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by

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Abstract

This paper analyzes certain effects of insider trading on the principal-agent problem in corporations. Specifically, we focus on those managerial choices that confront managers with the need to decide between options that produce different corporate value but do not differ in the managerial effort involved. In the absence of insider trading, and as long as managers' salaries are positively correlated with their firm's results, managers will make such choices efficiently, and consequently such choices have previously received little attention. We show that, in the presence of insider trading, managers may make such choices inefficiently. With such trading, managers might elect to have a lower corporate value -- that is, they may "waste" corporate value -- because having such a value might enable them to make greater trading profits. We analyze the conditions under which the problem we identify is likely to arise and the factors that determine its severity. We also identify those restrictions on insider trading that can eliminate this problem.

I. INTRODUCTION

The managers of a corporation may 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, place significant limits on the freedom of corporate insiders to engage in such trading. The extent to which such trading by insiders is harmful and should be constrained has been for long a central question for the regulation of capital markets. Accordingly, it has been the subject of active and intense public debate.

To the extent that the economic literature has analyzed insider trading, it has 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 analyzed how the presence of insider trading affects the accuracy of market prices (in particular, by gradually incorporating the insiders' information into the market price).[1] While such analysis is clearly important, an evaluation of insider trading clearly requires also an understanding of the ex ante effects of such trading.

One important class of such ex ante effects consists of the effects of

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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, while the presence of 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.

insider trading on the ex ante management decisions of insiders. Economists have in the last decade devoted much attention to the principal-agent problem in firms. Because insiders' behavior cannot be perfectly monitored by shareholders, insiders may not follow the value-maximizing course of action. Economists 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 makes the principal-agent problem better or worse. The possibility of trading obviously changes managers' incentives; with insider trading, their management 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 law review literature is full of informal assertions and speculations concerning this question,[2] the economic literature has thus far devoted little attention to it.[3]

This paper is part of a project aimed at modelling the effects of insider trading on the agency problem in corporations. In this paper, and the other parts of our 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 and trading in the firm's shares and their

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

[3] The only two papers by economists on this general subject are Leftwich and Verrecchia (1983) and Dye (1984). These two papers do not provide the analytical framework that we develop and view as necessary to study the effect of insider trading on the level of agency cost. And, in any event, none of these papers considers the type of managerial decisions on which this paper focusses.

behavior under contracts that prohibit such trading. In our view, such comparison must be analyzed using a principal-agent model, such as the one that we offer, that takes into account explicitly all the relevant ex ante effects; among other things, it must take into account 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.[4]

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. The present paper thus focusses on one important type of management decisions that insiders must make -- their reaction to opportunities to "waste" corporate value. (Other types of management decisions are analyzed in Bebchuk and Fershtman, 1989a, 1989b).[5] To analyze the effect of insider trading on

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[4] The effects on the agency problem are not the only ex ante effects of insider trading, and some recent works look at other ex ante effects. Specifically, Ausubel (1989) and Manove (1989) examine the effect that insider trading might have on ex ante investment even putting aside the agency problem. Because insider trading reduces the expected return to the initial shareholders, it might decrease their investment. Both papers abstract from the agency problem on which we focus. Ausubel assumes that the insiders 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 are solely concerned with 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). Abstracting from the agency problem, 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 (1989a) focusses on insiders' choice among uncertain investment projects, and Bebchuk and Fershtman (1989b) consider insiders' choice of their level of effort. Together, our three papers attempt to cover the effects of insider trading on all the different types of insiders' management decisions.

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. In addition to determining the treatment of trading, contracts also naturally specify a salary, which may include both a fixed component and a component that depends on results.

The aspect of insiders' behavior on which this paper focusses is one to which economists have in the past paid no attention, for reasons to be made clear presently, and it thus requires clarification. Suppose that a situation arises under which the insiders must make a decision -- choose between A and B -- where choosing either way would involve practically the same level of insider effort (and perhaps no or little effort) and would not significantly change the risk facing the insiders. While A and B are similar in the amount of effort and uncertainty that they involve, one of them may well be better for the corporation, and it would be desirable for the insiders to choose the value-increasing option. Choosing otherwise would involve "wasting" or "throwing away" corporate value. Such an insider choice, which is clearly different from the choice of effort level or the choice among projects with different levels of risk, is likely to arise often in the life of a company.

The reason why the literature investigating principal-agent issues has not previously paid attention to such choices is presumably the view, which is correct in the absence of insider trading, that such choice, unlike those involving insider effort or change in uncertainty level, are unproblematic. In the absence of insider trading, any contract that provides the insiders with any positive fraction of the company's value would induce insiders not to waste corporate value; insiders would have no reason to bring about such a waste. Thus, the possibility of insiders choosing, when a choice arises, to waste corporate value, can be ignored.

As this paper shows, however, this is no longer the case in the presence of insider trading. When insiders can trade, they may have a reason to cause corporate waste -- either by not preventing a loss or by not taking an advantage. Such a waste may lead to a change in market price which the insiders can use to make trading profits.

