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Corporate Financial Policy and the Theory of Financial Intermediation

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ABSTRACT

This paper examines the optimal structure of financial contracts in an economy subject to two forms of moral hazard. Multiple information problems are shown to generate a role for multiple classes of financial claimants. We then show that economic efficiency is enhanced if the financial structure of the economy consists of both direct and intermediated financial contract markets. Consequently, our results demonstrate a motivation for the complementarity between capital markets and depository financial institutions.

THE PURPOSE OF THIS paper is to provide an analysis of the complementary roles of direct financial contract markets and intermediated financial contract markets in the modern theory of corporate finance. The need to formulate such a model has been emphasized elsewhere by Stiglitz (1985) and Fama (1985), among others. However, an adequate explanation of this phenomenon has yet to be formulated. The model described in this paper focuses on the role of multiple information problems in a theory of complex financial structure. Specifically, in an environment with private action (i.e., unobservable investment allocations) and private information (i.e., partially unobservable project cash flows), multiple claimant classes arise to resolve the separate inefficiencies induced by moral hazard. In our model, the interaction of project risk and observability creates investment distortions which can be mitigated by increasing the number of outside claimant classes. Our results demonstrate explicitly the way in which a firm's optimal financial structure depends on the assumed configuration of an investment project's risk and observability characteristics. Under certain conditions, we show that the optimal contractual allocation in an economy with only direct financial contract markets consists of a debt contract and an outside equity claim. This contractual configuration restores the efficient investment allocation decision.

We then consider the feasibility of an intermediated financial contract market in this setting. We show that the existence of an intermediated financial contract market improves economic efficiency due to the reduced aggregate costs of

* Amos Tuck School of Business Administration, Dartmouth College. This paper is based on several chapters of my Ph.D. dissertation at the University of Wisconsin at Madison. I wish to thank my advisor, Lemma Senbet, and committee members Ramasastry Ambarish, Mark Gertler, Donald Hausch, and David Mauer for many valuable discussions and comments. Comments on earlier versions of the paper by Anjan Thakor, various faculty members of the Amos Tuck School, René Stulz (the editor), and an anonymous referee are gratefully acknowledged. I alone bear the responsibility of any remaining errors.

monitoring. However, a delegated monitor need not hold all of the financial contracts in our model. This result is due to the fact that appropriate incentives to efficiently monitor are created over a subset of the firm's optimal contractual allocation. As long as the intermediary holds a claim under which it receives the firm's entire output in this region, the efficient amount of monitoring is implemented. Thus, the incentive problems created by private action and private information are mitigated in our framework by allowing both direct and intermediated financial contract markets. Relatedly, our results describe the optimal priority structure among the diverse financial claimants in our economy.

The problem under consideration here is related to several previous studies of incentive problems, corporate financial policy, and the theory of financial intermediation. In the corporate finance literature, our analysis is closely related to studies of the agency conflict which can arise between a firm's bondholders and stockholders (see, e.g., Jensen and Meckling (1976), Smith and Warner (1979), and Barnea, Haugen, and Senbet (1985)). The economic foundation of this class of models is the incentive which insiders have to adopt suboptimal actions subsequent to the firm's financing decisions. For example, unobservability of certain actions (e.g., investment allocations) by the outside investors, together with the diverse nature of the firm's contractual allocations, leads to behaviors which would not arise under conditions of full information (i.e., unobservable actions preclude action contingent contracts). Consequently, it is the combination of diverse incentives and unobservable actions which leads to inefficiency in these models.

Several important studies examine various characteristics of observed financial contracts as solutions to these inefficiencies. The solutions to various bondholder-stockholder problems which have been examined in the finance literature recognize that contractual control of the conflicting objectives can increase the value of the firm by reducing the agency costs associated with the suboptimal decisions. Common contractual features such as restrictive bond covenants (see, e.g., Smith and Warner (1979), Kalay (1982), and John and Kalay (1982)), secured debt (see, e.g., Stulz and Johnson (1985)), and complex financial securities (see, e.g., Jensen and Meckling (1976), Barnea, Haugen, and Senbet (1985), Haugen and Senbet (1981), and Green (1982, 1984)) have been rationalized as optimal responses to the potential inefficiencies generated by the bondholder-stockholder conflict. More recently, Berlin and Loeys (1988) describe an environment where firms choose between the use of loan contracts with covenants and loan contracts enforced by a delegated monitor.

The studies cited above do not fully endogenize the structure of the firm's financial contracts. Williams (1985) is perhaps one of the first to do so. Williams presents a model which is similar in spirit to the problem under consideration here. He considers the optimal construction of corporate financial contracts in a private action/private information setting. In his model, corporate insiders face a reporting problem, so that feasible contractual allocations are constrained by an appropriate truth-telling condition. While Williams does provide some important insights about the optimality of multiple claimant classes, he does not consider the complementary roles of financial intermediaries and capital markets.

Also, our assumptions here about the ability to monitor the firm are quite different, as are our assumptions about the distribution of information across economic agents. Hence, we view financial structure as a monitoring problem rather than as a reporting problem.

Chang (1986) also considers an environment where contractual allocations are endogenously derived in a setting with partially observable output. However, he restricts his analysis to the case of private information and thus does not address the problems created by private action in this economy. Relatedly, the firm's investment decision is fixed in his model, so that he is unable to characterize marginal adjustments in both financing and investment decisions in response to the moral hazard under consideration. His analysis also assumes an equivalence between bankruptcy and verification. Our results demonstrate that this is generally not a valid assumption. Finally, the objectives of his paper are quite different from those described in this paper, as his primary concern is the determinants of capital structure rather than the complementary roles of direct and intermediated financial contract markets.

Recent advances in the theory of financial intermediation recognize that many of the same costly market imperfections which give rise to positive theories of corporate financial policy might also explain the purpose which intermediaries serve in capital markets. Important contributions enhancing our understanding of the intermediary function have focused on a variety of explanations: transactions cost (Benston and Smith (1976)), the role of confidentiality (Campbell (1979)), adverse selection and financial signaling (Leland and Pyle (1977), Campbell and Kracaw (1980), Chan (1983), and Boyd and Prescott (1986)), and delegated monitoring services (Diamond (1984), Fama (1985), Gorton and Haubrich (1986), and Williamson (1986)). As in Diamond (1986), our focus is on those financial institutions which provide asset services, in the sense that they provide benefits to the issuers of the assets which the intermediary holds.[1] Furthermore, our analysis also emphasizes the role of financial intermediaries as delegated monitors.

Diamond (1984) develops a theory of financial intermediation under moral hazard where financial institutions arise as delegated monitors. In his paper, a hidden information problem arises due to the unobservability of the firm's profitability by potential capital contributors. Furthermore, monitoring of the firm's activities by outsiders is costly. He demonstrates that diversification within the financial intermediary reduces the agency costs associated with monitoring the monitor, even in an economy where all economic agents are risk neutral. Intuitively, the agency costs associated with the incentive problem between the financial intermediary and the individual investors (i.e., its depositors) can be eliminated if the intermediary contracts with a sufficiently large number of firms. Diamond also derives the optimal configuration of financial contracts in his

[1] The viewpoint adopted throughout this paper is that the financial intermediaries under consideration are funding intermediaries. Ramakrishnan and Thakor (1984) and Millon and Thakor (1985) describe an environment where nonfunding intermediaries can arise as certification agents and coexist with direct financial contract markets.

model, which turn out to be standard debt contracts.[2] Thus, Diamond identifies the important role of financial intermediary institutions in the resolution of information problems.

The organization of the remainder of this paper is as follows. The next section specifies the production technology, monitoring technology, and financial contracts which characterize our model economy. Section II examines the role of financial contracts in the resolution of investment incentive problems in a private action/private information economy. We begin by considering the optimal investment and contractual allocation in a direct financial contract market. Thus, we initially preclude the formation of financial intermediaries in our model economy.

