# Insider Trading and the Managerial Choice among Risky Projects

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## Abstract

The concern of this paper is with the effects of insider trading on ex ante managerial behavior. Specifically, the paper focuses on how insider trading affects 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 be beneficial, however, because insiders' risk aversion pulls them toward a conservative investment policy. Insiders' choices of projects are identified and compared with insider trading and those without such trading. Using these results, the conditions under which insider trading increases or decreases corporate value by affecting the choice of projects with uncertain returns are identified.

## 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 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.

One possibly important effect of insider trading is on the ex ante management decisions of insiders. Given the general recognition that managers cannot always be induced to act in the shareholders' interest, it is natural to ask whether the possibility of trading leads insiders to make management decisions that are closer to, or further away from, the value-maximizing decisions. While the law review

literature is full of informal assertions and speculations concerning this question,[1] the economic literature has thus far devoted little attention to it.

Most of the substantial work done on insider trading in recent years has been devoted to modeling the insider trading process itself. Researchers have examined how the possession of inside information enables insiders to make profits and how this information eventually comes to be reflected in the market price.[2] Only a few papers allow the insiders to make corporate as well as trading decisions. Dye (1984) considers whether shareholders can draw useful information from the managers' trades, assuming that these trades are observable. Giammarino, Heinkel, and Hollifield (1992) examine a model in which managers who make corporate decisions are allowed to trade and thus have incentives to mislead the market through corporate announcements; they demonstrate that, in some cases, managers manipulate corporate actions in an opportunistic fashion. Bagnoli and Khanna (1991) develop the intuition that anonymous managerial insider trading eliminates the incentives to truthful revelation of information. Fischer (1992) considers insider trading by individuals who obtain inside information about a particular firm as a result of providing some services to the firm. Such insider trading may aggravate existing agency problems and hence justify a complete prohibition of such agent trading.

This paper analyzes the effect of insider trading on managers' choice among risky investment projects.[3] In particular, we compare the project choices that insiders make under contracts that allow insider trading with those they make under contracts that prohibit such trading. The main point of the paper is to show that insider trading is not necessarily harmful and can be a part of the optimal compensation scheme.

Under contracts that prohibit insider trading, managers' choice among risky investment projects may be inefficient for a familiar reason. Unlike the shareholders, who can diversify, managers' attitude toward a risky project's results is likely to be characterized by a significant degree of risk aversion. To the extent that the managers' salary is made dependent upon the firm's profits (to induce managerial effort), the managers will be too conservative: they may 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 will induce the managers to accept some desirable risky projects that would be rejected without insider trading. An alternative interpretation is that the existence of insider trading

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[1] See, for example, Carlton and Fischel (1983), Easterbrook (1985), and Scott (1980). The main claim of this literature is that insider trading should not necessarily be prohibited as allowing managers to insider trade can sometimes be a part of the managerial optimal compensation scheme. Our paper can thus be viewed as a formalization and analysis of the claims in the law review literature.

[2] See, for example, Glosten and Milgrom (1985), Kyle (1985), Laffont and Maskin (1990), and Mirman and Samuelson (1989). Recent papers by Ausubel (1990), Manove (1989), and Fishman and Hagerty (1992) have analyzed certain important ex ante effects of insider trading (on investment decisions and information acquisition), but these papers abstract from the agency problems on which our project focuses.

[3] Bebchuk and Fershtman (1992) analyze the effect of insider trading on managers' effort level, and Bebchuk and Fershtman (1991) focus on effect on managers' incentives to "waste" corporate value.

creates an option for the managers, the value of which is enhanced by increased volatility of the underlying cash flow to the firm.

Allowing insider trading, however, also involves certain disadvantages. First, the desire to increase trading profits might lead the managers to prefer a very risky project even if it offers a lower expected return than a safer alternative. Furthermore, compensating managers with trading profits of uncertain size increases the risk that they bear and thus requires an increase in their total expected compensation. The paper identifies the conditions under which these effects dominate the benefit from allowing insider trading and the conditions under which the converse is true.

