its projects succeed if and only if they are good. With this formulation one can let the θ's vary arbitrarily across intermediaries without affecting the analysis.

determination of the equilibrium rate of return on intermediary capital, β, will be described momentarily.

We assume that firms cannot monitor other firms, perhaps because they have insufficient capital to be credible monitors (see below) or because they do not have the informational expertise. Therefore, firms with excess capital will have to invest their surplus cash in the open market, earning the uninformed rate of return γ.

III. Fixed Investment Scale

In this section the investment scale I is fixed.

III.1. Direct Finance

We start by analyzing the possibility of financing a project without intermediation, that is, by using *direct finance.* Consider a firm that borrows only from uninformed investors, treated here as a single party. A contract specifies how much each side should invest and how much it should be paid as a function of the project outcome. It is easy to see that *one* optimal contract will have the following simple structure: (i) the firm invests all its funds A, while the uninformed investors put up the balance $I - A$; (ii) neither party is paid anything if the investment fails; (iii) if the project succeeds, the firm is paid $R_f > 0$, and the investors are paid $R_u > 0$, where

$$R_f + R_u = R.$$

Given (1), a necessary condition for direct finance is that the firm prefers to be diligent:

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

Direct finance, therefore, requires that the firm be paid at least

$$(\mathrm{IC}_f) \qquad R_f \geq B/\Delta p.$$

This leaves at most $R_u = R - B/\Delta p$ to compensate investors, so the maximum expected income that can be promised investors without destroying the firm's incentives, call it the *pledgeable expected income,* is $p_H[R - B/\Delta p]$. The pledgeable expected income cannot be less than $\gamma[I - A]$, the market value of the funds supplied by the uninformed investors. Therefore, a necessary and sufficient condition for the firm to have access to direct finance is

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

Defining

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

we conclude that only firms with $A \geq \bar{A}(\gamma)$ can invest using direct finance.[9]

In principle, $\bar{A}(\gamma)$ could be negative, in which case firms could invest without own capital. We rule out this uninteresting case by assuming that the external opportunities for investors are such that

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

Condition (3) simply 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.

It follows that in this model, as in most models with liquidity constraints, efficiency is not defined by total surplus maximization. Therefore, while it is true that aggregate surplus (and investment) could be increased by reallocating funds from uninformed investors to firms that are capital constrained, such transfers are not Pareto improving. There are no externalities in this model that the firm and the investor cannot internalize just as effectively as a social planner facing the same informational constraints.

III.2. Indirect Finance

An intermediary that monitors can help a capital-constrained firm to invest. Monitoring reduces the firm's opportunity cost of being diligent (by eliminating the high benefit B-project), allowing more external capital to be raised. Some of the external funds will be provided by the intermediary itself, and some by outside investors. Thus, in the case of indirect finance, there are three parties to the financial contract: the firm, the intermediary, and the uninformed investors.

9. Firms with $A > \bar{A}(\gamma)$ are indifferent between investing the surplus $A - \bar{A}(\gamma)$ in the firm or in the market for uninformed capital.

It is easy to see that an optimal three-party contract takes a form analogous to the two-party contract discussed earlier: in case the project fails, no one is paid anything; in case the project succeeds, the payoff R is divided up so that

$$R_f + R_u + R_m = R,$$

where R_m denotes the intermediary's share and R_f and R_u denote the firm's and the investors' shares as before.

Suppose that the intermediary monitors. Since monitoring eliminates the high benefit project (the B-project), the firm is left to choose between the good project and the low benefit project (the b-project). The firm's incentive constraint is now

$$(\mathrm{IC_f}) \qquad R_f \geq b/\Delta p.$$

We may assume that $R_f < B/\Delta p$, else the firm would behave without monitoring. In order for the intermediary to monitor, we must have

$$(\mathrm{IC_m}) \qquad R_m \geq c/\Delta p.$$

The two incentive constraints (IC_f) and (IC_m) imply minimum returns for the firm and the intermediary, respectively. The pledgeable expected income, again defined as the maximum expected income that can be promised to uninformed investors without destroying incentives, is then

$$(4) \qquad p_H[R - (b + c)/\Delta p].$$

Note that condition ($\mathrm{IC_m}$) implies that $p_H R_m - c > 0$, so monitors earn a positive net return in the second period. Competition will reduce this surplus by forcing monitors to contribute to the firm's investment in the first period. For the moment, assume that monitoring capital is scarce so that intermediaries make a strictly positive profit. We will later derive the condition under which this assumption holds. Intermediary capital is then entirely invested in the monitoring of projects. Let I_m be the amount of capital that an intermediary invests in a firm that it monitors. The rate of return on intermediary capital is then

$$\beta = p_H R_m / I_m.$$

Since monitoring is costly, β must exceed γ. Consequently, firms prefer (whenever possible) uninformed capital to informed capital. However, since the incentive constraint (IC_m) requires that the intermediary be paid at least $R_m = c/\Delta p$, it will contribute at least

$$I_m(\beta) = p_H c/(\Delta p)\beta$$

to each firm that it monitors. In fact, all firms that are monitored will demand precisely this minimum level of informed capital. More would be excessively costly, and less would be inconsistent with proper incentives for the monitor. However, note that it is not the capital put into the firm that provides the intermediary an incentive to monitor. The incentive is provided by the return R_m. The required investment $I_m(\beta)$ merely regulates the rate of return on the intermediary's capital so that the market for informed capital clears. (We can take either I_m or β as the equilibrating variable, since the relationship between the two is monotone.)

