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ABSTRACT

This paper studies certain effects of insider trading on the principal-agent problem in corporations. Specifically, we focus on insiders' choice among investment projects. Other things equal, insider trading leads insiders to choose riskier investment projects, because increased volatility of results enables insiders to make greater trading profits if they learn these results in advance of the market. This effect might or might not be beneficial, however, because insiders' risk-aversion pulls them toward a conservative investment policy. We identify and compare insiders' choices of projects with insider trading and those without such trading. We also study the optimal contract design with insider trading and without such trading, thus identifying the effects that allowing such trading has on other elements of insiders' compensation. Using these results, we identify the conditions under which insider trading increases or decreases corporate value by affecting the choice of projects with uncertain returns.

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I. INTRODUCTION

The managers of a corporation may well wish to buy or sell shares of their company. The legal rules of the United States, as well as those of other advanced market economies, substantially limit -- but, as explained below, do not prohibit or prevent -- such trading by corporate insiders. The extent, if any, to which such trading by insiders is harmful and should be constrained has long been the subject of active and intense public debate.

To the extent that the economic literature has analyzed insider trading, it has largely focussed on the trading process itself. Researchers studied, both theoretically and empirically, how the possession of insider information enables insiders to make trading profits, and how the presence of insider trading affects the accuracy of market prices.[1] Although such analysis is important, an evaluation of insider trading also requires an understanding of the ex ante effects of such trading.

One important class of such ex ante effects consists of the effects of insider trading on the ex ante management decisions of insiders.

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[1] Papers that develop models of trading and pricing decisions in the presence of better informed traders include Glosten and Milgrom (1985), Kyle (1985), Mirman and Samuelson (1989), and Radner (1979). These models show how the informed traders can make profits and how their trades lead gradually to the incorporation of the traders' private information into the market price. Papers that examine empirically the profitability of insiders' trades include Finnerty (1976), Jaffe (1974), and Seyhun (1986). Finally, two recent additions to this literature question the extent to which insider trading improves the accuracy of market prices. Fishman and Hagerty (1989) show that, although insider trading leads to the incorporation of the insiders' information into the market price, it might also discourage other traders from investing in the acquisition of other kinds of information and consequently might make market prices less "accurate." Laffont and Maskin (1990) show that, if the informed trader is sufficiently large, there is an equilibrium in which his trading would not reveal his private information.

Economists have devoted much attention in the last decade to the principal-agent problem in firms. Researchers have studied the level of "agency costs" -- that is, the amount lost due to managers' deviation from value maximization -- under different contractual features and corporate structures. Thus, it is natural to ask whether trading by corporate insiders aggravates or mitigates the principal-agent problem. With insider trading, managers' decisions may be partly shaped by the desire to increase their expected trading profits. The question, then, is whether the introduction of this consideration brings management decisions closer to, or further away from, the value-maximizing decisions. While the academic literature by lawyers is full of informal assertions and speculations on this question,[2] the economic literature thus far has devoted little attention to it[3] (even though economists have recently started exploring other ex ante effects of insider trading).[4]

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[2] See, e.g., Carlton and Fischel (1983), Easterbrook (1985), and Scott (1980).

[3] The only two papers by economists to consider this subject are Leftwich and Verrecchia (1983) and Dye (1984). These two papers do not develop the framework of analysis that we develop below and which seems to us necessary to study the question. Dye only considers, assuming that managers's trades are observable, whether shareholders would be able to draw useful information (for determining the managers' compensation) from the managers' trades. Dye does not consider, however, the question on which we focus, that is, how insider trading (and the resulting managerial desire to increase trading profits) affects management decisions. The relationship of the Leftwich and Verrecchia paper to ours is indicated in note 6.

[4] The effects on the agency problem are not the only ex ante effects of insider trading, and some recent work by economists looks at other ex ante effects. Ausubel (1990) and Manove (1989) examine the effect that insider trading might have on ex ante investment even without the agency problem. Because insider trading reduces the expected return to the initial shareholders, it might decrease their investment. Both papers assume away the agency problem on which we focus. Ausubel assumes that the insiders

This paper is part of a project modelling the effects of insider trading on the agency problem in corporations. In this project, we put forward what we view as the appropriate framework for examining these effects. We seek to contrast the behavior of insiders under contracts that allow trading in the firm's shares and their behavior under those that prohibit such trading. In our view, such a comparison requires a principal-agent model, such as the one that we use, that takes into account explicitly all the relevant ex ante effects; it must take into account, among other things, how the treatment of insider trading affects other compensation elements, and how the anticipated insider behavior will be reflected in the ex ante market price which will be the basis for subsequent insider trading.

Insiders make different types of management decisions, and we have found that the complexity of the subject makes it useful to examine separately the effect of insider trading on each type of insiders' decisions. Thus, the present paper focusses on one major type of management decisions that insiders must make -- their choice among risky investment projects. (Other types of management decisions are analyzed in different parts of our project).[5] To analyze the effect of insider trading on

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make no management decisions. In Manove's model, the insiders do make a decision -- they choose the investment level -- but he assumes that in making this decision they do not maximize their own rewards but rather serve only the interests of the initial shareholders. (Manove's model thus seems to apply better to trading by outsiders on the basis of inside information than to trading on the basis of such information by insiders). Both authors also abstract from the question of insider compensation -- they do not take into account, as we do, that allowing insider trading may affect (and presumably would reduce) the expected salary that must be given to insiders.

[5] Bebchuk and Fershtman (1990a) analyzes the insider's choice of a level of effort, and Bebchuk and Fershtman (1990b) focusses on the insider's incentives to "waste" corporate value. Together, our three papers attempt to cover the effects of insider trading on all the different types of insiders'

insiders' project choice, we compare the choices that insiders make under contracts that allow insider trading with those they would make under contracts that prohibit such trading. Contracts not only determine the treatment of trading, but also specify a salary, which may include both a fixed component and a component that depends on results.

Under contracts that prohibit insider trading, managers' choice among investment projects with uncertain returns may be inefficient for a familiar reason. Unlike the shareholders, who can diversify, the managers of a corporation are likely to be affected in their attitude to the project's results by a significant degree of risk aversion. To the extent that part of the managers' salary depends on the firm's profits, which might be necessary to induce managerial effort, the managers will be too conservative: they might choose a safer project even if it offers a lower expected return.

Under contracts that allow insider trading, managers look more favorably on risky projects. The reason for this is that, to the extent that managers learn ahead of the market how uncertainty is resolved, greater uncertainty enables them to make greater trading profits. Thus, the possibility of insider trading would induce the managers to accept some desirable risky projects that would be rejected without insider trading. Allowing insider trading, however, also involves certain disadvantages. First, the "correction" might lead to overshooting: the desire to increase their trading profits might lead the managers to prefer a riskier project even if it offers a lower expected return. Furthermore, compensating managers with trading profits of uncertain size increases the risk that they bear and thus requires an increase in their expected overall compensation. On the whole, allowing insider trading may make insiders' choice among investment projects better or worse, depending on

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management decisions.

parameters that the analysis identifies.