Section III allows for the formation of financial intermediaries as delegated monitors, in the manner originally identified by Diamond (1984). Section IV describes some interpretations and testable implications of the model. Section V provides a summary discussion and concluding remarks.

I. The Model

We begin our analysis of the firm's financial contracting problem by specifying the investment opportunity set. Each firm consists of a group of insider entrepreneurs who have access to a set of potentially profitable, risky investment projects. However, the insiders do not have sufficient wealth to internally finance the projects. Consequently, they have to obtain additional capital from outside investors in order to operate the perfectly divisible investment projects at their optimal level. In order to focus on a limited set of issues, we consider a single-period, state preference model of corporate financing and investment decisions. Within this framework, optimal financial contracts and investment allocations are determined endogenously.

We consider capital to be the sole productive input for the risky production technology, which yields a random end-of-period cash flow as the output. The production process is such that the level of investment is undertaken at the beginning of the period (time 1), and output is realized at the end of the period (time 2). Outside investors are able to costlessly observe the aggregate investment level. However, the allocation of capital across projects cannot be observed by the outside investors. The aggregate returns to the firm's risky production technology can be decomposed into the additively separable form:[3]

$$W(I, s) = X(I_1, s) + Y(I_2, s), \tag{1}$$

where

$$X(I_1, s) = k(I_1)(1 + R_1(s)), \tag{2}$$

[2] Gale and Hellwig (1985) elaborate further on the optimality of debt contracts in a single-period model where private information problems arise. While investment level decisions are endogenized in their model, they do not consider the role of financial intermediaries in their economy, nor do they consider risk incentive problems.

[3] A similar specification has been used elsewhere in the finance literature by Baron (1979), Green (1984), and Green and Talmor (1985).

$$Y(I_2, s) = g(I_2)(1 + R_2(s)). \tag{3}$$

In this representation, g and k are deterministic scale functions, I_j is the amount of capital allocated to production process j, and $(1 + R_j(s))$ represents a random multiplicative shock term for production process j. The shock term depends on the state of nature, s, which is an outcome from the universal set, U. Further, in order to characterize the firm's financing and investment behavior, we require the following secondary assumptions:

(A1) $g(\cdot)$ and $k(\cdot)$ are strictly increasing, twice continuously differentiable, and strictly concave, with $g(0) = 0$ and $k(0) = 0$;

(A2) $\lim_{I_1 \to \infty} k(I_1) = A_1 < \infty$,

$\lim_{I_2 \to \infty} g(I_2) = A_2 < \infty$;

(A3) $\lim_{I_1 \to 0} k'(I_1) = \infty$,

$\lim_{I_2 \to 0} g'(I_2) = \infty$;

(A4) $(1 + R_j(s)) \in (O, R) \qquad \forall s \in U, \quad j = 1, 2$;

(A5) $\dfrac{\partial^2 W}{\partial I \, \partial s} > 0$;

(A6) $1 + R_1(s) = 1 + R_2(s) + z(s), \quad \text{where} \quad \int_U z(s) p(s)\, ds = 0.$

The differentiability and concavity restrictions imposed in (A1) ensure uniqueness of the optimal investment allocation. (A2) helps bound the value of the firm and its claims, so that the investment capital input levels will be finite for each process. (A3) is an infinite marginal value product condition, while (A4) ensures that the technological productivity shock terms are positive. These latter two assumptions will ensure that the firm always undertakes some investement in each production process, as well as ensure the non-negativity of the firm's end-of-period cash flow. (A5) orders the firm's marginal output across the states of nature. This assumption will prove useful in our subsequent characterization of the verification region. Notice that this marginal output assumption imposes a condition on the firm's aggregate output level, but not on each process separately. Finally, (A6) states that the firm project is a "mean-preserving" and "price-preserving" spread of the second project. It is in this relative sense that the first project is riskier than the second project.

For valuation purposes, we assume that capital markets are complete.[4] While the agency problems described in this paper are generally not consistent with the existence of complete markets, we employ the latter merely for valuation purposes. This assumption allows all economic agents to unambiguously value the firm's cash flows. The unique state-claim prices are described by the function $p(\cdot)$.

[4] Green (1982, 1984) and Green and Talmor (1985) utilize the same assumption in their analyses of investment incentive problems.

Within this general framework, the private action problem which we consider is due to the fact that the relative allocation of capital across the feasible set of investment projects is not costlessly observable by the outside claimants. We also assume that agents in the economy are asymmetrically informed. The realization of $X(I_1, s)$ is costlessly observable by both insiders and outsiders, but the realization of $Y(I_2, s)$ is costlessly observable only by the insiders. In order to ease the notational burden, we subsequently refer to $X(I_1, s)$ as the observable project and $Y(I_2, s)$ as the unobservable project. By construction, the observable project is riskier than the unobservable project in the sense described by (A6). There are no market imperfections (e.g., taxes, transactions costs) other than those described above.

Outside claimants have access to a costly monitoring technology. Our specification allows outside investors access to a deterministic monitoring technology with perfect observability and a fixed cost of verification. In the set of states where monitoring occurs, outside claimants are able to observe the realization of the second project, $Y(I_2, s)$. However, monitoring reveals no information about the investment allocation across projects.[5]

Our analysis of the optimal contractual arrangement between the firm and the outside investors requires that we fully specify the sequence of decisions to be made.[6] The first decision to be made by the insider entrepreneurs and the outside investors is the manner in which the firm's total financing requirements should be divided. We assume that the insiders' initial equity contribution to the firm is fixed. Let E represent this initial capital investment. Since I represents the firm's aggregate investment level, the quantity $I - E$ represents the remaining amount of capital which the firm must raise from the outside investors.

Next, the contract must fully describe the sharing rule for the firm's output. A feasible contract requires that the payoff be made contingent on mutually verifiable events. In the absence of a costly verification, our model requires that the payoff structure can depend on the reported realization of two random variables. First, since a portion of the firm's true return is always costlessly observable, the financial contract can depend directly on the costlessly observable output, $X(I_1, s)$. In addition, since the firm's unobservable return is not (by construction) a mutually verifiable event, the financial contract can depend on the insiders' statements regarding the realized return, $Y(I_2, s)$. Note that we do not require that the insiders' statements with respect to this (unobservable) realized return be truthful.[7] As we will discuss subsequently, the insiders' state-

[5] An earlier version of this paper describes the financial contracting implications of different verification properties. Specific properties examined include the role of imperfect observability, the role of stochastic verification strategies, and the role of various state-contingent monitoring cost functions. While the proportional sizes of the direct and intermediated financial contract markets depend on each of these properties, our general results are robust to the extent that neither contract market ever dominates the other. For an analysis of the optimality of randomized monitoring strategies in a different setting, see Mookherjee and Png (1989).

[6] In keeping with the current state of agency theory literature, we assume that investment and state-contingent contracts are unenforceable or prohibitively expensive to implement.

[7] While our model permits insiders to report an incorrect outcome for the unobservable component of the firm's return, one could also append appropriate truthtelling constraints to the programming problem and apply the revelation principle. I am grateful to the referee for suggesting this point.

ment about the realized outcome of the unobservable project is a particular constant value in the absence of monitoring. However, with a costly verification, the optimal sharing rule can depend on the realized value of the firm's true output, $W(I, s)$. Finally, since our analysis considers only deterministic verification schemes, the optimal contract must also specify the set of states which are to be observed by the outside investors. Thus, the optimal contractual arrangement identifies (with probability one) whether or not any given outcome is to be verified.

Initially, our analysis of financial contracts in this economy explicitly precludes the formation of financial intermediaries, so that the only contractual arrangements which we permit are those written directly between the firm and the outside investors. The optimal contract can be described by its functional dependence on the observable output of the firm. Since the observability of the firm's output depends on whether a verification occurs, the structure of the optimal contract (and hence the actual payment to the outside investors) will also be a function of the optimal monitoring policy.