Uninformed investors must supply the balance $I_u = I - A - I_m(\beta)$, whenever this amount is positive. A necessary and sufficient condition for a firm to be financed therefore is

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

We can rewrite this condition as

$$A \geq \underline{A}(\gamma,\beta) = I - I_m(\beta) - (p_H/\gamma)[R - (b + c)/\Delta p]. \tag{5}$$

A firm with less than $\underline{A}(\gamma,\beta)$ in initial assets cannot convince uninformed investors to supply enough capital for the project. Could the firm still invest by demanding more than $I_m(\beta)$ in informed capital? That does not work either, because for each additional dollar of informed capital, the pledgeable expected income will be reduced by β. Since β exceeds γ, the total amount of capital that the firm can raise does not increase. This argument just restates that it is optimal for a firm to demand the minimum amount of informed capital.

It follows from (4) and (5) that $\underline{A}(\gamma,\beta)$ increases in both β and γ. As one would expect, it becomes more difficult to get financing when either the market rate of return γ or the monitoring rate of return β increases. If for some combination of interest rates $\underline{A}(\gamma,\beta) > \overline{A}(\gamma)$, the price of monitoring is too high, and there will be no demand for monitoring. The rate β has to come down. However, β must be high enough to make the intermediary prefer monitoring to investing its capital in the open market, where it would earn a rate of return γ. The minimum acceptable rate of return $\underline{\beta}$ is determined by the condition,

$$p_H c/\Delta p - c = \gamma I_m(\beta) = \gamma p_H c/(\Delta p \beta),$$

which translates into

$$\beta = p_H \gamma / p_L > \gamma.$$

If $\underline{A}(\gamma,\underline{\beta}) > \overline{A}(\gamma)$, there is no demand for informed capital even at the lowest rate of return acceptable to the monitor; the monitoring technology is too costly to be socially useful. Naturally, we want to rule out this case. A little algebra yields the following necessary and sufficient condition for monitoring to be socially valuable: $c\Delta p < p_H[B - b]$. This condition is met for a small enough c, since $B > b$.[10]

III.3. Certification versus Intermediation

The preceding analysis shows that firms fall into three categories according to their demand for informed capital. At one extreme are the well-capitalized firms with $A > \overline{A}(\gamma)$. These firms can finance their investment directly and demand no informed capital. At the other extreme are the poorly capitalized firms with $A < \underline{A}(\gamma,\beta)$. These firms cannot invest at all. In between, we have firms with $\underline{A}(\gamma,\beta) \leq A < \overline{A}(\gamma)$. These firms can invest, but only with the help of monitoring.

The typical firm in the monitoring category finances its investment with a mixture of informed and uninformed capital.[11] We can interpret mixed financing in one of two ways. As we have described the investment process so far, the uninformed are independent investors as illustrated in Figure II. They invest directly in the firm, but only after the monitor has taken a large enough financial interest in the firm that the investors can be assured that the firm will behave diligently. In this interpretation the

10. If $b + c < B$, monitoring would allow a firm to raise more uninformed capital than without monitoring; see (4). Therefore, there could be an equilibrium with monitoring even if intermediaries possessed no own capital. Since intermediaries earn a positive profit in that case, and since we have assumed that there is no constraint on how many firms an intermediary can technically monitor, such an equilibrium would feature rationing of intermediaries analogous to rationing in efficiency wage models. However, with any amount of intermediary capital, those without capital could not be active. For the benefit of Section IV we assume that $b + c > B$, ruling out intermediation without capital.

11. If there are firms for which $A < \overline{A}(\gamma)$, but $A + I_m(\beta) > I$, these firms only demand informed capital and invest their excess funds in the market for uninformed capital.

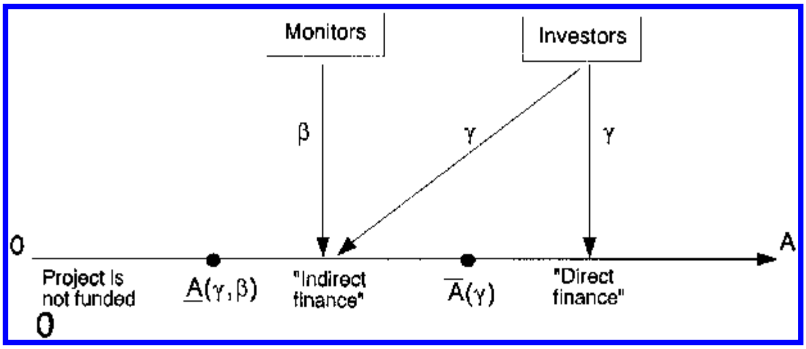

FIGURE II
Certification

monitor resembles a venture capitalist, a lead investment bank, or any other sophisticated investor whose stake in the borrower *certifies* that the borrower is sound, allowing the firm to go to less informed investors for additional capital.[12] A related example is that of a bank providing a loan guarantee, or originating a secured loan.