Our model enables us to solve explicitly for the behavior of managers, and the optimal contract design under the two different types of contracts. We also identify the effects of allowing insider trading on the structure and overall expected value of insiders' compensation. Using these results, we identify the conditions under which the presence of insider trading increases or decreases corporate value by affecting the choice among investment projects under uncertainly.[6]

In assessing the importance and relevance of conclusions about insiders' behavior in the presence of insider trading, it is important to recognize that a significant amount of such trading takes place. The law does not totally prohibit insiders from making trading profits. The law includes a per se prohibition only with respect to insiders' profiting from "short-swing" transactions -- transactions in which the insider buys and then sells (or sells and then buys) within a six-month period. But trading on the basis of private information might be of course quite profitable even if one cannot close one's position within six months. When insiders do not go in and out of the company's stock within a six-month period, the law constrains their trading only if it can be shown to be based on inside information. Insiders often can openly make profitable trades, as the evidence indeed indicates (see, e.g., Jaffe (1974)), because their motive for trading is often not observable or not verifiable. Furthermore, insiders may hide not their motive for trading but rather the trading

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[6] The observation that insider trading would lead managers, other things equal, to choose riskier projects has been made in the unpublished paper by Leftwich and Verrechia (1983). These authors, however, did not fully model the effect of insider trading on insiders' project choice; for example, they did not attempt to model how this effect counters the conservative tendency arising from managers' risk-aversion and how the provision of trading profits affects other compensation elements. Consequently, they do not analyze whether presence of insider trading makes insiders' choice among projects on the whole better or worse.

itself. Much trading by insiders may well go undetected.

The amount of insiders' trading profits is a function of both the strictness of the legal and corporate arrangements governing such trading and the expenditures on enforcement. The trading profits that insiders now make are presumably smaller than those that would be made in the absence of any restrictions, and larger than those that would be made under a regime that is harsher either in its rules or in its enforcement efforts. Thus, findings on the consequences of insider trading have both normative and positive implications. From a normative perspective, they are relevant for determining the optimal amount of insider trading. From a positive perspective, given that much insider trading takes place at present, such conclusions are necessary for a full understanding of actual insider behavior under the existing legal regime.

This paper is organized as follows. Section II presents the framework of analysis. Sections III and IV analyze the insider's choice among projects (and the optimal salary scheme) without inside trading and with such trading, respectively. Section V compares the two regimes. Section VI generalizes the analysis. Finally, Section VII presents concluding remarks.

II. THE MODEL

The sequence of events in the model is as follows. In period 0, the firm is formed, and the managerial contract is specified. In period 1, the managers choose an investment project, and in period 2 they work on it. In period 3, the managers get advance information about the project's results, and if the managerial contract allows them to do so, they use this private information to participate profitably in the trading that takes place during this period. In period 4, the final period, the project's results are realized. Our assumptions concerning each of these elements of the model are described below.

Period 0: Contract Specification. A company is formed, and the managers and the shareholders (or equivalently, the entrepreneur who sets up the company and sells its shares to the shareholders) specify a contract. The contract provides the managers with some salary that increases in the firm's final output (or the firm's final value). For simplicity we focus on schemes that are linear in the firm's final output, denoted by W.[7] Thus, the contract specifies some S and α, $0 \leq \alpha \leq 1$, and the salary scheme is $C(W) = S + \alpha W$. In addition, the contract specifies whether the managers are allowed to trade in the firm's shares or not. We shall refer to contracts prohibiting insider trading as NT (no-trading) contracts and to those allowing such trading as IT (insider-trading) contracts. In the case of an IT contract, we will denote by Π the insider trading profits managers will make. The total compensation that the managers will receive, which we denote by X(W), will be equal to C(W) in an NT contract and $C(W) + \Pi$ in an IT contract. The initial value of the firm is denoted as V_0 and will be endogenously determined, depending on the managers' contract and the set of possible projects from which they will choose. The main question to be considered in this paper is how NT and IT contracts differ in their effect on managers' subsequent project choice and on V_0.

Period 1: Project Choice. The managers choose an investment project. The choice that they must make is between two projects one of which is riskier. The less risky project, project zero, would produce a final output $W = W_0 + \theta$, where $W_0 \geq 0$ is a function of managerial effort, and θ is a random variable such that $E(\theta) = 0$. The riskier project,

[7] In our model, any scheme that is linear in the firm's final output can be translated into some scheme that is linear in the firm's final market value; and any scheme that is linear in the firm's final value can be translated into some scheme that is linear in the final output.

denoted as (r_R,ε_R), produces an output $W(r_R,\varepsilon_R) = W_0 + r_R + (1+\varepsilon_R)\theta$. ε_R is assumed to be positive, which makes the riskier project riskier. r_R may be positive or negative, and the riskier project accordingly may offer a higher or lower expected return than project zero. Thus, both projects produce an output of the form $W_0 + r + (1+\varepsilon)\theta$, with (r,ε) equal to (0,0) for project zero and to (r_R,ε_R) for the risky project.

For simplicity it will be useful to assume a specific distribution of θ. We will assume that θ can be either m or -m with probabilities (½,½) for some $m > 0$. This assumption will simplify our calculations considerably, and yet it will enable us to examine the various aspects of insider trading.

The shareholders can observe the managers' choice of project, and the firm's value at this period will reflect this observation. The managerial choice is not verifiable by courts, however, and for this reason the managerial compensation could not have been made contingent on it.

The value of shares in this period is V_1. We assume at this stage that the two projects between which the managers choose in period 1 are already known in period 0. Given this, the managers' choice in period 1, which will be identified in the analysis below, will be anticipated in period 0 and thus reflected in V_0. Thus, $V_1 = V_0$. Section V analyzes the case in which projects arrive randomly in period 1 and consequently V_1 might differ from V_0.

Period 2: Project Operation. In this period, the managers work on the chosen project, investing some effort. Although the focus of this paper is on the managerial choice among investment projects rather than on their subsequent choice of effort level (the latter question is analyzed in Bebchuk and Fershtman, 1990a), it is desirable to include in the present model a simple effort choice. The existence of effort choice is important for the purpose of analyzing project choice, because the need to induce managerial effort may make it desirable to have a positive α even if such α is not necessary for the purpose of influencing project choice. We introduce this consideration into our model by assuming the following simple effort choice. There are two effort levels e^* and 0, with $W_0(e^*) = W_0$ and $W_0(0) = W_0 - L$. We assume that L is sufficiently large for it to be always desirable to induce managers to choose e^*, and the only way to do so is to have a sufficiently high α. Specifically, let $\underline{\alpha}$ denote the minimum α that satisfies this condition. (Assuming that managerial utility is separable in the utility of wealth and disutility of effort, as we will assume, $\underline{\alpha} = e^*/L$.)

Period 3: Trading. At the beginning of this period, the managers (but not others) learn θ and thus know the final value, V_f. Subsequently, trading in the firm's shares takes place with the following participants: liquidity-motivated sellers, a market maker (specialist) who sets the price, and also the insiders, if their contract so allows. We make the standard assumptions about this trading. The liquidity sellers are some of the initial shareholders who cannot defer realizing the value of their shares until the final period. It is assumed that each of the initial shareholders faces the same probability of needing to liquidate his holdings during this trading period. The aggregate supply of shares from liquidity sellers in (any given round of) the trading is a random variable, with a distribution known by the market maker. If insider trading is possible, the market maker recognizes the presence of such trading but does not observe the orders placed by the insiders; he observes only the net aggregate of orders, and can draw inferences about the direction in which the insiders are trading only from this aggregate volume and from his knowledge of the distribution of the liquidity sellers' supply of shares. The market maker is assumed to make zero profits.

Under an NT contract, the market maker knows that all those who trade with him do not have information about θ. Therefore, the price will be set equal to the market maker's (unconditional) expectation of the firm's final value, and liquidity sellers will not have to bear any losses due to their trading.

Under an IT contract, the market maker knows that some of the orders that went into the aggregate of net orders were made by better informed insiders. Such trading has been already analyzed in detail by Kyle (1985) and by Glosten and Milgrom (1985). They have modelled how in such a trading, the market maker will set his price (to break even, the market maker will have to set his price below his (unconditional) expectation of the final value) and how the insiders' information will gradually become reflected in the shares' price. There is no reason to duplicate here the analysis of these models, and we will simply rely on their conclusions.

