Equity, Bonds, and Bank Debt: Capital Structure and Financial Market Equilibrium under Asymmetric Information

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# Equity, Bonds, and Bank Debt: Capital Structure and Financial Market Equilibrium under Asymmetric Information

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This paper proposes a model of financial markets and corporate finance, with asymmetric information and no taxes, where equity issues, bank debt, and bond financing coexist in equilibrium. The relationship banking aspect of financial intermediation is emphasized: firms turn to banks as a source of investment mainly because banks are good at helping them through times of financial distress. This financial flexibility is costly since banks face costs of capital themselves (which they attempt to minimize through securitization). To avoid this intermediation cost, firms may turn to bond

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or equity financing, but bonds imply an inefficient liquidation cost and equity an informational dilution cost. We show that in equilibrium the riskier firms prefer bank loans, the safer ones tap the bond markets, and the ones in between prefer to issue both equity and bonds. This segmentation is broadly consistent with stylized facts.

## I. Introduction

The main purpose of this paper is to build a tractable equilibrium model of the capital market comprising a banking sector and a primary securities market, where firms endogenously determine their financial structure. The model combines ideas from several existing capital structure theories under asymmetric information to provide a unified explanation of some well-known stylized facts.

The general observations our model is consistent with are that (i) the composition of bank finance and direct finance varies across firms: bond financing is found predominantly in mature and relatively safe firms whereas bank finance and equity are the main source of funding for start-up firms and risky ventures (Petersen and Rajan 1994, 1995); (ii) banks face substantial costs of issuing equity (Calomiris and Wilson 1998); (iii) a significant fraction of bank loans are securitized (Fabozzi and Carlson 1992); (iv) bank loan renegotiations are easier than bond restructuring (Lummer and McConnell 1989; Gilson, Kose, and Lang 1990); (v) bank debt is senior to debentures; (vi) firms switch out of bank loans into commercial paper (or other forms of securitized financing) when bank spreads increase (Kashyap, Stein, and Wilcox 1993); and (vii) changes in interest rates have a different effect on large and small firms (Gertler and Gilchrist 1994; Pérez-Quiros and Timmermann 1998).

Our paper is not the first attempt at building such a framework. It adds to a small recent theoretical literature concerned with the coexistence of bank lending and bond financing, most notably, Besanko and Kanatas (1993), Hoshi, Kashyap, and Scharfstein (1993), Chemmanur and Fulghieri (1994), Boot and Thakor (1997), Holmström and Tirole (1997), and Repullo and Suarez (1997). Our main contribution to this literature is to introduce outside equity along with bonds and bank debt and thus to provide the first synthesis of capital structure choice theories and financial market equilibrium based on information and incentive considerations.

In addition, by taking firms' capital structure choices to be the outcome of the interplay of aggregate demand for and supply of bank loans, we are able to explain financing patterns that could not be explained by a partial equilibrium approach focusing only on firms' demand for funds and abstracting from intermediaries' costs of funding. For example, we are able to explain why Myers's pecking order theory of financing appears to break down for risky start-up ventures. These firms would like to reduce informational dilution costs by funding their investments through a bank loan or a bond issue but are too risky to be able to obtain a bank loan or issue bonds. Their only option is equity financing, which maximizes dilution costs but is feasible.

Our model borrows from Myers and Majluf (1984) and others the idea that firms raising equity bear an informational dilution cost when there is asymmetric information between firms and investors. It borrows from Hart and Moore (1995), among others, the idea that bank debt is more easily renegotiated than a dispersed bond issue, and from Diamond (1994) the idea that although bank loans are easier to restructure, banks themselves must bear intermediation costs, which ultimately must be borne by borrowers.

In the capital market equilibrium we derive, firm financing is segmented as follows: (i) the riskiest firms (which are often start-ups) either are unable to obtain funding or are constrained to issue equity; (ii) somewhat safer firms are able to take out bank loans, which provide the cheapest form of flexible financing they demand; and (iii) the safest firms prefer to tap securities markets and thus avoid paying the intermediation cost.

This segmentation is broadly consistent with stylized facts. Admittedly, an important aspect of U.S. capital markets that is missing here is the presence of junk bonds. However, segmentation in European capital markets, where only the safest and most mature firms issue bonds, is quite accurately reflected in this equilibrium.

We take intermediation costs to be mainly banks' costs of raising equity to meet capital requirements. For simplicity, these costs are taken to be exogenous here, but they can be endogenized as in Bolton and Freixas (1998). In order to minimize these costs, banks securitize the safe portion of their loans in the form of pass-through certificates. This enables them to take part of the loan off their balance sheet and thus reduce their intermediation costs. It is interesting that securitization in our model is driven by the priority structure of bank debt versus corporate bonds, the latter being junior to the former. Because of the higher priority of bank debt over bonds, banks may be induced to inefficiently liquidate a firm that has issued too many bonds. As a result, their role as providers of flexible finance would be undermined. To overcome this constraint, banks take up a bigger share of a firm's debt and securitize the safe (asset-backed) portion of that debt. Overall, this financial transaction reduces the firm's financing costs, provided that dilution costs generated by securitization are not too high.

Thus, in our model, banks' equity base (and internally generated funds) is a key variable in constraining the total supply of bank loans. However, their ability to securitize a portion of their loans enables them to use their regulatory capital in a more efficient way. This is an important recent development of the intermediation process, especially in the United States, where the cumulative issuance of asset-backed securities now exceeds the total volume of credit provided by the banking system (''Credit Crunch,'' 1998).

The paper is organized as follows: Section II outlines the model. Section III derives the optimal mode of financing for firms. Section IV derives the credit market equilibrium. Finally, Section V offers some concluding comments. The proofs of most results are given in the Appendix.

## II. The Model

We consider an economy composed of a continuum of risk-neutral agents, firms and banks. Both firms and banks are run by wealth-constrained owner-managers who need to raise outside funds to cover their investment outlays. Firms' investments can be funded either by issuing securities (bonds or shares) or by obtaining a bank loan. Banks can be funded by deposits, equity, or bond issues and by securitization of their loans. We begin by describing the characteristics of firms' projects, and then we turn to the funding options available to firms and banks.

### *A. Firms' Investment Projects*

Each firm has a project requiring an investment $I$ at date $t = 0$ and yielding returns at $t = 1$ and $t = 2$. For simplicity, we assume that profits at dates $t = 1$ and $t = 2$ can take only two values, $\pi_H$ and $\pi_L$, with $\pi_H > \pi_L$, so that there are only four possible states of nature: $\{H, H\}$, $\{H, L\}$, $\{L, H\}$, and $\{L, L\}$. The project can be liquidated at $t = 1$, and a resale value $A$, such that $\pi_L < A < \pi_H$, is obtained. Of course, in that case the returns of period $t = 2$ are forgone. We assume, again for simplicity, that riskless interest rates are normalized to zero and that the liquidation value of the project at $t = 2$ is zero. The exact sequence of events and moves is outlined in figure 1.

Firms' owner-managers can invest at most $w < I$ in the firm and must raise at least $I - w$ from the financial markets or a financial intermediary. We shall assume, without loss of generality, that owner-managers invest all their wealth in the firm, and we normalize

