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The Impact of Alternative Bank Monitoring Policies on Corporate Investment and Financing Decisions

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The views expressed in this paper are those of the authors, not necessarily those of the Federal Reserve Bank of St. Louis or the Federal Reserve System.

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1. Introduction

Recent advances in the theory of financial intermediation have enhanced our understanding of the special role of bank loans in funding corporate investments. Much of the benefit from bank loans is generated by the specialized monitoring and information gathering role provided by financial institutions, including their role in facilitating the reorganization of firms experiencing financial distress. Despite these numerous benefits, it is somewhat surprising that aggregate trends suggest that the corporate sector has decreased its reliance on bank loans.

Kaufman (1991) discusses the factors which have diminished the role of the banking sector in the U.S. economy. Bank regulations, such as restrictions on geographic locations and product offerings, limit the ability of banks to compete. These constraints became especially onerous as advances in communications and technology lowered the innovation costs of other forms of financing. The net impact of these events was that the benefits of bank monitoring were being eroded by improvements in the financing alternatives available to corporations directly through the capital markets.

In addition, as the relative importance of international commerce increased, foreign banks expanded into the U.S. to provide services to their commercial customers. Frankel and Montgomery (1991) provide an interesting perspective on changes in the international banking sector. They note that, as foreign banks expanded, they were not subject to the same constraints as U.S. banks. This asymmetry allowed foreign banks to provide products and services that differed from the offerings of U.S. banks. Consequently, U.S. banks lost their traditional loan business to innovations in the capital markets (e.g., commercial paper, junk bonds) as well as to less-constrained foreign bank competitors. This suggests that the degree of competition as well as the manner in which banks form and preserve customer relationships are crucial determinants of performance.

There has, however, been very little formal analysis of this phenomenon. We model this problem by investigating the relationship between alternative bank monitoring policies and corporate investment and financing decisions. We choose to examine this relationship because of the delegated monitoring role provided by banks [see, e.g., Diamond (1984)]. The limitation of existing studies is that, while they explain the special economic service provided by banks, they do not typically describe how the size of the banking sector evolves through time, nor how changes in bank policy impact the efficiency of managerial decision-making. The main idea in this paper is that regulatory and competitive factors constrain the reaction of banks to changes in the economic environment. One plausible means of adapting to these changes is that banks alter some aspect of their monitoring policies. Thus, rather than taking the monitoring characteristics of the bank as fixed, we examine the effects of changes in bank monitoring policies on corporate investment and financing decisions. This analysis then provides us with very specific insights about how the banking sector evolves through time, and what the likely real and capital market consequences of such changes might be.

It is unlikely that changes in bank monitoring policies provide a complete explanation of the variation in the size of the banking sector. Berlin (1991) investigates the hypothesis that the size of the banking sector varies due to a bank's specialized role in restructuring troubled credits. He argues that the incentive for firms to borrow from banks depends on the likelihood of, and perceived benefits from, restructuring versus the costs generated by the capacity constraints that banks face in rescheduling loans. In reality, the special role of banks is undoubtedly a function of several important services that they provide, including information generation as well as loan workout specialists [see, e.g., Campbell and Kracaw (1980)]. Thus, we view the analysis in this paper as complementary to that contained in Berlin (1991).

The remainder of the paper is organized as follows.

2. The Base Case Model

The original insight that describes depository-type financial intermediaries as delegated monitors is contained in Diamond (1984). In order to fully analyze the properties of the delegated monitor, the extant literature exogenously characterizes the monitor with a particular set of attributes. For example, the monitor typically utilizes a deterministic verification policy to observe information at a fixed cost. The monitor is assumed to fully observe the firm's private information without error. There has been little analysis of the optimal combination of monitoring properties, and we do not pursue this issue in this paper. Rather, we show how changes in each of the properties of the monitor described above impact corporate investment and financing decisions. This approach then allows us to characterize how changes in bank monitoring policies ultimately impact the relative size of the banking sector.