An alternative interpretation of our model views the monitor as an *intermediary* such as a commercial bank. In this interpretation investors deposit their money with the bank, which invests the deposits, along with its own funds, in the firms that it monitors (see Figure III). One can check that the optimal, incentive-compatible intermediary arrangement is equivalent to the certification arrangement we have described.[13]

The amount of uninformed capital that an intermediary can attract will depend on how much equity it has as well as on the rates of return in the market for informed and uninformed capi-

12. There is a large literature on certification by venture capitalists; see, for instance, Barry et al. [1990] and Megginson and Weiss [1991] and references therein. For evidence that the participation of sophisticated investors can substantially enhance the ability to attract external capital, see Emerick and White [1992].

13. Intermediation can always duplicate the outcome of certification, which consists of writing an isolated contract for each funded project. One may wonder whether intermediation could not do strictly better than certification by "cross-pledging" the returns on the various projects that the intermediary funds. That this is not the case can be seen from the optimal contract under intermediation. Because of perfect correlation if one project fails and another succeeds, it must be the case that the intermediary did not monitor the former. Because harshest punishments are always optimal when a deviation is detected, the intermediary must then receive 0. This implies that the optimal strategy for the intermediary is either to monitor all projects or to monitor none, and that therefore intermediation does not improve on certification.

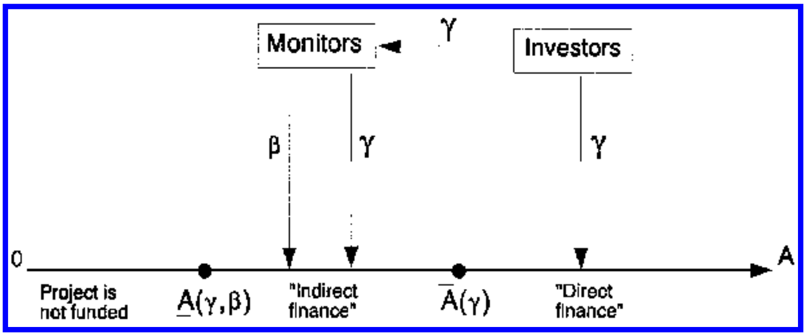

FIGURE III
Intermediation

tal. The intermediation case makes clear that investors will demand that intermediaries meet solvency conditions that put a lower bound on the ratio of their equity to total capital. For reasons of tractability, we will only analyze solvency conditions in the variable investment model (Section IV).

III.4. Equilibrium in the Credit Market

Since each firm demands the minimum amount of informed capital $I_m(\beta)$, the aggregate demand for informed capital is $D_m(\gamma,\beta) = [G(\bar{A}(\gamma)) - G(\underline{A}(\gamma,\beta))]I_m(\beta)$. Assuming that there is no excess supply of informed capital at the minimum acceptable rate of return $\underline{\beta}$,[14] an equilibrium in the monitoring market obtains when β satisfies

$$(6) \qquad K_m = D_m(\gamma,\beta) = [G(\bar{A}(\gamma)) - G(\underline{A}(\gamma,\beta))]I_m(\beta).$$

The demand for informed capital D_m is decreasing in β because $I_m(\beta)$ is decreasing and $\underline{A}(\gamma,\beta)$ is increasing in β. Therefore, for each γ there is a unique β that clears the market for informed capital. The effect of γ on D_m is ambiguous, however. A higher γ increases both $\bar{A}(\gamma)$ and $\underline{A}(\gamma,\beta)$, and then it depends on the distribution function G whether aggregate demand increases or decreases with γ.

Equation (6) fully describes the equilibrium if the rate of return γ demanded by the uninformed is exogenous. If γ is endogenous, that is, if the supply of uninformed capital $S(\gamma)$ is

14. The less interesting case of excess informed capital occurs when (6) is an inequality for $\beta = \underline{\beta}$. We will not discuss that case.

imperfectly elastic, one must add an equilibrium condition for uninformed capital. Let

$$(7)\quad D_u(\gamma,\beta) = \int_{\underline{A}(\gamma,\beta)}^{\bar{A}(\gamma)} [I - A - I_m(\beta)]dG(A) + \int_{\bar{A}(\gamma)}^{\infty} [I - A]dG(A)$$

denote the demand for uninformed capital.[15] The demand D_u is decreasing in γ. On the one hand, firms with assets just above $\underline{A}(\gamma,\beta)$ are squeezed out by an increase in γ. On the other hand, firms with assets just above $\bar{A}(\gamma)$ move from direct to indirect finance, which uses less uninformed capital (since $I_m > 0$). Both effects reduce the demand for uninformed capital. By contrast, an increase in β has an ambiguous effect on D_u because there are two opposing effects. Firms with assets just above $\underline{A}(\gamma,\beta)$ drop out, which reduces the demand for uninformed capital, while firms relying on intermediation, now demand more uninformed capital, since intermediaries have to invest less per firm ($I_m(\beta)$ decreases with β).

The market for uninformed capital clears when

$$(8)\qquad D_u(\gamma,\beta) = S(\gamma).$$

For each β there is a unique γ that solves (8).[16]

Instead of using (6) and (8) to determine β and γ, we can replace (8) with the following condition, obtained by substituting (6) into (8):

$$(9)\qquad \int_{\underline{A}(\gamma,\beta)}^{\infty} (I - A)dG(A) = S(\gamma) + K_m.$$

Equation (9) equates the firms' aggregate demand for capital (the left-hand side) with the total supply of external capital.