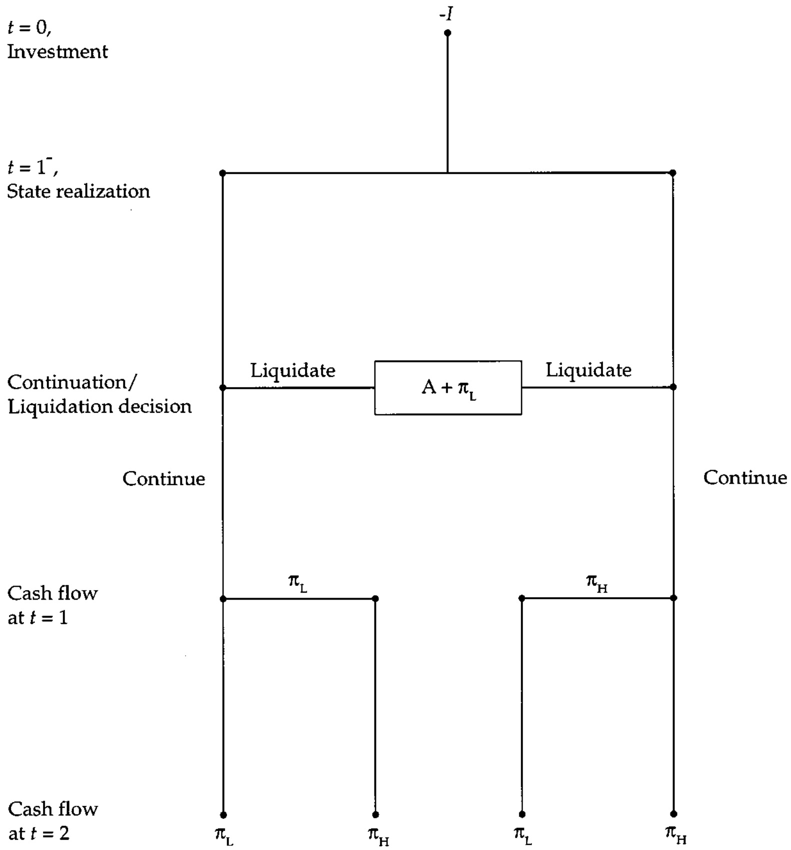


FIG. 1.—Return structure of projects

all our variables so that $I - w = 1$. We also introduce private benefits of control $B > 0$, which owner-managers obtain at date $t = 2$ if the firm is not liquidated. These benefits can be made arbitrarily small and are not transferable to outside investors.

Firms differ in the probabilities $p_1$ and $p_2$ of obtaining high cash flow realizations in, respectively, periods 1 and 2. The range of possible values for $p_1$ is $[\underline{p}_1, 1]$, where $\underline{p}_1 < 1/2$, and that for $p_2$ is simply $\{0, 1\}$. We shall label firms according to their second-period return: $L$ firms are said to be "bad" firms and have a second-period return of $\pi_L$ ($p_2 = 0$); $H$ firms are "good" and obtain $\pi_H$ during the second period ($p_2 = 1$). We assume that the value of $p_2$ is drawn independently of the value of $p_1$.[1]

[1] In an earlier version we allowed for $p_2 \in [\underline{p}, \bar{p}]$. This more general formulation burdens the analysis without yielding any qualitatively different results.

Agents have different information on the value of $p_1$ and $p_2$. We assume that $p_1$ is publicly observable but that $p_2$ is private information to the firm at $t = 0$. The probability $p_1$ can be thought of as a credit rating. The value of $p_2$ is revealed only at $t = 1$ to a bank that has lent to the firm at $t = 0$, and only at $t = 2$ to other security holders. At date $t = 0$, creditors' prior beliefs about the value of $p_2$ are that $p_2 = 1$ with probability $\nu$ (and $p_2 = 0$ with probability $1 - \nu$) so that $E[p_2] = \nu$.

We shall make several assumptions about firms' type distribution and cash flow streams along the way. We begin by assuming that some of the firms at least have positive net present value projects and that cash flow streams are sufficiently risky that firms cannot get funding by selling only the safe portion of their cash flows. Specifically, we make the following assumption.

ASSUMPTION 1. $\pi_H + \nu\pi_H + (1 - \nu)\pi_L > I$, so that at least firms with $p_1$ close to one can get funding.

We shall also assume that $L$ firms' investment projects have a negative net present value for all values of $p_1$. This is equivalent to stating that $\pi_H + \pi_L < I$. For convenience, we shall make the following slightly stronger assumption.

ASSUMPTION 2. $\pi_H + \pi_L < 1$.

This assumption implies that no firm would be able to raise funding of 1 without facing a liquidation risk, since $1 > \pi_H + \pi_L$ implies $1 > 2\pi_L + \nu(\pi_H - \pi_L)$, which is the maximum amount of bonds that can be issued without facing liquidation risk. With this assumption we also rule out signaling equilibria in which the firm's choice of capital structure may reveal its type. Indeed, under our assumption, a bad firm always wants to mimic a good firm, for otherwise it would never obtain any funding.

## B. *Firms' Financial Options*

Firms can choose any combination of bank debt, bond, and equity financing they desire. The main distinguishing features of these three instruments we emphasize are the following.

*Bond financing.*—A bond issue specifies a repayment to bondholders of $R_1$ at date $t = 1$ and a repayment of $R_2$ at date $t = 2$. If the firm is not able to meet its repayments at date $t = 1$, the firm is declared bankrupt and is liquidated. If the firm is not able to meet its last-period repayments, the bondholders appropriate the firm's accumulated, undistributed cash flow. Firms are allowed to roll over their bonds by making new bond issues at date $t = 1$.

*Equity issue.*—An equity issue specifies a share $a \in [0, 1]$ that outside shareholders are entitled to. It also specifies shareholder control rights, but we shall assume that shareholder dispersion is such that outside shareholders never exert any effective control over the owner-manager. We also assume that the private benefits of control are large enough that the owner-manager always decides to continue at date $t = 1$ if given the choice.

*Bank debt.*—A bank loan specifies a repayment schedule $\{\hat{R}_1, \hat{R}_2\}$. If the firm defaults on its first-period repayment, the bank is able to observe the type of firm (through monitoring) and decides whether to liquidate or let the firm continue. If it lets the firm continue, it appropriates all last-period returns (through, say, a debt/equity swap). Since the bank observes the firm's type at date $t = 1$, it lets the firm continue if and only if the firm is "good." Thus the main distinction between bank debt and bonds is that bank debt is more flexible (or easier to restructure).

Banks, however, are subject to minimum capital requirements. If they want to expand lending, they need to also raise additional costly outside equity financing. This is one source of intermediation cost. In our model we emphasize only this cost and abstract from other costs (e.g., those of setting up and maintaining a branch network). To keep things simple and realistic, we assume that deposits are fully insured in return for complying with minimum capital requirements. We also take the unit intermediation cost, denoted by $\rho$ ($\rho > 0$), to be exogenous.

When firms combine different instruments, we assume that the priority structure in bankruptcy is the one most commonly observed in practice, where bank debt has priority over bonds, and equity holders are residual claimants.

We shall see below how this priority structure has a significant impact on the way the different layers of debt are combined. In particular, we show that it is the main source (in our model) behind banks' incentives to securitize (by issuing a senior asset-backed security). Indeed, the existing priority structure between bank loans and bonds limits a firm's ability to combine bank debt with bonds efficiently (so as to reduce intermediation costs) since by taking on junior bonds it creates incentives for banks to liquidate the firm inefficiently when it is in financial distress.

The reason is that the bank can maintain priority in repayment over bonds only if the firm is liquidated. If it restructures its debt and lets the firm continue, it effectively relinquishes its right to be repaid first at time $t = 1$. More concretely, if the outstanding bond claims at date $t = 1$ are $R_1$ and the total bank loan repayment is $\hat{R}_1$, a bank deciding to rescue a good firm still has to pay bondholders the amount $R_1$ at date $t = 1$. It therefore prefers to liquidate an $H$ firm in financial distress (and accelerate its debt repayments) whenever $\min\{A + \pi_L, \hat{R}_1\} \geq \pi_H - R_1 + \pi_L$. The efficient decision, however, is not to liquidate when cash flows at date $t = 2$ are $\pi_H$. In other words, a bank may prefer inefficient liquidation since its claim takes priority over bond claims at date $t = 1$ only under liquidation. If the bank decides to continue, the bond payments at date $t = 1$ must be honored fully and the bank passes up an opportunity to take full priority over bonds.

Securitization in our model arises in order to undo this priority structure by replacing a security with lower priority (the bond) by one with higher priority (the asset-backed security). In other words, instead of inefficiently combining junior bonds and senior bank debt, banks can do better by undoing this priority ordering through securitization.

In the next section we shall determine firms' choice of financing for an exogenously given intermediation cost, $\rho$. This allows us to derive the aggregate demand for bank credit.

## III. Firms' Choice of Financing: Equity, Bonds, or Bank Loans

Having defined each instrument in the previous section, we begin our analysis of the choice of capital structure by outlining the main trade-offs involved in the three modes of funding. Since in our model the dilution cost occurs only on period 2 cash flows, this gives different advantages to the different types of instruments the firm is able to use.