It is important to note that one can mimic the managerial compensation that allows for insider trading with compensations that prohibit such trading but require managers to hold risky securities that give returns identical to the insider trading returns. Thus, the main interpretation of our result is not the fact that managers can be induced to choose risky investment optimally, but the observation that insider trading is not necessarily harmful and can even be used to correct some of the distortion created by the manager's risk aversion.

In assessing the importance and relevance of conclusions about insiders' behavior in the presence of insider trading, it is important to recognize that the world in which we live features a significant amount of such trading. The law does not totally prohibit insider trading. The law includes an absolute prohibition on such trading only when the insider buys and then sells (or sells and then buys) within a six-month period. When insiders do not go in and out of the company's stock during a six-month period, the law constrains their trading only when it can be shown to be based on "material" inside information. Because insiders' motive for trading is often not observable or not verifiable, they often can openly make profitable trades (as the evidence indeed indicates, see for example, Jaffe (1974) and Seyhun (1986)). Furthermore, insiders may hide the trading 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. Thus, findings on the consequences of insider trading have both normative and positive implications. From a normative perspective, they are relevant for determining how much (if any) insider trading should be curtailed. 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.

## 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. In period 2, 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 3, 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 firm is formed, and the managers and the shareholders specify a contract. The contract provides the managers with a salary that increases in the firm's final output. We focus on schemes that are linear in this output, denoted by $W$.[4] Thus, the contract specifies some $S$ and $\alpha \in [0, 1]$, 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. We shall refer to contracts prohibiting insider trading as NT contracts and to those allowing such trading as IT contracts. In the case of an IT contract, we will denote by $\Pi$ the insider trading profits managers will make. The initial value of the firm is denoted by $V_0$ and is endogenously determined, depending on the managerial contract and the set of possible projects available to managers. 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 the initial value $V_0$.

*Period 1: Project Choice.* The managers choose an investment project. The choice is between a project that will produce final output $W = W_0 + \theta$ ("project zero"), where $\theta$ is a random variable such that $E(\theta) = 0$, and a riskier project, denoted by $(r_R, \epsilon_R)$, that produces final output $W(r_R, \epsilon_R) = W_0 + r_R + (1 + \epsilon_R)\theta$. $\epsilon_R$ is assumed to be positive, which makes the project riskier, while $r_R$ may be positive or negative.

For simplicity, we assume that $\theta$ can be either $m$ or $-m$, each with probability $1/2$, for some $m > 0$. This assumption will simplify our calculations considerably, allowing us to focus our analysis on the effects of insider trading.

The shareholders can observe the managers' choice of project, and the firm's value in period 1 will reflect this observation. The managerial choice is not verifiable by courts, however, and for this reason the managerial compensation cannot be made contingent on it.

The value of the firm's shares in this period is $V_1$. We assume that the two projects between which the managers choose in period 1 are known in period 0. Given this, the managers' choice in period 1 will be anticipated in period 0 and thus reflected in $V_0$. Therefore, $V_1 = V_0$.

*Period 2: Trading.* At the beginning of this period, the managers (but not others) learn $\theta$ and thus know the final value of the firm, $V_f$. Subsequently, trading in the firm's shares takes place with the following participants: liquidity-motivated sellers, a (zero-profit) market maker (specialist) who sets the price, and the insiders, if their contract so allows. The liquidity-motivated sellers are some of the initial shareholders who cannot defer realizing the value of their shares until the final period; each of the initial shareholders is assumed to face the same probability of needing to liquidate his holdings during this trading period. For our purposes, there is no reason to model the trading process, as it has already been analyzed in detail by Kyle (1985) and by Glosten and Milgrom (1985), and we can rely on their conclusions. These authors have shown that the insiders will be able to make some profits, but will not be able to capture the full gap between the pretrading

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[4]We focus on linear schemes for the sake of tractability. For a similar assumption in a similar context, see Holmstrom and Tirole (1990). For an analysis of the conditions under which linear contracts are optimal, see Holmstrom and Milgrom (1987).

value and the final value of the firm.[5] Clearly, if there are no insider trading profits, then NT and IT contracts are equivalent.

