Insider Trading and the Problem of Corporate Agency

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Working Paper 95-2
May 1995

Abstract: This paper models an economy in which managers, whose efforts affect firm performance, are able to make "inside" trades on claims whose value is also dependent on firm performance. Managers are able to trade only on "good news," that is, on returns above market expectations. Further, managers cannot trade at all unless permission for such trading is granted by shareholders. Insider trading is in derivative securities and thus does not adversely affect the firm's cost of raising funds. In this setting, it is shown that a prohibition on insider trading may still generate welfare improvement over a regime that allows shareholders to determine insider trading policy. This result obtains because insider trading, although improving managerial effort incentives for any fixed compensation level, also improves the bargaining position of shareholders relative to managers. This reduces the willingness of shareholders to provide expensive effort-assuring managerial compensation packages.

The views expressed here are those of the author and not necessarily those of the Federal Reserve Bank of Atlanta or the Federal Reserve System. The author is a visiting scholar at the Federal Reserve Bank of Atlanta. This research has been supported, in part, by a research grant from the College of Business Administration of Georgia State University. The author thanks the participants in the Atlanta Finance Workshop for their many helpful comments on earlier drafts. Any remaining errors are the author's responsibility.

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1 Introduction

Securities trading by corporate officers has become one of the most heavily regulated capital market transactions. The Securities and Exchange (SEC) Act of 1933, as interpreted by the Supreme Court in cases such as *Speed v. Transamerica Corporation*, places broad prohibitions on trading by corporate insiders on firm-specific private information.[1] More recent legislative initiatives, such as the Insider Trading and Securities Fraud Enforcement Act of 1984, have fortified this prohibition.

Not surprisingly, the rationale for this elaborate structure of regulation has received significant attention both from financial economists and legal scholars. Much of this attention has been provided by the "Law and Economics" literature. For the most part, this literature has viewed insider trading prohibitions unfavorably. This view finds its classic expression in the work of Manne (1966). One of the arguments made by Manne (1966) for allowing insider trading is that such trading allows the information possessed by insiders to be rapidly impounded in the prices of securities and thus increases the efficiency of capital markets. The importance of this argument is evidenced by its profound impact on subsequent research into insider trading.[2]

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[1] 99F. Supp. 808, 828-32 (D. Del. 151).

[2] However, not all of the insights from this literature are consistent with Manne's argument. For example, Fishman and Hagerty (1992) show that insider trading may discourage the production of information by outside analysts and thus reduce the net informational efficiency of stock markets. It has also been demonstrated by Ausubel (1990) and Manove (1989) that, even absent this effect, the adverse selection costs for outsiders engendered by insider trading make the raising of external finance more costly for outside investors.

There is, however, another aspect of security trading by corporate officers discussed by Manne which has received considerably less analytical attention: the effect of security market transactions on managerial incentives and agency problems within the corporation. The view of Manne and other adherents of the Law and Economics school is that security trading can improve the alignment of interests between outside claimants and management by allowing managers to profit from the appreciation in firm value engendered by their efforts. Of course, the salience of this argument is somewhat muted by the obvious rejoinder, offered by opponents of insider trading, that managers may as well profit by taking short positions and engendering corporate failures. However, Manne argues that, although the security market profits may be the same for engendering success as they are for failure, almost all non-trade-related incentives, such as compensation and reputation, favor engendering success and thus, given the neutrality of the trade-related incentives, insiders will never produce "bad news" solely in order to trade on such news. Further, Macy (1991) argues that, even if managers had an incentive to engage in such short trades, it would always be possible to place broad restrictions on the *direction* of their trading activities, precluding trading on "bad news" (e.g., short sales) but permitting trade on "good news," and thereby eliminate this incentive problem.[3]

The aim of this paper is to extend this literature on moral hazard and insider trading by investigating, in the context of a formal model, the incentive effects of trading in securities whose value is influenced by managerial actions. We model a firm owned by

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[3] Manne's arguments on the incentive effects have been extended and clarified by a number of researchers. Leftwitch and Verrecchia (1983) argue that trading opportunities bias managers toward risky projects. Easterbrook (1985) argues that other incentives, such as firm-specific human capital, will bias managers against risk-taking and, thus, insider trading opportunities may, on net, improve managerial incentives. In fact, Easterbrook and Fischel (1991) argue that the current prohibition on short-swing profits actually exacerbates managerial conservatism by forcing managers to hold large portions of their wealth in corporate stock rendered illiquid by insider trading restrictions. Some consideration has also been given to insider trading and adverse selection in the managerial labor market. Carlton and Fischel (1983) argue that, by accepting compensation contracts providing compensation via insider trading opportunities, high-quality managers can signal their ability.