1. Under equity financing, there are no bankruptcy costs. But there may be higher dilution costs for good firms since the firm is selling claims on cash flows that depend on the borrower's type.

2. Under bond financing, dilution costs will be lower. But when the firm's debt is high, it may be forced into bankruptcy and liquidation. It is efficient to liquidate the firm when it is bad ($p_2 = 0$), but not when it is good ($p_2 = 1$). Under bond financing, however, the firm is always liquidated following default, so that there is a bankruptcy cost for good firms in making large bond issues.[2]

3. As with bond financing, under a bank loan the firm may also be forced into bankruptcy. But unlike bond financing, bankruptcy will not give rise to inefficient liquidation. The bank, endowed with superior information and with a greater ability to restructure its

[2] In practice, some bond issues can be restructured so as to avoid inefficient liquidation. However, bond restructurings are typically more difficult and costlier than bank loan reschedulings. We magnify this difference between bonds and bank loans in our model by assuming that bonds cannot be restructured at all and bank loans can be renegotiated costlessly.

loans, will choose to liquidate only bad firms. Thus bank lending dominates bond financing in terms of expected bankruptcy costs. It also dominates in terms of dilution costs since, following a restructuring, the bank knows the true continuation value of the firm and is therefore able to price it correctly. The main drawback of bank lending is the cost of intermediation that must be borne by the firm.

The main distinguishing features of equity, bonds, and bank debt that we have chosen to emphasize are, thus, that bank loans are easier to restructure than bond issues and that equity issues (whether for firms or banks) involve higher dilution costs.

Before we describe a firm's optimal capital structure choice, it is helpful to begin our analysis by first considering, as a benchmark, a more general optimal financial contracting problem, where the firm is not restricted to standard debt or equity instruments but is able to issue contingent claims.

### A. *The* H-*Optimal Contingent Contract*

We shall consider the optimal contracting problem from the perspective of an $H$ firm that knows that any contract it offers to financiers will be mimicked by $L$ firms, so that it is always pooled with $L$ firms in the same observable risk class.[3]

In order to compare these contracts not only to bonds but also to loans, we shall consider both nonmonitored contingent contracts related to bond contracts and monitored contingent contracts akin to bank loans.

The optimal nonmonitored contracting problem for an $H$ firm is to offer (1) a feasible repayment schedule, $\{R_1^H, R_1^L, R_2^H, R_2^L\}$ with $R_1^H \leq \pi_H$, $R_1^L \leq \pi_L$, $R_2^H \leq \pi_H$, and $R_2^L \leq \pi_L$, where $R_t^K$ is the time $t$ repayment of a firm with a $\pi_K$ return at time $t$; and (2) a continuation decision at date $t = 1$ that is given by the probability of continuation $x_1$, to solve

$$\max\, p_1(\pi_H - R_1^H) + (1 - p_1)(\pi_L - R_1^L) + x_1(\pi_H - R_2^H + B)$$

subject to

$$p_1 R_1^H + (1 - p_1) R_1^L + \nu x_1 R_2^H + (1 - \nu) x_1 R_2^L + (1 - x_1) A \geq 1.$$

[3] The reason why $L$ firms imitate $H$ firms is that a different strategy would reveal that they are $L$ firms with negative net present value projects. Moreover, we assume that it is not possible to bribe $L$ firms to reveal themselves ex ante since any positive bribe would be a "free lunch" for any firm pretending to be an $L$ firm. In principle, $H$ firms could attempt to partially reveal themselves by offering a menu of contracts that would support a semiseparating equilibrium. We shall not consider this possibility since such outcomes can be supported only by ad hoc beliefs.

It is easy to see that the firm's nonmonitored efficient choice is $x_1 = 1$ if $\nu B + \nu\pi_H + (1 - \nu)\pi_L > A$.

Determining the optimal monitored contingent contract leads to a similar problem, except for the fact that the continuation decision is made after observing the firm's type. In the optimal contract, only type $L$ firms will be liquidated, and the bank will obtain the liquidation value $A$ ($A > \pi_L$). In addition, there is a monitoring cost $\rho$.

Whether under monitored or nonmonitored finance, it is obvious (and easy to show) that the optimal contract is such that $R_1^H = \pi_H$, $R_1^L = \pi_L$, and $R_2^L = \pi_L$, setting $R_2^H - R_2^L$ equal to the smallest possible value satisfying the individual rationality constraint of the investor. Indeed, this is the contract that minimizes dilution costs. For future reference we highlight the optimal contract under monitored and nonmonitored finance in the two propositions below.

Denote by $\tilde{I} = p_1\pi_H + (1 - p_1)\pi_L + \pi_L$ the cash flow stream on which there is no asymmetric information and consequently no information dilution cost. Suppose that $\tilde{I} < 1$, so that the firm must pay dilution costs on the portion $1 - \tilde{I}$ of the funds it raises. Then we obtain the following result for nonmonitored finance.

Proposition 1. In the *H*-optimal financial contract with no monitoring, when $\tilde{I} < 1$, the firm sets maximum period 1 repayments $R_1^H = \pi_H$; $R_1^L = \pi_L$ and maximum period 2 risk-free repayment $R_2^L = \pi_L$, and it minimizes the dilution costs in the following ways: (1) The firm sets

$$R_2^H = \frac{1 - p_1\pi_H - (1 - p_1)\pi_L - (1 - \nu)\pi_L}{\nu}$$

and $x_1 = 1$ if $\nu B + \nu\pi_H + (1 - \nu)\pi_L > A$. In this case the firm incurs a positive dilution cost of $(R_2^H - \pi_L)(1 - \nu) = (1 - \tilde{I})(1 - \nu)/\nu$, and there is inefficient continuation of bad firms. (2) The firm sets $x_1 = 0$ if $\nu\pi_H + (1 - \nu)\pi_L + \nu B \le A$. In this case the type $H$ firm incurs no dilution cost but pays a positive bankruptcy cost.

The proof is obvious.

The value of the dilution cost in the first case is quite intuitive since the dilution cost per dollar raised is $(1 - \nu)/\nu$ and since there is no dilution cost on the portion of funds raised $\tilde{I}$. In the second case the model reduces to a one-period model. In the next sections we shall disregard this last case.

When there is monitoring, the dilution-free portion of cash flows is larger and equal to $\tilde{I} + (A - \pi_L)$, since by monitoring a firm's return the bank is always able to obtain $\pi_H$ in the favorable case and $A$ in the unfavorable one. Suppose that $\tilde{I} + (A - \pi_L) < 1$, so that the firm must incur dilution costs on the portion $1 - \tilde{I} - A + \pi_L$.

Then the optimal contract under monitored finance is given by the following proposition.

PROPOSITION 2. *Optimal financial contract with monitoring.*—If $\tilde{I} + (A - \pi_L) < 1$, the firm sets maximum period 1 repayments, $R_1^H = \pi_H$, $R_1^L = \pi_L$, maximum period 2 risk-free repayment $R_2^L = \pi_L$, and

$$R_2^H = \frac{1 + \rho - p_1\pi_H - (1 - p_1)\pi_L - (1 - \nu)A}{\nu}.$$

It incurs a positive dilution and intermediation cost of

$$\frac{(1 + \rho - \tilde{I} + A - \pi_L)(1 - \nu)}{\nu}$$

so that the intermediation cost $\rho$ implies a cost $\rho(1 - \nu)/\nu$ for the $H$ firm. The liquidation policy is efficient, with $x_1 = 0$ if and only if a type $L$ firm is observed.

The proof is obvious.

Again the dilution cost can be reduced by making a maximum payment at time $t = 1$. The comparison of the optimal contracts under monitored and nonmonitored finance immediately reveals that monitored finance reduces dilution costs but implies paying the intermediation cost $\rho$. Depending on the relative importance of these costs, a firm may favor monitored or nonmonitored finance.

It is also clear from the description of the optimal contract under nonmonitored finance that it cannot be replicated by any combination of equity, bank debt, or bonds. Indeed, to replicate the contract the firm must (i) issue safe debt worth $2\pi_L$, (ii) issue 100 percent outside equity, and (iii) give the manager a call option on all the outside equity to be exercised at date $t = 2$ at the exercise price $R_2^H - \pi_L$. Only managers of good firms will then exercise this option and get a payoff $\pi_H - R_2^H$ as under the optimal contract.[4] In the same way it is impossible to replicate the optimal monitored finance contract with a bank loan.