The model we develop enables us to study the reasons why insider trading may produce such inefficient behavior as well as the conditions under which, and the extent to which, such behavior might arise. Note, for example, that a decision to waste value can produce trading profits only if the waste is not already fully reflected in the prior market price; this might happen if the waste is brought about only with a probability because, say, the opportunity to bring it about arises only with a probability. Similarly, note that the insiders would bring about such a waste only if the expected insider profits, which are made against the background of a price that anticipates the possibility of some such profits, exceed the adverse effect that the waste of value would have on the other elements of the insiders' compensation. These points and others emerge from our results concerning the conditions under which inefficient behavior would arise, the frequency of such behavior, and the magnitude of the resulting loss in value.

Having shown that allowing insiders to trade in the firm' securities can lead them to make a decision to waste corporate value, we examine which limitations on insider trading can eliminate this problem. We show that the problem would not arise if insider trading is limited to purchasing shares -- that is, if insiders are allowed only to increase their holdings (whenever they wish) but never to decrease them (until they leave office and stop making decisions for the firm).

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 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 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 abnormally profitable trades, as the evidence indeed indicates (see, e.g., Jaffee (1974)). Furthermore, insiders may hide not their motive for trading but rather the trading itself: Much trading by insiders may well go undetected.

Clearly, the amount of trading profits that insiders make 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. Results on the consequences of insider trading thus have both normative and positive implications. From a normative perspective, they are relevant for assessing the optimal amount of insider trading. From a positive perspective, and 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 describes the assumptions of the model. Sections III and IV analyze how insiders would react -- with and without insider trading -- when faced with a choice between having and effortlessly preventing a certain loss in expected corporate value. Section V extends the model to apply to the case in which the insiders face a choice between foregoing or effortlessly getting a certain increase in the firm's expected value. (As will be seen, the analysis of the choice between having and foregoing a value increase is similar, but not equivalent, to the analysis of the choice between foregoing and having a certain value decrease.) Section VI shows that the problem identified in the earlier sections would not arise if sufficient restrictions were placed on investors' ability to decrease their holdings in the firm's shares. Finally, Section VII makes concluding remarks.

II. FRAMEWORK OF ANALYSIS

The sequence of events in the model is as follows. In Period 0, the managerial contract is specified. In Period 1, an opportunity to "waste" corporate value may arise, in which case the managers must decide how to react to it. In Period 2, there is trading in the firm's shares; the managers participate in this trading if their contract allows them to do so. In Period 3, the final period, the firm's output is realized. Our assumptions concerning each of the elements of the model are described below.

<u>Period 0: Contract Specification</u>. At t = 0, a company is formed, and a contract is made between the shareholders (or the entrepreneur setting up the

firm and selling its shares to the initial shareholders) and the managers (the "insiders"). 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.[6] Thus, the contract specifies some S and α, $0 \le \alpha \le 1$, and the salary scheme is $S(W) = S + \alpha W$. The company gives the managers an amount S when the contract is made (if S is negative, the company actually receives a payment from the managers), and also gives them a right to receive a fraction α of the firm's final output W. It is assumed that, due to limited managerial wealth and/or enforcement problems, S cannot be lower than some negative lower bound -D for some $D > 0$.

In addition to providing the above "direct" compensation, the contract also specifies whether the managers will be allowed to buy or sell shares of the company. We shall refer to contracts prohibiting trading by insiders 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 that the managers will make. The total compensation that the managers will receive, which we denote by $C(W)$, will be equal to $S(W)$ under an NT contract and to $S(W) + \Pi$ under an IT contract.

Both managers and shareholders are assumed to be risk-neutral. The managers have an alternative employment with expected compensation of $\bar{C}$. Thus, the contract made with the managers must satisfy the managerial participation constraint $EC(W) \ge \bar{C}$.

[6] 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.

Period 1: Managerial Reaction to Opportunities to Waste Corporate Value. In this period, a contingency P may arise, with probability $0 < p \leq 1$, in which case the managers will face an opportunity to "waste" corporate value. Specifically, at this stage we will assume that, if P arises and the managers do not take a certain effortless action, the firm's expected output will decrease by L. Thus, the managers' decision will be whether or not to prevent the expected loss L. (In Section V we will examine the similar -- but not equivalent -- possibility of the managers having to decide whether or not to take an effortless action that will increase expected output.) Outsiders cannot observe whether the contingency P arose and, if so, how the managers reacted to it. As a result, the firm's market value in this period, V_1, is equal to the firm's Period 0 value, V_0.

Period 2: Trading. In this period, trading in the firm's shares takes place with the following participants: liquidity-motivated sellers, a market maker (specialist) who sets the price, and, under an IT contract, also the insiders. 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 having 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 whose distribution is known by the market maker. When 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 attempt to 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 private information. Therefore, the price set will be 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.

In contrast, 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 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 market maker's price. There is of course 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, initially the market maker 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 value, which we denote by V_o, and the firm's final value, which we denote by V_f; for one thing, as the insiders trade more shares, their information will be increasingly reflected in the prices set by the market maker. Specifically, we assume that the insiders' expected profits from trading are $\beta|V_f - V_o|$ for some $0 < \beta < 1$.