Given our assumptions regarding the firm's production technology, the deterministic verification scheme, and perfect observability, we can describe the payoff due to the outside investors at the end of the period as follows. Let a represent the observable characteristics of the contractual claim held by the outside investors in the set of states where monitoring occurs.[8] Define b to be the observable contractual characteristics in the set of states where a verification does not occur. We allow for the possibility that $a = b$, but we do not impose such a restriction. Finally, let S represent the set of outcomes over which a verification occurs. Then the payment to the outside investors can be described by the following schedule:

$$P = \begin{cases} C(a, X(I_1, s), Y(I_2, s)) & \forall s \in S, \\ K(b, X(I_1, s)) & \forall s \in S^c, \end{cases} \tag{4}$$

where S^c is the complement of S and hence represents the set of outcomes over which monitoring does not occur.[9]

A distinguishing feature of our formulation is that the firm's realized return is partially observable in the absence of monitoring.[10] The payoff to the outside investors can depend on the observable portion of the firm's output, even in the absence of verification. As a result, the optimality of a standard debt contract is no longer immediate in this environment. It should be noted that the model described here also yields a debt contract as the optimal contractual allocation if

[8] Although our formulation of the firm's contracting problem is quite general, we restrict our attention to the case where the observable characteristics can be described by a scalar.

[9] Note that $K(,)$ is not written explicitly as a function of the firm's report of the unobservable return in the nonverification region. As we discussed above (but have not yet proven), this value is a constant. Since the optimal $K(,)$ will be derived later as a solution to an initial value problem, this report can be considered to be contained in the constant of integration. This reported value will appear later in our representation of a contractual distribution which supports the optimal mechanism $K(,)$. Hence, we treat K as a function of b and $X(I_1, s)$ only.

[10] Chang (1986) also considers certain financial contracting implications of partially observable output.

the observable component of the firm's output is deterministic. Thus, state dependence of the observable component is crucial for our results.

In our model, verification occurs so that outside investors are then able to observe the realization of $Y(I_2, s)$. This observation increases the set of mutually verifiable events over which financial contracting can occur. The verification region under our deterministic scheme can be determined as follows. Recall that $K(b, (X_1, s))$ represents the contractual allocation to the outside investors in the absence of monitoring. Clearly, it is optimal for a verification to occur only if the firm's report of its realized return is less than $K(b, X(I_1, s))$. That is, outside investors should monitor the firm only if the firm's reported output is less than their contractual obligation. The argument which supports this assertion is straightforward. If the firm's report of its realized return is greater than (or equal to) $K(b, X(I_1, s))$, then the outside investors receive their promised payment, and there is no benefit gained from a costly verification. However, if the firm's report of its realized return is less than $K(b, X(I_1, s))$, insiders optimally turn over the firm's entire output to the outside investors. The intuition is that, by so doing, insiders can reduce the expected cost of verification and minimize the payments that must be made to outside investors if there is no verification.[11] We state these results in the form of the following proposition.

PROPOSITION 1: *The optimal direct financial contract requires that*

$$C(a, X(I_1, s), Y(I_2, s)) = X(I_2, s) + Y(I_2, s), \forall s \in S.$$

A costly verification occurs so that the outside investors receive the full value of their residual claim. In the absence of a verification, insiders could declare a low return realization and consume the difference between true and declared output as perks. These results, then, allow us to interpret the state, $\bar{s}$, where

$$X(I_1, \bar{s}) + Y(I_2, \bar{s}) = K(b, X(I_1, \bar{s}), \tag{5}$$

as the upper bound on the optimal verification region, S. By assumption (A5), this point is unique.

Now, given our assumptions about the firm's productive opportunities and the capital markets, the insider entrepreneurs choose a contractual allocation and an investment allocation which maximize the value of their residual claim. Let w represent the fixed (i.e., state-independent) cost of monitoring in the economy. Define F to represent the total amount of capital which insiders have available to allocate across the firm's set of investment projects. Then a complete statement of the insider entrepreneur's optimization program is as follows:

[11] Although we state this result without proof, the intuition here is similar to the results obtained in other private information models. The primary effect of introducing private action and partial observability into the firm's financial contracting problem is that the upper bound on the verification region is no longer constant as in previous papers (e.g., Townsend (1979), Gale and Hellwig (1985), and Williamson (1986)). Rather, the upper bound is a function of the firm's observable output, $X(I_1, s)$, and the structure of the payoff claims in the states where verification does not occur. A formal proof of this result is available from the author upon request.

$$\underset{F,I_1,I_2,a,b}{\text{Maximize}} \int_{S^c} [X(I_1, s) + Y(I_2, s) - K(b, X(I_1, s))]p(s)\, ds \tag{6}$$

$$+ \int_S [X(I_1, s) + Y(I_2, s) - C(a, X(I_1, s), Y(I_2, s))]p(s)\, ds$$

subject to

$$0 \leq P \leq X(I_1, s) + Y(I_2, s), \tag{7}$$

$$F \leq \int_S [C(a, X(I_1, s), Y(I_2, s)) - w]p(s)\, ds$$

$$+ \int_{S^c} K(b, X(I_1, s))p(s)\, ds + E \tag{8}$$

$$I \in \underset{I' \geq 0}{\text{argmax}} \int_S [X(I_1', s) + Y(I_2', s) - C(a, X(I_1', s), Y(I_2', s))]p(s)\, ds \tag{9}$$

$$+ \int_{S^c} [X(I_1', s) + Y(I_2', s) - K(b, X(I_1, s))]p(s)\, ds$$

subject to

$$I_1' + I_2' \leq F, \tag{10}$$

$$K(b, X(I_1, s)), C(a, X(I_1, s), Y(I_2, s)) \geq 0. \tag{11}$$

In this formulation, (7) and (11) represent non-negativity constraints on the firm's contractual allocation and hence impose limited liability restrictions on the set of feasible distributions.[12] Equation (8) is a financial constraint on the set of feasible contracts and represents a rationality condition. In particular, (8) states that the outside investors and not "fooled" despite the existence of moral hazard and only pay into the firm at optimality the true equilibrium value of their contractual claims. As is well known in the financial agency literature, insiders bear the full cost of their adverse incentives. Finally, (9) represents the incentive compatibility condition, which states that insiders choose their private action (i.e., the investment allocation) so as to maximize their own personal benefit.

Now, in order to simplify further the program (6)–(11), we can make use of our observations regarding the verification region. From that discussion, we know that monitoring occurs whenever the firm reports that its return is less than the promised payment to outside investors in the nonverification region. Furthermore, from Proposition 1, we know that the optimal contractual allocation requires that outside investors receive the firm's entire output whenever moni-

[12] Note that this formulation does not endogenize limited liability itself. Consequently, our analysis endogenizes the optimal contractual allocation subject to this exogenous restriction of limited liability. An interesting extension of our results would be an investigation of the importance of this treatment of limited liability.

toring occurs. Given these results, we can reformulate the program (6)–(11) as follows:

$$\underset{F,a,b,I_1,I_2}{\text{Maximize}} \int_{S^c} [X(I_1, s) + Y(I_2, s) - K(b, X(I_1, s))]p(s)\, ds \tag{12}$$

subject to

$$0 \leq K(b, X(I_1, s)) \leq X(I_1, s) + Y(I_2, s), \tag{13}$$

$$F \leq \int_S [X(I_1, s) + Y(I_2, s) - w]p(s)\, ds \tag{14}$$

$$+ \int_{S^c} K(b, X(I_1, s))p(s)\, ds + E$$

$$I \in \underset{I' \geq 0}{\text{argmax}} \int_{S^c} [X(I_1', s) + Y(I_2', s) - K(b, X(I_1', s))]p(s)\, ds \tag{15}$$

subject to

$$I_1' + I_2' \leq F, \tag{16}$$

where

$$S = \{(X, Y): X(I_1, s) + Y(I_2, s) < K(b, X(I_1, s))\}. \tag{17}$$

II. Optimal Financing and Investment Decisions under Private Action and Private Information

This section describes the firm's financing and investment decisions in an economy where both private action and private information problems arise. In order to fully characterize the incentive problems which arise in our framework, we investigate the investment choices and distortions that evolve in a sequence of increasingly complex economies. We consider initially the financing and investment decisions which occur in a full, symmetric information setting.