an "outside" non-managing shareholder. This shareholder must choose between liquidating the firm's assets at time 0 or operating the firm. If the firm is operated, the shareholder must hire the manager from a competitive managerial labor market. The outside shareholder first fixes managerial compensation and decides whether to allow managers to trade on inside information or prohibit such trades. A manager is then hired who subsequently makes a trading and/or effort decision. Our assumption is that the manager makes his effort/trading decision *after* compensation has been determined.

The manager is effort averse and risk neutral. After being hired, the manager makes a portfolio-investment and effort decision. The manager is endowed with liquid wealth at the start of the period which he can use to purchase financial claims. These claims are pure securities that pay one dollar if and only if a specified event occurs. The securities markets are derivative markets, rather than primary markets, and thus resemble, albeit in a stylized way, the options market in which most actual (illicit) insider trading probably takes place.[4] We focus our attention on "one-sided" markets, markets in which the manager can only buy claims whose payoffs are positively dependent on corporate "success." Thus, we assume that trading on bad news by managers is precluded.[5] However, managers are unable, because of nonobservability or verifiability, to precommit *ex ante* to a specific pattern of insider trading and firms are not able to write trade-contingent compensation contracts. Their only option is either to allow or prohibit trading on good news.[6]

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[4] This assumption eliminates one of the costs of insider trading identified by the literature, i.e., that insider trading increases the cost of raising capital. Thus, one would expect that the adverse welfare effects from insider trading would be exacerbated if trade took place in primary security markets. See also footnote 1.

[5] However, we also consider "two-sided" markets in which managers can trade in claims that are contingent on corporate success or failure. Allowing managers to trade on failure, as one might well expect, only straightens our results. See the conclusion of the paper for further discussion.

[6] This contrasts with the earlier work of Dye (1984) which assumes that managers can precommit to a trading strategy at the time their compensation is fixed. A number of authors (e.g., Leftwitch and

Moral hazard is incorporated into the analysis by the assumption that the probability of success is positively related to the manager's effort. As well as receiving income from his portfolio, the manager receives incentive compensation that is tied to corporate success. Given the structure of security prices and the features of his compensation contract, the manager makes a "trading/effort" decision, consisting of a portfolio-investment strategy and effort decision. Market prices for traded claims are determined by marketmakers in a fashion similar to that in Admati and Pfleiderer (1988).

In this framework the consequences of allowing shareholders to determine corporate insider trading policies are analyzed. We show that shareholders are biased toward allowing too much insider trading. This follows because such trading provides managers with an alternative, albeit imperfect, incentive for exerting effort, namely the profits from insider trading. Shareholders can thus substitute insider trading opportunities for more effective but costlier compensation structures based on explicit managerial bonus contracts. This substitution increases shareholder profits but adversely affects firm efficiency.

Interestingly, while shareholder and social interests conflict, the *ex ante* interests of managers are weakly aligned with social interests in that managerial utility is never increased by prohibiting insider trading when allowing such trading lowers effort and is never lowered by prohibiting insider trading when such trading induces suboptimal project liquidations. The basis for the alignment is that managers, as well as society, prefer efficient compensation though explicit bonus schemes to the less efficient low-salary-cum-insider-trading employment contracts, when the high salary contracts are feasible. Further, when effort-assuring bonus schemes cannot be supported by project returns, managers have no incentive *ex ante* to prohibit insider trading. Thus, allowing

Verrecchia (1983) have argued that allowing such precommitment is unrealistic. See Easterbrook (1985) for more discussion of the Dye (1984) model.

managers to control the provisions of the corporate charter that affect insider trading produces superior welfare results to either a blanket prohibition or shareholder control. The rent-seeking of managers is better aligned with the interests of society than the profit seeking of shareholders.