(In Section VI we will refine this assumption to consider the case in which the managers' expected profits are $\beta_1|V_f - V_o|$ when $V_f > V_o$ and $\beta_2|V_o - V_f|$ when $V_f < 0$, with $\beta_1 \neq \beta_2$.) Of course, the insiders' expected trading profits all come at the expense of the liquidity sellers, as the market maker is assumed to make zero expected profits.

Period 3: Realization. In this period, the firm's output W is realized. The expected output is $\bar{W}$, unless the contingency P arose and the managers decided to "waste" value, in which case the expected value of W is $\bar{W} - L$.[7] The firm's final value is $V_f = (1 - \alpha)W - S$. The story ends now: the firm dissolves; or alternatively, a new contract is made with the managers.

The Shareholders' Objective. In designing the managerial contract, the initial shareholders (or the entrepreneur who sets up the company and sells the shares to them) wish to maximize V_o.

Note that, for any contract that makes the participation constraint binding, V_0 will equal $EW - \bar{C}$. Therefore, among such contracts, the shareholders wish to have the contract that would lead the managers to maximize the expected output EW. We have intentionally structured the model so that the only way in which the managers can affect EW is through their Period 1 reaction to opportunities to waste corporate value. Let k, $0 \leq k \leq 1$, denote the managers' Period 1 strategy -- k is the probability that, if the contingency P arises, the managers will choose to lose the value L. Clearly, among the set of contracts that make the participation constraint binding, the

[7] W will be equal to its expected value plus some "noise" term ϵ. To the extent that the managers learn ϵ before the investors do, they may engage in some profitable trading. In order to abstract from the possibility of such trading, we assume that the insiders and outsiders all learn ϵ at the same time. We wish to abstract from this possibility because insiders' ability to make trading profits on private information concerning ϵ would not affect their Period 1 reaction to opportunities to waste value.

shareholders would like a contract that would induce the managers to choose the strategy $k = 0$.

III. INSIDER BEHAVIOR AND CORPORATE VALUE WITHOUT INSIDER TRADING

Let us first look at behavior and value under NT contracts, which are straightforward to analyze. Under any NT contract, (S,α), the insiders will seek to maximize $E(S + \alpha W)$. Consequently, for any $\alpha > 0$, managers will wish to maximize EW and hence, if P occurs, they will always choose to prevent the loss L. Therefore:

<u>Proposition 1</u>: Under any NT contract with $\alpha > 0$, managers' optimal strategy is $k^* = 0$.

Note that, under an NT contract, liquidity sellers will not bear expected losses. Consequently,

(1) $$V_0 = EV_f = EW - (S + \alpha EW) = (1 - \alpha)\bar{W} - S.$$

To make the participation constraint binding for a given α, the fixed salary S must satisfy

(2) $$S = \bar{C} - \alpha\bar{W}.$$

Because S cannot be below -D, it may not be possible to make the participation constraint binding. (Specifically, when $\alpha > (\bar{C} + D)/\bar{W}$, lowering S to its minimum level, -D, will provide managers with expected compensation $\alpha\bar{W} - D$, which is higher than the competitive level $\bar{C}$.) However, as long as α is chosen below $(\bar{C} + D)/\bar{W}$, the participation constraint can be made binding. From Proposition 1 and the above discussion, we can conclude the following:

Corollary 1: There are always NT contracts (specifically, all those with $\alpha \leq (\bar{C} + D)/\bar{W}$) that would yield the highest possible initial value, $V_0 = \bar{W} - \bar{C}$.

IV. INSIDER BEHAVIOR AND CORPORATE VALUE WITH INSIDER TRADING

A. Insider Behavior

Whereas under an NT contract the managers' compensation (and thus their choice of k) does not depend on V_0, this is no longer the case under an IT contract. Under such a contract, the managers' compensation includes the expected trading profit Π, which clearly depends on V_0. Thus, the managers' strategy k depends on the initial value V_0, and at the same time the initial value V_0 must reflect the anticipated value of k. We let $E\Pi(V_0,k)$ denote the expected managerial trading profit as a function of the initial value and managers' strategy, and state the conditions that a (rational expectations) equilibrium must satisfy:

Definition 1: A rational expectations equilibrium is (V_0^*,k^*) such that:

(i) k^* is the managers' optimal strategy given the initial value V_0^*, i.e.,

(3) $$k^* \in \{k \in [0,1] | k = \mathrm{Arg}_k\mathrm{Max}\ [S + \alpha EW(k) + E\Pi(V_0^*,k)]\}.$$

(ii) V_0^* is the expected final value EV_f (given the strategy choice k^*) minus the managers' total compensation, i.e.,

(4) $$V_0^*(k^*) = E[(1 - \alpha)W(k^*) - S] - E\Pi(V_0^*(k^*),k^*).$$

Given an initial value managers decide whether to waste value (if P occurs) by comparing the $-\alpha L$ reduction in salary that would result from wasting value with the expected increase in trading profits that they might realize from choosing another strategy. Before turning to identify the equilibrium for any IT contract (S,α), let us first state the following lemma.