Green (1984) shows that, in this full information setting, the optimal investment allocation requires that I_1 and I_2 be chosen so that their marginal value products are equal. Furthermore, investment in each production technology requires that the firm invest until its marginal value product equals the firm's current cost of funds. Under the assumptions we adopt here, this implies equal investment in each project, so that $I_1^* = I_2^*$. One additional issue of interest is to note that the optimal investment allocation (I_1^*, I_2^*) is the same as that which maximizes the present value of this firm. Hence, residual claim value maximization and firm value maximization investment decisions lead to the same optimal allocations in this setting. Finally, the economics of the firm's optimal contracting problem are such that financial structure is irrelevant here to the extent that *any* combination of contractual characteristics which satisfy the firm's budget constraint (evaluated at the optimal investment allocation) constitutes an optimal contract in this full information setting.

Consider next a full information economy characterized by the private action problem described earlier in this paper. Risk incentive problems would arise in such an economy if the firm were to issue risky debt, thereby allowing insiders to select suboptimal investment allocations which transfer wealth from bondholders to stockholders. Consequently, an optimal financial contract in such an economy would be a pure outside equity claim, where the outsider equity ownership percentage is determined by the firm's budget constraint.

The introduction of private information into this framework creates an additional investment distortion which cannot be resolved efficiently by issuing a pure outside equity claim. Full verification of the firm's return could be restored, but only if the firm precommits to verification in every state of nature. Such an arrangement is excessively costly for insiders, so that they do not offer such a combination. Rather, insiders precommit to verification in certain states of nature in order to allow some degree of fully contingent contracting. The optimal size of the verification region is then determined as an optimal trade-off between the incentives to overinvest in the risky project and the incentive to misrepresent the firm's true output. As a result, the optimal contractual allocation must consist of payoff structures which simultaneously mitigate the incentive to shift risk and control the incentive to misrepresent the firm's true output. Thus, project risk and observability are both crucial determinants of financial structure in our model. The following theorems provide an explicit characterization of the investment and financing implications of these insights.

THEOREM 1: *If the observable project is riskier than the unobservable project, then the firm's optimal configuration of its financial contracts has the following form*:

$$\begin{aligned} C(a, X, Y) &= X + Y && \textit{if } X^R + Y^R < D, \\ K(b, X) &= b[X + \bar{Y}^R - D] + D && \textit{if } X^R + Y^R \geq D, \end{aligned}$$

where

$$\bar{Y}^R = \min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s),$$

and D represents the face value of the firm's debt obligation.

Here, X^R and Y^R represent the insiders' report of the firm's return. Since X^R is always freely observable by all economic agents, then $X^R = X$. We can interpret $\bar{Y}^R$ as the insider's minimum feasible report of the unobservable component of the firm's return in the set of states where a verification does not occur.

Theorem 1 characterizes the optimal contractual agreement between the insider entrepreneurs and the outside investors. The contract consists of two separate claims against the firm which can be interpreted as debt and outside equity. The firm's debt obligation has face value D, while outside equity owners hold an ownership percentage of b. The optimal contract specifies the following payoff structures to the various claimant classes. First, if the firm's report of its total return is less than D, then a verification occurs and the bondholders receive the entire (true) output of the firm. If the firm's report of its return exceeds D, then no verification occurs. In this case, since insiders are assumed to maximize the value of their own claim, their optimal strategy is to report the lowest feasible outcome for the unobservable project such that the report of the firm's total output precludes verification. This, in turn, permits some degree of perk consumption by insiders which, in addition to their equity ownership, provides the appropriate payoff structure to restore investment incentives.

This result has several interesting aspects which differ from existing analyses. The existing literature generally focuses on the incentive effects created by the bondholder-stockholder conflict in a private action economy. Since these studies take as exogenous the structure of financial claims in the economy, they effectively provide a conditional study of the conflicts which arise between debt claimants and equity claimants. That is, complex financial contracts are rationalized as the solution to an incentive problem which arises due to the exogenous specification of particular corporate securities. In this view, debt contracts held by outside investors and the residual claim held by corporate insiders cause the problem under consideration.

Here, we incorporate a private information dimension into the firm's general investment and financial contracting problem. This additional informational asymmetry leads to a natural role for debt contracts in our costly monitoring economy. However, debt contracts are not solely sufficient as optimal contracts here due to partial observability of the firm's return by outside investors. Since $X(I_1, s)$ is freely observable by all economic agents, investors are able to construct output-contingent contracts in the set of states where a verification does not occur. Surprisingly, we show that a combination of outside debt and outside equity contracts supports the unique contractual distribution which solves the investment incentive problem here. Thus, while debt and inside equity contracts conditionally cause adverse investment incentives in existing studies, we show that debt and outside equity contracts can (under certain conditions) unconditionally solve distortionary investment incentive problems.

As noted in the conditional in Theorem 1, our results focus on the case where the return on the riskier project is also fully observable.[13] However, if the return on the unobservable project were in fact riskier than the observable project, then it can be shown (following the same procedure described in Appendix A) that the contractual allocation described in Theorem 1 would not generally solve the firm's investment incentive problem. In particular, not only would the contractual characteristics (i.e., a and b) take on different values, but the entire structure of the contractual distribution (i.e., $C(\cdot, \cdot, \cdot)$ and $K(\cdot, \cdot)$) would change. Why? As described above, the private action problem leads to a wealth transfer problem across security claimant classes. The private information problem creates the possibility of wealth transfers between insiders and outsiders. Due to the complex financial structure which resolves these problems jointly, these groups (i.e., the security claimant classes, and insiders and outsiders) are not necessarily identical. Since the opportunity to transfer wealth depends directly on the combination of observability and risk here, a change in the configuration of investment projects

[13] The analysis presented in this paper focuses on the case where the return on the riskier project is fully observable because of the well established results in the finance literature on risk incentive problems (see, e.g., Green (1984) or Jensen and Meckling (1976)).

endowed with these attributes will alter the way in which financial contracts can control these separate sources of conflict.

Note that this result would not arise in an investment allocation problem subject only to private action (e.g., see Green (1984)). In this latter problem, it does not matter (in the sense of affecting the optimal characteristics or configuration of the firm's financial contracts) which project is riskier. While risk is important in the sense of leading to the construction of a complex financial contract, the structure of contracts does not change if one project is riskier than another. In our model, private action also leads to a role for financial contracts in the resolution of risk incentive problems. However, the optimal financial structure does depend explicitly on which project is riskier because observability alters the set of states over which risk-induced wealth transfers can occur.

THEOREM 2: *The set of states over which a verification occurs and the set of states over which the firm is bankrupt are identical only if*

(i) $b = 0$, *or*

(ii) $$\min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s) = Y(I_2, \bar{s}).$$

Otherwise, these two sets are not equivalent.

Theorem 2 describes the set of conditions under which the optimal monitoring strategy is to verify aggregate output whenever the firm is bankrupt. In our framework, the equivalence is shown to depend on the firm's financial contracts and production technology. The first condition which leads to verification in all bankruptcy states is that the outside investors hold no equity ownership position. The second condition imposes certain restrictions on the firm's production technology. Recall that assumption (A5) orders the firm's aggregate marginal output across states of nature. It does not, however, necessarily order the separate marginal outputs for the observable and unobservable projects. When condition (ii) in Theorem 2 holds, the firm's minimum feasible report of its output from the unobservable project occurs at the upper bound on the verification region. Violation of this condition allows insiders to report a lower outcome for the unobservable project in the nonverification region, which in turn induces the contracting parties to alter the optimal monitoring policy.