Relying on the conclusions of the existing insider trading models, we assume that the insiders can capture some fraction of the difference between the pretrading values $V_1$ and the final value $V_f$. Specifically, we assume that the insiders' trading profits are $\Pi = \beta|V_f - V_1|$ for some $\beta \in [0, 1]$.[6] We let the parameter $\beta$ be exogenously given. The comparison between the two types of contract will depend, among other things, on the value of $\beta$.

Of course, the insiders' trading profits all come at the expense of the liquidity-motivated sellers, as the market maker is assumed to make zero-expected profit. Thus, because each of the initial shareholders faces the same ex ante probability of having to liquidate his holdings in period 2, the initial shareholders expect to bear the costs of the insiders' trading profits as much as they expect to bear the costs of other elements of the insiders' compensation scheme.

*Period 3: Realization of Output.* The final output $W$ is realized, and the salary $S + \alpha W$ is paid to the managers. The final value of the shares is thus $V_f = W - C(W) = (1 - \alpha)W - S$. The curtain now goes down and the firm dissolves.

## A.   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, while the shareholders are risk neutral, the managers are risk averse. Specifically, we assume that managers' expected utility from random return $x$ is given by

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

where $\sigma(x)$ is the standard deviation of $x$, and $0 < \gamma < 1$ is a given constant.[7]

We further assume that the managerial labor market is perfectly competitive. Let $\bar{C}$ be the managers' reservation wage. The managers' participation constraint

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[5] While the rich structure of these models cannot be summarized briefly, the following points may be made about the basic conclusions described in the text. First, the insiders will be able to make some profit because, at least initially, the market maker will not be able to tell for sure whether the insiders are selling or buying. (The supply of shares from liquidity-motivated sellers is assumed to be a random variable, and the market maker is assumed to observe only the net aggregate of orders from liquidity-motivated sellers and insiders; consequently, while the market maker can draw some inferences about the direction in which the insiders are likely to be trading, he cannot know for sure.) Second, one reason why the insiders can capture only part of the gap between the pretrading value and the final value of the firm is that, as the insiders trade more shares, their information will be increasingly reflected in the market price. We assume that the managers trade anonymously; if they do not, then their position could be used to convey their private information (see also John and Lang (1991)).

[6] We thus assume that insiders are equally able to sell and buy shares and can capture the same fraction of the gap between pretrade and final value when the final value is high as when the final value is low. Allowing for different $\beta$s for the two cases would complicate our calculations considerably. If only one direction of inside trading is possible, then our analysis will collapse, but if insiders' ability to trade is similar (but not identical) in good and bad states, then we expect that there would not be a change in the nature of our results and that there would be values of $\beta$ for which an IT contract is superior.

[7] $\gamma > 0$ is implied by the managers' risk aversion. $\gamma < 1$ is necessary to guarantee that if the riskier project dominates project zero, i.e., if $W_0 + r_R - (1 + \epsilon_R)m > W_0 + m$, then the riskier project will be chosen by the managers.

requires that their compensation under the managerial contract gives them expected utility greater than or equal to $\bar{C}$.

## B. The First-Best

The initial shareholders wish to maximize the firm's initial value, $V_0$, which is the firm's expected output minus the managers' total expected compensation. Clearly, if the managerial actions were all observable and verifiable, the initial shareholders would direct the managers to choose the riskier project if and only if $r_R > 0$, and would provide the managers a salary equal to $\bar{C}$. Consequently, the first-best initial value is $V_0^* = W_0 + \max(0, r_R) - \bar{C}$.