III.5. Changes in the Supply of Capital

Our main interest is with the effects that changes in asset values and capital supply have on the equilibrium outcome. Unfortunately, the fact that neither D_u nor D_m is monotone limits what we can say about the behavior of interest rates. The prob-

15. In this demand function we have netted out the capital that firms with $I_m + A > I$ or $I > A$ will reinvest in the market.

16. The reader familiar with Yanelle's [1989] analysis might be concerned that an intermediary could raise deposit rates enough to attract all deposits, and having obtained a monopoly, control the interest rates on loans. However, Yanelle, who uses Diamond's [1984] model with perfect diversification, rules out agency problems. In our model the intermediary's ability to attract deposits is limited by its own capital. So long as informed capital is not too concentrated, each intermediary will take β and γ as approximately given.

lem stems from our assumption that the investment size is fixed, which creates discontinuities in individual firm demands and makes the distribution function $G(A)$ play a critical role. Rather than trying to circumvent these problems by introducing specific assumptions about G, we will in this section restrict attention to the behavior of investment in response to changes in the supply of capital. The next section will look at the behavior of interest rates in a variant of the model that is analytically more tractable.

We consider three types of capital tightening, corresponding to the three forms of capital in the model. In a *credit crunch* the supply of intermediary capital K_m is reduced. In a *collateral squeeze* aggregate firm capital $K_f = \int A dG(A)$ is reduced. Moreover, we assume that the reduction affects firms in proportion to their assets. In a *savings squeeze* the savings function $S(\gamma)$ shifts inward.

PROPOSITION 1. In either type of capital squeeze, 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 all capital were supplied inelastically, this result would be immediate, since a firm with more assets can always do as well as a firm with fewer assets. The one detail to check is that a reduction in firm or intermediary capital is not offset by an increase in uninformed capital.

Suppose, hypothetically, that $\underline{A}(\gamma,\beta)$ goes down with any kind of capital squeeze. A reduction in $\underline{A}$ is equivalent to an increase in aggregate investment. Since an increase in investment must be funded by uninformed capital, S would have to go up (see equation (9)), implying an increase in the interest rate γ. As uninformed capital becomes more expensive, fewer firms have access to direct finance; $\overline{A}(\gamma)$ goes up as seen from equation (2). With $\underline{A}$ reduced and $\overline{A}$ increased, intermediation spans a strictly larger set of firms. Each firm must therefore receive less informed capital (I_m decreases; see equation (6)), implying that β is pushed up. As informed and uninformed capital both have become more expensive, $\underline{A}(\gamma,\beta)$ cannot go down (see equation (5)), contradicting the initial hypothesis.

QED

Proposition 1 implies that at least one of the interest rates, β or γ, must go up when there is a capital squeeze. If both went down, equation (5) would imply that $\underline{A}$ goes down. If uninformed capital is supplied inelastically, so that γ is exogenous, then β must increase. But in general we cannot rule out the possibility that one of the two interest rates decreases. For instance, in a credit crunch, as $\underline{A}$ and $\overline{A}$ move up, I_m could be pushed above its original level, implying a decrease in β. It all depends on the shape of the distribution function G. Similar ambiguities about interest rate effects can arise in the other cases as well.

Another corollary of Proposition 1 is that the equilibrium in the fixed investment model must be unique. If there were two different equilibria, Proposition 1 implies that $\underline{A}$ would have to be the same in both. But then $\overline{A}$ must also be the same, else both β and γ would be lower in one of the equilibria, which, as we just noted, is impossible.

Since all forms of capital tightening result in the same outcome, namely that capital-poor firms lose their financing, the effect will be all the stronger when the tightening occurs on all three fronts. While simple, this conclusion is quite robust, which is reassuring given the strong empirical evidence that small firms are more highly leveraged and bear the brunt of a capital squeeze. The conclusion is reinforced by considering changes in R or in p_H. In a recession it is natural to assume that both R and p_H decrease as well. Following the logic of the proof of Proposition 1, it is easy to see that either change will again cause an increase in $\underline{A}(\gamma,\beta)$, that is, in capital poor firms being squeezed out first.

One may argue that in the real world small firms are abandoned because of scale economies in monitoring. In a credit crunch, banks will have to sort out the good risks from the bad, and small firms will not be worth the fixed cost of getting informed. On the surface, our model does not seem to have scale economies. But in fact it does, with much the same effect as just described. A large firm that is monitored has to pay the same absolute amount for monitoring as a small firm, so per unit of net worth, which is the relevant measure here, monitoring costs do decrease with size.

IV. Variable Investment Scale

For the remainder of the paper we switch to a model with a variable level of investment in order to avoid the problem with discontinuities in individual demand for capital. We assume that investments can be undertaken at any scale I. All benefits and costs are proportional to I (the private benefits are $B(I) = BI$, respectively, $b(I) = bI$, the cost of monitoring is $c(I) = cI$, and the return from a successful investment is $R(I) = RI$). Thus, the investment technology is constant returns to scale. The probabilities of success remain as before equal to p_H or p_L depending on the firm's action.