For our purposes, what is important to recognize is that, as has been established by the above literature, the trading under an IT contract has the following features. First, the insiders can make some profits; for the market maker, at least initially, will not be able to tell for sure whether the insiders are selling or buying. Second, even though the insiders can make profits, they can capture only part of the gap between the pre-trading period 1 value V_1 and the firm's final value V_f ; for one thing, as they trade more shares, the insiders' information will be increasingly reflected in the prices set by the market maker. We capture these essential features by assuming that the insiders can capture a certain fraction β, $0 < \beta < 1$, of the gap between V_1 and V_f; that is, $\pi = \beta \,|V_f - V_1|$.[8] Of course, the insiders' expected profits all come at the

[8] We thus assume that selling and buying shares is equally accessible to insiders and that insiders can capture the same fraction of the gap between initial and final value when the final value is high as when the final value is low. Allowing for different β's for the two cases, as we do in Bebchuk and Fershtman (1989b), would complicate our calculations considerably but would not change the nature of our results.

Note that because we assume that the contract puts no restrictions on expense of the liquidity sellers, as the market maker makes zero expected profits.

Period 4: Realization of Output. The final output W is realized, and the salary $S + \alpha W$ is paid to the shareholders. The final value of the shares is thus $V_f = W - C(W) = (1-\alpha)W - S$. The curtain now goes down. (The firm dissolves, or alternatively, a new contract is made with the managers.)

The Managerial Labor Market Constraint. In designing the contract, the following aspects about the managers must be taken into account. Since only shareholders can spread the risk among many firms we assume that whereas the shareholders are risk-neutral, the managers are risk-averse. Specifically, we assume that their expected utility from random return x is given by

$$(1) \qquad U(x) = E(x) - \gamma\sigma(x),$$

where $\sigma(x)$ is the standard deviation of x, and $0 < \gamma < 1$ is a given constant.[9]

We further assume that managerial utility is separable in the utility of wealth and disutility of effort. Let C_A be the highest expected utility of wealth net of effort that is available to the managers from employment elsewhere, and let $\bar{C} = C_A + e^*$. Thus, for the contract to satisfy the managers' participation constraint, the expected managerial

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trading, the reason for β being smaller than 1 is only the ability of the market to get some information from the trades. To the extent that the contract puts some restrictions on trading, it can lower β further.

We do not examine the choice of β because we assume that, although firms can choose α, they have limited ability to influence β.

[9] $\gamma > 0$ is implied by the managers' risk aversion. $\gamma < 1$ is necessary to guarantee that if the risky project dominates project zero -- that is, if $W_0 + r_R - (1+\varepsilon_R)m > W_0 + m$ -- the risky project (r_R,ε_R) will be chosen by the managers.

utility must not be below $\bar{C}$.

In order to make the constraint binding, the owners may lower the fixed salary S. We shall assume that S can be lowered as much as is desirable to make the participation constraint binding.

The First Best. If the managerial actions were all observable and verifiable, the shareholders would direct the managers to choose the risky project if $r_R > 0$ and project zero otherwise, and they will pay the managers a fixed salary equal to $\bar{C}$. Consequently, the first-best initial value is $V_0^* = W_0 + \max(0, r_R) - \bar{C}$. Because managerial actions are not observable or not verifiable, however, it is not possible to attain this first best. We shall explain below the various ways in which the performance of NT and IT contracts falls short of the first best.

III. PROJECT CHOICE AND CORPORATE VALUE UNDER NT CONTRACTS

Insiders' Project Choice

Let us first examine the managers' choice under a given NT contract (S,α). In the absence of trading profits the managers' total returns will be $C(W(r,\varepsilon))$ where (r,ε) is the project chosen by management.

(2) $$E(C(W(r,\varepsilon))) = S + \alpha E(W(r,\varepsilon)) = S + \alpha(W_0 + r)$$

(3) $$\sigma(C(W(r,\varepsilon))) = \alpha(1 + \varepsilon)m.$$

Thus the managers' expected utility is:

(4) $$U(C(W(r,\varepsilon))) = S + \alpha(W_0 + r) - \gamma\alpha(1 + \varepsilon)m.$$

Proposition 1: Given any NT contract (S,α) the managers will choose the risky project if and only if

(5) $$r > \underline{r}_{NT}(\varepsilon_R) \equiv \gamma\varepsilon_R m.$$

Proof: The managers will choose the risky project as long as $U(C(W(r_R,\varepsilon_R))) > U(C(W(0,0)))$. Substituting (2)-(4) into this inequality yields that (r_R,ε_R) is chosen if and only if

$$(6) \qquad S + \alpha(W_0 + r_R) - \gamma\alpha(1 + \varepsilon_R)m > S + \alpha W_0 - \gamma\alpha m.$$

Simplifying (6) yields that managers prefer the risky project (r_R,ε_R) over project zero if and only if $r_R > \gamma\varepsilon_R m$. ■

Remark: Examining $\underline{r}_{NT}(\varepsilon)$, notice that it is strictly positive for every $\alpha > 0$. That is, the managers might not choose the riskier project even if it offers a higher expected return than project zero; this will happen if the rise in the managers' expected compensation would not be sufficient to compensate them for the higher risk they would have to bear. The higher is the extra risk associated with the risky project (i.e., the higher is ε), then the higher the extra expected return that the risky project must offer to be accepted. Notice that for the same reason an increase in γ (more risk-averse managers) implies an increase in $\underline{r}_{NT}(\varepsilon)$.

Corporate Value

Having identified the managers' choice, let us now consider the initial corporate value. Assuming that shareholders can make the participation constraint binding and project (r,ε) is chosen:

$$(7) \qquad S_{NT} = \bar{C} - \alpha(W_0 + r) + \gamma\alpha(1 + \varepsilon)m.$$

Thus, given that managers are provided with an NT contract, the optimal compensation scheme is $(S_{NT},\underline{\alpha})$, which implies that the initial value of the firm, as a function of the accepted project, is:[10]

(8) $$V_1(r,\varepsilon) = (W_0 + r) - \bar{C} - \gamma\underline{\alpha}(1 + \varepsilon)m$$

where

(9) $$\begin{cases} r = r_R,\ \varepsilon = \varepsilon_R & \text{if } r_R > \underline{r}_{NT}(\varepsilon_R) \\ r = 0,\ \varepsilon = 0 & \text{if } r_R \leq \underline{r}_{NT}(\varepsilon_R). \end{cases}$$

The first expression in (8) is the value of the project from which we subtract the managers' alternative salaries, $\bar{C}$, and the compensation given to them for the risk they are bearing.

Notice that the above V_1 may be lower than the first best value in two ways. First, the managers' choice of project might be inefficient. Second, because managers must be compensated for the risk they bear, the expected compensation that must be given to them exceeds $\bar{C}$ by the required risk premium (which is the last term on the right side of (8)).

Note that, because managers must be compensated for the risk imposed on them, shareholders no longer prefer any risky project with $r_R > 0$ over the project zero; the risk premium that is necessary to compensate the managers might exceed the increase in the expected value of the project. Specifically:

Proposition 2: (i) Given that managers are to get an NT contract that makes the participation constraint binding (i.e., that compensates managers for the risk they are expected to bear), shareholders prefer the risky project (r_R,ε_R) if and only if

$$r_R > r^*_{NT}(\varepsilon_R) \equiv \gamma\alpha m\varepsilon_R.$$

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[10]At this stage we have not yet shown that the optimal contract is one with $\alpha = \underline{\alpha}$. Rather we examine the initial value for a given α and S_{NT} that satisfies (7), i.e., makes the participation constraint binding.