This paper is organized as follows: In Section 2, the basic model is delineated. In Section 3, the conditions for insider trading are determined and comparative statics are performed. In Section 4, managerial compensation is endogenized and the effect of insider-trading prohibitions is determined. Extensions of the analysis and policy implications are discussed in the conclusion. Propositions, Lemmas, and Corollaries are numbered as a single sequence. Definitions are numbered separately. The proofs for most of these results are collected in the Appendix.

2 Managerial Incentives and Insider Trading Opportunities

Consider the following two-date, single-period economy. There are two possible events, labeled "s" and "f." Here s can be thought of as representing success of a project and f representing failure. The outcome is dependent on the efforts of a manager. This manager chooses between two effort levels, e and n, e representing the decision to exert effort and n representing the decision to "shirk," that is, not to exert effort. Let $a \in \{e, n\} \equiv A$ represent the action chosen by the manager. Let $I{:}A \rightarrow \{0, 1\}$ be the indicator function, which equals 0 whenever n is chosen and 1 whenever e is chosen. The probability of s (f) conditioned on the action a is represented by p_a $(1 - p_a)$, $a \in A$. Finally, let $\Delta p \equiv p_e - p_n$ represent the increase in the probability of success induced by managerial effort.

A contingent claim written on an event is a financial security that costs b dollars to purchase at time 0 and pays 1 dollar at time 1 if the event occurs and 0 if the event does not occur. We assume a success-contingent or "s-claim" trades on the financial market. The market for this claim operates in a fashion similar to the securities market modeled in Admati and Pfleiderer (1988). At time zero, before the effort decision is made, the market is opened. Prices are posted at which marketmakers buy and sell claims. Both the manager and uninformed liquidity or "noise" traders have the opportunity to trade in the contingent-claim market with risk-neutral marketmakers. The manager may not take short positions or take long positions in excess of their liquid wealth endowment, w. Funds not invested by the manager in the claim market are costlessly stored until time 1. The securities market is assumed to be competitive, and, thus, Bertrand competition between marketmakers ensures that the prices are set so that marketmakers earn zero profit. The demand for claims from uninformed traders is fixed and exogenous to the model and statistically independent of the agent's strategy. The expected value of this demand is represented by $\pi/(1 - \pi)w$. On the other hand, the manager's claim demand is determined endogenously in the model. In this formulation, π will be shown to represent the fraction of total wealth invested in the security market by uninformed "noise" traders.

Coincident with the security purchase decision, the manager chooses an action a $\in$ A. At time 1, subsequent to the choice of action and portfolio decision, the state of the world is revealed and agents receive the payoff from their claims. The manager's utility function exhibits risk-neutrality, effort-aversion, and additive separability in wealth and effort. Wealth consists of the payoffs from securities purchased as well as an incentive payment, which the manager receives. This incentive payment of i dollars is contingent on s occurring. We assume the manager's disutility of effort equals ε. Let θ represent the fraction of managerial wealth invested in s-claims. The payoff to the agent from choosing action a and investment strategy θ is thus given by

$$U(a, \theta) = (w\,\theta\,R + i)P[s \mid a] + w\,(1 - \theta) - \varepsilon\,I\ (a).$$

Here $R = 1/b$ represents the gross returns on s-claims if, in fact, event s occurs. An investment effort strategy then consists of a pair $(\theta, a) \in [0, 1] \times A$. It is easy to show that weak dominance arguments can be used to rule out all strategies except (a) setting θ equal to 1 and exerting effort, a = e, or (b) setting $\theta = 0$ and not exerting effort, a = n. We assume that weakly dominated strategies are never played. Thus, we assume that one of these two strategies is always played; we call (a) the effort strategy and (b) the shirking strategy. We also allow agents to randomize between these two strategies. Thus, to simplify notation, let λ represent the probability that the manager chooses the shirking strategy, and let $(1 - \lambda)$ represent the probability that the manager chooses the effort strategy. A strategy can thus be identified with a scalar between 0 and 1 representing the probability that the agent chooses the shirking strategy. It is clear that the shirking strategy is optimal whenever $[i + w R] p_e - \varepsilon < w + p_n i$. The effort strategy is optimal whenever $[i + w R)] p_e - \varepsilon > w + p_n i$. The agent is indifferent whenever $[i + w R)] p_e - \varepsilon = w + p_n i$. Thus, we can define the manager's best-reply correspondence, when the manager has the opportunity to trade in financial markets, as follows:

$$BR(R, i) = \begin{cases} 0 & \text{if} [i+wR]p_e - \varepsilon > w + p_n i \\ [0,1] & \text{if} [i+wR]p_e - \varepsilon = w + p_n i \\ 1 & \text{if} [i+wR]p_e - \varepsilon < w + p_n i \end{cases} .$$