<u>Lemma 1</u>: Suppose that in equilibrium shareholders expect the managers' strategy to be $k = \theta$. Then:

(i) the expected insider trading profits are

(5) $$E\Pi(V_0^*(\theta),\theta) = [(1 - \theta p)2\theta p\beta/(1 - \beta(1 - 2\theta p))](V_f^2 - V_f^1)$$

where V_f^1 is the final value when the loss L occurs and V_f^2 is the final value when it does not.

(ii) the difference between the insiders' trading profits when the loss L occurs and when it does not occur is:

(6) $$\Delta\Pi = \beta[(2\theta p - 1 + \beta)/(1 - \beta(1 - 2\theta p))](V_f^1 - V_f^2).$$

<u>Proof</u>: See the Appendix.

<u>Proposition 2</u>: $k^* = 0$ (managers never waste value) in an equilibrium if and only if $\beta < \alpha/(1 - \alpha)$.

<u>Proof</u>: For $k^* = 0$ the equilibrium initial value is $V_0^* = (1 - \alpha)\bar{W} - S$. Given such V_0^*, suppose that contingency P occurs. If the managers prevent the loss they will have a salary $S + \alpha\bar{W}$, but, given V_0^*, will not be able to make any trading profits. If the managers choose to have the loss, they will expect V_f to be $(1 - \alpha)(\bar{W} - L) - S$, and will be able to make trading profits. Thus, if they choose not to prevent the loss, their total compensation will be

(7) $$S + \alpha(\bar{W} - L) + \beta|V_f - V_0^*|.$$

Substituting for V_f and V_0^* and simplifying yields that managerial payoffs from letting the loss occur are $S + \alpha\bar{W} - \alpha L + \beta(1 - \alpha)L$. Comparing these payoffs with the payoffs associated with preventing the loss implies that the managers are better off by choosing $k^* = 0$ as long as $\beta < \alpha/(1 - \alpha)$.∎

Remark: The intuition behind Proposition 2 is as follows. αL is the direct reduction in salary caused by letting the loss L occur, while $\beta(1 - \alpha)L$ is the trading profits that managers can make if they let the loss occur. The condition in the above proposition indicates that these trading profits are smaller than the reduction in salary.

Note that the equilibrium with $k^* = 0$ exists either when α is large enough or when β is small enough. In this case the direct effect on salary is large relative to the possible gains from insider trade.

Proposition 3: There is an equilibrium with $k^* = 1$ if and only if

$$(8) \qquad \frac{\alpha}{1 - \alpha} < \beta \frac{1 - \beta - 2p}{1 - \beta + 2\beta p} .$$

Proof: When $k^* = 1$ the shareholders expect that with probability p contingency P will arise, the value L will be wasted, and the expected final value will be

$$(9) \qquad V_f^1 = (1 - \alpha)(\bar{W} - L) - S;$$

and that with probability $1 - p$, the final value will be

$$(10) \qquad V_f^2 = (1 - \alpha)\bar{W} - S.$$

Given V_0^*, managers will prefer to let the loss occur only if the resulting effect on trading profits, $\Delta\Pi$, is higher than the αL reduction in direct salary caused by the loss. Thus, $k^* = 1$ is optimal as long as

$$(11) \qquad -\alpha L + \Delta\Pi > 0.$$

Using Lemma 1 to substitute for $\Delta\Pi$ yields that condition (11) can be rewritten as

$$(12) \qquad -\alpha L + \beta\frac{\beta - 1 + 2p}{1 - \beta(1 - 2p)}(V_f^1 - V_f^2) > 0.$$

From (9) and (10) we can verify that $V_f^1 - V_f^2 = -(1 - \alpha)L$. Substituting in (12) and rearranging yields that playing $k^* = 1$ is optimal if and only if equation (8) holds. ∎

Remark 1: The intuition behind Proposition 3 is as follows. When $k^* = 1$ the initial value V_0^* is between V_f^1 and V_f^2 and thus enables the managers always to make trading profits. Given such V_0^*, the managers' choice of $k^* = 1$ is optimal only if (i) the direct loss of salary $-\alpha L$ plus the trading profits $\beta(V_0^* - V_f^1)$ that can be made by letting the loss occur are larger than (ii) the trading profits $\beta(V_f^2 - V_0^*)$ that can be made by preventing the loss. To satisfy this condition β should be sufficiently above α, and p should be sufficiently low, so that V_0^* will be closer to V_f^2 than to V_f^1. The condition of the proposition guarantees that these conditions be satisfied.

Remark 2: For $p = 1$ condition (8) can be rewritten as $\alpha/(1 - \alpha) < \beta(-\beta - 1)/(1 + \beta)$ -- which cannot be satisfied as long as β and α are positive. Thus, Proposition 3 implies that, if the opportunity to waste value always arises, i.e., $p = 1$, it will not be always used by insiders. The reason for this is that, if the opportunity to waste value always arises and is always used, then the waste of value will be certain and will be fully reflected in V_0^*, and consequently letting the loss occur will not enable insiders to make any trading profits.