In the main body of the paper we shall allow firms to choose only among equity, bonds, and bank debt. Thus we do not allow firms to exploit the best available financial options. However, it will become clear from the analysis below that the loss in efficiency from ruling out exotic financial instruments is small in our model, so that our restriction to standard financial instruments is not very strong. More-

[4] It is interesting that this contract resembles in some ways standard venture capital contracts in which the venture capital fund often holds close to 100 percent of the equity but gives the manager a call option to buy all or most of the fund's stake.

over, the results we obtain under this restriction are easier to relate to empirical evidence.[5]

## *B. The Mix among Equity, Bonds, and Bank Loans*

As above, we first characterize the optimal capital structure without monitoring and then ask which firms would prefer monitored (bank) finance.

### 1. The Bond-Equity Choice

It is clear from the analysis above that firms should issue no less than $2\pi_L$ in riskless debt no matter what form of additional financing they choose to obtain, provided, of course, that this debt is senior to any other claim issued. If the firm's primary consideration is to avoid bankruptcy at date $t = 1$, it has two financial alternatives: either issue safe bonds worth $2\pi_L$ and raise the remaining funds with equity, or issue the amount of debt $\hat{I} = 2\pi_L + \nu(\pi_H - \pi_L)$, which is "default-free" at date $t = 1$ (the firm is able to repay the bond at date $t = 1$ with the proceeds of a new bond issue based on period 2 expected cash flows). Either option involves a dilution cost on the pledged second-period cash flows. The following lemma determines under what conditions the first mode is preferable to the second.

LEMMA 1. If equity is issued, then it is optimal for an $H$ firm to issue the maximum amount of first-period default-free bonds, $2\pi_L + \nu(\pi_H - \pi_L)$, if $\nu \geq 1 - p_1$. If $\nu < 1 - p_1$, then it is optimal for the firm to issue only an amount of debt $2\pi_L$.

*Proof.* See the Appendix.

The intuition behind this lemma is as follows. Up to the level $\hat{I} = 2\pi_L + \nu(\pi_H - \pi_L)$, debt financing does not give rise to default at date $t = 1$, even when first-period profits are $\pi_L$, because the firm is able to raise $\nu(\pi_H - \pi_L)$ by selling claims to second-period cash flows. But selling these claims in the event of a low-profit outcome at date $t = 1$ implies that the firm will bear maximum dilution costs. Therefore, if the probability of a low-profit outcome, $1 - p_1$, is large, the firm will abstain from issuing more than $2\pi_L$ in debt. Lemma 1 gives the precise necessary and sufficient condition for risky bond financing to have higher dilution cost than equity.

For the remainder of the paper we shall restrict attention to the

[5] In practice there may be many reasons why firms do not fully optimize their choice of financing mix. It is beyond the scope of this paper to address the question why standard financial instruments such as equity, bonds, and bank loans are so widely used.

case in which dilution costs are higher under equity financing by making the following assumption.[6]

ASSUMPTION 3. $\nu > 1 - \underline{p}_1$.

We shall also focus on the case of inefficient liquidation by making the following assumption.

ASSUMPTION 4. $\nu\pi_H + (1 - \nu)\pi_L > A$.

All $H$ firms issuing equity then also issue $\hat{I} = 2\pi_L + \nu(\pi_H - \pi_L)$ worth of bonds. Under this assumption we can reduce the choice of an $H$ firm's nonmonitored financial structure to two options: either issue only risky bonds ($B$), which the firm may default on in period $t = 1$, or issue equity with maximum first-period default-free debt, $2\pi_L + \nu(\pi_H - \pi_L)$ ($E$). The reason is that raising an amount of bonds superior to $\hat{I}$ will combine the cost of inefficient liquidation with the dilution cost of equity.

Firms' preference between risky bonds and equity generally depends on the first-period probability of success, $p_1$. Issuing risky bonds implies that in the event of bankruptcy the firm is liquidated and incurs a deadweight loss of $\nu(\pi_H - \pi_L) - (A - \pi_L)$. Alternatively, issuing equity with safe debt involves an additional dilution cost for the funds raised above $\hat{I} = 2\pi_L + \nu(\pi_H - \pi_L)$. The choice between risky bond financing and equity with default-free debt depends on the relative importance of these costs. Specifically, we show that it depends on the sign of

$$\Delta\pi = -(1-\nu)(1-\hat{I}) + (1-p_1)[\nu(\pi_H-\pi_L) - (A-\pi_L)]. \quad (1)$$

When $\Delta\pi$ is negative, risky bond financing is preferred. Note that $\Delta\pi$ is decreasing in $p_1$ and is negative for high values of $p_1$.

In addition, whenever bond financing is feasible, equity financing is also feasible since it does not involve any bankruptcy inefficiency. Thus, when bond financing is feasible but is a dominated choice, equity financing is always available as an option. The choice of financing between these two instruments is thus driven only by demand side considerations as long as bond financing is feasible. If it is not feasible, then firms may be constrained to issue equity. This discussion suggests that the following proposition must hold.

PROPOSITION 3. Under assumptions 3 and 4, there exists a $\hat{p}_1 \in [1 - \nu, 1)$ such that 100 percent bond financing is preferred by a $p_1$ firm to issuing a combination of equity and bonds if and only if $p_1 \geq \hat{p}_1$. In addition, if 100 percent bond financing is feasible, then a combination of equity and bonds is also feasible.

[6] This is not a very restrictive assumption. However, one possible financial class we exclude with this assumption is risky (low-$p_1$) firms financed with junk bonds. This financial class could be obtained in our model if we did not make assumptions 3 and 4.

*Proof*. See the Appendix.

Proposition 3 establishes that the firms with the safest first-period cash flows turn to bond financing as their main source of outside finance. These are the so-called investment grade firms. Firms with riskier first-period cash flows prefer (or are constrained) to issue some equity. Notice also that, for some parameter constellations, $\Delta\pi$ in (1) is negative even for the smallest value of $p_1$. In that extreme case, all firms turn to (risky) bond financing and no firms issue equity. Firms may be constrained to issue equity if

$$\hat{p}_1[\pi_H + \nu(\pi_H - \pi_L)] + (1 - \hat{p}_1)A + \pi_L < 1.$$

Then some $p_1$ firms that prefer to issue 100 percent in bonds are forced to issue equity and an amount $\hat{I}$ of bonds.

## 2. Direct versus Intermediated Finance with Securitization

When we introduce the additional option of bank financing, a firm's choice of capital structure is roughly as follows: (i) firms with $p_1$ close to one choose bond financing over bank lending since their expected bankruptcy cost is negligible and outweighs the cost of intermediation; (ii) for all other firms the bank loan option may be attractive provided that intermediation costs are not too high. As in our comparison between bonds and equity, one potential difficulty that we face is determining which mode of financing involves higher dilution costs. Bank loans, just as bond financing, may actually involve higher dilution costs than equity when $\nu$ is low. Although this is a theoretical possibility, it is not entirely plausible empirically. Accordingly, we shall rule out this possibility by making the following assumption.

Assumption 5. $\nu \geq (\pi_H - A)/(\pi_H - \pi_L)$.

As we already hinted at earlier, when bank loans are senior to bonds, the possibilities for combining bank loans with bonds while preserving the bank's ability to renegotiate efficiently are limited. The reason is that if bank loans are senior, even the riskless fraction $2\pi_L$ cannot be securitized as "riskless."

Of course, it is possible to avoid this inefficiency by lengthening the maturity of the bond and reducing bond repayments at date $t = 1$, but in our model this involves incurring higher dilution costs. We show below that instead of incurring this dilution cost, it is more efficient for a firm not to combine bond financing with bank lending but instead to rely on the bank to securitize a portion of its loan. This involves a transfer of priority rights for the bank to the buyers of the securitized claims for the portion of securitized cash flows.

What portion of the loan should the bank securitize? The bank should securitize at least the portion $2\pi_L$ since this involves no dilution cost. Whether it should securitize the additional amount $\nu(\pi_H - \pi_L)$ depends on the relative weight of dilution and intermediation costs, as stated precisely in lemma 2 below.