Our next task is to determine the equilibrium security prices offered by the marketmaker. If the manager chooses the shirking strategy, then the marketmaker expects that only $\pi/(1 - \pi)w$ dollars from uninformed traders will be invested in s. On the other hand, if the manager chooses the effort strategy, then $\pi/(1 - \pi) w + w$ dollars will be invested in s-claims. Thus, the total expected funds traded in the s-market are $\lambda \pi/(1 - \pi)w + (1 - \lambda)[\pi/(1 - \pi)w + w]$. When the effort strategy is played, the marketmaker pays $b (R [\pi/(1 - \pi)w + w])$ with probability p_s and 0 with probability $1 - p_n$. When the shirking strategy is played, the marketmaker pays $b(R [\pi/(1 - \pi)e])$ with probability p_n and zero with probability $1 - p_n$. Thus, the expected profit to the marketmaker can be represented by

$$b\,[\,(\lambda\,(\pi/(1-\pi))w + (1-\lambda)[(\pi/(1-\pi))w + w])$$

$$-\,R\ \ (\lambda\, p_n\,(\pi/(1-\pi))\,w + (1-\lambda)p\ _s[(\pi/(1-\pi))w + w])].$$

The Bertrand condition implies that marketmakers earn zero profits and this condition defines the marketmaker's best responses $\mathbf{R} : [0,\,1] \rightarrow [0,\,\infty)$ as a function of the strategy distribution employed by the agent. Here, $\mathbf{R}(\cdot)$ represents the rate of return (the reciprocal of the state price) offered by the marketmaker. Bertrand competition implies the following response functions:

$$\mathbf{R}\,(\lambda) \equiv \frac{\pi+(1-\lambda)(1-\pi)}{\lambda p_n \pi+(1-\lambda)p_e}.$$

Note that $\mathbf{R}\,(\lambda)$ is increasing in λ ; $\mathbf{R}(0) = 1/p_e$ and $\mathbf{R}(1) = 1/p_n$.

A Nash equilibrium is a choice of strategy distribution $\lambda \in [0,\,1]$ such that (i) given the posted prices, λ is an optimal strategy and (ii) under λ, the marketmaker breaks even. A Nash equilibrium is thus a scalar $\lambda \in [0,\,1]$, which satisfies the following condition, $\lambda \in \mathrm{BR}(\mathbf{R}(\lambda),\,i)$. To simplify the analysis, note that this condition can be reduced to $\lambda \in \Gamma^t(\lambda)$, where Γ^t is the correspondence defined by

$$\Gamma^t(\lambda;\,i) = \begin{cases} 1 & \text{if } \ wH(\lambda)+(i\Delta p-\varepsilon)<0 \\ [0,1] & \text{if } \ wH(\lambda)+(i\Delta p-\varepsilon)=0 \\ 0 & \text{if } \ w\,H(\lambda)+(i\Delta p-\varepsilon)>0 \end{cases} \tag{1}$$

In (1), $H(\lambda) \equiv p_e\,\mathbf{R}(\lambda) - 1$ is the gross expected equilibrium trading profit of the manager. Note that this trading profit is given by

$$H(\lambda) = \pi\,\Delta p\,\frac{\lambda}{\lambda p_n \pi+(1-\lambda)p_e} \tag{2}$$

Let $T^t(\lambda) \equiv (1-\lambda)\,p_e\,\mathbf{R}(\lambda) + \lambda$. T^t represents the trading profit from an investment of \$1.00 if trade is allowed. Finally, let $P(\lambda)$ be the expected probability of s given effort probability λ, that is, $P(\lambda) \equiv (1 - \lambda)\, p_e + \lambda\, p_n$. The *ex ante* utility of the manager when insider trading is allowed, which we represent by $u_m(t, i, \lambda)$, is thus given by

$$u_m(t, i, \lambda) = \lambda\,(w + i\, p_n) + (1 - \lambda)(w\ \ \mathbf{R}(\lambda) + i\, p_e - \varepsilon).$$