Our interest is this result is due to previous results on financial contracting under costly state verification (e.g., Townsend (1979), Gale and Hellwig (1985), and Williamson (1986)). In these papers, the set of states where a verification occurs is interpreted as the event of bankruptcy. It is interesting to note that, in each of these papers, debt contracts are derived as the sole optimal financial contract. Hence, $b = 0$ in each paper. By the conclusion of Theorem 2, this case does represent one of the conditions which leads to an equivalence between the verification region and the event of bankruptcy. However, Theorem 2 also cautions against a generalized statement of this equivalence under conditions where more complex financial structures emerge.

THEOREM 3: *If*

(i) $b > 0$, *and*

(ii) $\min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s) \neq Y(I_2, \bar{s})$,

then $D > X(I_1, \bar{s}) + Y(I_2, \bar{s})$.

This result demonstrates that, if there is not an equivalence between the verification region and the event of bankruptcy, then the face value of the firm's debt claim will always be at least as large as the firm's maximum output in the verification region. Intuitively, Figure 1 illustrates why this is the case. In order to mitigate the private information problem, outside investors hold a debt claim. This contractual allocation together with the private action problem leads to a risk incentive problem. This additional distortion can be reversed provided that

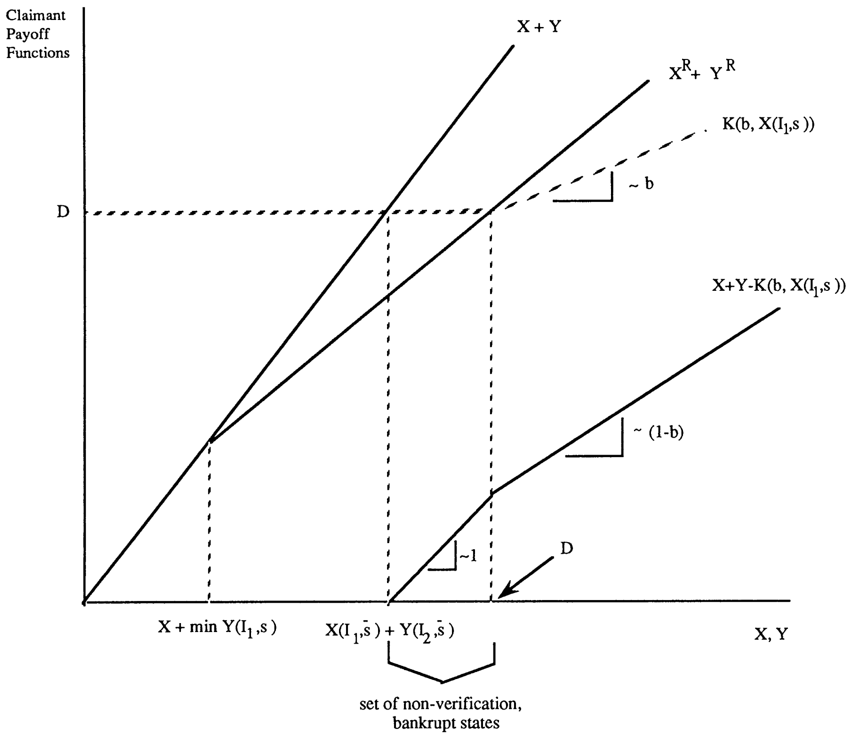

Figure 1. Optimal contractual configuration when $\min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s) \neq Y(I_2, \bar{s})$. The line $X + Y$ describes the firm's true return while the line $X^R + Y^R$ describes the firm's reported return. For reported returns less than $X(I_1, \bar{s}) + Y(I_2, \bar{s})$, the report is verified, the firm is bankrupt, and outsiders receive the firm's entire output. For reported returns between $X(I_1, \bar{s}) + Y(I_2, \bar{s})$ and D, the face value of the firm's debt, there is no monitoring, but the firm is bankrupt. Insiders are able to consume the difference between $X + Y$ and $X^R + Y^R$. Finally, when the firm's reported return exceeds D, the debt claimant is fully paid, outside equity holders receive the percentage b of the reported return above D, and insiders receive the remainder.

the insider entrepreneurs' payoff function is convex over some range of output and then concave over the remaining range. By setting the face value of the firm's debt above the set of outcomes in the verification range, the necessary convex-concave payoff structure emerges. As shown in Appendix A, the face value of the firm's debt claim in this case depends explicitly on the outside equity ownership percentage and the minimum feasible report for the firm's unobservable return.

The divergence between the event of bankruptcy and the verification region here can be explained as follows. With private information only, the optimal financial contract is designed to efficiently monitor the insiders' incentive to report the firm's unobservable return. The verification region is established to restore appropriate incentives while concurrently minimizing the costs of monitoring. Insiders will, as residual claimants, always choose to report the minimum feasible return in the nonverification region. By introducing private action, insiders face an additional source of conflict. In order to simultaneously resolve the private action and private information problems, the optimal financial contract is efficiently structured to minimize the total costs created by these adverse incentives. Theorems 2 and 3 demonstrate that the equivalence between bankruptcy and verification is broken because the dual sources of conflict can be most efficiently controlled by forgoing verification in certain bankruptcy states. By decreasing the set of states over which a verification occurs, this in turn changes the way in which insiders allocate investment because of the enhanced ability to transfer wealth by shifting risk. In other words, by enlarging the set of costly state verifications to coincide with the event of bankruptcy, insiders would then choose to deviate from the desired investment allocation, thereby reducing aggregate firm value. Here, in order to restore appropriate investment incentives, outside investors precommit to not verify reported outcomes in certain bankruptcy states.

COROLLARY 3.1: *If*

(i) $b > 0$, *and*

(ii) $\min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s) \neq Y(I_2, \bar{s})$,

then D decreases as

$$\min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s)$$

increases. Furthermore, this change is proportional to the ratio of outsider equity ownership to insider equity ownership (i.e., $b/(1 - b)$*).*

The main content of this result is that the face value of the firm's debt will decrease as the amount of output which insiders can appropriate for themselves decreases. As this amount becomes smaller, the optimal investment allocation is financed by larger proportions of external equity. The diminimished opportunity for insiders to misrepresent the firm's unobservable return leads directly to an increased reliance on output-contingent financial contracts and less reliance on the output-independent financial contracts. The intuition behind this result is as follows. As $\min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s)$ decreases, the effect is to decrease the payment to bondholders in the set of nonverification bankrupt states. In order to compensate for this, outside investors require an increase in the face value of their debt claim. A marginal increase in the face value of the debt claim held by outsiders must then be borne by the firm's residual claimants. Since there are two classes of residual claimants in our model (i.e., corporate insiders and outside equity holders), the increased promised payment to bondholders must be borne in direct proportion to their respective ownership positions.

This completes our initial study of the firm's direct financial contract problem. In the following section, we will examine the role of intermediated contract markets in this economy.

III. Direct and Intermediated Financial Contract Markets

An important feature of modern capital markets is the seemingly endless innovation in financial contracts and institutions. Behind these recent innovations is the intent to construct contractual relationships which most efficiently control the incentives of borrowers. In view of these changes, financial economists have begun to investigate the roles of banking institutions and direct financial contracts in the capital formation process. The modern theory of financial intermediation (e.g., Diamond (1984), Gorton and Haubrich (1986), Stiglitz (1985)) is based on the notion that it is too costly (relative to the anticipated benefits) for outside investors to continuously learn about all aspects of the firm's real activities. Banks arise as financial institutions in this environment to act as delegated monitors. Thus, intermediated credit markets and direct capital markets exist as alternative methods of controlling firm behavior. However, existing economic theories of these distinct markets focus on the nature of their substitutability. As Stiglitz (1985) notes, a more complete theory would focus on the complementarity between these markets.