We do not allow banks to securitize more than the ''default-free'' portion of their cash flow $\hat{I} = \nu(\pi_H - \pi_L) + 2\pi_L$. In practice, the overwhelming fraction of securitized loans are of the highest risk quality, and a number of institutional features of asset-backed securities or collateralized loan obligations give banks incentives to securitize only the safest loans (see Zweig 1989; Fabozzi and Carlson 1992). Our assumption is thus in line with observed securitization practice. The main difficulty with securitizing a fraction of a firm's debts beyond $\hat{I}$ is that if the firm defaults, the bank must step in as a guarantor to cover the securitized obligations that cannot be met with the firm's cash flow. To do this the bank must set aside reserves to be available in the event of default. While such an arrangement is feasible and desirable in principle, it is somewhat complex and mostly untried in practice. For all these reasons we have decided to rule out this possibility.

LEMMA 2. There exists a threshold $\hat{\rho}$ such that, for $\rho > \hat{\rho}$, it is always optimal for the bank to securitize its loans up to the level of nonliquidation risk $\hat{I}$. For $\rho < \hat{\rho}$, it is optimal to securitize only $2\pi_L$. In addition, a firm never strictly prefers to hold a combination of bonds and bank loans.

*Proof.* See the Appendix.

Lemma 2 establishes, first, that banks facing capital requirement constraints (or other fund-raising costs) will make use of all opportunities to economize on costly capital and other external funds. Note that it is crucial to think of intermediation costs as costs of raising funds for banks to explain securitization. If intermediation costs were simply monitoring costs, as in Holmström and Tirole (1997) or Repullo and Suarez (1997), there would be no benefit from securitizing bank loans. Second, lemma 2 establishes that if a firm issues an amount of bonds such that it is exposed to a risk of inefficient liquidation, it is not profitable for this firm to also take on a bank loan since this implies incurring an intermediation cost without obtaining greater financial flexibility.

To our knowledge, we highlight here a new aspect of securitization linked to the prevailing priority structure of debt. The standard explanation of securitization emphasizes the pooling of small loans to create a sufficiently liquid secondary market, as well as economies on banks' regulatory capital. This liquidity creation role of banks may well be the most important aspect of securitization of mortgages, but our model suggests that for larger loans to firms (which are increasingly securitized) a necessary condition for securitization may be the inversion of the priority ordering between bonds and bank debt.

To keep the model tractable and to better reflect reality, we have limited securitization to the safe portion of the bank loan. Is it conceivable that securitization can go beyond that and that the whole loan can be securitized? In that case we would see an inefficient form of financing—nonrenegotiable debentures—being replaced by a more efficient form of financing—renegotiable secured debt. In other words, this form of securitization would be a way of contracting around the potential inefficiencies of the Trust Indenture Act.[7] Our analysis thus suggests that, if the market for asset-backed securities develops enough and becomes sufficiently liquid, an arbitrage opportunity may open up for banks to offer firms the same flexible loan at a lower cost, and in the limit at the same cost as bonds, which fall under the Trust Indenture Act. Banks' expansion into this market would then be limited only by the costs of holding reserves to be able to act as guarantor or, possibly, firms' desire not to be able to renegotiate bonds as a self-disciplining device.

Moving on to the determination of the demand for bank loans (with securitization), we can show that, under assumptions 2–5, only firms with low $p_1$ choose bank loans over direct financing.

Proposition 4. Under assumptions 2–5, the demand for bank loans is the measure of $p_1$ firms in the interval $[1 - \nu, p_1^*(\rho)]$, which we denote by $\mathcal{M}([1 - \nu, p_1^*(\rho)])$; $p_1^*(\rho)$ is decreasing in $\rho$, with $p_1^*(0) = 1$ and $p_1^*(\rho) = 1 - \nu$ for any $\rho \geq \rho_c$.

*Proof.* See the Appendix.

In other words, the demand for bank loans comes from the firms with the greatest underlying cash flow risk. If the intermediation cost is zero ($\rho = 0$), all firms in the economy seek bank financing and $\mathcal{M}([1 - \nu, p_1^*(0)]) = \mathcal{M}([1 - \nu, 1])$. As intermediation costs rise, the demand for bank lending goes down: $d\mathcal{M}([1 - \nu, p_1^*(\rho)])/d\rho < 0$. Furthermore, for a positive intermediation cost, the safest firms prefer to issue bonds. Equity may or may not be issued by some firms depending on whether $p_1^*(\rho) \leq \hat{p}_1$ or $p_1^*(\rho) > \hat{p}_1$, where $\hat{p}_1$ is the threshold level defined in proposition 3.

## IV. Intermediation Costs and Capital Structure

The previous section characterizes the ''demand structure'' for equity, bonds, and bank loans: For a given intermediation cost $\rho$, firms

[7] The Trust Indenture Act of 1939 requires unanimous debt holder consent before a firm can alter the principal, interest, or maturity of its public debt. Inevitably, this requirement makes it much more difficult to renegotiate a bond issue.

in the interval $[\hat{p}_1, 1]$ demand financing in the form of a bond issue, and firms in the interval $[1 - \nu, p_1^*(\rho)]$ demand bank loans. In addition, if $\rho$ is such that $p_1^*(\rho) < \hat{p}_1$, then firms in the interval $[p_1^*(\rho), \hat{p}_1]$ demand financing in the form of a determinate bond/equity ratio.

In this section we derive an equilibrium in the capital market by matching this ''demand structure'' with an aggregate supply of bank loans for a given spread (or intermediation cost) $\rho$. To keep the model tractable, we simply assume an exogenous supply function $S(\rho)$, which is continuous and strictly increasing in $\rho$.[8]

The main point of this section is to show how capital structures and segmentation vary as intermediation costs evolve.

If $\rho$ is high, then equilibrium segmentation may be such that a positive interval of firms $[1 - \nu, p_1^B(\rho)]$ that prefer bank lending get no financing at all or are forced to get equity financing. The cutoff $p_1^B(\rho)$ is defined by banks' break-even constraint

$$(1 + \rho^*)(1 - \hat{I}) = p_1^B(\rho^*)(\pi_H - \pi_L) + [1 - p_1^B(\rho^*)](1 - \nu)(A - \pi_L).$$

Firms with risks $1 - p_1$ higher than $1 - p_1^B(\rho)$ are not profitable enough to cover banks' high intermediation costs. At best they may be able to get financing in the form of an equity stake. These firms are then constrained to issue the least desirable instrument, equity, involving the highest dilution cost because no other feasible form of financing is available.[9]

Equity financing by high-risk firms in a nonempty interval $[p_1^E, p_1^B(\rho)]$ arises in equilibrium when spreads are such that the following conditions hold: (1) Banks make losses even if they impose a maximum repayment of $\hat{R}_1 = 2\pi_H$ and appropriate the entire cash flow generated by a firm with $p_1 \in [1 - \nu, p_1^B(\rho)]$,

$$p_1[\pi_H + \pi_L + \nu(\pi_H - \pi_L)] + (1 - p_1)[\pi_L + \nu\pi_H + (1 - \nu)A].$$

This is possible for equilibrium spreads $\rho \geq \bar{\rho}$, where $\bar{\rho}$ is defined by the equation

$$(1 + \bar{\rho})(1 - \hat{I}) = (1 - \nu)(\pi_H - \pi_L) + \nu(1 - \nu)(A - \pi_L).$$

[8] It is possible to derive such a function endogenously. The capital market equilibrium is then given by some equilibrium spread $\rho^*$ such that $S(\rho^*) = \mathcal{M}([1 - \nu, p_1^*(\rho^*)])$. In fact we propose one derivation based on informational dilution costs for banks in Bolton and Freixas (1998).

[9] This may be one reason why Myers's pecking order theory of financing breaks down for the riskiest firms: investors are willing to invest in such firms only if they get an equity stake and can share the upside when the firm succeeds.