The construct of our base case model is similar to the structure described in Seward (1990). We consider a single period model where the firm has access to two separate, perfectly divisible investment projects. Let $\mathbf{I_j}$ represent the amount of capital allocated to production process j. An investment of $\mathbf{I_1}$ in Project 1 generates an end-of-period state-contingent cash flow of $\mathbf{X(I_1,s)}$, where

$$\textbf{(1)} \qquad X(I_1, s) = k(I_1)\ (1 + R_1(s))$$

Similarly, an investment of $\mathbf{I_2}$ in project 2 produces cash flow of $\mathbf{Y(I_2, s)}$, where

$$\textbf{(2)} \qquad Y(I_2, s) = g(I_2)\ (1 + R_2(s))$$

In this representation, the deterministic scale functions $\mathbf{g(\cdot)}$ and $\mathbf{k(\cdot)}$ are assumed to be concave and twice differentiable in their arguments. We assume that $\mathbf{g'(0) = k'(0) = \infty}$ where the prime denotes the derivative. In order to facilitate our subsequent characterization of the delegated monitor's verification policy, we assume that the firm's marginal aggregate output is increasing across the states of nature. The random multiplicative shock term for production process **j, (1 +**

$\mathbf{R_j(s)}$), depends on the state of nature **s**, which is an outcome from the universal set, **U**. We assume that the firm's production process is additively separable. Hence, the firm's aggregate cash flow, **W(I,s)**, is the sum of the cash flows from each of the firm's investment projects:

$$\textbf{(3)} \qquad W(I, s) = X(I_1, s) + Y(I_2, s)$$

There are two sources of post-contracting moral hazard in our model. First, the firm's realized cash flow is only partially observable by outside investors. In particular, outsiders can costlessly observe the cash flow component $\mathbf{X(I_1, s)}$, but can observe the cash flow $\mathbf{Y(I_2, s)}$ only by expending resources to verify managerial statements about the realization of $\mathbf{Y(I_2, s)}$. Since a policy of verification in all states of nature would be prohibitively costly, one goal of the firm's financial contracting decision is to establish an efficient outside verification policy. The second problem which confronts outside investors is that, while they can observe the firm's aggregate investment level, the allocation of capital across investment projects is unobservable. As a result, outside investors cannot observe the relative allocation of funds to projects 1 and 2. This distinction matters to outside investors because Project 1 is riskier than Project 2, in the sense described by the following assumption:

$$\textbf{(4)} \qquad 1 + R_1(s) = 1 + R_2(s) + z(s), \qquad \text{where } \acute{U}_U\, z(s)\, p(s)\, ds = 0$$

In our framework, **p(s)** describes the unique state-claim prices in our complete market setting. Expression (4) states that the first 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. Table 1 summarizes the relevant characteristics of the firm's investment projects.

Outside investors can verify the realization of the second project, $\mathbf{Y\ (I_2, s)}$, through a costly monitoring technology. Our base case model allows outside investors access to a deterministic monitoring technology with perfect observability. Furthermore, the cost of

verification, **w**, is initially assumed to be fixed. This type of monitoring policy impacts the firm's contracting problem because the return realized by outside investors depends on whether verification occurs. In the absence of a costly verification, insiders would declare a low realization of the unobservable return component of the firm's aggregate cash flow stream. However, excessive verification policies can be costly for two reasons. First, verification entails the expenditure of resources. Second, since verification occurs only in the set of states where default occurs, an increase in the firm's debt level induces insiders to adopt riskier investment policies. Thus, in this framework, private information allows insiders to benefit from the consumption of unobservable cash flows while private action transfers wealth to insiders from the firm's bondholders. In part, the firm's contracting decisions must balance these two agency problems.

The payoff due to the outside investors at the end of the period can be described as follows. Let **a(b)** represent the observable characteristics of the contractual claim held by the outside investors in the set of states where monitoring occurs (does not occur). Let **S** describe the set of outcomes over which a verification occurs. Then the payment due to the outside investors can be described by the following schedule:

$$(5) \qquad P = \begin{cases} C\,(a,\ X\,(I_1,\ s),\ Y\,(I_2,\ s)) & \forall\ s \in S, \\ K\,(b,\ X\,(I_1,\ s)) & \forall\ s \in S^c, \end{cases}$$

where $\mathbf{S^c}$ is the complement of **S** and hence represents the set of outcomes over which monitoring does not occur. Finally, let **E** represent the insiders' initial equity contribution to the firm, and let **F** represent the total amount of capital which insiders can allocate across the firm's set of investment projects. Then the firm's investment and financing problem can be written as:

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

$$+ \int_{S} [X(I_1, s) + Y(I_2, s) - C(a, X(I_1, s), Y(I_2, s))]\, p(s)\, ds$$

subject to

(7) $$0 \le P \le X(I_1, s) + Y(I_2, s),$$

(8) $$F \le \int_{S} [C(a, X(I_1, s), Y(I_2, s)) - w]p(s)\, ds + \int_{S^c} K(b, X(I_1, s))\, p(s)\, ds + E$$