IV.1. The Firm's Program

Given the rates of return β and γ, a firm that holds initial assets A_0 will choose its overall level of investment I, its own capital contribution A, and the variables R_f, R_m, R_u, I_m, I_u to solve Program A_0:

$$\text{maximize } U(A_0) = p_H RI - p_H R_m - p_H R_u + \gamma(A_0 - A)$$

subject to

$$\text{(i)} \quad A \leq A_0,$$

$$\text{(ii)} \quad A + I_m + I_u \geq I,$$

$$\text{(iii)} \quad p_H R_m \geq \beta I_m,$$

$$\text{(iv)} \quad p_H R_u \geq \gamma I_u,$$

$$\text{(v)} \quad R_m \geq cI/\Delta p,$$

$$\text{(vi)} \quad R_f \geq bI/\Delta p, \text{ and}$$

$$\text{(vii)} \quad R_f + R_m + R_u \leq RI.$$

In setting up the program in this way, we are assuming that it is desirable to employ an intermediary and, as in Section III, that informed capital is scarce. We will return to check that this is indeed the case in equilibrium.

Divide through all equations in Program A_0 by the firm's level of assets A_0. This yields a program in which all choice variables are scaled by A_0 and all the parameters are independent of A_0. Consequently, an optimal solution takes the form, $R_f = \tilde{R}_f A_0$, $R_m = \tilde{R}_m A_0$, and so on, where the variables with a tilde solve the program with $A_0 = 1$. In other words, firms with different levels of assets use the same optimal policy scaled by their assets. This feature greatly simplifies the aggregate analysis.

It is evident from our previous discussion that in equilibrium all constraints will bind. The firm will invest all its assets; it will be paid just enough to be diligent; the intermediary will be paid just enough to have an incentive to monitor; the intermediary will be required to invest to the point where its return on capital is β; and the investors will invest to the point where the pledgeable expected return equals the market return γ. This way the firm maximizes the leverage and return on its own assets. To find the maximum level of investment, substitute equalities (i) and (iii)–(vii) into (ii) to get

$$A_0 + \frac{I p_H c}{\beta \Delta p} + I\left(\frac{p_H}{\gamma}\right)\left[R - \left(\frac{b+c}{\Delta p}\right)\right] \geq I. \tag{10}$$

We see that the highest sustainable level of investment is

$$I(A_0) = A_0/A_1(\gamma,\beta), \tag{11}$$

where the denominator

$$A_1(\gamma,\beta) = 1 - \frac{p_H c}{\beta \Delta p} - \left(\frac{p_H}{\gamma}\right)\left[R - \left(\frac{b+c}{\Delta p}\right)\right] \tag{12}$$

represents the amount of firm capital needed to undertake an investment of unit size ($I = 1$). Clearly, $A_1(\gamma,\beta) < 1$, reflecting the fact that the firm can lever its own capital; the lower is $A_1(\gamma,\beta)$, the higher the leverage. In equilibrium, rates of return must also be such that $A_1(\gamma,\beta) > 0$, else the firm would want to invest without limit.

Substituting equalities (i)–(vii) into the objective function gives the firm's maximum payoff:

$$U(A_0) = p_H b I(A_0)/\Delta p. \tag{13}$$

The net value of leverage to the firm is

$$[p_H b/(\Delta p A_1(\gamma,\beta)) - \gamma]A_0. \tag{14}$$

Assuming that monitoring is valuable, the term in brackets is positive.[17] It represents the difference between the internal and the external rate of return on firm capital. As in most models with liquidity constraints, the internal rate of return exceeds the market rate, in our case, because a dollar inside the firm is worth the market rate plus the incentive effect.

17. It is easy to give a condition for monitoring to be of value. If a firm tried to finance investment without monitoring, the optimal solution would be the same as with monitoring, but with the substitutions $c = 0$ and $b = B$. Comparing monitoring with no monitoring, evaluated at the lowest acceptable rate of return $\beta = \underline{\beta}$ $(= p_H\gamma/p_L)$, one finds that monitoring will be preferred to direct finance whenever $c(p_H\gamma - p_L)/\Delta p < (B - b)/B$. Taking γ as exogenous, this condition is satisfied for small enough c.

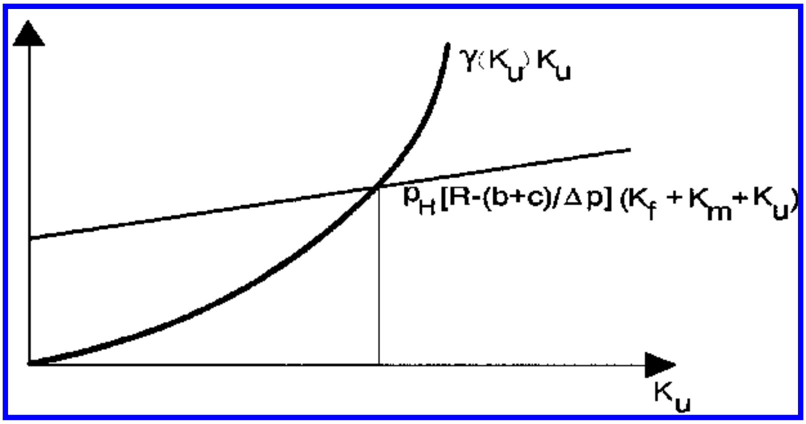

FIGURE IV

IV.2. Equilibrium in the Capital Markets

Because firms choose the same optimal policy per unit of own capital, an equilibrium is easily found by aggregating across firms. Let K_f be the aggregate amount of firm capital, K_m the aggregate amount of informed capital, and K_u the aggregate supply of uninformed capital. The first two are fixed, while the third, K_u, is determined so that the demand for uninformed capital (the sum of the pledgeable expected returns of individual firms, discounted by γ) equals the supply $S(\gamma)$. Let $\gamma = \gamma(K_u)$ be the inverse supply function. The equilibrium in the market for uninformed capital obtains when