## III.    Project Choice and Corporate Value under NT Contracts

### A.    Insiders' Project Choice

Let us first examine the managers' choice under a given NT contract $(S, \alpha)$. In the absence of trading profits, the managers' total compensation will be $C(W(r, \epsilon))$, where $(r, \epsilon)$ is the project chosen by management. Now observe that

$$(2) \qquad E(C(W(r,\epsilon))) \;=\; S + \alpha E(W(r,\epsilon)) \;=\; S + \alpha (W_0 + r),$$

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

Thus, the managers' expected utility is

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

*Proposition 1.* Given any NT contract $(S, \alpha)$, the managers will choose the riskier project $(r_R, \epsilon_R)$ iff

$$(5) \qquad\qquad r_R \;>\; \underline{r}_{\mathrm{NT}}(\epsilon_R) \;\equiv\; \gamma\epsilon_R m.$$

*Proof.* The managers will choose the riskier project as long as $U(C(W(r_R, \epsilon_R))) > U(C(W(0,0)))$. Thus, using (4), the riskier project is chosen iff

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

Simplifying (6) yields the condition in (5). $\square$

Note that $\underline{r}_{\mathrm{NT}}(\epsilon_R)$ is *strictly* positive for every $\alpha > 0$. That is, the managers may 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 is not sufficient to compensate them for the higher risk associated with the project $(r_R, \epsilon_R)$.

### B.    Corporate Value

Having identified the managers' choice, let us now consider the firm's initial value. Assuming that shareholders can make the participation constraint binding and project $(r, \epsilon)$ is chosen,

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

Thus, given that managers are provided with an NT contract $(S_{NT}, \alpha)$, which implies that the initial value of the firm, as a function of the chosen project, is

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

where

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

The first expression in (8) is the value of the project and the initial value is this project value minus the managers' reservation wage, $\bar{C}$, and the additional compensation given to them for the risk they are bearing. Notice that $V_1$ may be lower than the first-best initial value in two ways. First, the managers' choice of project may 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 (the last term on the right side of (8)).

Note that, because managers must be compensated for the risk imposed on them, shareholders may no longer prefer the riskier project (with $r_R > 0$) over project zero. Specifically:

*Proposition 2.* i) Given that managers are to get an NT contract $(S_{NT}, \alpha)$, shareholders prefer the riskier project $(r_R, \epsilon_R)$ iff

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

ii) There are projects $(r_R, \epsilon_R)$ 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 riskier project $(r_R, \epsilon_R)$ as long as $V_1(r_R, \epsilon_R) > V_1(0, 0)$. Using (8), this condition implies that the riskier project is preferred by shareholders as long as $W_0 + r_R - \bar{C} - \gamma\alpha(1 + \epsilon_R)m > W_0 - \bar{C} - \gamma\alpha m$, which, in turn, implies that shareholders prefer the risky project if and only if $r_R > \gamma\alpha m\epsilon_R$.

Using (5), as long as $\alpha < 1$, $r^*_{NT}(\epsilon_R) < \underline{r}_{NT}(\epsilon_R)$ for every $\epsilon_R$. Thus, a project $(r_R, \epsilon_R)$, such that $r^*_{NT}(\epsilon_R) < r_R < \underline{r}_{NT}(\epsilon_R)$, will not be chosen by managers by Proposition 1, even though i of Proposition 2 implies that shareholders prefer it to project 0. □

Intuitively, when $r_R < r^*_{NT}(\epsilon_R)$ the risk premium that shareholders must provide exceeds the benefits to them of the managers' choice of the riskier project. Note that for every given $(S, \alpha)$, such that $\alpha < 1$, the shareholders prefer the choice of the riskier project whenever $r_R > 0$; however, when the contract includes automatic compensation for extra risk, i.e., specifies $(S_{NT}, \alpha)$ where $S_{NT}$ is defined by (7), shareholders prefer the riskier project only when $r_R > r^*_{NT}(\epsilon_R)$.