Propositions 2 and 3 imply that when $\beta(1 - \beta - 2p)/(1 - \beta + 2\beta p) < \alpha/(1 - \alpha) < \beta$, there is no equilibrium with pure strategies. Under such a value of the parameters, the value V_0^* that is associated with $k^* = 0$ would lead the managers to choose $k^* = 1$, for, with such V_0^*, the trading profits that would result from letting the loss occur would be large. Similarly, the low value of V_0^* that is associated with $k^* = 1$ would lead the insiders to choose $k^* = 0$. But even though a pure strategy equilibrium does not exist for such values of the parameters, a mixed strategy equilibrium does exist.

<u>Proposition</u> <u>4</u>: For every α, β, and p such that

$$(13) \qquad \beta \frac{1 - \beta - 2p}{1 - \beta + 2\beta p} < \frac{\alpha}{1 - \alpha} < \beta,$$

there is a mixed strategy equilibrium such that the insiders' equilibrium strategy is:

$$(14) \qquad k^* = \frac{(\beta - \beta\alpha - \alpha)(1 - \beta)}{2p\beta} .$$

<u>Proof</u>: When contingency P occurs, the strategy $1 > k^* > 0$ will be optimal only if the managers are indifferent between letting the loss occur and preventing it. Letting the loss occur will result in a salary reduction of αL which needs to be covered by the extra trading profits that having the loss will enable. Specifically, a mixed strategy equilibrium exists if and only if $-\alpha L + \Delta\Pi = 0$, where, as before, $\Delta\Pi$ is the difference between the trading profits that the insiders can make if they let the loss occur and the profits that they can make if they prevent the loss. Using Lemma 1 to substitute for $\Delta\Pi$ yields

$$(15) \qquad -\alpha L + \beta\frac{2k^*p - 1 + \beta}{1 - \beta(1 - 2k^*p)}(V_f^1 - V_f^2) = 0.$$

From (9) and (10) we obtain that $V_f^1 - V_f^2 = -(1 - \alpha)L$. Substituting in (15) and rearranging terms yields the equilibrium mixed strategy (14). ∎

Putting Propositions 2 - 4 together, it is easy to see that for each value of the parameters, there is one and only one equilibrium. Specifically, putting the three propositions together gives:

<u>Proposition</u> <u>5</u>: For any IT contract, there is a unique equilibrium strategy characterized by

$$(16) \qquad k^* = \begin{cases} 0, & \text{if } \frac{\alpha}{1 - \alpha} \geq \beta; \\ \frac{(1 - \beta)(\beta - \alpha - \alpha\beta)}{2p\beta}, & \text{if } \beta\frac{1 - \beta - 2p}{1 - \beta + 2\beta p} < \frac{\alpha}{1 - \alpha} < \beta; \text{ and} \\ 1, & \text{if } \frac{\alpha}{1 - \alpha} \leq \beta\frac{1 - \beta - 2p}{1 - \beta + 2\beta p} \end{cases}$$

From Proposition 5, it is evident that, whenever β exceeds $\alpha/(1 - \alpha)$, k^* will be positive and insiders will sometimes waste value. For example if α = 1%, then it is sufficient for β to exceed 1.01% for the equilibrium to include some waste.

Alternatively, there will be some expected waste if α is below $\beta/(1 + \beta)$. Note also that, once α satisfies this condition, a further decrease in α implies a greater expected loss as $\partial pk^*/\partial\alpha = -(1 - \beta^2)/2\beta < 0$. The expected waste will get to its highest value once α is sufficiently low to induce the strategy $k^* = 1$.

B. Maximal Corporate Value with Insider Trading

Since the participation constraint implies that insiders' total expected compensation cannot be below $\bar{C}$, the maximum possible value of V_0 is $\bar{W} - \bar{C}$ and it will be achieved only if the managers are induced to choose $k^* = 0$. As was shown in Section III, any NT contract with $\alpha > 0$ would lead to the choice $k^* = 0$. In contrast, as the first part of this Section has shown, under an IT contract $k^* = 0$ will be induced only if $\alpha > \beta/(1 + \beta)$.

Raising α to the level of $\beta/(1 + \beta)$ might be costly. First, when the firm's returns are uncertain and the managers are risk averse, increasing α will increase the risk bearing costs borne by managers. This type of cost is absent from our model as we assume risk-neutral managers. The second way in which increasing α may be costly -- and the one we chose to introduce in our model -- results from limited managerial wealth. Because we assume that S cannot be decreased below some lower bound -D, increasing α might require giving the managers a compensation in excess of $\bar{C}$. Specifically if

$$(17) \qquad -D + \bar{W}\frac{\beta}{1 + \beta} > \bar{C},$$

then increasing α to the level of $\beta/(1 + \beta)$ will require paying the managers more than $\bar{C}$ (because only S below -D will be sufficiently negative to make the participation constraint binding).