$$p_H(K_f + K_m + K_u)[R - (b + c)/\Delta p] = \gamma(K_u)K_u. \tag{15}$$

The equilibrium rates of return in the two capital markets are

$$\gamma = p_H K[R - (b + c)/\Delta p]/K_u, \tag{16}$$

$$\beta = p_H cK/(\Delta p)K_m, \tag{17}$$

where $K = K_f + K_m + K_u$ is the total amount of capital invested.

Figure IV provides a graph of how K_u is determined. As can be seen from Figure IV, in order for investment to be finite, the equilibrium value of γ must be such that it exceeds the pledgeable expected income $p_H[R - (b + c)/\Delta p]$ (per unit of investment).

Equations (16) and (17) show that the equilibrium rates of return on firm and intermediary capital depend in the obvious way on the relative scarcity of these two forms of capital. However, equation (15) shows that the aggregate level of investment only depends on the sum of firm and intermediary capital. This is a consequence of our assumption that firm and intermediary capital are in fixed supply; only uninformed capital responds to changes in the rate of return. If firms had more than one type of investment opportunity, the optimal choice would generally depend on the relative costs of capital, and consequently, overall investment would be sensitive to the relative supplies of firm and intermediary capital. Subsection IV.4 will illustrate a variation on this theme.

IV.3. Changes in the Supply of Capital

In addition to analyzing the effect that changes in the supply of capital have on interest rates and investment, we will also consider the effect these changes have on the solvency ratios of firms and intermediaries. Each firm's solvency ratio equals the aggregate solvency ratio, which is defined by $r_f = K_f/K$. Likewise, an intermediary's solvency ratio is defined by $r_m = K_m/(K_m + K_u)$.[18]

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. *An inward shift in* $S(\gamma)$ (*savings squeeze*)
 (i) increases γ, (ii) decreases β,
 (iii) increases r_m, (iv) increases r_f.

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

These results follow directly from (15)–(17). To illustrate, in a credit crunch, when intermediary capital contracts, less uninformed capital can be attracted, lowering K_u and γ. Dividing equation (15) through by K_u shows that K_m/K_u must decrease, since K_f/K_u increases and γ goes down. The contraction in uninformed capital is less than proportional to the contraction in K_m. Consequently, informed capital will be relatively scarcer than be-

18. Here we are adopting the interpretation that investors invest in firms via an intermediary.

fore, which increases β and lowers r_m. Since both informed and uninformed capital contracts, the solvency ratio r_f of firms will increase.

As an illustration, let us see how the predictions of Proposition 2 match up with the Scandinavian experience of the late 1980s and early 1990s. A recession, of course, hits all our capital variables as well as some of the parameters, such as the probability of success (p_H) or the payoff R, so it may be imprudent to compare our results with reality. On the other hand, if reality looked very different from our simple predictions, it would be disquieting.

Arguably, the Scandinavian recession started as a credit crunch. Banks were overextended and had to rein in on lending.[19] The gap between lending and deposit rates widened at this stage, which is in line with the increase in β and decrease in γ. Overall investment dropped by more than the reduction in bank lending as banks forced firms to consolidate their battered balance sheets (improve solvency); this is consistent with A(iv).

A related empirical counterpart to r_f is the leverage provided by a dollar's worth of collateral. We know of no systematic evidence, but anecdotal reports from Scandinavia indicate that at the height of the 1980s boom, a dollar of collateral brought in about a dollar and a half of loans. Currently, that ratio averages 70 cents per dollar of collateral. Again, this is consistent with A(iv).

The solvency of the banks dropped dramatically and recovered only with government support and a monetary ease. Even though r_m should go down according to A(iii), this result cannot be directly matched with the evidence, since regulatory rules clearly governed the behavior of banks. Nevertheless, our analysis may have some bearing on the ongoing debate about the regulation of capital ratios. Should these ratios vary with the business cycle and, if so, how? Our model suggests one reason why capital ade-

19. It appears that the Scandinavian credit crunches were a consequence of the deregulation of credit markets, which first caused them to overheat and then collapse [Vihriala 1996]. Regulatory reforms have been implicated in other credit crunches as well. For example, the big 1966 credit crunch in the United States started when ceilings on CD rates were imposed (see Wojnilower [1966]). More recently, the 1990 reclassification of many private placements, from investment grade to speculative grade, produced a sharp decrease in lending by life insurance companies. In 1991 gross insurance holdings of nonfinancial corporations below investment grade, fell by 53 percent (while those of investment grade fell by 6 percent; see Carey et al. [1993]). In his review of recent empirical work on the credit crunch, Sharpe [1995] concludes that the current evidence does not pin the decline in lending on any particular change in capital regulation but that there is other evidence (especially for New England) that suggests a close link.

quacy ratios should be procyclical. In a recession, intermediaries will have the right incentives with a lower share of own capital, because interest rates, and hence contingent payoffs, are higher.[20]

Needless to say, there are numerous other aspects to consider when discussing the regulation of solvency. Our model gives no reason for regulating solvency ratios in the first place, since the market will provide the proper level of discipline. Indeed, if one adds solvency constraints to the model, the aggregate level of investment and welfare will go down if the constraints bind. But if one views government as a representative of investors, as in Dewatripont and Tirole [1994], then our results on solvency ratios can be interpreted normatively.