To determine the effect of insider trading on managerial utility, we also analyze managerial behavior in the absence of trade. Let

$$\Gamma^{nt}(\lambda, i) = \begin{cases} 1 & \text{if } i\Delta p - \varepsilon < 0 \\ [0,1] & \text{if } i\Delta p - \varepsilon = 0 \\ 0 & \text{if } i\Delta p - \varepsilon > 0 \end{cases}$$

be the best reply correspondence in the absence of trading opportunities. Thus, let $u_m(nt, i, \lambda)$ represent the level of managerial utility when the manager is unable to trade in the contingent claim market and receives an incentive payment of i and shirks with probability λ. Because, in this case, the manager's only choice is between effort and shirking, it is easy to see that

$$u_m(nt, i, \lambda) \equiv \lambda\,(w + i\, p_n) + (1 - \lambda)(w + i\, p_e - \varepsilon). \tag{3}$$

3 Characterization of the Equilibrium Outcomes

In this section, we characterize the equilibrium outcomes of the game for general but fixed levels of managerial compensation. We derive the conditions under which insider trading will be observed and analyze the associated comparative statics. A natural place to begin this analysis is by determining the conditions under which the manager will always choose the effort strategy. The basic trade-offs faced by the manager are clear. If the manager is playing the pure strategy of not shirking, then marketmakers can anticipate the manager's actions and thus impound the manager's effort decision into the claim price. This implies that he is unable to earn any profits from securities trading. Thus, the marketmaker breakeven condition implies that the price posted in the s-claims equals p_e and trading profits from the effort strategy are zero. An equilibrium in which the manager chooses effort with probability 1 is sustainable only if, given these prices, managers are still willing to exert effort.

Lemma 1. *If i, the incentive compensation, is greater than or equal to* $\bar{i} \equiv \varepsilon/\Delta p$, *then the unique equilibrium is a pure strategy equilibrium in which the agent chooses effort with probability 1. On the other hand, if* $i < \bar{i}$, *then no equilibrium in which the agent chooses effort with probability 1 exists.*

In light of Lemma 1, we will henceforth refer to $\bar{i} \equiv \varepsilon/\Delta p$ as the *effort-assuring compensation level.* This terminology is motivated by Lemma 1, which shows that, if the incentive payment i is greater than or equal to $\bar{i}$, the manager will exert effort with probability 1 in all Nash equilibria. A similar condition, Lemma 2, describes the parameterizations of the model under which shirking with probability 1 is the outcome of a Nash equilibrium. The sustainability of this outcome requires the disutility of effort to outweigh both the increased incentive payments from switching to the effort strategy and the trading profits from exerting effort and buying s-claims priced conditional on no effort being exerted.

Lemma 2. *If i, the incentive payment, is less than or equal to* $\bar{i} - \frac{w}{p_n}$, *then the unique equilibrium is a pure strategy equilibrium in which the agent chooses no effort with probability 1. If* $i > \bar{i} - w/p_n$, *then no pure strategy equilibrium in which the agent chooses to shirk with probability 1 exists.*

If neither the conditions of Lemma 1 nor the conditions of Lemma 2 are met, then pure-strategy equilibria do not exist. In this case, mixed-strategy equilibria obtain. In such equilibria, the manager chooses both the effort and the shirking strategies with positive probability. A positive correlation emerges between the realized outcome and the "direction" in which the manager trades. That is, the s-outcome is more likely when the manager is choosing the effort strategy. Similarly, the f-outcome is most likely when the manager is choosing the shirking strategy. This positive correlation is required for the manager to obtain trading profits. In other words, the manager profits from insider trading if, and only if, in equilibrium, he plays a mixed strategy. On the other hand, when the manager plays a pure strategy he cannot profit from insider trading. In fact, in this case, utilizing the costless storage technology is a perfect substitute for trading in the contingent claim. For this reason, and to avoid constant trivial qualifications relating to degenerate cases, we *define* insider trading as a choice of $\lambda \in (0, 1)$.