The economic argument which supports the view of banking institutions as delegated monitors runs roughly as follows. In general, the holders of marketable corporate securities have little economic incentive to monitor firms in order to control agency problems. In particular, while each investor may act rationally by deciding not to monitor, the aggregate net effect is that the firm is not efficiently monitored. This is due to the public good nature of monitoring a firm by outside investors. Thus, while the total gains from the act of monitoring may be quite large, each individual investor's expected personal gain is likely to be quite small. Hence, there is an inefficient amount of monitoring in this framework since investors have inadequate incentives to do so. However, a bank which acts as a delegated monitor by aggregating the capital of a large number of individual investors and financing the investment projects of a large number of firms can emerge as a viable institution, provided that the gains from monitoring are sufficiently large.

We now demonstrate that financial intermediaries can arise as delegated monitors in our model. The keys to establishing this result are the principles of value additivity and diversification. Diamond (1984) was the first to recognize the role of diversification in establishing a theory of financial intermediaries as delegated monitors. The intuition is that, by holding a well diversified portfolio of loans, the costs of delegation become small. One can view the costs of delegation as the agency costs which arise in the contractual relationship between individual investors and the bank. Here, the threat of bankruptcy acts as an incentive device for the bank to perform its monitoring function. By holding a well diversified portfolio of loan contracts, the financial intermediary reduces the probability that pure chance will create a bad outcome on its loan portfolio. Hence, poor results will be due to lack of diligence in performing its delegated monitoring function rather than to nature drawing a bad outcome. Thus, monitoring reduces the incentives for a bank's borrowing firms to engage in suboptimal behavior, while diversification reduces the likelihood that the bank will fail to monitor the firm.[14]

In order to generate a role for a financial intermediary in our model economy, we will consider a multiple agent framework. Suppose that each of n outside investors holds an initial endowment of I^*/n units of investment capital, where $n \geq 2$. In this setting, a duplication of effort occurs in a direct contract market because each of the n investors must monitor the firm if a verification occurs. As in Diamond (1984), this potential duplication of effort gives rise to a delegated monitor. In the absence of an intermediated credit market, either the aggregate amount of monitoring is too small or an inefficiently large amount of resources is expended on this activity.

An intermediary here is shown to be an institution which issues financial claims to outside investors and then participates in the financing of the insider entrepreneurs' investment projects. The expected cost of monitoring by the intermediary is recovered from the expected return on the intermediary's investment portfolio. The cost of monitoring the intermediary by the outside investors goes to zero as the size of the bank's portfolio increases. It should be noted that the monitoring technology, the cost of monitoring, and the timing of monitoring decisions are different in our model than in Diamond (1984). However, the basic principle regarding the role of diversification in the resolution of information problems remains important. We are ready to state the main result of this section.

THEOREM 4: *The optimal contractual allocation in a direct financial contract market is dominated by an economy which allows both intermediated financial contract markets and direct financial contract markets. Furthermore, an efficient*

[14] A seemingly interesting application of this principle is in the area of interstate banking laws. Relaxation of interstate banking restrictions should enhance the ability of financial intermediaries to compete in credit markets. Since diversification reduces the agency costs associated with intermediated contract markets, enhanced opportunities to diversify loan portfolios should increase the efficiency of bank loan contracts. Whereas Texas banks may have largely been limited to lending capital to petroleum industry firms in the past, their ability to contract with firms in other industries should improve the competitiveness of bank loans.

monitoring policy will be implemented in the latter economy if the delegated monitor holds the following claim:

$$\int_S [X(I_1^*, s) + Y(I_2^*, s)]p(s)\, ds + \int_{S^c} D^* p(s)\, ds.$$

Due to limited space considerations, we omit the proof of this result. However, the intuition is relatively straightforward. First, note that the claim held by the monitor can be interpreted as a debt contract. The monitor need not hold the entire set of financial claims against the firm, in contrast to other models of financial intermediaries. Previous studies on the endogeneity of financial intermediaries consider only simple contractual arrangements, so that the dominance of intermediated contract markets over direct markets requires that the intermediary hold all outside claims. In effect, there is an equivalence between the formation of financial intermediaries and the structure of the economy's financial contracts. Such a result is not as immediate in our environment due to the existence of a more complex financial contracting relationship.

The key to our result is the recognition of the optimality of a lower-tail investigation strategy. Since such a strategy arises in our deterministic verification scheme, the claim held by the monitor should be sufficient to finance a portion of the optimal investment level at the lowest possible cost. As the expected cost of monitoring is an increasing function of the verification region, the face value of the intermediary's claim will be the minimum amount which simultaneously satisfies the firm's budget constraint.

Theorems 1 and 4 imply that the direct contract market which emerges with the intermediated contract market is an "outside equity" market. Thus, our results provide the foundation for the existence of an intermediated credit market and a direct equity contract market. Note also that, if $\min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s) \neq Y(I_2, \bar{s})$, then it is possible for a second class of debt claimants to arise in the firm's financial structure. In this latter case, this result is due to the fact that there is no longer an equivalence between the verification region and the event of bankruptcy. This, then, allows for the possibility that the debt component of the optimal contractual allocation can consist of two distinct classes. The higher priority claim, as Theorem 4 suggests, must be a monitored allocation. This facilitates our interpretation of this part of the debt contract as a bank loan. The lower priority portion of the debt contract can be interpreted as a traded, nonmonitored corporate bond. Consequently, the economy's optimal financial structure would consist of direct and intermediated credit markets, as well as direct outside equity markets.

This result may also shed some light on the empirical evidence regarding share price reaction to new security issues. In particular, our results suggest that, due to their monitoring function, bank loans may serve as substitutes for complex financial securities rather than straight corporate debt. However, bank loans would generally be a less risky security than complex corporate securities. Thus, shareholders are the beneficiary of improved incentives without the disadvantages of the issuance of risky securities. If the cost of monitoring borne by bank loan borrowers is less than the total costs generated by complex corporate security issuance, then share prices will react differently to the use of each type of capital. This suggests that, in some environments, bank loans may provide more appropriate incentives than "self-enforcing" corporate financial contracts.

IV. Interpretations and Implications of the Model

The purpose of this section is to discuss several implications and interpretations of our theoretical analysis. Several researchers have previously considered polar cases of the model under consideration in this paper. For example, Green (1984) and Green and Talmor (1985) investigate the incentive effects of the firm's liability structure in a private action model. Townsend (1979), Diamond (1984), and Gale and Hellwig (1985) examine the optimal structure of corporate financial contracts in a private information environment. For completeness, let us record the results of these studies in the context of our framework.

LEMMA 1: *If the firm's return is completely observable, then the appropriate investment incentives can be restored through the use of an all-equity financial structure. If the firm's return is completely unobservable, then the optimal financial contract is a debt contract.*

The first part of Lemma 1 describes the firm's optimal financial structure in a private action economy. Since insiders hold a residual claim on the firm's output, the introduction of a risky debt contract distorts the insiders' investment incentives. The consequent bondholder-stockholder conflict arises here because of their diverse preferences for the firm's payoff. The convexity of the claim held by the insiders leads directly to risk-seeking behavior in this framework. The second part of the lemma describes the firm's optimal financial contract in a private information economy. Here, observability problems preclude state (i.e., output)-contingent financial contracts. Hence, in order to finance the firm's investment level, the only feasible contract must be independent of the firm's output (in the absence of a costly verification), which is shown to be a standard debt contract.

Our decomposition of the firm's return into an observable and an unobservable component can have several instructive interpretations. However, the basic principle which generates our results is much more general than the issue of partial observability. Corporations often make investment decisions which, for various reasons, lead to outcomes upon which interested parties may not be able to contract. For example, the value of an exclusive patent or of large, undeveloped real estate holdings is an outcome upon which observed contractual arrangements do not directly depend. The point to focus on is that investment policies often produce outcomes which cannot form the basis of a contractual agreement. This is not to imply that such investments have no value, but rather that their idiosyncratic characteristics preclude contingent contracting. Our general interest here is the analysis of the real and financial consequences of such phenomena. The consideration of partially observable investment returns is really a special (but tractable) case of this more general situation.