(9) $$I \in \underset{I' \ge O}{\text{argmax}} \int_{S} [X(I'_1, s) + Y(I'_2, s) - C(a, X(I'_1, s), Y(I'_2, s))]\, p(s)\, ds$$

$$+ \int_{S^c} [X(I'_1, s) + Y(I'_2, s) - K(b, X(I_1, s))]\, p(s)\, ds$$

subject to

(10) $$I'_1 + I'_2 \le F,$$

(11) $$K(b, X(I_1, s)), C(a, X(I_1, s), Y(I_2, s)) \ge 0.$$

In this formulation, the firm's management implements investment and financing policies which maximize the value of the insiders' wealth. Because the optimal sharing rule depends on whether outsiders verify the realization of the unobservable cash flow stream, insiders' wealth depends upon the nature of their residual claim and their ability to consume "perks". The opportunity for the latter arises in those states where outsiders choose not to monitor, and insiders claim that realized cash flow is less than its actual outcome. Equations (7) and (11)

describe non-negativity constraints on the payoffs from the firm's financial claims. Hence, these conditions impose limited liability restrictions on the set of feasible distributions. Equation (8) is a rationality condition which states that investors do not overpay for the firm's financial securities, despite the moral hazard. Finally, equation (9) is the incentive compatibility condition which states that investment decisions by insiders are made to maximize their own personal benefit.

The solution to the insiders' programming problem provides a characterization of the optimal investment decision, financing choices, and verification strategy. We now briefly discuss each of these policy decisions.

A. Investment

The assumption that investment decisions can be made after the firm has completed its financing plans creates the possibility that the allocation of fund may disproportionately benefit insiders. Thus, taking as given the firm's scale and capital structure, we consider the mix of investment projects undertaken by the firm.

The relative allocation of capital across the firm's investment projects is determined by analyzing the first-order condition for the insiders' programming problem. Let $(\hat{I}_1, \hat{I}_2)$ solve the programming problem (6) - (11). In order to describe the allocation of capital among the set of investment projects undertaken by the firm, we form the ratio of marginal scale products. After some simplification, the investment allocation decision solves the following:

$$(12) \qquad \frac{g'(\hat{I}_2)}{k'(\hat{I}_1)} = \frac{\int_u \left[(1 + R_1(s)) \left(1 - \frac{\partial K}{\partial X} \right) \right] J(s)\, p(s)\, ds}{\int_u [(1 + R_2(s))]\, J(s)\, p(s)\, ds}$$

where

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

Here, **J(s)** is an indicator function for the event that the firm is not monitored. Subsequently, **J(s)** will also indicate that the firm is solvent. This relationship will provide the base case investment allocation benchmark against which we subsequently compare other investment decisions under alternative monitoring policies. Equation (12) indicates that two factors influence the relative proportion of investment capital allocated to Project 1. Either an increase in the present value of the project's random shock term, or a decrease in the marginal payoff to outside claimants in the non-bankrupt states per dollar of cash flow from the risky, observable project increases the firm's investment in Project 1. Conversely, an increase in the present value of the second project's random shock term increases the insiders' investment in Project 2.

B. Monitoring

The extant literature typically assumes an equivalence between verification by the monitor and the event of bankruptcy. That is, monitoring of private information occurs in those states where the firm is unable to repay its debt obligations. As discussed in Seward (1990), however, the interpretation of the verification region as the set of states where bankruptcy occurs holds only in certain cases. However, in order to facilitate the comparison of our results with other studies, we will assume that verification occurs only in the set of states where the firm declares bankruptcy. Seward (1990) shows that the contract **K (•,•,•,)** takes the form of the standard debt obligation. Let **D** represent the face value for the firm's pure discount debt obligation. In this case, the verification region is defined by the relationship:

$$\textbf{(13)} \quad \mathbf{D} = \mathbf{X(I_1, \bar{s}) + Y(I_2, \bar{s})}$$

where $\bar{s}$ defines the lower bound on the set of states where a verification does not occur. Hence, the state $\bar{s}$ also defines the minimum report to outside investors for outcomes in the non-verification region. This relationship simply states that, for a firm which has a maturing debt obligation with face value **D**, the optimal monitoring policy involves verification in any state where the firm declares bankruptcy. Thus, in our model, the firm's choice of debt financing will simultaneously determine the verification region. Since delegated monitoring reduces the duplication costs of verification and we have posited an equivalence between bankruptcy and verification, then all of the debt in our framework will be in the form of bank loans (i.e., no publicly-traded corporate bonds). Thus, there is an equivalence between the amount of corporate debt financing and the size of the financial intermediary sector in our model. Higher debt levels increase the set of states over which the private information problem is resolved, but also reduces the firm's reliance on outside equity. Since it is the latter which mitigates the insiders' risk-shifting incentives, the choice of an optimal monitoring policy is quite complex.