Because of this adverse selection problem, the marketmaker will break even only if he sets the price of the s-claim higher than the expected probability of event s. The premium induced by adverse selection in trading markets is one of the standard features of the analysis and represents one part of the Nash equilibrium condition. The second requirement for a Nash equilibrium is that both strategies, effort and shirking, yield the same profit at the equilibrium pricing terms. This condition distinguishes the analysis of trading under moral hazard from the standard analysis of trading under asymmetric information. In the standard adverse selection setting, the insider manager has an exogenously given information advantage over outside investors. In our analysis, the informational asymmetry regards the manager's *own* trading pattern, an endogenous variable. If the manager is to profit from uncertainty, he must create uncertainty through his own actions. Uncertainty requires that the manager play both strategies with positive probability. In order for this mixed strategy to be subgame perfect, the expected payoff to the manager from the shirking and effort strategies must be the same. These two conditions are embedded in the mixed strategy equilibrium conditions given below.

Proposition 3. (a) *If*

$$\bar{i} - \frac{w}{p_n} < i < \bar{i},$$

a unique Nash equilibrium exists in which the manager engages in insider trading. In this equilibrium, the agent chooses to shirk ($a = n$) with probability λ^*, where λ^* is given by the equation

$$\lambda^* = \left(\frac{1}{p_e} \left(\frac{w\pi}{\bar{i} - i} + (p_e - \pi p_n) \right) \right)^{-1} \tag{4}$$

Moreover,

(b) λ^*, *the equilibrium probability of shirking, is an increasing function of* ε *and a decreasing function of* π *and* i*. Finally,*

(c) the manager's utility, in all equilibria, equals his utility in the absence of the opportunity to trade. That is, if $\lambda^* \in \Gamma^t(\lambda^*, i)$, *then* $u_m(t, \lambda^*, i) = Max\{u(nt, \lambda, i) : \lambda \in [0, 1]\}$.

4 The Design of Optimal Compensation Contracts

In this section, managerial compensation contracts are endogenized. The manager's effort/trading decision, analyzed in the previous section, is viewed as a proper subgame of a larger game in which the shareholder first fixes a management compensation scheme and a corporate policy regarding insider trading and then hires a manager. More specifically, management compensation is endogenized within the following framework: the firm is owned by a single, risk-neutral "outside" shareholder. Operating the firm requires hiring a manager from a competitive labor market. The shareholder receives, at date 1, a random cash flow. This cash flow is equal to $\bar{x}$ dollars if s occurs and equal to 0 if f occurs. The manager has, at time zero, outside options that provide him with a certain income stream equal to this wealth endowment, w, plus his reservation salary, s_0. Thus, in order to be induced to work for the shareholder, the manager must receive compensation, either directly, via payments out of firm cash flows, or indirectly, via opportunities for insider trading profits, worth at least s_0. The direct compensation received by the manager takes the form of an incentive payment of i dollars received if, and only if, event s occurs, where $0 \leq i \leq \bar{x}$.[7] The level of this incentive payment is determined by the shareholder. The incentive payment, i, can be thought of either as resulting from an explicit compensation contract or from granting the manager an "inside" equity position. We are concerned only with the effect of insider trading on the moral hazard problem in firms whose continuation is economically viable and whose efficient operation dictates high managerial effort. Thus, we assume that

$$\Delta p\, \bar{x} > \varepsilon; \qquad \text{(+EFF)}$$

$$p_n\, \bar{x} - \varepsilon - s_0 > 0. \qquad \text{(+NPV)}$$

The first assumption, (+EFF), ensures that the total gain from effort exceeds its cost. This implies that, conditional on the decision to operate, effort (e) is socially preferable to no effort (n). It is this assumption that allows us to identify the action choice of exerting effort, a = e, with economic efficiency, for such is the action choice that a social planner would always dictate in any Pareto optimal allocation of effort and cash flows between the shareholder and manager.[8] The second assumption, (+NPV), in essence requires that operation be feasible at all effort levels, that is, that the total gain from operating the firm exceeds the total cost of operation, which is given by the sum of the manager's effort (ε) and opportunity costs (s_0).

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[7] It is easy to see that this is, in fact, the only feasible compensation contract design satisfying limited corporate liability.

[8] Of course, trade in the contingent claims market will generate losses to uninformed noise traders. If these agents are treated as endogenous to the analysis, the effect of insider trading on their welfare should be considered. If their demand for the contingent claim from noise traders is perfectly inelastic, then permitting insider trading induces a wealth transfer but no additional economic distortion. Otherwise, the distortion in noise trader asset demands will result in welfare losses. In any case, the analysis in this paper shows that allowing shareholders to determine insider trading policy can be social disadvantageous even if these costs are not present or are not factored into the analysis.