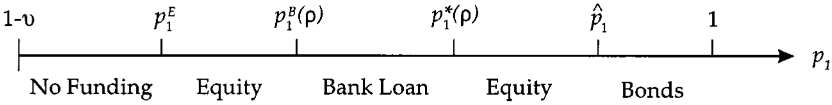


FIG. 2.—Equilibrium with "high" spreads

(2) Investors' break-even risk under equity financing is greater than banks' break-even risk. That is,

$$p_1^E < p_1^B(\rho^*)$$

or

$$\frac{1-\hat{I}}{\pi_H-\pi_L} < \frac{(1+\rho^*)(1-\hat{I})-(1-\nu)(A-\pi_L)}{(\pi_H-\pi_L)-(1-\nu)(A-\pi_L)},$$

or, if we rearrange,

$$\rho \geq (1-\nu)(A-\pi_L)\left(\frac{1}{1-\hat{I}}-\frac{1}{\pi_H-\pi_L}\right).$$

Strictly speaking, firms with risks in $[p_1^E, p_1^B(\rho)]$ combine equity financing with some riskless debt financing. In a richer model, which could distinguish venture capital financing as a separate mode, these firms might well be thought of as risk classes seeking venture capital financing.

In sum, when $\rho$ is large, firms are partitioned into the following five financial classes (as illustrated in fig. 2): (1) firms with $p_1 \in [1-\nu, p_1^E]$ get no funding, (2) firms with $p_1 \in [p_1^E, p_1^B(\rho)]$ are equity financed, (3) firms with $p_1 \in [p_1^B(\rho), p_1^*(\rho)]$ are bank financed, (4) firms with $p_1 \in [p_1^*(\rho), \hat{p}_1]$ are financed by equity and default-free bonds, and (5) firms with $p_1 \in [\hat{p}_1, 1]$ are bond financed.

Alternatively, when the supply of bank loans is large relative to demand, so that $\rho$ is small, equilibrium segmentation may be such that the market for outside equity financing is negligible or possibly even disappears. When $\rho$ is small, firms may be partitioned into as few as two financial classes (as illustrated in fig. 3): In this equilib-

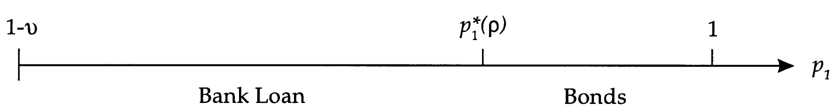


FIG. 3.—Equilibrium with low spreads

rium, (1) firms with $p_1 \in [\max[1 - \nu; p_1^B(\rho)], p_1^*(\rho)]$ are bank financed, and (2) firms with $p_1 \in [p_1^*(\rho), 1]$ are bond financed.[10]

Thus both firms' capital structure choice and the capital market equilibrium may vary considerably with the overall efficiency of the banking sector. If it takes a small spread $\rho$ to generate a large supply of loanable funds by banks (or the market for asset-backed securities is very liquid), then, other things being equal, the banking sector will be dominant relative to primary equity or bond markets and firms will have high ratios of bank debt to equity. In other words, to be able to explain firms' capital structure choices in practice, it may be essential to know the cost of intermediation. Partial equilibrium theories of capital structure determination, which are usually based implicitly on the assumption of frictionless capital markets, may thus be potentially misleading.

Our model also generates two interesting comparative statics results. First, as the cost of intermediation $\rho$ decreases, the market for new equity issues tapers off. Second, as $\nu$ decreases (so that dilution costs go down), the market for new equity issues develops. In both cases, these results seem to be broadly consistent with the existence of ''hot issue markets'' initially pointed out by Ibbotson and Jaffee (1975). The model predicts that as bank spreads vary, the new-issues market may develop or dry up, thus generating the observed cyclical pattern of the volume of new issues.

Finally, if one compares the U.S. financial market structure with that prevailing in Europe and Japan, one finds that bank financing is relatively larger in Europe and Japan and that in the United States firms rely more on bond and equity financing. Within our model these striking differences might be explained by pointing either at intermediation costs (or spreads) (with those in Europe being relatively lower) or at equity dilution costs (with those in the United States being lower), or possibly even at the distribution of firms across risk classes (with firms in the United States being mostly concentrated in the safe to medium-risk categories). The most plausible of these three potential explanations seems to be that dilution costs (or more generally the costs of issuing securities) are substantially lower in the United States than in continental Europe.

## V. Conclusion

This paper proposes a simple model of the capital market and the interaction between real and financial sectors built around two gen-

[10] In the extreme situation in which $\rho^* = 0$, there is only one financial class, with all firms getting all their funding through bank loans.

eral observations: (i) Firms face informational dilution costs when they issue equity; they attempt to reduce that cost by issuing bonds or taking out a bank loan. (ii) Bank lending is more flexible and more expensive than bond financing (because of intermediation costs); as a result, only those firms with a sufficiently high demand for flexibility choose bank lending over bond financing.

These observations are widely accepted, and a growing body of empirical evidence supports these two hypotheses. It is remarkable that the simple model developed here, which abstracts from many other relevant considerations, generates qualitative predictions about the equilibrium in the capital market that are broadly consistent with most of the stylized facts on investment and firm financing uncovered by recent empirical studies. Some obvious but important considerations that have been left out of the model are the dimensions of firm size or age, as well as the fixed costs of issuing securities (equity or bonds). Introducing these considerations is likely to strengthen our general conclusions if one equates size and age with lower risk (as seems plausible). Our model would then lead to the general conclusion that the bigger (or the more mature) the firm, the bigger the share of securities in its financial structure. This is broadly consistent with stylized facts.

The basic structure of the model proposed here thus seems to be a good basis for exploring further the interface between financial and real sectors and to address the question of the effects of banking regulation on the entire system. An important avenue for further research, in particular, is to explore in greater detail the effect on aggregate activity of changes in bank liquidity and to analyze the effects of different forms of monetary policy on the real sector in a fully closed general equilibrium model, which would trace the effects of monetary policy on both firms and households. Finally, an interesting question to consider is whether the different overall structures of the financial systems of Germany or Japan versus the United States and the United Kingdom have important consequences for how monetary shocks get transmitted to the real sector.

## Mathematical Appendix

*Proof of Lemma 1*

We have to compare the cost of funds under the two financing modes for a firm that has already issued the amount of riskless debt $2\pi_L$.

Raising \$1 beyond $2\pi_L$ costs

$$1 = p_1 + (1 - p_1)\nu R,$$

where $R$ is the second-period repayment. But this implies $R = 1/\nu$. The dilution cost results when the $H$ firm has to repay $R - 1$, an event that occurs with probability $1 - p_1$. Therefore, the dilution cost equals

$$(1 - p_1)\left(\frac{1}{\nu} - 1\right) = \frac{1 - p_1}{\nu}(1 - \nu).$$

On the other hand, for a firm with debt $2\pi_L$, raising \$1 in equity implies handing over a percentage $\Delta a$ of the firm's equity such that

$$1 = \Delta a[p_1(\pi_H - \pi_L) + \nu(\pi_H - \pi_L)],$$

which for an $H$ firm amounts to giving up

$$\Delta a[p_1(\pi_H - \pi_L) + (\pi_H - \pi_L)]$$

in expected profits, so that the dilution cost of this alternative mode of financing is

$$\frac{p_1 + 1}{p_1 + \nu} - 1 = \frac{1 - \nu}{p_1 + \nu}.$$

Simplifying, we obtain that raising equity with safe debt $2\pi_L$ is dominated by equity with maximum safe debt $2\pi_L + \nu(\pi_H - \pi_L)$ if and only if

$$\frac{1}{p_1 + \nu} > \frac{1 - p_1}{\nu},$$

that is, if and only if $\nu > 1 - p_1$. Q.E.D.