With this discussion as background, we can now proceed to develop specific implications from our model. We focus first on comparative changes in the marginal productivity of firms' real investment projects.[15]

THEOREM 5: *An increase in the marginal productivity of the firm's observable return leads to an increase in the percentage of outside equity ownership and a decrease in the face value of the firm's debt.*

THEOREM 6: *An increase in the marginal productivity of the firm's unobservable return leads to a decrease in the percentage of outside equity ownership and an increase in the face value of the firm's debt.*

These results would seem to have some intuitive appeal. Consider two firms in our private action/private information economy. Suppose that their observable project returns have the same marginal productivity but that one firm has a higher marginal productivity for its unobservable project returns. Theorem 5 states that this firm will employ larger amounts of debt and smaller amounts of equity than the "comparable" firm. Intuitively, as the marginal productivity of the unobservable project increases, outside investors place less value on the marginal payoff on the firm's observable return. This causes outside investors to decrease their demand for the firm's output-contingent contractual distribution. In order to satisfy the firm's budget constraint (so that the optimal investment level can be financed), this leads to an increased reliance on debt contracts.

Alternatively, if we view the firm's optimal contracting problem as consisting of intermediated credit contract markets and direct equity capital contracts markets, then Theorem 5 states that the intermediated contract market will expand as the marginal productivity of unobservable projects in the economy increases. Similarly, periods of new technological innovation would likely see greater reliance on intermediated credit markets if one believes that it takes outside investors time to learn about the return-generating process of those investments. Arguments similar to those described above clarify the interpretation of Theorem 6.

THEOREM 7: *An increase in the marginal productivity of both the firm's observable return and the firm's unobservable return may increase or decrease the firm's reliance on the outside equity market.*

Thus, when both components of a firm's marginal productivity increase concurrently, the financial contracting effects are ambiguous. The reason for this ambiguity is that investors value the *relative* magnitude of the projects' marginal productivity. When both components increase together, the increase in the marginal productivity of the observable project is partially offset by the increase in the marginal productivity of the unobservable project. Thus, in order to restore appropriate investment incentives, the optimal financial contracting arrangement may require that the outside equity ownership percentage increase, decrease, or even remain the same. The important point is that, under the conditions of Theorem 7, the incentive effects created by one information problem (i.e., private action) are partially offset by the incentive effects created by another (i.e., private

[15] In order to keep our analysis manageable, we omit the proofs of these results. Proofs of the theorems in this section are available on request from the author.

information). Thus, it is not always necessary that the optimal financial contracting arrangement change to mitigate these distortions. In effect, the existence of multiple incentive problems may be sufficient to restore appropriate investment incentives without altering the optimal contractual allocation. As a result, the net effect in this case is ambiguous.

THEOREM 8: *As the cost of monitoring increases, the optimal investment level decreases, or the promised contractual allocation to the outside investors must increase.*

The result described in Theorem 8 depends on whether the cost of monitoring increases by an amount large enough to make the Pareto optimal investment level leave the feasible set. Thus, the focus is on the way in which the asset substitution problem and the partial observability problem are solved, together with the budgetary effect of costly monitoring.

V. Conclusions

In this paper, we have examined the structure of corporate investment and financing decisions in a private action/private information economy. The existence of these multiple agency problems gives rise to investment incentive distortions, which can be mitigated by the appropriate construction of a complex financial structure. As a result, our analysis focuses on the positive role of multiple claimants with divergent payoff structures rather than the traditional approach of rationalizing existing contractual characteristics and complex financial securities. We also demonstrate the important role of financial intermediary institutions in this framework. An important distinction in our model, however, is that intermediated financial contract markets emerge in conjunction with a direct financial contract market, rather than in place of it. We also provide a number of insights regarding the determinants of the relative size of each market sector in our economy.

There are a number of issues which remain to be explored in this setting. The current controversy regarding the separation of commercial banking and investment banking should properly be examined in a model where both direct and intermediated contract markets emerge simultaneously and endogenously. The model developed here provides such a framework. The framework here also provides a natural setting for examining the phenomenon of asset securitization. Intuitively, it is not clear that the role of financial institutions as delegated monitors is consistent with loan securitization. This is because, in our framework, it is important (from an efficiency standpoint) that some contracts be held by the intermediary sector. Since securitization effectively repackages claims in such a way that individuals hold a direct claim against the issuer, securitization effectively transforms intermediated contracts into direct contract. Clearly, this issue requires further analysis.

Our theoretical results describing the priority structure between monitored and nonmonitored loan contracts contradict the arguments of Fama (1985). He argues that bank loans will generally have lower priority than nonmonitored loan contracts since the latter can free-ride on the bank's costly evaluation of their own claim. In our framework, we have shown that the incentive problems under consideration require the monitored loan contract to be in the "lower tail of the lower tail"! Consequently, this issue would seem to require further investigation. In particular, what is the role of bank loans not only in providing investment capital and monitoring services but also in serving as an externality for other publicly traded corporate securities? Does the asset service provided by banks as delegated monitors improve the financial contracting terms and conditions available in the direct financial contract markets? The results here certainly provide support for an affirmative answer to these questions.

Appendix A

This Appendix describes the firm's financing and investment decisions in an economy where both private action and private information problems arise. Formally, it represents the insider entrepreneurs' solution to the programming problem described in equations (6)–(11). We begin our analysis by examining the solutions to the agent's problem in order to determine the insiders' optimal investment allocation. The first-order conditions from the agent's problem in our private action and private information economy can be written as follows:

$$g'(\bar{I}_2)/k'(\bar{I}_1) = \int_{S^c} p(s)\left[(1+R_1(s))\left(1-\frac{\partial K}{\partial X}\right)\right]ds \Big/ \int_{S^c} p(s)[(1+R_2(s))]\,ds, \quad \text{(A1)}$$

where $(\bar{I}_1, \bar{I}_2)$ is the second best investment allocation. Now in order for the firm's contractual allocation to be able to restore appropriate investment incentives, we must show that appropriate design of financial contracts leads to the first best result. The corresponding expression for the programming problem in a full information economy is

$$g'(I_2^*)/k'(I_1^*) = \frac{\int_U p(s)(1+R_1(s))\,ds}{\int_U p(s)(1+R_2(s))\,ds}, \quad \text{(A2)}$$

where (I_1^*, I_2^*) is the first best (i.e., firm value-maximizing) investment allocation. Hence, by combining (A1) and (A2), we must show

$$\frac{\int_U p(s)\left[J(s)(1+R_1(s))\left(1-\frac{\partial K}{\partial X}\right)\right]ds}{\int_U p(s)[J(s)(1+R_2(s))]\,ds} = \frac{\int_U p(s)(1+R_1(s))\,ds}{\int_U p(s)(1+R_2(s))\,ds}, \quad \text{(A3)}$$

where

$$J(s) = \begin{cases} 1 & \text{if } s \in S^c, \\ 0 & \text{if } s \in S. \end{cases} \quad \text{(A4)}$$

If we can show that this result holds, then our choice of the firm's optimal contractual allocation will restore appropriate investment incentives. Note that, by assumpiton (A6), the right-hand side of equation (A3) is identically equal to one. We are now ready to use this representation to help characterize the optimal contractual allocation.