C. Financing

In our framework, the form of the firm's financial contracts is important because it can reduce the investment distortions that arise from private action and private information. Since we have assumed that monitoring occurs in each bankruptcy state, the face value of the firm's debt contract is important because it determines the verification region. An increase in the face value of the firm's debt is beneficial because verification enhances the observability of the firm's cash flow. This incremental benefit is somewhat offset by the cost of verification, so that the optimal monitoring strategy depends on several factors in our model.

Corporate insiders can also obtain investment capital from outside equity claimants in our framework. Again, utilizing the first-order conditions for the insiders' programming problem, the optimal proportion of outside equity ownership, $\hat{b}$, solves the following:

$$(14) \quad \frac{\hat{b}}{(1-\hat{b})} = 1 + \frac{\int_u [J(s)\, z(s)]\, p(s)\, ds}{\int_u [J(s)\, (1 + R_2(s))]\, p(s)\, ds}$$

The interpretation of the relationship described by (14) is relatively straightforward. The left hand side is the ratio of outside equity ownership to inside equity ownership. The right hand side indicates that the optimal ownership percentages depend on two covariances. The first, which is described by the integral in the numerator, is the covariability between the idiosyncratic risk of Project 1 and the event of bankruptcy. The second, described by the integral in the denominator, is the covariability between the second project's random shock term and the event of bankruptcy. Assuming both covariances are positive, a higher value of the numerator covariance and a lower value of the second covariance increases the ownership percentage of the outside equity claimants. Note also that, when the covariances have the same sign, outsiders will optimally control a majority of the firm's equity. Equation (14), in conjunction with equation (13), describes the firm's financing decisions in our base case scenario.

3. The Role of Imperfect Observability

In this section, we extend our basic results to examine two related issues. First, we characterize the impact of imperfect verification on the firm's investment and financial contracting policies. We also investigate the impact of imperfect observability on the formation of financial intermediaries. In general, relative to the alternative of choosing not to contract with the monitor, the introduction of imperfect observability produces two opposing effects on the welfare of the contracting parties. First, since the information generated by the monitor is imperfect, an additional source of uncertainty is introduced into the principal-agent contracting problem. The risk preferences of the contracting parties may be such that this additional uncertainty reduces welfare. However, the incorporation of an "informative" (albeit imperfect) monitoring technology tends to motivate managerial actions which subsequently improve the

welfare of corporate insiders and outside investors. Thus, despite the introduction of this additional source of uncertainty, the potential for welfare gains provides the incentive to design contracts which incorporate the outcome of the imperfect monitoring technology.

We consider an imperfect monitoring technology of the form:

$$\textbf{(15)} \quad \mathbf{Z(I_2,s) = Y(I_2,s) + n(I_2,s)}$$

where

$$(16) \quad \int_{\Omega} n(I_2,s)\ p(s)\ ds = O$$

This formulation expresses the notion that the observability problems that arise in this framework are a function of the firm's investment allocation to the unobservable project as well as the state of nature. It also states that, over the entire state-space, the economic impact of the observability problem is neutral. Corporate insiders can costlessly observe **Y (•, •)**, while a costly verification reveals **Z (•, •)** to the outside investors. This additional source of uncertainty is factored into the amount of investment capital which outside investors are willing to commit to the firm, as well as the structural form of the financial contracts. This occurs because actual observation errors in any particular state have different impacts on each group of agents. In particular, the firm's investment and financial contracting decisions are chosen to solve the following programming problem:

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

subject to

(18) $$O \le P \le X(I_1, s) + Y(I_2, s)$$

(19) $$F \le \int_{S} [C(a, X(I_1, s), Z(I_2, s)) - \omega]\, p(s)\, ds + \int_{S^c} K(\beta, X(I_1, s))\, p(s)\, ds + E$$

(20) $$I \in \underset{I' \ge 0}{\text{argmax}} \int_{S^c} [X(I_{1'}, s) + Y(I_{2'}, s) - K(\beta, X(I_{1'}, s))]\, p(s)\, ds$$

subject to

(21) $$I_{1'} + I_{2'} \le F$$

(22) $$K(\beta, X(I_1, s)),\ C(\alpha, X(I_1, s), Y(I_2, s)) \ge 0$$

The incremental effect introduced by imperfect observability can be seen by examining equations (18) and (20). Since costly verification reveals the outcome $\mathbf{Z(I_2,s)}$ to outside investors, the contractual claim in the set of states where monitoring occurs will be imperfectly related to the true cash flow realization from the firm's unobservable project, $\mathbf{Y(I_2,s)}$.