Proposition 6: There is no IT contract that will produce the maximal value of $V_0 = \bar{W} - \bar{C}$ if

$$(18) \qquad \frac{\beta}{1 + \beta} > \frac{\bar{C} + D}{\bar{W}} .$$

Proof: When condition (18) holds, at least one of the following two things must occur -- (i) α being below $\beta/(1 + \beta)$, or (ii) the insiders' compensation exceeding $\bar{C}$. Either one will be sufficient to produce an initial value lower than $\bar{W} - \bar{C}$. ∎

When β is sufficiently small it is possible to devise a compensation scheme such that managers in equilibrium will not waste value and yet their compensation does not exceed $\bar{C}$. Specifically, using Proposition 6, we can conclude the following:

Corollary 2: The existence of opportunities for insiders to waste value will not produce a reduction in corporate value if and only if

$$(19) \qquad \beta < \frac{\bar{C} + D}{\bar{W} - \bar{C} - D} .$$

For example, assuming that $\bar{C} = 0.02\bar{W}$ and that $-D = -0.01\bar{W}$, then β must be kept below 3 percent to avoid reductions in corporate value. Only with such a low level of β will it be possible to design an IT contract that will both induce managers to choose $k^* = 0$ and provide them with compensation not exceeding $\bar{C}$.

V. OPPORTUNITIES TO INCREASE VALUE

We continue to make the same assumptions as before with one difference: we now assume that, if contingency P occurs in Period 1, the managers can, by taking an effortless action, increase the expected output from $\bar{W}$ to $\bar{W} + G$. Thus, if P occurs and the managers do not take advantage of the opportunity to increase value, they will be "wasting" corporate value. In the considered situation, the highest possible initial value is $\bar{W} + pG - \bar{C}$. As before, k^* will denote the equilibrium strategy of the insiders -- that is, the probability that, if P occurs, the insiders will elect to "waste" value (i.e., will not take advantage of the opportunity to raise value).

Using the methods of the preceding part, we can establish the propositions stated below. The proofs of these propositions are all relegated to the Appendix, but the text includes a remark that explains intuitively the difference between the equilibrium results in this Section and in the preceding one.

Proposition 7: Under any NT contract with $\alpha > 0$, managers will choose $k^* = 0$. Moreover, there is always a set of NT contracts that would produce the highest possible initial value of

$$V_0 = \bar{W} + pG - \bar{C}. \tag{20}$$

Proposition 8: Under an IT contract:

(i) There is no equilibrium with $k^* = 1$.

(ii) $k^* = 0$ is an equilibrium if and only if

$$\frac{\alpha}{(1 - \alpha)} \geq \beta \frac{2p - 1 - \beta}{1 + \beta - 2p\beta} . \tag{21}$$

(iii) There is a mixing equilibrium ($0 < k^* < 1$) if and only if

$$\frac{\alpha}{(1 - \alpha)} < \beta \frac{2p - 1 - \beta}{1 + \beta - 2p\beta} , \tag{22}$$

in which case the equilibrium strategy is:

$$k^* = 1 - \frac{(1 + \beta)(\alpha + \beta - \alpha\beta)}{2p\beta} . \tag{23}$$

Remark: The differences between the equilibrium in this case and the case discussed in the previous Section may be best understood by considering the lotteries induced by the strategy k. In both Sections, there are two possible final values, a high value and a low value. In Section IV, when the contingency P implies a possible loss, the probability of having the low value is pk. In this Section, when P implies a possible gain, the probability of having the low value is $1 - p + pk$. When $p = 1$ the two lotteries are identical and yield equivalent results. When $p < 1$, however, the two cases are not identical. As we can see from the above probabilities, when P implies a possible loss, then the probability of having the low value is zero if $k = 0$; in contrast, when P implies a possible gain, the possibility of ending up with the low value exists even with $k = 0$. It is exactly this difference that yields the different types of equilibrium.

For example, when P implies a possible gain, there is no equilibrium with $k^* = 1$; for such a strategy would imply that the low value is certain, no trading profits would be possible, and playing $k = 1$ would thus not be optimal. When P implies a possible loss, even playing $k^* = 1$ does not imply that the low value would result with certainty; thus, the initial value would be between the two possible values, trading profits would be possible, and consequently there may be an equilibrium with $k^* = 1$ (Proposition 3).

<u>Proposition</u> <u>9</u>: There is <u>no</u> IT contract that produces the highest possible initial value if and only if

$$\frac{\beta(\bar{W} + pG)(2p - 1 - \beta)}{(1 - \beta^2)} > \bar{C} + D. \tag{24}$$

VI. RESTRICTIONS ON INSIDER TRADING

Thus far we have analyzed the conditions under which, taking the profitability of insider trading as given, the presence of such trading reduces corporate value by leading insiders to "waste" corporate value. In this Section, we identify certain restrictions on insider trading that would address the identified problem.

A. Prohibiting Insiders from Ever Decreasing Their Holdings

Let us first consider a restriction that would prohibit insiders, as long as they are in office, from ever selling shares but leave them free to buy shares. Note that the considered restriction is much stricter than a prohibition on insiders' selling short their company's shares: the restriction under consideration would prohibit insiders from ever decreasing their holding even if such a decrease would leave them with a long position in the company's stock.