(ii) There are risky projects that the managers will not choose even though they are preferred by the shareholders.

Proof: As shareholders wish to maximize the initial value V_1, they prefer the risky project (r_R, ε_R) as long as $V_1(r_R, \varepsilon_R) > V_1(0,0)$. Using (8) this condition implies that the risky project is preferred by owners as long as

$$W_0 + r_R - \bar{C} - \gamma\alpha(1 + \varepsilon_R)m > W_0 - \bar{C} - \gamma\alpha m,$$

which yields that shareholders prefer the risky project if and only if $r_R > \gamma\alpha m\varepsilon_R$.

Using (5) yields that $r^*_{NT}(\varepsilon_R) < \underline{r}_{NT}(\varepsilon_R)$ for every ε_R. Thus a risky project (r_R, ε_R) such that $r^*_{NT}(\varepsilon_R) < r_R < \underline{r}_{NT}(\varepsilon_R)$ will not be chosen by managers according to Proposition 1 even though Proposition 2(i) implies that shareholders wish it would be accepted. ■

Intuitively, the above proposition indicates that when $r_R < r^*_{NT}(\varepsilon_R)$ the risk premium that shareholders must provide exceeds the benefits that they have from the managers' choice of the risky project. Note that still for every given (S,α) the shareholders prefer the choice of the risky project; but when the contract includes automatic compensation for extra risk, i.e., (S_{NT},α) contract where S_{NT} is as specified by (7), shareholders prefer the risky project only when $r_R > r^*_{NT}(\varepsilon_R)$.

The Optimal NT Contract

Equation (8) indicates that $V_1(r,\varepsilon)$ is a decreasing function of α. The greater α is, the greater is the risk managers have to bear, and thus the greater is the expected compensation they get. Thus it is not optimal for shareholders to increase α beyond the necessary level $\underline{\alpha}$ that induce the effort level e^*.

IV. PROJECT CHOICE AND CORPORATE VALUE UNDER IT CONTRACTS

Insiders' Project Choice

Under an IT contract, managers' compensation consists not only of the direct compensation C(W) but also of trading profits Π. The profits from insider trade is a random variable that depends on the chosen project and on the initial value $V_1(r,\varepsilon)$. Denoting by $X(r,\varepsilon)$ the overall returns of managers if they choose the project (r,ε) and insider trade is feasible, we obtain that

$$X(r,\varepsilon) = S + \alpha W(r,\varepsilon) + \Pi(r,\varepsilon) \tag{10}$$

where $\Pi(r,\varepsilon)$ is the insider trade profits that depend on the chosen project and on the initial value, which is also a function of (r,ε).

Under an IT contract, managers' compensation (and thus their project choice) depend on V_1, as their trading profits depend on V_1. V_1 in turn depends on shareholders' expectations as to how the managers will choose an investment project. Given the expected managerial choice between (0,0) and (r_R,ε_R), a (rational expectations) equilibrium is a value V_1^* and a managerial choice (r^*,ε^*) such that: the choice of (r^*,ε^*) is optimal for the managers given V_1^*; and given the choice (r^*,ε^*), V_1^* is the expected value of the final output net of the managers' total compensation.

Proposition 3: Given an IT contract, managers will choose the risky project (r_R,ε_R) if and only if

$$r_R > \underline{r}_{IT}(\varepsilon_R) \equiv \gamma\varepsilon_R m - \beta\varepsilon_R m(\beta\gamma + 1)\left(\frac{1-\alpha}{\alpha}\right). \tag{11}$$

Proof: The managers' project choice is determined by comparing

$U(X(r_R, \varepsilon_R))$ and $U(X(0,0))$. The expected profits from inside trade are[11]

$$(12) \qquad E(\Pi(r,\varepsilon)) = E(\beta\,|V_f(r,\varepsilon,\theta) - V_1(r,\varepsilon)|)$$
$$= \tfrac{1}{2}\beta[(1-\alpha)(W_0 + r + (1+\varepsilon)m) - S - V_1(r,\varepsilon)]$$
$$+ \tfrac{1}{2}\beta[V_1(r,\varepsilon) - (1-\alpha)(W_0 + r - (1+\varepsilon)m) + S]$$
$$= \beta(1-\alpha)(1+\varepsilon)m.$$

Using (12) yields the managers' expected returns:

$$(13) \qquad E(X(r,\varepsilon)) = S + \alpha E(W(r,\varepsilon)) + E(\Pi(r,\varepsilon))$$
$$= S + \alpha(W_0 + r) + \beta(1-\alpha)(1+\varepsilon)m.$$

Simple calculations indicate that

$$(14) \qquad \sigma(X(r,\varepsilon)) = \alpha(1+\varepsilon)m + \beta^2(1-\alpha)(1+\varepsilon)m.$$

Substituting (13) and (14) into (1) yields the managers' expected utility:

$$(15) \qquad U(X(r,\varepsilon)) = S + \alpha(W_0 + r) + \beta(1-\alpha)(1+\varepsilon)m$$
$$- \gamma[\alpha(1+\varepsilon)m + \beta^2(1-\alpha)(1+\varepsilon)m].$$

The risky project (r_R, ε_R) is chosen only if $U(X(r_R, \varepsilon_R)) > U(X(0,0))$. Using (15) implies that the risky project yields higher utility if and only if

$$(16) \quad S + \alpha(W_0 + r_R) + \beta(1-\alpha)(1+\varepsilon_R)m - \gamma[\alpha(1+\varepsilon_R)m + \beta^2(1-\alpha)(1+\varepsilon_R)m]$$
$$> S + \alpha W_0 + \beta(1-\alpha)m - \gamma[\alpha m + \beta^2(1-\alpha)m].$$

Rearranging (16) yields that the risky project is chosen only if

$$r_R > \gamma\varepsilon_R m - \beta\varepsilon_R m(\beta\gamma + 1)\left(\frac{1-\alpha}{\alpha}\right) \equiv \underline{r}_{IT}(\varepsilon_R). \quad \blacksquare$$

[11]In calculating the expected profit from insider trade we consider the case in which $(1-\alpha)(W_0 + r - (1+\varepsilon)m) - S < V_1(r,\varepsilon) < (1-\alpha)(W_0 + r + (1+\varepsilon)m) - S$, which indeed is satisfied as one can calculate $V_1(r,\varepsilon)$.

Remarks: (i) Note now that higher β implies lower $\underline{r}_{IT}(\varepsilon_R)$, which implies that projects that were not acceptable with the low β become acceptable for managers. Intuitively, one can see (Eq. (12)) that the profits from insider trade are correlated with the variability of the project, i.e., $E\Pi(\bullet)$ goes up with ε. Thus an increase in β implies that there is more profits that can be done now from insider trading and thus managers will be willing to accept projects with lower expected returns as long as they can benefit from exploiting the variability of the project.

(ii) Note that if $\underline{r}_{IT}(\varepsilon_R) < 0$, the possibility of insider trading might induce managers to accept projects that yield a negative expected return. Using (11) yields that $\underline{r}_{IT}(\varepsilon_R) < 0$ if and only if $\gamma < (1 - \alpha)\beta(\beta\gamma + 1)/\alpha$. To illustrate this possibility consider the case when $\alpha = 2\%$ and $\gamma = .10$. In this case any $\beta \geq .205\%$ implies that $\underline{r}_{IT} < 0$. Increasing α to $\alpha = 3\%$ yields a slight increase in the critical β, and $\underline{r}_{IT} < 0$ for every $\beta \geq .31\%$. Further increase of α to $\alpha = 4\%$ yields that the critical β is $\beta = .42\%$.