## IV.   Project Choice and Corporate Value under IT Contracts

### A.   Insiders' Project Choice

Under an IT contract, the profit from insider trading is a random variable that depends on the chosen project and the initial value $V_1(r, \epsilon)$. Denoting by $X(r, \epsilon)$

the total compensation managers receive if they choose the project $(r, \epsilon)$, we obtain that

$$(10) \qquad X(r,\epsilon) \;=\; S + \alpha W(r,\epsilon) + \Pi(r,\epsilon),$$

where $\Pi(r, \epsilon)$ is the insider trading profit. This profit can be written $\Pi(r, \epsilon)$ as it depends on the chosen project and on the initial value, which is also a function of $(r, \epsilon)$.

Under an IT contract, managers' compensation (and thus their project choice) depends 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 make their project choice. Given the expected managerial choice between $(0,0)$ and $(r_R, \epsilon_R)$, a (rational expectations) *equilibrium* is a value $V_1^*$ and a managerial choice $(r^*, \epsilon^*)$ such that: the choice of $(r^*, \epsilon^*)$ is optimal for the managers given $V_1^*$; and, given the choice $(r^*, \epsilon^*)$, $V_1^*$ 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 $(r_R, \epsilon_R)$ iff

$$(11) \qquad r_R \;>\; \underline{r}_{IT}(\epsilon_R) \;\equiv\; \gamma \epsilon_R m - \beta \epsilon_R m (1 - \beta\gamma)[(1 - \alpha)/\alpha].$$

*Proof.* The managers' project choice is determined by comparing $U(X(r_R, \epsilon_R))$ and $U(X(0,0))$. The expected profits from insider trading are[8]

$$
\begin{aligned}
(12) \quad E(\Pi(r,\epsilon)) \;&=\; E\left(\beta \,|V_f(r,\epsilon,\theta) - V_1(r,\epsilon)|\right) \\
&=\; 1/2\beta\,[(1 - \alpha)(W_0 + r + (1 + \epsilon)m) - S - V_1(r,\epsilon)] \\
&\quad + 1/2\beta\,[V_1(r,\epsilon) - (1 - \alpha)(W_0 + r - (1 + \epsilon)m) + S] \\
&=\; \beta(1 - \alpha)(1 + \epsilon)m.
\end{aligned}
$$

Given the expected insider trading profit, one can calculate the initial value, which is the expected final output minus the expected managerial compensation, i.e.,

$$(13) \qquad V_1 \;=\; (1 - \alpha)(W_0 + r) - S - \beta(1 - \alpha)(1 + \epsilon)m.$$

Using (12) and (13), the managers' expected compensation and standard deviation of their compensation are

$$
\begin{aligned}
(14a) \qquad E(X(r,\epsilon)) \;&=\; S + \alpha E(W(r,\epsilon)) + E(\Pi(r,\epsilon)) \\
&=\; S + \alpha(W_0 + r) + \beta(1 - \alpha)(1 + \epsilon)m, \\
(14b) \qquad \sigma(X(r,\epsilon)) \;&=\; \alpha(1 + \epsilon)m + \beta^2(1 - \alpha)(1 + \epsilon)m.
\end{aligned}
$$

Substituting (14a) and (14b) into (1) yields the managers' expected utility,

$$
\begin{aligned}
(15) \qquad U(X(r,\epsilon)) \;&=\; S + \alpha(W_0 + r) + \beta(1 - \alpha)(1 + \epsilon)m \\
&\quad - \gamma\left[\alpha(1 + \epsilon)m + \beta^2(1 - \alpha)(1 + \epsilon)m\right].
\end{aligned}
$$

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[8]In calculating the expected profit from insider trading, we consider the case in which $(1 - \alpha)(W_0 + r - (1 + \epsilon)m) - S < V_1(r,\epsilon) < (1 - \alpha)(W_0 + r + (1 + \epsilon)m) - S$. $V_1(r,\epsilon)$ in (13) satisfies this inequality.