*Proof of Proposition 3*

We begin by computing the maximum repayment $R_1 + \pi_L$ for which the firm faces no default risk. With probability $1 - p_1$ the firm has cash flow $\pi_L$ in period 1 and can raise at most $\nu(\pi_H - \pi_L)$ in new bonds to cover the cash shortfall $R_1 - \pi_L$, so that

$$\nu(\pi_H - \pi_L) = R_1 - \pi_L \tag{A1}$$

and the investors' zero-profit condition is

$$\hat{I} = 2\pi_L + \nu(\pi_H - \pi_L). \tag{A2}$$

1. An $H$ firm's profit when issuing a fraction $a$ of equity (and $\hat{I}$ in bonds) then is

$$W_E = (1 - a)[p_1(\pi_H - R_1) + p_1(\pi_H - \pi_L)]. \tag{A3}$$

Replacing $R_1$, we obtain

$$W_E = (1 - a)p_1(2 - \nu)(\pi_H - \pi_L), \tag{A4}$$

where $a$ is such that exactly the additional amount $1 - \hat{I}$ is raised:

$$1 - \hat{I} = a[p_1(\pi_H - R_1) + p_1\nu(\pi_H - \pi_L)]. \tag{A5}$$

Again replacing $R_1$, we obtain

$$1 - \hat{I} = a[p_1(\pi_H - \pi_L)], \tag{A6}$$

and therefore,

$$W_E = (2 - \nu)[p_1(\pi_H - \pi_L) - (1 - \hat{I})]. \tag{A7}$$

2. An $H$ firm issuing bonds has to promise a repayment $R_1$ in period 1 such that

$$1 = p_1 R_1 + (1 - p_1)A + \pi_L. \tag{A8}$$

Therefore, the $H$ firm's profits under bond financing are

$$W_B = p_1(\pi_H - R_1) + p_1(\pi_H - \pi_L). \tag{A9}$$

Replacing $R_1$, we obtain

$$W_B = 2p_1(\pi_H - \pi_L) + (1 - p_1)(A - \pi_L) - (1 - 2\pi_L). \tag{A10}$$

3. If an $H$ firm can get both sources of funding, the optimal funding mode is then determined by the sign of $\Delta = W_E - W_B$:

$$\begin{aligned}\Delta = &-\nu p_1(\pi_H - \pi_L) - (1 - \hat{I})(2 - \nu)\\ &+ (1 - \hat{I}) + \nu(\pi_H - \pi_L) - (1 - p_1)(A - \pi_L),\end{aligned} \tag{A11}$$

that is,

$$\Delta = -(1 - \hat{I})(1 - \nu) + (1 - p_1)[\nu(\pi_H - \pi_L) - (A - \pi_L)]. \tag{A12}$$

Therefore, under assumption 4, $\Delta$ is decreasing with $p_1$, and in addition we have $\Delta < 0$, for $p_1 = 1$.

4. A firm can get enough funding with equity if by pledging no more than $a \leq 1$ of its equity it gets enough funding for its investment. From equation (A6) this is possible if

$$p_1 \geq \frac{1 - \hat{I}}{\pi_H - \pi_L} \equiv p_1^E.$$

(Notice that assumption 1 implies $p_1^E < 1$.)

5. A firm can get enough funding by issuing bonds if by pledging no more than $R_1 \leq \pi_H$ it gets enough funds. From equation (A8) this requires that

$$p_1 \geq \frac{1 - A - \pi_L}{\pi_H - A} \equiv p_1^B.$$

6. The condition $p_1^B \geq p_1^E$ is then equivalent to

$$(1 - A - \pi_L)(\pi_H - \pi_L) \geq (\pi_H - A)(1 - \hat{I})$$

or to

$$A[(1 - \hat{I}) - (\pi_H - \pi_L)] \geq (\pi_H - \pi_L)\pi_L + \pi_L - 2\pi_H\pi_L - \nu\pi_H(\pi_H - \pi_L).$$

Rearranging this yields

$$A(1 - \hat{I}) \geq (\pi_H - \pi_L)[A - (1 - \nu)\pi_L - \nu\pi_H] - (\pi_H - \pi_L)\nu\pi_L + \pi_L - 2(\pi_L)^2$$

and

$$A(1-\hat{I})+(\pi_H-\pi_L)[(1-\nu)\pi_L+\nu\pi_H-A]\geq\pi_L(1-\hat{I}),$$

which is always true since $A>\pi_L$. Q.E.D.

*Proof of Lemma 2*

Consider first securitization of the amount $\hat{I}=2\pi_L+\nu(\pi_H-\pi_L)$. Then an $H$ firm's payoff under bank financing is

$$W_{BL}=p_1(\pi_H-\hat{R}_1), \tag{A13}$$

with $\hat{R}_1$ given by

$$(1+\rho)(1-\hat{I})=p_1(\hat{R}_1-\pi_L)+(1-p_1)(1-\nu)(A-\pi_L). \tag{A14}$$

If only $2\pi_L$ are securitized, the firm's payoff becomes

$$\tilde{W}_{BL}=p_1(\pi_H-\tilde{R}_1)+p_1(\pi_H-\tilde{R}_2), \tag{A15}$$

with $\tilde{R}_1$ and $\tilde{R}_2$ given by

$$\begin{aligned}(1+\rho)(1-2\pi_L)=&\ p_1(\tilde{R}_1-\pi_L)+p_1\nu(\tilde{R}_2-\pi_L)\\&+(1-p_1)[(1-\nu)(A-\pi_L)+\nu\,(\pi_H-\pi_L)].\end{aligned} \tag{A16}$$

To minimize dilution costs, the optimal contract is thus either (1) $\tilde{R}_2=\pi_L$ and $\tilde{R}_1\leq\pi_H$ or (2) $\pi_L<\tilde{R}_2\leq\pi_H$ and $\tilde{R}_1=\pi_H$.

Subtraction of (A14) from (A16) yields

$$(\rho+p_1)\nu(\pi_H-\pi_L)=p_1(\tilde{R}_1-\hat{R}_1)+p_1\nu(\tilde{R}_2-\pi_L)$$

so that

$$\tilde{\Delta}\equiv W_{BL}-\tilde{W}_{BL}=p_1(\tilde{R}_1-\hat{R}_1)-p_1(\pi_H-\tilde{R}_2).$$

Substituting for $\tilde{R}_1$ and $\hat{R}_1$, we get

$$\tilde{\Delta}=(\rho+p_1)\nu(\pi_H-\pi_L)-p_1\nu(\tilde{R}_2-\pi_L)-p_1(\pi_H-\tilde{R}_2)$$

or, rearranging, we get

$$\tilde{\Delta}=(\pi_H-\pi_L)[\rho\nu-(1-\nu)p_1]+(1-\nu)p_1(\tilde{R}_2-\pi_L).$$

Thus, for $\rho>[(1-\nu)/\nu]p_1$, $\tilde{\Delta}$ is positive; for $\rho=0$, it is negative. By continuity there exists a value $\rho^*$ such that $\tilde{\Delta}=0$. Since $\tilde{R}_2$ is an increasing function of $\rho$, we have $\tilde{\Delta}>0$ if and only if $\rho>\rho^*$.

The second part of lemma 2 is straightforward. Given that a combination of risky bonds and bank loans triggers liquidation in the event of a first-period low return $\pi_L$, it is suboptimal to take on a bank loan that costs $\rho$ when the same outcome can be obtained by taking on bonds that do not involve any intermediation cost. Q.E.D.

*Proof of Proposition 4*

We compare the best funding terms a firm is able to get with a bank loan ($BL$) and show that the difference in firm profit $\Delta$ is always a decreasing function of $p_1$. Several cases need to be considered, depending on whether banks securitize all or only part of their safe liabilities, whether there are second-period repayments, and whether the comparison is made with bond financing or equity financing.

### 1. Securitized Bank Loans of $\nu(\pi_H - \pi_L) + 2\pi_L$

*Bonds versus bank loans.*—There are two subcases to consider.

A. The bond has a first-period repayment $R_1$ and a second-period repayment of $\pi_L$. The bondholders' break-even condition is then

$$1 = p_1(R_1 - \pi_L) + (1 - p_1)(A - \pi_L) + 2\pi_L. \tag{A17}$$

The equivalent break-even condition under bank lending is (A14). Subtracting (A14) from (A17), we obtain

$$1 - (1 + \rho)(1 - \hat{I}) = p_1(R_1 - \hat{R}_1) + (1 - p_1)\nu(A - \pi_L) + 2\pi_L. \tag{A18}$$

Relabeling all terms independent of $p_1$ in a constant $K_0$, we can rewrite expression (A18) as

$$p_1(R_1 - \hat{R}_1) = K_0 + p_1\nu(A - \pi_L). \tag{A19}$$

The expected profit for an $H$ firm financed with a securitized bank loan is given by (A13). Under bond financing it is given by

$$W_B = p_1(\pi_H - R_1) + p_1(\pi_H - \pi_L). \tag{A20}$$

Consequently,

$$\Delta = W_{BL} - W_B = p_1(R_1 - \hat{R}_1) - p_1(\pi_H - \pi_L). \tag{A21}$$

Using (A19), we obtain

$$\Delta = K_0 - p_1[(\pi_H - \pi_L) - \nu(A - \pi_L)], \tag{A22}$$

so that $\Delta$ is decreasing in $p_1$. In addition, replacing $p_1 = 1$ in (A18) allows us to obtain $R_1 - \hat{R}_1 = \nu(\pi_H - \pi_L) - \rho(1 - \hat{I})$. Substituting in (A21), we obtain

$$\Delta = -(1 - \nu)(\pi_H - \pi_L) - \rho(1 - \hat{I}) < 0, \tag{A23}$$

so that bond financing is preferred for high values of $p_1$.