Note that the considered restriction would still enable managers to use their private information to make trading profits. They would be able to profit by increasing their holdings when they get private information that is "good news". They would only be precluded from adjusting their position downward on the basis of bad news.

Let us denote by IT^* a contract that allows insiders to increase their holdings but not to decrease them. And let us suppose that the restriction on insiders' decreasing their holdings is perfectly enforced. Under such an IT^* contract, the insiders' trading profits will be $\beta(V_f - V_0)$ if $V_f > V_0$ and 0 otherwise.

<u>Proposition 10</u>: Under any IT^* contract with $\alpha > 0$, managers will always

follow the strategy $k^* = 0$; that is, they will never waste value.

<u>Proof</u>: We will prove the proposition for the case of potential loss. The case of potential gain can be proven in a similar way.

Let us first prove that there is an equilibrium with $k^* = 0$. Given $k^* = 0$, the initial value of the firm is $V_0^* = (1 - \alpha)\bar{W} - S$. By leading to a loss, managers will decrease their salary by αL without being able to compensate themselves by increased trading profits, as they cannot reduce their holding.

Let us now verify that there is no other equilibrium. For every equilibrium with $k^* > 0$, the initial value is $V_0^* = \bar{W} - kpL - \bar{C}$. Given this V_0^*, the optimal managerial strategy is $k = 0$, as it would give the managers both a higher salary and increased trading profits. ∎

<u>Remark</u>: That the IT^* contract leads to efficient insider behavior can be explained intuitively as follows. It is not insider trading profits per se that could lead to inefficiency but rather only trading profits based on bad news. Under an IT^* contract, managers still can benefit from getting private information that is "good news". But being able to benefit from "good news" cannot induce managers to waste corporate value. IT^* prevents insiders from profiting from bad news; consequently, it eliminates any incentive to produce bad news by wasting corporate value.

B. <u>Restrictions that Reduce the Profitability of Trading on Bad News</u>

Preventing insiders from ever decreasing their holdings may not be feasible or desirable for two reasons. First, such restriction may not be possible to enforce perfectly; that is, even if the restriction is adopted, some sales may go undetected. Second, a flat prohibition on insiders decreasing their holdings may be viewed as imposing severe liquidity costs on insiders. Thus, the question arises whether it may be possible to address the problem identified in this paper by reducing, rather than eliminating, insiders' ability to profit from trading on bad news.

To study this question, let us suppose that restrictions and enforcement measures have been adopted that make the expected profits from trading on bad news lower than those from trading on good news. Specifically, let us assume that the insider trading profits will be $\beta_1(V_f - V_0)$ if $V_f > V_0$ and $\beta_2(V_0 - V_f)$ if $V_f < V_0$, with $0 < \beta_2 < \beta_1$.

Proposition 11: When P implies a possible loss, $k^* = 0$ is an equilibrium if

$$\beta_2 < \alpha/(1 - \alpha). \tag{25}$$

Proof: Given $k^* = 0$, the initial value is $V_0^* = (1 - \alpha)\bar{W} - S$. Given such V_0^*, playing $k = 1$ provides managers with $\alpha(\bar{W} - L) + S + \beta_2\{V_0^* - [(1 - \alpha)(\bar{W} - L) - S]\}$, while playing $k = 0$ provides them with $\alpha\bar{W} + S$. The condition $\beta_2 < \alpha/(1 - \alpha)$ can be shown to guarantee that playing $k^* = 0$ is optimal. ∎

In a similar way and following the methods of the proof of Proposition 8 in the Appendix (with $\beta_1 \neq \beta_2$), we can prove the following proposition.

Proposition 12: When P implies a possible gain, $k^* = 0$ is an equilibrium if

$$\frac{\alpha}{1 - \alpha} > \frac{p(\beta_1 + \beta_2) - \beta_1(1 + \beta_2)}{1 + \beta_2(1 - p) - p\beta_1}. \tag{26}$$

VII. CONCLUSION

This paper has shown that, in the presence of trading in shares by insiders, it is no longer certain that insiders will not "waste" corporate value. The paper has identified the conditions under which a problem may arise. Whether this problem would arise depends on how α, the fraction of changes in corporate value that managers experience through their salary schemes, compares with β, the fraction of the gap between market price and true value that insiders can capture by trading.

Having identified this problem, the paper has also investigated which restrictions on trading can eliminate it. One such sufficient restriction, would prohibit insiders from decreasing (but not from increasing) their holdings in their company's stock as long as they serve the company. Under this restriction, insiders would still be able to make some trading profits by increasing their holdings when their private information is favorable. But since they would be able to make trading profits only from good news, they would have no reason to produce bad news.

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.