The riskier project $(r_R, \epsilon_R)$ is chosen only if $U(X(r_R, \epsilon_R)) > U(X(0,0))$. Using (15), the riskier project yields higher expected utility iff

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

Rearranging (16) yields the condition in (11). $\square$

*Remarks.* i) Note now that for $\alpha < 1$, a higher $\beta$ implies a lower $\underline{r}_{IT}(\epsilon_R)$. Intuitively, one can see (in Equation (12)) that the expected gap between the pretrading value and the final value of the firm is positively correlated with the variability of the project, i.e., the expected gap goes up with $\epsilon$. Thus, an increase in the fraction $\beta$ of the gap captured by the managers improves the relative attractiveness of the riskier project. Thus, managers will be willing to accept a project with a lower expected return, given that they can benefit more from exploiting the variability of the project.

ii) Note that if $\underline{r}_{IT}(\epsilon_R) < 0$, the possibility of insider trading might induce managers to accept projects that yield a negative expected return. Using (11), $\underline{r}_{IT}(\epsilon_R) < 0$ iff $\gamma < (1 - \alpha)\beta(\beta\gamma + 1)/\alpha$.

## B. Corporate Value

Having identified the managers' choice under a given IT contract, let us consider the firm's initial value. Shareholders can make the participation constraint binding by fixing the salary $S_{IT}$ as follows,

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

For such $S_{IT}$, the initial value is

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

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

The value $V_1$ may be lower than the first-best initial value in two ways. First, the managers' choice of project may 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. 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 $\alpha$.

*Proposition 4.* i) Given that managers are to get an IT contract that makes the participation constraint binding, shareholders prefer the riskier project $(r_R, \epsilon_R)$ to project zero iff

(19) $\qquad r_R > r_{IT}^*(\epsilon_R) \equiv \gamma m\left[\alpha + \beta^2(1 - \alpha)\right]\epsilon_R.$

ii) There are two possible types of "conflict" between shareholders and managers: it is possible that the managers prefer the riskier project while shareholders prefer project zero, and it is also possible that the managers prefer project zero while shareholders prefer the riskier project.

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

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

which yields after simplifications the condition in (19).

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

## V.  Comparison of IT and NT Contracts

We will first compare an NT contract with the salary scheme $(S_{NT}, \alpha)$ and an IT contract with the salary scheme $(S_{IT}, \alpha)$. That is, both contracts specify the same $\alpha$ and specify $S$ such that managers get exactly their reservation wage. Our first comparison formalizes the basic intuition that the possibility of exploiting inside information creates an option for managers and causes them to increase the risk of projects they accept, offsetting the risk aversion they otherwise exhibit in project selection.

*Proposition 5.* i) If the riskier project is chosen by managers under the NT contract $(S_{NT}, \alpha)$, then it is also chosen under the IT contract $(S_{IT}, \alpha)$.

ii) There are risky projects that are chosen under the IT contract while the same projects are rejected by managers with the NT contract.

*Proof.* i) A project $(r_R, \epsilon_R)$ is chosen by the managers under the NT contract iff $r_R > \underline{r}_{NT}(\epsilon_R)$, the same project is chosen under the IT contract iff $r_R > \underline{r}_{IT}(\epsilon_R)$. Using (5) and (11) yields

$$(21) \qquad \underline{r}_{IT}(\epsilon_R) - \underline{r}_{NT}(\epsilon_R) = -\beta\epsilon_R m(1 - \gamma\beta)[(1 - \alpha)/\alpha] < 0.$$

Thus, if project $(r_R, \epsilon_R)$ is chosen by managers under the NT contract, i.e., $r_R > \underline{r}_{NT}(\epsilon_R)$, then it is also chosen by managers under the IT contract $(r_R > \underline{r}_{IT}(\epsilon_R))$.

ii) Any project $(r_R, \epsilon_R)$ such that $\underline{r}_{IT}(\epsilon_R) < r_R < \underline{r}_{NT}(\epsilon_R)$ is chosen under the IT contract, but not under the NT contract. □

Propositions 1 and 2 imply that under an NT contract there is only one type of management-shareholder conflict. Since $\underline{r}_{NT}(\epsilon_R) > r_{NT}^*(\epsilon_R)$, managers may reject projects that shareholders wish to accept, but managers never accept projects that

shareholders wish to reject. Under an IT contract, however, there are two types of conflict. Using Propositions 3 and 4 and comparing $\underline{r}_{IT}$ and $r_{IT}^*$, managers may reject projects that shareholders wish to accept but may also accept projects that shareholders wish they would reject.