Now, for analytical convenience, we can decompose the observability error term, $\mathbf{n(I_2,s)}$, into a deterministic and a random component. In particular, we shall assume:[1]

(23) $$\mathbf{n(I_2,s) = g(I_2)\, R_3(s)}$$

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[1] From Equation (12), we then have that $\int_{\Omega} \mathbf{R_3(s)\, p(s)\, ds = O}$. Thus the real and financial effects of imperfect observability arise because insiders consider its impact only in the set of states where a verification occurs.

The impact of imperfect observability on corporate investment and financing decisions can be determined by analyzing the first-order conditions for the manager's programming problem (18) - (22). The following proposition summarizes the impact of imperfect observability on managerial investment incentives.

<u>Proposition 1:</u> Imperfect observability by the monitor leads to over- (under-) investment in the risky project,

$$\frac{g'(\hat{I}_2)}{k'(\hat{I}_1)} > (<) \frac{g'(\bar{I}_2)}{k'(\bar{I}_1)}$$

when the covariance term **($R_3(s)$, $J(s)$)** is positive (negative).

<u>Proof:</u> See Appendix 1

Thus, relative to the case of perfect observability by the monitor, the incremental investment effects induced by imperfect observability depend on the covariance between the random error component, **$R_3(s)$**, and the set of states where a verification occurs. Insiders prefer to invest in projects whose payoffs are positively correlated with the set of states where no verification occurs. Thus, when observation errors are positively correlated with the event of verification (bankruptcy), insiders increase their proportional investment in the unobservable, low risk project. The intuition is that, since insiders care about returns in the solvency states, when **Cov ($R_3(s)$, $J(s)$)** is negative then outsiders underestimate the unobserved cash flow component in the non-bankrupt states. Note that while the primary impact of imperfect observability is to exacerbate the private information problem, the secondary effect is that it also influences the relative importance of the risk shifting problem. From the perspective of the firm's management, imperfect observability alters the gains available from investing in projects subject to private information problems relative to the wealth transfers that accrue from risk shifting.

This characterization suggests an interesting distinction among investment projects whose returns are subject to private information problems. Typically, there is no linkage between the firm's financial condition and the severity of the information problems confronting outside investors. However, in the case of imperfect observability, investment distortions depend importantly on the correlation between the firm's solvency and observation errors by the monitor. As Proposition 1 demonstrates, when the monitor's verification reveals that the cash flow from the low risk, unobservable project is higher (lower) than actual cash flow in the bankruptcy states, the incentive to under- (over-) invest in risky projects exists. Thus, when private information problems arise, it is important to consider when observation errors are likely to occur. Thus, for example, the incentive for insiders to adopt riskier investments as the firm nears financial distress may not be universal. The intuition is that, for certain types of assets, the wealth transfers available from risk shifting are outweighed by the welfare losses from consumption of perks. Thus, assets whose values are more likely to be overestimated in distressed situations are less likely to be subject to risk-shifting problems.

Imperfect observability also impacts the optimal mix of inside and outside equity ownership. The following proposition summarizes this result.

<u>Proposition 2:</u> Imperfect observability by the monitor leads to increased (decreased) reliance on outside equity ownership,

$$\frac{\bar{b}}{\left(1-\bar{b}\right)} > (<) \frac{\hat{b}}{\left(1-\hat{b}\right)}$$

when the term covariance $R_3(s)$, $J(s)$ is positive (negative).

<u>Proof:</u> See Appendix 2

When the monitor's observation error is positively correlated with the set of states where there is no verification, Proposition 1 establishes that the proportional allocation of the firm's budget to the risky project increases. Since this investment incentive exacerbates the risk shifting problem, the intuitive financial contracting adjustment is to increase the firm's reliance on outside equity. By increasing the firm's reliance on outside equity, the insiders mitigate the secondary effect of increasing the risk of the firm's investment projects. In our framework, this effect occurs because a shift in the firm's investment allocation toward the observable project also increases the firm's commitment to risky production technologies.