First, if we assume that $\partial K/\partial X$ is state-independent, then (A3) becomes

$$\frac{\int_U p(s)[J(s)(1 + R_2(s) + z(s))]\, ds}{\int_U p(s)[J(s)(1 + R_2(s))]\, ds} = 1 \bigg/ \left(1 - \frac{\partial K}{\partial X}\right). \tag{A5}$$

From the first-order conditions in the agent's problem, it can be shown that $0 < \partial K/\partial X < 1$. Now, $\partial K/\partial X$ is state-independent only if it does not depend on $X(I_1, s)$. Thus, the partial derivative $\partial K/\partial X$ can be written only as a function of the contractual characteristic, b. In order words, we have established that

$$\frac{\partial K}{\partial X} = f(b), \qquad 0 < \frac{\partial K}{\partial X} < 1, \tag{A6}$$

where f is some arbitrary function. Next, if we rearrange the left-hand side of (A5) and simplify, then the Pareto optimal investment allocation can be restored if

$$1 + \frac{\int_U p(s)[J(s)z(s)]\, ds}{\int_U p(s)[J(s)(1 + R_2(s))]\, ds} = \frac{\dfrac{\partial K}{\partial X}}{1 - \dfrac{\partial K}{\partial X}}. \tag{A7}$$

Hence, (A6) and (A7) together define two conditions which any optimal contractual allocation must satisfy this economy. Now, if

$$\frac{\partial^2 Y}{\partial I_2 \partial s} > 0, \tag{A8}$$

then

$$Y(I_2, \bar{s}) = \min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s). \tag{A9}$$

That is, the state $\bar{s}$ defines the lower bound on the set of states where a verification does not occur and the minimum report to the outside investors in the nonverification region. Note that, if

$$Y(I_2, \bar{s}) \neq \min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s), \tag{A10}$$

then

$$Y(I_2, \bar{s}) > \min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s). \tag{A11}$$

(If this were not the case, then (A9) would necessarily hold.)

Now, if we temporarily ignore (A7), we can show that there is one particular financial contract which can universally resolve the incentive distortions for an arbitrary investment opportunity set. This claim can be interpreted as a complex contract which consists of debt and outside equity. From (A6), we have

$$K(b, X(I_2, s)) = f(b) \cdot X(I_1, s) + C_1. \tag{A12}$$

From the initial condition, we can determine the constant of integration, C_1, as follows. Recall

$$\begin{aligned} K(b, X(I_1, \bar{s})) &= X(I_2, \bar{s}) + Y(I_2, \bar{s}) \\ &= f(b) \cdot X(I_1, \bar{s}) + C_1. \end{aligned} \tag{A13}$$

Thus, we have

$$C_1 = (1 - f(b))X(I_1, \bar{s}) + Y(I_2, \bar{s}). \tag{A14}$$

However, since f is an arbitrary function, we can write (without loss of generality)

$$f(b) = b, \qquad 0 < b < 1. \tag{A15}$$

Thus, (A12) can be written as

$$K(b, X(I_1, s)) = b[X(I_1, s) + Y^R(I_2, s) - D] + D, \tag{A16}$$

where

$$D = X(I_1, \bar{s}) + \frac{Y(I_2, \bar{s}) - b \cdot Y^R(I_2, s)}{(1 - b)} \tag{A17}$$

and $Y^R(I_2, s)$ is the insiders' report of the firm's unobservable return to the outside investors in the absence of a verification.

In other words, this claim represents a contractual allocation consisting of an outside equity claim (where outsiders hold the fraciton b of the firm's equity) and a debt claim (where D represents the face value of the bond). From (A16), we observe that the optimal contractual allocation recognizes that the insiders will always report the minimum unobservable output in the absence of a verification because the value of the insider entrepreneurs' claim is a decreasing function of this report. That is,

$$Y^R(I_2, s) = \min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s). \tag{A18}$$

From (A16) and (A17), we can obtain the following results. First, if (A9) holds, then $D = X(I_1, s) + Y(I_2, s)$ always. That is, under these conditions, there is an equivalence between the verification region and the event of bankruptcy. However, if (A10) holds, then we have four possible cases to consider. To facilitate the exposition, define

$$Y(I_2, \bar{s}) \equiv \bar{Y}, \tag{A19}$$

$$\min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s) \equiv \hat{Y}. \tag{A20}$$

Then we have

$$\text{(i) } b = 0, \quad \hat{Y} > 0 \rightarrow D = X(I_1, \bar{s}) + Y(I_2, \bar{s}), \tag{A21}$$

$$\text{(ii) } b = 0, \quad \hat{Y} = 0 \rightarrow D = X(I_1, \bar{s}) + Y(I_2, \bar{s}),$$

$$\text{(iii) } b > 0, \quad \hat{Y} > 0 \rightarrow D = X(I_1, \bar{s}) + \frac{\bar{Y} - b\hat{Y}}{(1 - b)},$$

$$\text{(iv) } b > 0, \quad \hat{Y} = 0 \rightarrow D = X(I_1, \bar{s}) + \frac{\bar{Y}}{(1 - b)}.$$

Interestingly, in the latter two cases, (A16) suggests that state verification will not always occur when the firm is considered to be bankrupt, since $D \geq K(b, X(I_1, s))$. Thus, contrary to existing results (e.g., Gale and Hellwig (1985), Williamson (1986)), we may not necessarily be entitled to interpret state verification as equivalent to the event of bankruptcy in more complex financial contracting environments. The equivalence between state verification and the event of bankruptcy depends on 1) no outside equity ownership and 2) the minimum feasible report for the firm's unobservable return. Otherwise, the face value of the firm's debt claim will be larger than the maximum output level in the verification region. Recall that

$$Y(I_2, s) > \min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s)$$

if these two values are not equal. Hence,

$$Y(I_2, s) > b \min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s)$$

since $0 < b < 1$. Therefore, from (A21)(iii) and (A21)(iv), we see that the face value of the firm's bond decreases as $\min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s)$ increases.

Hence, certain bankrupt states will not be verified, where the number of unobserved states depends on the outside ownership position. Equation (A21) confirms that the face value of the firm's bond increases as the percentage of outside equity ownership increases.

Henceforth, we will assume

$$\min_{\substack{s \in S^c \\ I \geq 0}} Y(I_2, s) = Y(I_2, \bar{s}), \tag{A22}$$

so that

$$D = X(I_1, \bar{s}) + Y(I_2, \bar{s}). \tag{A23}$$

This allows us to interpret the verification region as the set of states where the firm is bankrupt. This assumption will facilitate a comparison of our subsequent results with existing analyses which make use of this equivalence.

Recall, however, that this complex claims structure was derived by ignoring the necessary condition (A7). From (A16), we have

$$\frac{\partial K}{\partial X} \Bigg/ \left(1 - \frac{\partial K}{\partial X}\right) = \frac{b}{(1 - b)}, \tag{A24}$$

which is merely the ratio of outside equity ownership relative to insider equity ownership. Thus, combining (A7) and (A24), in order for the debt and outside equity claims to restore the appropriate investment incentives, we must have

$$1 + \frac{\int_U p(s)[J(s)z(s)]\, ds}{\int^U p(s)[J(s)(1 + R_2(s))]\, ds} = \frac{b}{(1 - b)}. \tag{A25}$$

As discussed in Green (1984), the numerator on the left-hand side will be positive since $J(s)$ is positively correlated with the firm's output. Similarly, the demoninator on the left-hand side will be positive since both expectations and the covariance term are all positive. Therefore, the left-hand side is positive. Since $0 \leq b \leq 1$, the right-hand side will likewise be positive. Furthermore, the optimal contractual allocation (A12) is unique since it was derived as the solution to an initial value problem. Equation (A17) shows how the firm should optimally select the face value of its debt contracts, and equation (A25) provides the appropriate condition for the distribution of the firm's outside equity ownership. Finally, the contractual characteristics should be chosen so that the first-best investment level can be financed:

$$I_1^* + I_2^* = \int_S [X(I_1^*, s) + Y(I_2^*, s) - s]p(s)\, ds + E \tag{A26}$$

$$+ \int_S [b[X(I_1^*, s) + Y^R(I_2^*, s) - D] + D]p(s)\, ds.$$

These expressions complete our characterization of the firm's optimal contractual distribution in our private action/private information economy.

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