APPENDIX

Proof of Lemma 1:

Observe that

$$\text{(A.1)} \qquad V_0^* = \theta p V_f^1 + (1 - \theta p) V_f^2 - E\Pi(V_0^*, \theta)$$

and

$$\text{(A.2)} \qquad E\Pi(V_0^*, \theta) = \theta p \beta (V_0^* - V_f^1) + (1 - \theta p)\beta(V_f^2 - V_0^*).$$

Substituting (A.1) into (A.2) and arranging yields

$$\text{(A.3)} \qquad E\Pi(V_0^*, \theta) = \frac{(1 - \theta p) 2\theta p \beta}{1 - \beta(1 - 2\theta p)} (V_f^2 - V_f^1).$$

Once the contingency P occurs, the difference in the insider trade profits between not preventing and preventing the loss L is:

$$\text{(A.4)} \qquad \Delta\Pi = \beta(V_0^* - V_f^1) - \beta(V_f^2 - V_0^*)$$

$$= 2\beta V_0^* - \beta(V_f^1 + V_f^2)$$

$$= 2\beta p \theta V_f^1 + 2\beta(1 - \theta p) V_f^2 - \beta(V_f^1 + V_f^2) - \frac{(V_f^2 - V_f^1) 2\beta(1 - \theta p) 2\theta p \beta}{1 - \beta(1 - 2\theta p)}$$

$$= \beta(2\theta p - 1)(V_f^1 - V_f^2) + \frac{2\beta^2(1 - \theta p) 2\theta p (V_f^1 - V_f^2)}{1 - \beta(1 - 2\theta p)}$$

$$= \frac{(V_f^1 - V_f^2)\beta(2\theta p - 1 + \beta)}{1 - \beta(1 - 2\theta p)}. \qquad \blacksquare$$

Proof of Proposition 7:

Given an NT contract with $\alpha > 0$, any deviation from the strategy $k^* = 0$ will yield a loss of salary. Since α can be made arbitrarily small, it is possible to choose $S = \bar{C} - \alpha(\bar{W} + pG) > 0$. Given such S the initial value is as stated by (20). ∎

<u>Proof of Proposition 8</u>:

(i) Given the strategy $k^* = 1$ and assuming that α is sufficiently low such that it is possible to find $S = \bar{C} - \alpha\bar{W} \geq -D$, the initial value is $V_0 = \bar{W} - \bar{C}$. (If there is no such S, V_0 will be even lower, but our following argument will still hold.) Now notice that, given such V_0, the managers' optimal strategy is to play $k = 0$. By playing $k = 0$ when contingency P occurs, the managers get additional salary of αG and can also gain $\beta(1 - \alpha)G$ by insider trade.

(ii) Given that P occurs, playing $k = 0$ implies the final value $V_f^2 = (1 - \alpha)(\bar{W} + G) - S$. When P does not occur the final value is $V_f^1 = \bar{W}(1 - \alpha) - S$. The initial value of the firm when $k = 0$ is

$$\text{(A.5)} \qquad V_0^* = (1 - p)V_f^1 + pV_f^2 - E\Pi(V_0^*,0)$$

Given this V_0^* the expected insider trade profits is

$$\text{(A.6)} \qquad E\Pi(V_0^*,0) = (1 - p)\beta(V_0^* - V_f^1) + p\beta(V_f^2 - V_0^*)$$

From (A.5) and (A.6) we obtain the expected insider trade profits when $k = 0$:

$$\text{(A.7)} \qquad E\Pi(V_0^*,0) = \frac{2p(1 - p)\ \beta(1 - \alpha)G}{1 + \beta - 2p\beta}$$

Once contingency P occurs, playing $k = 0$ is optimal if and only if

$$\text{(A.8)} \qquad \alpha G + \beta(V_f^2 - V_0^*) > \beta(V_0^* - V_f^1)\ .$$

Using (A.5) and (A.7) to substitute for V_0^* and $E\Pi$ in (A.8) yields that the condition that guarantees that playing k = 0 is optimal is

$$\text{(A.9)} \qquad \frac{\alpha}{(1 - \alpha)} > \frac{\beta(2p - 1 - \beta)}{1 + \beta - 2p\beta} .$$

(iii) When contingency P occurs, a strategy 1 > k* > 0 is optimal when managers are indifferent between k = 0 and k = 1. Following the proof of part (ii) we can calculate the initial condition and the expected insider trade profits for 1 > k > 0. The indifference condition implies that

$$\text{(A.10)} \qquad \frac{\alpha}{1 - \alpha} = \beta\frac{2(1 - k)p - 1 - \beta}{1 + \beta - 2p(1 - k)\beta} .$$

Solving (A.10) yields the equilibrium strategy k*. ■

<u>Proof of Proposition 9</u>:

Proposition 8 (ii) yields that if condition (21) does not hold, then if managers have an IT type contract there will be an expected waste of value. Owners can increase the level of α such that condition (21) holds. Thus rearranging (21) yields that if

$$\text{(A.11)} \qquad \alpha \geq \frac{\beta(2p - 1 - \beta)}{1 - \beta^2}$$

there will be no waste of value. Such a level of α however might mean that

$$\text{(A.12)} \qquad \overline{C} - \alpha(\overline{W} + pG) < -D$$

which implies that the participation constraint is not binding and that the managerial compensation exceeds $\overline{C}$. Substituting the required level of α from (A.11) into (A.12) yields condition (24). ■

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