Consider the case where the covariance described in Propositions 1 and 2. We know that, relative to the case of perfect observability, the firm will increase its investment in the observable, risky project and its reliance on outside equity. How does imperfect observability affect the firm's scale decision and the verification policy? Establishing the size of the verification region is important here because it determines the set of states over which insiders benefit from their investment decisions. Holding the firm's scale decision fixed, the impact of imperfect observability on the size of the financial intermediary sector again depends on the correlation between $R_3(s)$ and $J(s)$. When the covariance is positive, Proposition 2 establishes that the firm increases its reliance on external equity financing, and hence the imperfect observability diminishes the size of the banking sector. However, from the first-order conditions for the firm's investment decision, the scale of the firm also depends on the observation error. When the error is an increasing function of the firm's allocation to the unobservable project, the scale of the firm will generally decrease. Thus, the shrinkage in the financial intermediary sector comes about because b increases and I decreases.

Note also that, for projects where **Cov $(R_3(s), J(s))$** is negative, then the reverse holds. thus, the size of the financial intermediary sector depends importantly on the direction (i.e., over or under) of the misestimation by the monitor in the set of states where verification occurs.

This suggests that the financial intermediary sector is most likely to expand when unobservable low-risk projects are likely to be undervalued in bankruptcy. If one argues that

many of the assets of financially distressed corporations have in fact been overvalued in today's economy, then this analysis offers an explanation for the observed shrinkage in the size of the financial intermediary sector recently.

4. The Role of the Monitoring Cost Function

In this section, we retain the assumption of perfect observability and focus on the investment and financing implications of structural changes in the monitoring cost function. There are several reasons why this approach is worth investigating. First, general improvements in technology, communications and innovation directly alter the cost effectiveness of direct monitoring activity. These changes will exert a twofold effect on the efficiency of intermediated financial contracts. Although the determinants of a bank's cost of monitoring are not well understood, it seems reasonable to assert that recent advances in technology and communication have reduced the costs of monitoring. These changes may also have expanded the menu of cost functions that banks can feasibly employ in their monitoring activities. On the other hand, similar innovations in the capital markets have undoubtedly reduced the costs of direct financial contracting, thereby reducing the direct and indirect costs of alternative forms of financing.

We suppose that monitors can choose from a menu of feasible cost functions in establishing a deterministic verification strategy with a particular firm. For example, a particular monitor could elect to implement a different verification strategy for different firms, with the monitoring cost function chosen in response to certain firm specific characteristics. The existing literature generally ignores this possibility, as a given delegated monitor is assumed to employ the same verification scheme for all firms.

In order to gain some insight into these issues, we examine two separate functional forms for the monitoring cost. Initially, we assume that the cost of monitoring depends only on the firm's unobservable return component, $\mathbf{Y(I_2,s)}$. The rationale for a cost function of this form is that there exists a direct linkage between the cost of verification and the state which is to be

verified. Let the cost of monitoring in this case be described by the function **J ((YI$_2$,s))**. We will refer to this as an output contingent cost function. We assume that $\frac{2J}{2Y}$ is positive and covex, so that the cost of verification is an increasing function of the firm's unobservable output. Thus, higher aggregate unobservable output requires a costlier expenditure of resources by the monitor to verify.

Alternatively, the cost of monitoring may depend directly on the configuration of the firm's outstanding financial contracts, and hence indirectly on the firm's observable and unobservable project returns. This approach establishes a direct relationship between the amount of resources expended on monitoring and the structure of the firm's financial contracts. The rationale is that insider behavior can be controlled directly by the process of verification, or indirectly through the use of financial contracts. That is, direct financial contracts <u>induce</u> certain behavior while direct monitoring <u>restricts</u> certain behavior. We assume that the firm's complete structure of financial contracts is important in determining the total cost of verification, so that the contractual allocation in both the verification region and the non-verification region matter. While the appropriate design of financial contracts can help to align the diverse interests of different claimant classes, we recognize that such contracts cannot always be constructed to restore appropriate incentives under all conditions. Hence, in this view, direct monitoring serves to complement the incentive effects of the firm's direct financial contracts. We utilize the **function J[K(b, X(I$_1$,s)), C(a, X(I$_1$,s), Y(I$_2$,s))]** to represent the cost of monitoring in this case. We refer to this as a contract contingent cost function.