In both types of contracts, we let the fixed salary be such that the managers' expected utility equals their reservation wage. Since managers are risk averse, this does not imply that the two types of contracts involve the same expected monetary payment. Specifically,

*Proposition 6.* Given a project $(r_R, \epsilon_R)$, insiders' total expected compensation 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 $\gamma m[\alpha(1 + \epsilon) + \beta^2(1 - \alpha)(1 + \epsilon)]$. Meanwhile, from (7) we learn that the risk premium under the NT contract is $\gamma\alpha(1 + \epsilon)m$. Thus, for a given $\alpha < 1$ and $\epsilon$, the risk premium under the IT contract is greater than the risk premium under the NT contract. □

An important corollary of Proposition 6 is that if both IT and NT contracts produce the same managerial choice, then the NT contract is superior as it implies lower managerial compensation and thus higher initial value.

Thus, it remains to compare the two contracts when they yield different managerial decisions. Proposition 5 indicates that when the riskier project is chosen under an NT contract, it will also be chosen under an IT contract. Therefore, the only possible difference in managerial decisions is that the riskier project is rejected under an NT contract and accepted under an IT contract. Examining such a case yields the following result.

*Proposition 7.* Given a project $(r_R, \epsilon_R)$, the IT contract yields a higher initial value than the NT contract if the following conditions hold,

i) $\underline{r}_{NT}(\epsilon_R) > r_R > \underline{r}_{IT}(\epsilon_R)$

ii) $r_R > \gamma m \alpha \epsilon_R + \gamma m \beta^2(1 - \alpha)(1 + \epsilon_R)$.

*Proof.* Condition i guarantees that $(r_R, \epsilon_R)$ is accepted under the IT contract and rejected under the NT contract. Using Equations (8) and (18) to compare the initial values under the two types of contract, it is evident that Condition ii guarantees that the IT contract yields a higher initial value. □

Proposition 7 summarizes one of the main conclusions of this paper. As Proposition 5 indicates, letting managers engage in insider trading leads them to choose riskier projects. But such incentives are costly: as Proposition 6 indicates, the IT contract involves higher expected managerial compensation, which lowers initial value. The overall effectiveness of the IT contract depends on both these effects and, as Proposition 7 indicates, when Conditions i and ii hold, the IT contract yields a higher initial value than the NT contract.

## VI.    Optimal Contracts

In the previous section, we compared NT and IT contracts with the same $\alpha$. However, it is possible that shareholders will choose one $\alpha$ for the NT contract and another $\alpha$ for the IT contract. We will now consider and compare the optimal NT and IT contracts when shareholders choose both $\alpha$ and $S$ optimally.

We would like to note, however, that the analysis below is carried out under the simplifying assumption that the managerial choice is between two risky projects and shareholders are aware of the characteristics of these projects. If shareholders know only that the risky projects are taken from some given distribution, then $\alpha$ will be set to maximize the value of $V_1$ averaged over all project features, taking into account the managers' optimal accept/reject choice.

### A.    The Optimal NT Contract

Equation (8) indicates that $V_1(r, \epsilon)$ is a decreasing function of $\alpha$. The greater $\alpha$ 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 $\alpha$ beyond some exogenously given minimal level of $\underline{\alpha}$, and the optimal NT contract is $(S_{NT}, \underline{\alpha})$.