B. The bond has a first-period repayment of $\pi_H$ and a second-period repayment of $R_2$. The bondholders' break-even condition is then

$$1 = p_1(\pi_H - \pi_L) + (1 - p_1)(A - \pi_L) + p_1\nu(R_2 - \pi_L) + 2\pi_L, \tag{A17$'$}$$

from which we obtain

$$\frac{\partial[p_1(R_2 - \pi_L)]}{\partial p_1} = -\frac{1}{\nu}(\pi_H - A) < 0.$$

We obtain a similar expression from equation (A14):

$$\frac{\partial[p_1(\hat{R}_1 - \pi_L)]}{\partial p_1} = (1 - \nu)(A - \pi_L) > 0.$$

The expected profit for an $H$ firm under bond financing is now given by

$$W_B = p_1(\pi_H - R_2). \tag{A20′}$$

Consequently, $\Delta$ is now given by

$$\Delta = W_{BL} - W_B = p_1(R_2 - \hat{R}_1),$$

which is again decreasing in $p_1$.

To see that when $p_1 = 1$ we have $\Delta < 0$, note that

$$\nu(R_2 - \hat{R}_1) = 1 - 2\pi_L - (\pi_H - \pi_L) - \nu(1 + \rho)(1 - \hat{I})$$

is negative when $\rho\nu > 1 - \nu$, since then

$$\nu(R_2 - \hat{R}_1) \leq 1 - 2\pi_L - (\pi_H - \pi_L) - (1 - \hat{I})$$

or

$$\nu(R_2 - \hat{R}_1) \leq -(1 - \nu)(\pi_H - \pi_L) < 0.$$

*Equity versus bank loans.*—Equations (A14) and (A13) remain unchanged. The payoff of an equity-financed $H$ firm is

$$W_E = (2 - \nu)[p_1(\pi_H - \pi_L) - (1 - \hat{I})] \tag{A24}$$

so that

$$\frac{dW_E}{dp_1}(2 - \nu)(\pi_H - \pi_L). \tag{A25}$$

From equation (A13) we have

$$\frac{dW_{BL}}{dp_1} = \pi_H - \frac{d(p_1\hat{R}_1)}{dp_1}. \tag{A26}$$

Differentiating (A14), we obtain

$$\frac{d(p_1\hat{R}_1)}{dp_1} = (1 - \nu)(A - \pi_L) + \pi_L$$

so that

$$\frac{dW_{BL}}{dp_1} = \pi_H - \pi_L - (1 - \nu)(A - \pi_L).$$

Thus for $\Delta = W_{BL} - W_E$, we have

$$\frac{d\Delta}{dp_1} = -(1 - \nu)[(\pi_H - \pi_L) + (A - \pi_L)] < 0.$$

### 2. Securitized Bank Loans of $2\pi_L$

*Bonds versus bank loans.*—Note that now both bonds and bank loans may have first- and second-period repayments so that there are four subcases to consider.

A. The bond has first-period repayment $R_1$ and second-period repayment $\pi_L$, and the bank loan specifies first-period repayment $\tilde{R}_1$ and second-period repayment $\pi_L$: The bondholders' break-even condition is equation

(A17) as before. But the equivalent break-even condition under bank lending is now equation (A16). Subtracting (A17) from (A16), we obtain

$$\rho(1 - 2\pi_L) = p_1(\tilde{R}_1 - R_1) + p_1\nu(\tilde{R}_2 - \pi_L) + (1 - p_1)\nu(\pi_H - A). \tag{A18$'$}$$

The expression for $\Delta$ is now obtained from equations (A15) and (A20):

$$\Delta = \tilde{W}_{BL} - W_B = p_1(R_1 - \tilde{R}_1) + p_1(\pi_L - \tilde{R}_2).$$

Since we have $\tilde{R}_2 = \pi_L$,

$$\Delta = \tilde{W}_{BL} - W_B = p_1(R_1 - \tilde{R}_1).$$

And since

$$\frac{\partial[p_1(R_1 - \tilde{R}_1)]}{\partial p_1} = -\nu(\pi_H - A),$$

from equation (A18′) we have established that $\Delta$ is decreasing with $p_1$. Finally, when $p_1 = 1$, equation (A18′) yields $\Delta = -\rho(1 - 2\pi_L) < 0$.

B. The bond has first-period repayment $R_1$ and second-period repayment $\pi_L$, but the bank loan specifies first-period repayment $\tilde{R}_1 = \pi_H$ and second-period repayment $\pi_L \leq \tilde{R}_2 \leq \pi_H$. Trivially, in this case all firms prefer bond financing.

C. The bond has first-period repayment $\pi_H$ and second-period repayment $R_2$, but the bank loan specifies first-period repayment $\tilde{R}_1$ and second-period repayment $\pi_L$. Equations (A15) and (A20′) then imply

$$\Delta = \tilde{W}_{BL} - W_B = p_1(\pi_H - \tilde{R}_1) + p_1(\pi_H - R_2) > 0,$$

so that the cheaper bank loans are preferred by all firms here.

D. The bond has first-period repayment $\pi_H$ and second-period repayment $R_2$, and the bank loan specifies first-period repayment $\tilde{R}_1 = \pi_H$ and second-period repayment $\pi_L \leq \tilde{R}_2 \leq \pi_H$. Here

$$\Delta = \tilde{W}_{BL} - W_B = p_1(R_2 - \tilde{R}_2).$$

Subtracting equation (A17′) from equation (A16) yields

$$\rho(1 - 2\pi_L) = p_1\nu(\tilde{R}_2 - R_2) + (1 - p_1)\nu(\pi_H - A). \tag{A27}$$

As before,

$$\frac{\partial[p_1(R_2 - \tilde{R}_2)]}{\partial p_1} = -(\pi_H - A) < 0$$

implies that $\Delta$ is decreasing.

*Equity versus bank loans.*—Here again, two subcases must be considered.

A. $\tilde{R}_2 = \pi_L$ and $\tilde{R}_1 \leq \pi_H$: From equation (A16) we derive

$$\frac{\partial[p_1(\tilde{R}_1 - \pi_L)]}{\partial p_1} = (1 - \nu)(\pi_H - A) + \nu(\pi_H - \pi_L),$$

so that

$$\frac{\partial \tilde{W}_{BL}}{\partial p_1} = (2 - \nu)(\pi_H - \pi_L) - (1 - \nu)(\pi_H - A).$$

Using equation (A25), we obtain $\partial\Delta/\partial p_1 < 0$.

B. $\tilde{R}_1 = \pi_H$ and $\pi_L \leq \tilde{R}_2 \leq \pi_H$: Again, from equation (A16) we obtain

$$\frac{\partial[\nu p_1(\tilde{R}_2 - \pi_L)]}{\partial p_1} = (1 - \nu)(A - \pi_L) - (1 - \nu)(\pi_H - \pi_L),$$

and therefore,

$$\frac{\partial \tilde{W}_{BL}}{\partial p_1} = (\pi_H - \pi_L) - \frac{1}{\nu}[(1 - \nu)(A - \pi_L) - (1 - \nu)(\pi_H - \pi_L)],$$

so that

$$\frac{\partial\Delta}{\partial p_1} = (\pi_H - \pi_L)\left[\frac{1}{\nu} - (2 - \nu)\right] - \frac{1}{\nu}(1 - \nu)(A - \pi_L)$$

or

$$\frac{\partial\Delta}{\partial p_1} = \frac{1 - \nu}{\nu}[(1 - \nu)\pi_H + \nu\pi_L - A],$$

which is negative by assumption 5. Q.E.D.

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