We first consider the real and financial impact of the output contingent cost function. The insiders' revised programming problem can be written as follows:

(24) $$\underset{I,\beta,\alpha,F}{\text{Maximize}} \int_{S^c} [\, X(I_1, s) + Y(I_2, s) - K(\beta, X(I_1, s))\,]\, p(s)\, ds$$

$$+ \int_{S} [X(I_1, s) + Y(I_2, s) - C(\alpha, X(I_1, s), Y(I_2, s))]\, p(s)\, ds$$

subject to

(25) $$O \le P \le X(I_1, s) + Y(I_2, s)$$

(26) $$F \le \int_{S} [\, X(I_1, s), + Y(I_2,s) - J(Y(I_2,s))]\, p(s)\, ds$$

$$+ \int_{S^c} [\, K(\beta, X(I_1, s)\ p(s)\,]\, ds + E_o$$

(27) $$I \in \underset{I' \ge 0}{\text{argmax}} \int_{S^c} [\, X(I_{1'}, s) + Y(I_{2'}, s) - K(\beta, X(I_{1'}, s))]\, p(s)\, ds$$

subject to

(28) $$I_{1'} + I_{2'} \le F$$

(29) $$K(\beta, X(1_1,s)),\ C(\alpha, X(I_1,s), Y(I_2,s)) \ge 0$$

The following proposition demonstrates that a change from fixed cost verification strategy to ether form of state contingent monitoring cost function has no impact on the insiders' relative investment allocation decision.

Proposition : The implementation of a state (i.e., output or contract) contingent monitoring cost function does not affect the insider entrepreneurs' decision rule for determining the optimal investment allocation across projects.

Proof: See Exhibit _____

The intuition for the result stated in Proposition _____ follows immediately as a direct consequence of the choice variables under consideration in our model and the way in which the monitoring cost function enters the insider entrepreneurs' programming problem. The adoption of a state contingent monitoring cost function introduces an additional source of uncertainty into the optimization problem. This uncertainty manifests itself in the form of the cost and amount of monitoring rather than through investment distortions. Consequently, as the following propositions indicate, the main impact of the state contingent monitoring cost function is through the adjustment of financial contract characteristics and the verification region.

Proposition : All else equal, the implementation of a state contingent monitoring cost function leads to an increase in the size of the financial intermediary sector and a decrease in the size of the direct contract market.

Proof: See Exhibit _____

Proposition : The size of the financial intermediary sector under an output contingent monitoring cost function is smaller than the size of the financial intermediary sector under a contract contingent monitoring cost function.

Proof: See Exhibit _____

Thus, the form of the monitoring cost function in intermediated credit relationships is an important determinant of the aggregate size of the financial intermediary sector. These results provide some useful insights into the problem of credit rationing. For example, Stiglitz and Weiss (1981) and Williamson (1986) demonstrate how contractual characteristics within a single contract market adjust in equilibrium to ration credit. In our model, with both direct and intermediated contract markets arising endogenously, rationing can occur through adjustments in

either market. Our results suggest that, even if the level of aggregate investment decreases in our model, the relative size of the intermediated contract market increases.

5. The Role of Stochastic Monitoring Strategies

A contractual arrangement based upon a deterministic verification policy pre-specifies the set of outcomes over which monitoring occurs. As a result, monitoring occurs with probability one or zero. An alternative agreement could entail a monitoring strategy in which the decision to verify is random. The advantage of the stochastic monitoring policy is that random procedures reduce the expected costs of monitoring while the credible threat of a verification induces honest reporting of the unobservable project's cash flow. The net benefit of the random policy depends on its effect on the firm's investment and financing decisions. The purpose of this section is to explore these implications. Ultimately, the applicability of a stochastic verification policy may depend on whether the process of information gathering is random or deterministic.

Townsend (1979) demonstrates the potential dominance of a stochastic verification scheme over a deterministic verification policy through the use of an example. Dye (1986) investigates the feasibility of stochastic verification strategies in a standard principal-agent framework, where monitoring reveals information about the agent's effort level. However, neither Townsend or Dye consider the financial contracting effects or the delegated monitoring implications of the random strategy.