Corporate Value

Now, having identified the managers' choice under a given IT contract, let us consider the initial corporate value. Shareholders can make the participation constraint binding by fixing the fixed salaries S_{IT} as follows:

(17) $$S_{IT} = \bar{C} - \alpha(W_0 + r) - \beta(1 - \alpha)(1 + \varepsilon)m + \gamma m[\alpha(1 + \varepsilon) + \beta^2(1 - \alpha)(1 + \varepsilon)].$$

In other words, given an α and $\bar{C}$ the optimal contract must be such that the fixed salary does not exceed S_{IT}. For such S_{IT} the initial value is:

(18) $$V_1(r,\varepsilon) = W_0 + r - \bar{C} - \gamma m[\alpha(1 + \varepsilon) + \beta^2(1 - \alpha)(1 + \varepsilon)].$$

where

$$\begin{cases} r = r_R,\ \varepsilon = \varepsilon_R & \text{if } r_R \geq \underline{r}_{IT}(\varepsilon_R) \\ r = 0,\ \varepsilon = 0 & \text{if } r_R < \underline{r}_{IT}(\varepsilon_R). \end{cases}$$

Again, notice that the value V_1 may be lower than the first-best value in two ways. First, the mangers' choice of project might be inefficient. Second, because the managers must be compensated for the risk they bear (as the compensation is based in part on the uncertain final value and also partly on uncertain trading profits), the expected compensation that must be given to them exceeds $\bar{C}$ by the required risk premium. This risk premium is equal to the last term on the right side of (18), and as will be discussed later, it is greater than the risk premium required in the case of an NT contract with the same α.

Note that, because managers must be compensated for the risk they bear, it is not the case that shareholders would always prefer to have any risky project with $r_R > 0$. As before, we provide a proposition that describes the shareholders' preferences and contrasts it with the insiders' choices.

Proposition 4: (i) Given that managers are to get an IT contract that makes the participation constraint binding (i.e., that compensates managers for the risk they are expected to bear), shareholders prefer the risky project (r_R, ε_R) over project zero if and only if

$$(19) \qquad r_R > r^*_{IT}(\varepsilon_R) \equiv \gamma m[\alpha + \beta^2(1 - \alpha)]\varepsilon_R.$$

(ii) There are two possible types of "conflict" between shareholders and managers: it is possible that the managers accept a risky project that shareholders would like them to reject, and it is also possible that the managers reject a risky project that shareholders would like them to accept.

Proof: (i) Shareholders prefer the risky project (r_R,ε_R) as long as $V_1(r_R,\varepsilon_R) > V_1(0,0)$. Using (18) this condition implies that the risky project is preferred by shareholders as long as

$$(20) \qquad W_0 + r_R - \bar{C} - \gamma m[\alpha(1 + \varepsilon_R) + \beta^2(1 - \alpha)(1 + \varepsilon_R)] > W_0 - \bar{C} - \gamma m[\alpha + \beta^2(1 - \alpha)] ,$$

which yields after simplifications that shareholders prefer the risky project if and only if (19) is satisfied.

(ii) If $(1 + \alpha)\gamma\beta^2 > \gamma\alpha - \beta$, then $r^*_{IT}(\varepsilon_R) > \underline{r}_{IT}(\varepsilon_R)$. Thus every risky project (r_R,ε_R) such that $\underline{r}_{IT}(\varepsilon_R) < r_R < r^*_{IT}(\varepsilon_R)$ will be accepted by managers against the shareholders' interest. On the other hand if $(1 + \alpha)\gamma\beta^2 < \gamma\alpha - \beta$, then $r^*_{IT}(\varepsilon_R) < \underline{r}_{IT}(\varepsilon_R)$, which implies that there are risky projects (r_R,ε_R) such that $r^*_{IT}(\varepsilon_R) < r_R < \underline{r}_{IT}(\varepsilon_R)$ which are not accepted by managers even though shareholders wish them to accept. ■

The Optimal IT Contract

Next we examine the optimal compensation scheme (S,α). As was previously discussed, for any given α the shareholders adjust the fixed salary so that the participation constraint is binding. The resultant S_{IT} is given by (17). From (14) we can learn that $d\sigma/d\alpha = (1 + \varepsilon)m(1 - \beta^2) > 0$, which implies that an increase in α increases the risk that managers bear. Managers must be compensated for this increased risk by an increase in their expected compensation. As previously assumed, any increase of α beyond $\underline{\alpha}$ does not change the managers choice of effort e^* and thus does not change the returns from the chosen project. The only reason, therefore, to provide a contract with $\alpha > \underline{\alpha}$ is to induce managers to change their choice of project. From (11) it is evident that an increase of α implies a higher $\underline{r}_{IT}(\varepsilon_R)$. Thus all the projects that are acceptable to managers with $\alpha > \underline{\alpha}$ are also acceptable with $\alpha = \underline{\alpha}$. Therefore an increase of α may have a desirable effect only if for $\alpha = \underline{\alpha}$ the risky project (r_R, ε_R) is such that

$$\underline{r}_{IT}(\varepsilon_R) < r_R < r^*_{IT}(\varepsilon_R).$$

In such a case the risky project is accepted by the managers although shareholders prefer that they accept project zero. An increase of α beyond $\underline{\alpha}$ might induce managers to change their choice and reject the risky project. Note also that a higher α implies a higher r^*_{IT} because it also increases the risk premium that managers get.

Let (r_R, ε_R) be such that $\underline{r}_{IT}(\varepsilon_R) < r_R < r^*_{IT}(\varepsilon_R)$. In order to induce the managers to reject this project shareholders should provide α_{IT} such that the adjusted $\underline{r}_{IT}(\varepsilon_R)$ becomes equal to r_R so that the risky project is rejected. Any increase of α beyond this level is not optimal, because it does not affect the managerial choice of project but increases their expected compensation. Therefore, for such (r_R, ε_R) equation (11) implies that if shareholders wish the project to be rejected they ought to provide a contract with

$$\text{(21)} \qquad \alpha_{IT}(r_R, \varepsilon_R) = \frac{\beta m(\beta\gamma + 1)\varepsilon_R}{\gamma m \varepsilon_R + \beta m(\beta\gamma + 1)\varepsilon_R - r_R}.$$

Providing a compensation scheme with $\alpha_{IT}(r_R, \varepsilon_R)$ induces managers to change their behavior and to reject a project that shareholders wish them to reject. But at the same time it increases the risk that they bear and consequently their expected compensation. Thus such a contract is optimal only if $V_1(r, \varepsilon)$ is greater with $\alpha_{IT}(r_R, \varepsilon_R)$, which implies that the risky project is rejected, than with $\underline{\alpha}$, which implies that the risky project is accepted. Specifically, α_{IT} is optimal if:

$$\text{(22)} \qquad W_0 - \bar{C} - \gamma m[\alpha_{IT}(r_R, \varepsilon_R)(1 - \beta^2) + \beta^2]$$
$$> W_0 + r_R - \bar{C} - \gamma m(1 + \varepsilon_R)[\underline{\alpha}(1 - \beta^2) + \beta^2].$$

Let Δ_{IT} be the set of all risky projects for which

$\underline{r}_{IT}(\varepsilon_R) < r_R < r^*_{IT}(\varepsilon_R)$ and Eq. (22) holds. Then the optimal compensation scheme is:

$$(S_{IT}, \alpha_{IT}(r_R, \varepsilon_R)), \text{ if } (r_R, \varepsilon_R) \in \Delta_{IT}$$
$$(S_{IT}, \underline{\alpha}), \qquad \text{otherwise}$$

when S_{IT} is given by (17) and thus depends on α and the chosen project.