### B.    The Optimal IT Contract

Using (14) to differentiate $\sigma$ with respect to $\alpha$ yields that $d\sigma/d\alpha = (1 + \epsilon)m(1 - \beta^2) > 0$. Thus, an increase in $\alpha$ increases the risk that managers bear, which implies higher expected managerial compensation. In our model, therefore, the only reason to provide managers with a contract with $\alpha > \underline{\alpha}$ is to induce them to change their choice of project. From (11), it is evident that $\underline{r}_{IT}(\epsilon_R)$ increases with $\alpha$. Thus, increasing $\alpha$ beyond $\underline{\alpha}$ is optimal only when the riskier project is accepted with $\alpha = \underline{\alpha}$ and shareholders prefer that the managers reject the riskier project.[9] In order to induce managers to reject this project, shareholders should set $\alpha = \alpha_{IT}(r_R, \epsilon_R)$, where $\alpha_{IT}(r_R, \epsilon_R)$ is such that the adjusted $\underline{r}_{IT}(\epsilon_R)$ is equal to $r_R$. Any increase of $\alpha$ beyond this level is not optimal, as it does not affect the managers' choice of project, but increases their expected compensation. Using (11), we obtain that

$$(22) \qquad \alpha_{IT}(r_R, \epsilon_R) = \frac{\beta m(1 - \beta\gamma)\epsilon_R}{\gamma m\epsilon_R + \beta m(1 - \beta\gamma)\epsilon_r - r_R}.$$

Providing a compensation scheme with $\alpha_{IT}(r_R, \epsilon_R)$ induces managers to change their behavior and, in particular, to reject a project that shareholders wish them to reject. But, at the same time, it increases the risk that they bear and increases, consequently, their expected compensation. Such a contract is optimal only if $V_1(r, \epsilon)$ is greater with $\alpha_{IT}(r_R, \epsilon_R)$, which implies that the riskier project is rejected, than

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[9]Note also that a higher $\alpha$ implies a higher $r_{IT}^*$ because it also increases the risk premium that managers get.

with $\underline{\alpha}$, which implies that the riskier project is accepted. Specifically, the contract with $\alpha_{IT}$ is optimal only if

$$(23) \qquad W_0 - \bar{C} - \gamma m \left[ \alpha_{IT} \left( r_R, \epsilon_R \right) \left( 1 - \beta^2 \right) + \beta^2 \right]$$
$$> \quad W_0 + r_R - \bar{C} - \gamma m \left( 1 + \epsilon_R \right) \left[ \underline{\alpha} \left( 1 - \beta^2 \right) + \beta^2 \right].$$

It remains to see how optimal contracting affects the comparison between NT and IT contracts:

i) $\underline{r}_{IT}(\epsilon_R) < \underline{r}_{NT}(\epsilon_R)$ even when the two types of contract specify different values at $\alpha$. Thus, we can extend Proposition 5 to optimal contracts and claim that if the riskier project is accepted with the optimal NT contract, then it is also accepted with the optimal IT contract.

ii) From (17), the managerial risk premium under the IT contract is $\alpha m (1 + \epsilon)[\alpha + \beta^2(1 - \alpha)]$ whereas, using (7), this risk premium under the NT contract is $\gamma \alpha (1 + \epsilon) m$. When the optimal IT contract is with $\alpha = \underline{\alpha}$, Proposition 6 applies. When the optimal IT contract is with $\alpha_{IT} > \underline{\alpha}$, then, since the risk premium is increasing with $\alpha$, the IT contract involves an even larger risk premium. Hence, Proposition 6 can also be extended to optimal contracts: the total expected compensation under the optimal IT contract is higher than under the optimal NT contract.

iii) Proposition (7) discusses situations in which the IT contract yields higher initial value than the NT contract. This proposition can be also extended to optimal contracts by considering contracts with $\alpha = \underline{\alpha}$ and keeping in mind that letting shareholders change $\alpha$ can only increase the initial value.

## VII. 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 that managers' risk aversion leads them to choose a more conservative investment policy than shareholders desire. In the presence of insider trading, increased uncertainty presents insiders not only with costs, but also with benefits, as uncertainty enables them to make greater trading profits. This effect mitigates, and may 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. 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 that are of uncertain size. Second, under some circumstances, the presence of insider trading leads to a relative increase in the degree to which insiders' salary depends on the firm's results.

More generally, the analysis of this paper 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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