The notion of a stochastic monitoring policy certainly has appeal in a principal-agent framework where supervisors are unable to costlessly observe subordinates' actions. It is perhaps less clear that such a verification scheme would work in a financial contracting framework. This perception is supported by Gale and Hellwig's (1985) intuitively appealing analysis of the equivalence between the event of bankruptcy and costly monitoring in a deterministic verification scheme. However, we believe that it is not unrealistic to explore the implications of stochastic monitoring in a financial contracting problem. For example, the management of

corporations operating under the protection of bankruptcy laws often set forth their own reorganization plans. Often times, creditors accept these terms, and hence (in our framework) can be construed as not verifying the true value of the firm. Furthermore, lenders often serve in some advisory or directorship capacity (e.g., on a corporation's Board of Directors) and hence gain knowledge of the firm's activities even in solvent states.

Thus, despite the intuitive appeal of the equivalence between bankruptcy and verification, it is quite likely that the process of information gathering is more random in nature. By analyzing the simultaneous choice of financial contracts and stochastic monitoring policies, we hope to gain further insights regarding the interaction between the incentive compatibility of random state verification strategies.

The basic structure of the stochastic monitoring policy is as follows. The end-of-period payoffs to the firm's financial claimants depends in part on whether there is a verification, and the latter is determined in a random way. Specifically, the random investigation strategy is represented by the function $\mathbf{f(Y_2,s))}$, where $\mathbf{f(')}$ is the probability of a verification contingent upon the insiders' statements with respect to the realization of the firm's unobservable return component. The programming problem can now be written as follows:

(30) Maximize $\int_{\Omega} \{ f(Y(I_2,s)) [X(I_1,s) + Y(I_2,s) - C(\alpha, X(I_1,s), Y(I_2,s))]$

$+ (1 - f(Y(I_2,s))) [X(I_1,s) + Y(I_2,s) - K(\beta, X(I_1,s))] \} p(s) ds$

subject to

(31) $0 \leq P \leq X(I_1,s) + Y(I_2,s)$

(32) $F \leq \int_{\Omega} \{ f(Y(I_2,s)) [C(\alpha, X(I_1,s), Y(I_2,s)) - \omega] + (1 - f(Y(I_2,s))) [K(\beta, X(I_1,s))]\}$

$p(s) ds + E_o$

(33) $1 \in \underset{1' \geq 0}{\text{argmax}} \int_{\Omega} \{ f(Y(I_{2'},s)) [X(I_{1'},s) + Y(I_{2'},s) - C(\alpha, X(I_{1'},s), Y(I_{2'},s))]$

$+ (1 - f(Y(I_{2'},s))) [X(I_{1'},s) + Y(I_{2'},s) - K(\beta, X(I_{1'},s))] \} p(s) ds$

subject to

(34) $I_{1'} + I_{2'} \leq F$

(35) $C(\alpha, X(I_1,s), Y(I_2,s)), K(\beta, X(I_1,s)) \geq 0$

(36) $0 \leq f(Y(I_2,s)) \leq 1$

Unfortunately, the nature of the firm's investment and contracting problem becomes quite complex when we allow for a random monitoring policy. This additional degree of freedom dramatically enlarges the feasible contracting strategies available to the economic agents in our model. Our first result describes the general form f the random monitoring technology.

Proposition: The optimal random monitoring strategy is a lower-tail investigation policy.

Proof: See Appendix _____.

The optimality of a lower-tail investigation strategy is relatively straightforward. Low output outcomes may be due to inappropriate investment decisions by the insider entrepreneurs. By verifying all low output outcomes and keeping the firm's entire output in these states, outside investors motivate insider entrepreneurs to choose optimal investment behavior. Since high output outcomes will generally not evidence distortionary investment allocations, these states are not monitored. Intuitively, outside investors discount the fact that, beyond the verification region, insider entrepreneurs always declare the unobservable output $\mathbf{Y(I_2,s)}$ to be low enough so as to just avoid investigation. Unobservability reduces the risk incentive problem because insiders no longer gain at the expense of the firm's debt claimants.

As Appendix ____ indicates, however, the factors which influence the exact structure of the random monitoring policy are quite complex. In particular, the verification strategy depends upon the following: (1) the firm's production technologies; (2) the available monitoring technologies; (3) the firm's set of financial contracts; and (4) the state probabilities. The complexity of the verification strategy described is due to the fact that the additional restrictions necessary for Proposition _____ are relatively minimal. The remaining results described in this section are obtained by imposing several additional restrictions. In particular, e restrict our derivation of the optimal monitoring policy to the class of all linear strategies.

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Table 1

Summary of Investment Project Characteristics

Project	Investment	Cash flow	Observability of Cash Flow	Risk
1	I_1	$X(I_1, s)$	Yes	High
2	I_2	$Y(I_2, s)$	No	Low