Clearly Δ_{IT} might be empty. For example, Δ_{IT} is empty when $(1 + \underline{\alpha})\gamma\beta^2 < \gamma\underline{\alpha} - \beta$, which guarantees according to Proposition 4 that $r^*_{IT}(\varepsilon_R) < \underline{r}_{IT}(\varepsilon_R)$. But depending on the parameters of the problem it is possible to identify cases for which it is not empty.

V. COMPARISON OF IT AND NT CONTRACTS

The following propositions compare insider behavior and corporate value under the (best) NT and IT contracts.

Proposition 5: Comparing insiders' choices under the (best) NT contract and the (best) IT contract we can conclude the following:

(i) If a risky project is accepted by managers under the NT contract, then it will also be accepted under the IT contract.

(ii) Under the NT contract, managers may not accept a risky project that they would accept under the IT contract.

Proof: A project (r_R, ε_R) is accepted under the NT contract if and only if $r_R > \underline{r}_{NT}(\varepsilon_R)$, the same project is accepted under the IT contract if and only if $r_R > \underline{r}_{IT}(\varepsilon_R)$. $\underline{r}_{NT}(\varepsilon_R)$ does not depend on α. Therefore, for every $0 < \alpha < 1$ that is given as part of the IT contract we obtain that

$$\underline{r}_{IT}(\varepsilon_R) - \underline{r}_{NT}(\varepsilon_R) = -\beta\varepsilon_R m(1 + \gamma\beta)\left(\frac{1 - \alpha}{\alpha}\right) < 0. \quad (23)$$

Condition (23) holds for both $\underline{\alpha}$ and $\alpha_{IT}(r_R,\varepsilon_R)$. Thus, every risky project that is accepted by managers with NT contract, i.e., $r_R > \underline{r}_{NT}(\varepsilon_R)$, is also accepted by managers with IT contract because $r_R > \underline{r}_{IT}(\varepsilon_R)$. Any project (r_R,ε_R) such that $\underline{r}_{IT}(\varepsilon_R) < r_R < \underline{r}_{NT}(\varepsilon_R)$ is accepted with the IT contract but not with the NT contract. ■

Now note that Propositions 2 and 4 imply that: (i) Under the NT contract there are risky projects that the managers would reject even though the shareholders wish that they would accept them; under the IT contract, there may or may not be such risky projects.

(ii) Under the NT contract, there is no risky project that the managers would accept even though the shareholders wish that they would reject it. Under the IT contract, there may or may not be such a risky project.

Proposition 6: Given a risky project (r_R,ε_R), the expected total monetary compensation to the insiders is always higher under the IT contract than under the NT contract.

Proof: From (17) it is evident that the risk premium under the IT contract is:

$$\gamma m[\alpha(1 + \varepsilon) + \beta^2(1 - \alpha)(1 + \varepsilon)] \quad (24)$$

whereas from (7) we can learn that the risk premium under the NT contract is

$$\gamma\alpha(1 + \varepsilon)m. \quad (25)$$

For a given α and ε the risk premium under the IT contract (Eq. (24)) is greater than the risk premium under the NT contract (Eq. (25)). Such a comparison is not sufficient, because in the IT case shareholders may change the incentives, giving $\alpha_{IT}(r_R, \varepsilon_R)$ instead of $\underline{\alpha}$, and the different types of contracts may yield different choices of projects. Now note that both risk premiums are increasing functions of α as well as of ε, that in the IT case the α is at least as high as the α in the NT case, and as Proposition 5 indicates, that the ε in the IT case is also at least as high as in the NT case. Thus, the risk premium in the IT case (Eq. (24)) is always higher than the risk premium in the NT case (Eq. (25)). ■

Proposition 7: If the risky project is one that the managers adopt under the NT contract or one that the managers reject under the IT contract, then the NT contract is superior as it yields a higher initial value.

Proof: From Proposition 5 it follows that in the situation considered in Proposition 7, both the NT contract and the IT contract would produce the same managerial choice. Proposition 6 indicates that the managers expected compensation is higher under the IT contract. Thus, because the initial value V_1 is the return from the project minus the expected managerial compensation, for the risky projects considered in Proposition 8 the NT contract leads to a higher V_1. ■

Because Proposition 7 is concerned only with situations in which both the NT and IT contracts produce the same result, which is not always the case (as $\underline{r}_{NT} \neq \underline{r}_{IT}$), it does not provide us with a full comparison of the NT and IT contracts. Such a comparison is supplied by the following proposition.

Proposition 8: (i) The IT contract is superior to the NT contract if and only if the following two conditions are met:

(26) $$\underline{r}_{NT}(\varepsilon_R) > r_R > \underline{r}_{IT}(\varepsilon_R)$$

(27) $$r_R > \tilde{r}(\varepsilon_R) \equiv \gamma m \alpha \varepsilon_R + \gamma m \beta^2 (1 - \alpha)(1 + \varepsilon_R).$$

(ii) There always exist values of r_R for which the NT contract is superior. There is a value of r_R for which the IT contract is superior if and only if

$$(28) \qquad \beta < \sqrt{\frac{\varepsilon_R}{1 + \varepsilon_R}}$$

Proof: (i) From Proposition 7 it is evident that if under both the NT and IT contracts the risky project is accepted or if under both it is rejected, then the NT contract yields higher V_1. Thus, to complete the comparison, we only need compare the two types of contract when they yield different managerial choice. From Proposition 5 the only such possible case is when a risky project is accepted under the IT contract but rejected under the NT contract, i.e., when condition (26) holds. Note that if a risky project is accepted under the optimal IT contract, then the compensation scheme is

$(\underline{\alpha}, S_{IT})$. (Increasing α to $\alpha_{IT}(r_R, \varepsilon_R)$ was done to induce managers to reject risky projects.) Thus we need only consider here IT contracts with $\alpha = \underline{\alpha}$.

Suppose (26) holds. Thus under NT we have the zero project, while under IT we have the risky project. Comparing the initial value function under both types of contract, (8) and (18) yield that the IT contract is superior if and only if (27) holds.

(ii) Clearly it is always possible to find r_R that does not satisfy (26) or (27). Comparing (5) and (27) yields that $\tilde{r}(\varepsilon) < \underline{r}_{NT}(\varepsilon)$ if and only if $\varepsilon_R > \beta^2/(1 - \beta^2)$, which after rearranging yields condition (28). Thus, if the risky project fails to satisfy condition (28), then shareholders prefer that it be rejected by managers with NT contracts rather than accepted by managers with an IT contract.