Incidentally, our dual interpretation of monitoring illustrates rather nicely one dilemma with regulating capital adequacy. The market equilibrium is the same whether investors invest directly in firms (certification) or indirectly (intermediation). In the former case, the monitor offers an implicit guarantee to the investors, while in the latter case the guarantee is more explicit (there is a contract between the parties). The investors—and this is the crucial point—do not care about which form the guarantee takes. All they care about is whether the monitor holds a sufficient contingent interest in the project. Solvency ratios alone do not capture the effective guarantee provided. Indeed, the solvency ratio of a certifier that does not intermediate is by definition equal to 1, but that is no assurance for proper monitoring.

IV.4. Endogenous Monitoring

So far, we have kept monitoring intensity fixed. The logic of the model suggests that monitoring intensity should vary in response to changes in aggregate as well as individual levels of capital. There is an obvious way to model varying monitoring intensity: let the opportunity cost b be a continuous rather than discrete variable. In accordance with our earlier interpretation of monitoring, one can imagine that the firm has a continuum of alternative bad projects, distinguished by differing levels of private benefit b. Monitoring at the intensity level c eliminates all bad projects with a private benefit higher than $b(c)$, say, where c represents the cost of monitoring and $b(c)$ the functional relationship between monitoring intensity and the firm's opportunity cost for being diligent.

20. In an unconventional interpretation of government subsidies, one can see them as a way to permit countercyclical solvency ratios.

With this apparatus let us first revisit the fixed investment model. In that model all firms that were monitored demanded the same amount of informed capital because the monitor had to be paid a minimum return. It is evident, however, that if firms could choose to reduce the intensity of monitoring, all but the most poorly capitalized firms would do so. Any firm for which $A > \underline{A}(\gamma,\beta)$ can reduce its cost of capital by letting b increase. A higher b implies a lower c. This relaxes the intermediary's incentive-compatibility constraint ($\mathrm{IC_m}$) and with it the amount that the intermediary has to be paid, R_m, and the amount the intermediary has to invest, I_m. The firm replaces the loss in intermediary capital with cheaper uninformed capital for a net gain.

In this variation the relationship between the intensity of monitoring and the level of firm assets is continuously rather than discretely declining. More interestingly, the model implies that the intensity of monitoring is positively related to the amount of capital that the intermediary has to put up. Intermediaries that monitor more intensively are required to have a higher solvency ratio. This seems consistent with casual evidence. Commercial banks do not monitor very intensively, which partly explains why they can leverage their capital so extensively. By contrast venture capitalists hold a much larger stake in the projects they finance because their participation in overseeing management is much more intense.

In the variable investment model with endogenous monitoring, all firms would be monitored at the same level of intensity (because the choice of b in Program A_0 is independent of A_0). However, this level would vary with the relative amounts of intermediary and firm capital. Using (11)–(13), we see that a firm would choose b to minimize $A_1(\gamma,\beta)/b$, the amount of own assets per unit of private benefit. It is immediate, by revealed preference, that b increases in response to an increase in β (keeping γ exogenous). Therefore, when informed capital gets scarcer, the response is to shift toward less intensive monitoring. Conversely, when informed capital gets more abundant relative to firm capital, the most efficient use of informed capital requires that it be employed for more intensive monitoring.

When monitoring is endogenous, aggregate investment will depend not just on the sum of firm and monitoring capital as in equation (15), but also on the relative amounts of each. In particular, an extra dollar of informed capital will expand investment by more than an extra dollar of firm capital because an increase in monitoring capital leads to more intensive monitoring, which in turn allows firms to increase their leverage (without a change in monitoring, equation (15) tells us that the transfer would have no investment effect). As before, transferring a dollar from investors to intermediaries would not be Pareto improving. But for a government preoccupied with the level of economic activity, this suggests a reason why it may be more efficient to subsidize intermediaries than to subsidize firms. (Of course, a second reason is that, unlike in our model, the government typically has little knowledge of which firms are worthy of support. Using intermediation utilizes information more effectively.)

Another variation in which aggregate investment will depend on the relative amounts of firm and intermediary capital is worth brief mention.