Define now the set

$$A_{IT} \equiv \{(r_R,\varepsilon_R)\ \varepsilon\ R^2 | \max[\tilde{r}(\varepsilon_R), \underline{r}_{IT}(\varepsilon_R)] < r_R < \underline{r}_{NT}(\varepsilon_R)\}.$$

The set A_{IT} under the above conditions is not empty, because condition (28) implies that $\tilde{r}(\varepsilon) < \underline{r}_{NT}(\varepsilon)$ and because $\underline{r}_{IT}(\varepsilon) < \underline{r}_{NT}(\varepsilon)$. From the definition of $\tilde{r}(\varepsilon_R)$, for every $(r_R,\varepsilon_R)\ \varepsilon\ A_{IT}$, shareholders are better off by providing IT contract than by providing NT contracts (see Figure 1). ■

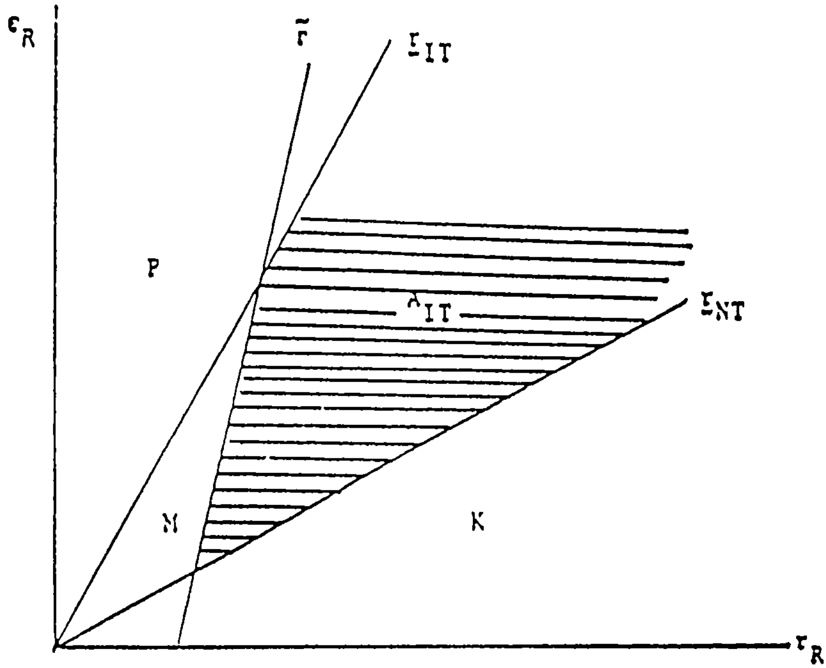
VI. GENERALIZATION: RANDOM ARRIVAL OF RISKY PROJECTS

In the previous sections we assumed that the choice the insiders will confront -- i.e., the pair of projects between which the insiders will have to choose -- is known at t = 0. We now drop this assumption and consider the case of random arrival of projects. Specifically, we assume that, in stage 0 of the game the risky project is not identified yet; what is known is only the distribution from which the risky project is drawn. In this case V_0 and V_1 might differ, because V_1 is determined after the risky project is identified. To simplify the analysis we assume that although ε_R is known, r_R is uniformly distributed in the interval $[-k_1,k_2]$ where $k_2 > 0$ and $-k_1 < 0$.

Note that, because the arrival of projects is stochastic, there is now a source of uncertainty that did not exist in our previous setting. When managers sign their employment contract they do not know what will be the risky project. They know only the distribution from which it is drawn. Thus, as managers are risk averse, the participation constraint must be adjusted to account for such additional risk.

In the first-best scenario the managers will choose the risky project if and only if $r_R > 0$. Thus, the expected value of the final output is

$$\text{(29)} \qquad W_0 + \left(\frac{k_2}{k_1 + k_2}\right)\left(\frac{k_2}{2}\right) .$$



The NT contract is superior

The IT contract is superior

P	Projects rejected by both NT and IT managers
K	Projects accepted by both NT and IT managers
M	Projects accepted by managers with IT contract but rejected by managers with NT contract

<u>Figure 1</u>

The first-best scenario gives the managers exactly their reservation utility $\bar{C}$. Thus, the value V_0 in the first-best case is

$$(30) \qquad W_0 + \left(\frac{k_2}{k_1 + k_2}\right)\left(\frac{k_2}{2}\right) - \bar{C} \ .$$

A. Behavior and Value Under NT Contract

Let us first consider the case of managers with NT contracts. Once (r_R, ε_R) is determined in period 1 the managerial decision problem is identical to the one described in Section III. Specifically, the risky project is chosen only if $r_R > \underline{r}_{NT}(\varepsilon_R)$. As before, the managers will not take a risky project with negative expected returns, but they might reject a project with $r_R > 0$.

Because in the NT case the bonus α does not affect the managerial choice of project, i.e., $\underline{r}_{NT}$ does not depend on α, shareholders will provide a contract with $\alpha = \bar{\alpha}$ in order to induce managers to invest the effort level e^*.

Using the decision rule of managers with NT contracts one can obtain the expected value of the final output as[12]

$$(31) \qquad \bar{W}_{NT} = W_0 + \left(\frac{k_2 - \underline{r}_{NT}}{k_1 + k_2}\right)\left(\frac{k_2 + \underline{r}_{NT}}{2}\right).$$

Comparing (29) and (31) yields that the NT contract leads to a lower expected value of the final output than the first-best and the loss is $\underline{r}_{NT}^2/2(k_1 + k_2)$. The reason for this difference is that in the interval $(0, \underline{r}_{NT})$ the risky project is rejected.

[12]We assume that $k_2 > \underline{r}_{NT}$, i.e., that there does exist a possibility that there will be risky projects that will be accepted under the NT contract.

Let us now turn to the initial value V_0^{NT}. As before, V_0^{NT} is the expected value of the final output $\bar{W}_{NT}$ minus the expected managerial compensation.

Let $Z_{NT}(\varepsilon_R)$ be the payoffs of managers with NT contracts:

$$(32) \qquad Z_{NT}(\varepsilon_R) = \begin{cases} C(W((r_R, \varepsilon_R)), & r_R > \underline{r}_{NT}(\varepsilon_R) \\ C(W((O,O)), & r_R \leq \underline{r}_{NT}(\varepsilon_R) \end{cases}$$

The optimal fixed salary S_{NT} is determined now in order to make the participation constraint binding, i.e., $U(Z_{NT}(\varepsilon_R)) = \bar{C}$.

$$(33) \qquad S_{NT} = \bar{C} - \underline{\alpha} W_0 - \underline{\alpha} \int_{\underline{r}_{NT}}^{k_2} rf(r)dr + RP_{NT} = \bar{C} - \underline{\alpha}\bar{W}_{NT} + RP_{NT}.$$

where $RP_{NT} = \gamma\sigma(Z_{NT}(\varepsilon_R))$ is the risk premium that managers get. Using (33) to calculate the initial value V_0^{NT} yields that

$$(34) \qquad V_0^{NT} = \bar{W}_{NT} - \bar{C} - RP_{NT}$$

which implies that the initial value is the first-best value minus the loss from reduced expected value of the final output and minus the risk premium that managers get.

B. Behavior and Value Under IT Contract

Once the risky project (r_R, ε_R) is determined, management face the same decision problem as in Section IV. Specifically, they will adopt the risky project if and only if $r_R > \underline{r}_{IT}(\varepsilon_R)$. Thus, as before, it is possible that a risky project with $r_R < O$ will be adopted by the managers.

We assume for simplicity that the parameters of the problem are such that Δ_{IT} is empty, which implies that for all possible risky projects the optimal IT contract sets $\alpha = \underline{\alpha}$. Note that without this assumption there are projects for which it is optimal to provide $\alpha = \alpha_{IT}$.

Using the managerial optimal decision rule, the expected value of the final output is[13]

$$\text{(35)} \qquad \bar{W}_{IT} = W_0 + \left(\frac{k_2^2 - \underline{r}_{IT}^2}{2(k_1 + k_2)}\right).$$

Comparing (29) and (35) yields that the IT contract leads to a lower expected value of the final output than the first-best, and the loss is $\underline{r}_{IT}^2/2(k_1 + k_2)$.

The initial value V_0^{IT} is the expected value of the final output minus the expected managerial compensation.

Let $Z_{IT}(\varepsilon_R)$ be the payoffs of managers with IT contracts:

$$Z_{IT}(\varepsilon_R) = \begin{cases} X(r_R, \varepsilon_R), & r_R > \underline{r}_{IT}(\varepsilon_R) \\ X(0,0), & r_R \leq \underline{r}_{IT}(\varepsilon_R) \end{cases}$$

where $X(r_R, \varepsilon_R)$ and $X(0,0)$ are the managerial (uncertain) returns from choosing project (r_R, ε_R) and $(0,0)$, respectively. The fixed salary S_{IT} is chosen such that the participation constraint is binding.

$$\text{(36)} \qquad S_{IT} = \bar{C} - \underline{\alpha} W_0 - \underline{\alpha} \int_{\underline{r}_{IT}}^{k_2} r f(r) dr - E\Pi + RP_{IT},$$

where $E\Pi$ is the expected return from insider trade, and $RP_{IT} = \gamma\sigma(Z_{IT}(\varepsilon_R))$ is the risk premium that the managers must get to induce them to participate in the game.

The initial value is the expected final output minus expected managerial payoffs, i.e.,

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[13] We assume that $-k_1 < \underline{r}_{IT}$, that is, there exists a possibility that the risky project will be rejected under the IT contract.

$$V_0^{IT} = (1 - \alpha)\bar{W}_{IT} - S_{IT} - E\Pi. \tag{37}$$

Using (36) to substitute for S_{IT} yields

$$V_0^{IT} = \bar{W}_{IT} - \bar{C} \ - RP_{IT}. \tag{38}$$

C. Comparison

The initial value under both the NT and IT contracts depends on two elements: the expected final output and the risk premium. Comparing (35) and (38) yields that

$$V_0^{NT} - V_0^{IT} = (\bar{W}_{NT} - \bar{W}_{IT}) - (RP_{NT} - RP_{IT}). \tag{39}$$

Proposition 9: The IT contract yields a higher expected final output if and only if

$$\beta(\beta\gamma + 1)\left(\frac{1 - \alpha}{\alpha}\right) < 2\gamma. \tag{40}$$

Proof: Equations (31) and (35) yield that

$$\bar{W}_{NT} - \bar{W}_{IT} = \frac{\underline{r}_{IT}^2 - \underline{r}_{NT}^2}{2(k_1 + k_2)} \ . \tag{41}$$

Proposition 5 indicates already that $\underline{r}_{IT} < \underline{r}_{NT}$. Given this, the only case for which the NT contract yields a higher expected final output is when $-\underline{r}_{IT} > \underline{r}_{NT}$. That is, when

$$\beta\varepsilon m(\beta\gamma + 1)\left(\frac{1 - \alpha}{\alpha}\right) > 2\gamma\varepsilon m. \quad \blacksquare \tag{42}$$

The condition $\underline{r}_{IT} < \underline{r}_{NT}$ implies that any project that is accepted under the NT contract is also accepted under the IT contract, and all the projects with $\underline{r}_{IT} < r_R < \underline{r}_{NT}$ are chosen only by management with IT contract. If all the projects are such that $r_R > 0$, then the IT contract yields higher expected output. The only case in which the NT contract yields higher expected final output is when $\underline{r}_{IT}$ is negative enough to lead management with an IT contract to accept enough projects with negative expected returns. Condition (42) specifies exactly under what circumstances management with an IT contract would accept enough projects with negative returns to induce lower expected final output.

In principle one can use (39) to find which type of contract is superior. Such an analysis will include a comparison of the risk premiums that accompany each type of contract. While we were unable to characterize fully the conditions under which each type of contract is superior, we will now provide a condition that is sufficient for the IT type contract to be superior.

Proposition 10: The following condition guarantees that the IT contract is superior, i.e., implies higher initial value.

$$\underline{r}_{IT}^2 + 2\beta m[k_1 + (1 + \varepsilon)k_2 - \varepsilon \underline{r}_{IT}] < \underline{r}_{NT}^2. \tag{43}$$

Proof: (i) First note that $S_{IT} \leq S_{NT}$. Under both the NT and IT contracts the fixed salary is determined so that the participation constraint is binding. Thus when managers get $(S_{NT}, \underline{\alpha})$ and an NT type contract, they have the competitive wage. Giving managers the same compensation $(S_{NT}, \underline{\alpha})$ with an IT type contract makes them better off. They will agree now to take a cut in their fixed salary in order to be able to engage in insider trading. Using (12) the expected insider trading profits are

$$\begin{aligned} E\Pi \; &= \beta\,(1 - \alpha)m\left(\frac{\underline{r}_{IT} + k_1}{k_1 + k_2}\right) \\ &+ \;\beta\,(1 - \alpha)\,(1 + \varepsilon)m\left(\frac{k_2 - \underline{r}_{IT}}{k_1 + k_2}\right) \\ &= \beta(1 - \alpha)\,m\left[1 + \varepsilon\left(\frac{k_2 - \underline{r}_{IT}}{k_1 + k_2}\right)\right]. \end{aligned} \tag{44}$$

Now note that

$$V_0^{NT} = (1 - \underline{\alpha})\bar{W}_{NT} - S_{NT}$$
$$V_0^{IT} = (1 - \underline{\alpha})\bar{W}_{IT} - S_{IT} - E\Pi.$$

We know that $S_{IT} \leq S_{NT}$. We will finish the proof by showing that (43) guarantees that

$$(45) \qquad (1 - \underline{\alpha})\bar{W}_{IT} - E\Pi > (1 - \underline{\alpha})\bar{W}_{NT}.$$

Substituting for $\bar{W}_{IT}$, $\bar{W}_{NT}$, and $E\Pi$ to rewrite (45) yields the condition:

$$(1 - \underline{\alpha})\left[W_0 + \left(\frac{k_2^2 - r_{IT}^2}{2(k_1 + k_2)}\right)\right] - \beta(1 - \underline{\alpha})m\left[1 + \varepsilon\left(\frac{k_2 - r_{IT}}{k_1 + k_2}\right)\right] > (1 - \underline{\alpha})\left[W_0 + \left(\frac{k_2^2 - r_{NT}^2}{2(k_1 + k_2)}\right)\right],$$

which is equivalent after simplification to condition (43). ■

VI. CONCLUSION

Insider trading has been shown to have a significant effect on insiders' choice among investment projects with uncertain returns. In particular, it requires refining the familiar proposition, which holds in the absence of insider trading, that managers' risk-aversion leads them to choose a more conservative investment policy than shareholders would want. In the presence of insider trading, increased uncertainty presents insiders not only with costs but also with benefits, as it might enable them to make greater trading profits. This effect might mitigate or even outweigh the conservative tendency arising from insiders' risk-aversion. Whether the presence of insider trading improves or worsens insiders' project choices depends on conditions that our analysis has identified.

The presence of insider trading has also been shown to have an effect on the structure and overall level of insiders' compensation (beyond the obvious effect that providing insiders with trading profits enables shareholders to reduce other elements of their compensation). First, with insider trading, the expected value of insiders' total compensation must be higher, to compensate insiders for the fact that they are partly paid in trading profits which are of uncertain size. Second, under some circumstances, the presence of insider trading leads to a relative increase in the proportion of insiders' salary that depends on the firm's results.

More generally, the analysis of this paper (as well as of the other parts of our project) suggests that the extent to which insiders may trade in their firm's shares has considerable effects on the agency problem in corporations. Thus, an understanding of these effects is necessary for both (i) designing the corporate and legal arrangements governing insider trading, and (ii) forming an accurate picture of the agency problem in corporations. We have sought in this paper to contribute to the understanding of these effects.

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