Suppose that investment is continuous, but subject to decreasing returns to scale. Let $R(I)$ denote a firm's gross profit in case of success, with $R' > 0$, $R'' < 0$, $R'(0) = \infty$, $R'(\infty) = 0$. For given expected rates of return β and γ, a firm's net utility $U(I)$ is still equal to the expected net profit, $p_H R(I) - \gamma I$, minus the extra cost of using intermediary capital, $(\beta - \gamma) I_m$, or

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

$U(I)$ is maximized at some investment I^*. A firm's utility therefore depends on its asset level only through its borrowing capacity. The latter is obtained by replacing "RI" by "$R(I)$" in the derivation of equation (11). Incentive compatibility for the firm requires that $I \leq I(A_0)$, where $I(A_0)$ is given by

$$\Delta p \left[R(I) - \frac{cI}{\Delta p} - \frac{\gamma}{p_H} \left(I - \frac{p_H c I}{\beta \Delta p} \right) - A_0 \right] = bI.$$

The investment capacity $I(A_0)$ is an increasing and concave function of assets A_0. Firms with assets A_0 such that $I(A_0) > I^*$ bunch at investment level I^* while the others are credit constrained.

In this version the investment-over-assets multiplier is a decreasing function of assets; that is, firms with more assets will have a higher solvency ratio r_f. For this reason, it is evident that the distribution of capital across firms, as well as between firms and intermediaries, influences aggregate investment, unlike in the constant returns to scale case analyzed in subsection IV.1. Whether firms with more capital will be more adversely affected by a reduction in intermediary capital depends on the shape of

$R(I)$. There are two conflicting effects: lower leverage makes large firms less sensitive, while lower marginal returns make them more sensitive to a rise in β.

V. Concluding Remarks

We have offered this analysis as a first step toward understanding the role played by the distribution of capital across differently informed sources of capital. In our model the borrowing capacity of both firms and intermediaries is limited so that a redistribution of wealth across firms and intermediaries impacts investment, monitoring, and interest rates. All types of capital tightening—a credit crunch, a collateral squeeze, and a savings squeeze—hit poorly capitalized firms the hardest, and as Proposition 2 shows, each such shock has a distinguishable impact on interest rates, monitoring intensity, the solvency of intermediaries and the firms' leverage.

The models we have worked with are simple, and the exercises we have been through should be seen as experiments with prototype models that will be useful to future efforts to understand how information and ideas get matched through a financial network featuring different levels and kinds of expertise, and how such a financial network reacts to real or monetary shocks. The fact that our models are able to reproduce some of the stylized facts associated with capital crunches is encouraging. Also, the general methodology seems quite tractable.

We have been careful not to get ahead of ourselves on policy matters; the models are too primitive for that. Nevertheless, it is legitimate to let pilot studies suggest new avenues for thinking about policy issues. In this regard, we find the logic behind procyclical solvency ratios of interest for the regulatory debate.

In a desire to get a first cut at the relative shifts in capital and its implications for monitoring and investment, we have made several unpalatable assumptions. We wish to point out some limitations of our modeling that deserve particular attention.

In our analysis we took the supply of firm and intermediary capital as exogenous and performed comparative statics exercises on each one of them independently. A proper investigation of the transmission mechanism of real and monetary shocks must take into account the feedback from interest rates to capital values. This will require an explicitly dynamic model, for instance, along the lines of Kiyotaki and Moore [1993]. Preliminary investigations suggest that this route is interesting and tractable.

To keep matters simple, we have stayed away from modeling features that would enable us to identify monitoring with alternative forms of institutions. Our intermediary could be a bank, an equity holder, a venture capitalist, or any other monitor. To the extent one wants to explain the emergence of and evaluate the relative role of these institutions, one has to bring in other ingredients (presumably control-related considerations) into the model. However, for a preliminary macroeconomic analysis, organizational refinements of this kind may not be of first-order importance.

Another caveat concerns our assumption that the intermediary's projects are perfectly correlated. As we explained, there is nothing realistic about this assumption. It is just a way of avoiding the extreme (and equally unrealistic) conclusion that all intermediation can be carried out without own capital. We see the issue of diversification, the degree of leverage, and the intensity of monitoring as closely linked, complementary choice variables that deserve more careful study in the future.

Our final, and most important, caveat concerns the role of own capital. It seems to make sense only in an entrepreneurial model. But most intermediaries (including firms) are of course not run by entrepreneurs. So how is one to interpret our model? First, let us note that most agency models in finance suffer from the same criticism, though here the critique may have more bite, because we are highlighting the role of own capital. One interpretation is that the manager and the owners of the intermediary have formed such close ties that for practical purposes they can be treated as a single entrepreneur—not a very convincing story, and logically hollow in that it leaves open the question why new capital providers cannot join this close-knit team, obviating the need for external funds (going along this route would require introducing some adverse selection, say). Another interpretation, and the one we favor, is that management enjoys a continuing stream of private benefits (which in our analysis is normalized to zero for convenience), which is proportional to the funds under its management. Thus, committing funds to a project in which the funds may get lost has incentive consequences much like those in the original model. We have explored this variation, which leads to somewhat different expressions for incentive compatibility, necessary levels of assets and so on, but the fundamental insights and the character of the analysis do not change. Yet, it is evident that a fuller understanding of how intermediaries allocate capital will require a much richer managerial model.

In closing, we emphasize the broader research agenda associated with the introduction of scarce loanable funds. Limited intermediary capital is a necessary ingredient in the study of credit crunches and cyclical solvency ratios. But it also ought to be the key to a better understanding of other issues such as the propagation of monetary policy through the banking system. Accordingly, we hope that future theoretical research will put greater emphasis on loanable funds.

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