The s-claim market is open at the time the manager makes his effort decision, and, thus, he is technically able to trade on his decision. He may be precluded from trading, however, either because of a blanket prohibition on such trades imposed by the state or because the outside owner has prohibited such trade in the manager's compensation contract. In order to analyze the effects of such prohibitions, we need to determine the equilibrium compensation designs when trading is allowed and when it is prohibited. Let r represent a generic element of $\mathcal{R}$, the set of possible insider-trading regimes. $\mathcal{R} = \{t, nt\}$ where t corresponds to allowing insider trading and nt to prohibiting such trade. If incentive of i is offered to the manager and the manager shirks with probability λ, then the payoff to the owners is given by the map v: $[0, 1] \times [0, \bar{x}] \rightarrow \mathbb{R}$ defined by $v(\lambda, i) \equiv (\bar{x} - i)\ P(\lambda)$. For each regime, the owners' compensation design problem can be expressed as

OP(r) $\qquad\qquad$ $\text{Max}_{\lambda, i}\ v(\lambda, i),$

$$\text{subject to } (\lambda, i) \in \mathbf{F}^r,$$

where

$$\mathbf{F}^r = \{(\lambda, i) \in [0, 1] \times [0, \bar{x}]: \lambda \in \Gamma^r(\lambda) \text{ and } u_m(r, \lambda, i) \geq w + s_o\}.$$

In **OP**(r), $\mathbf{F}^r$ represents the set of feasible combinations of shirking probabilities and compensation levels given trading regime r. Feasibility requires, first, that the effort decision be subgame perfect, i.e., that it be a Nash equilibrium in the effort/trading subgame. This requires that $\lambda \in \Gamma^r(\lambda)$. Further, feasibility requires that the participation constraint be satisfied, that is, that the *ex ante* payoff to the manager, if he is employed by the firm, $u_m(r, \lambda, i)$, at least equal what he can obtain from his other employment options, $w + s_o$. Note that the standard regularity conditions are satisfied for the **OP**(r) problems and, thus, solutions exist for each regime. Thus, for each $r \in \mathcal{R}$, let $\bar{v}(r)$ represent the payoff to the firm under market regime r at an optimal compensation policy. In other words, let $\bar{v}(r) \equiv \mathrm{Max}\{\, v(\lambda, i) : (\lambda, i) \in \mathbf{F}^r\}$.

4.1 Optimal Compensation When Insider Trading Is Precluded

The determination of $\bar{v}(nt)$, the value of the firm under the optimal operating policy in the absence of insider trading, is particularly simple. When the reservation level of the manager's salary is sufficiently high, the value of the manager's compensation is, of necessity, high enough to bond the manager to optimal effort decisions. On the other hand, when the manager's reservation utility is low, the shareholder can either pay the manager premium above their reservation compensation to bond them to high effort or opt for a low compensation policy and the associated managerial shirking. Firms whose project quality is high enough to justify effort-assuring salaries in excess of the manager's reservation compensation requirement will be termed supermarginal firms. Firms with positive net present value projects that are not of high enough quality to support effort-assuring compensation will be termed marginal firms. Our results on the optimal compensation designs for both firm types in the absence of managerial insider trading are presented below.

Lemma 4. *Consider the regime in which insider trading is prohibited. If the firm is supermarginal, that is, if*

$$\bar{x}\,\Delta p > p_e\,\bar{i} - s_o, \tag{EE}$$

the unique optimal compensation policy for shareholders to adopt the effort-assuring compensation policy given by $\lambda^*(O) = 0$, $i^*(O) = \mathrm{Max}[(s_o + \varepsilon)/p_e,\ \bar{i}\,]$. If the firm is marginal, that is, if

$$\bar{x}\,\Delta p < p_e\bar{i} - s_o, \tag{IE}$$

the unique optimal policy is to adopt a low-compensation policy which does not ensure effort, that is, $\lambda^*(O) = 1$, $i^*(O) = s_n/p_n$.

In borderline cases, that is, when

$$\bar{x}\,\Delta p = p_e\,\bar{\imath} - s_o, \qquad (EN)$$

both of these policies are optimal. Furthermore, firm value at the optimal compensation contract in the absence of insider trading, $\bar{v}(nt)$, *satisfies*

$$\bar{v}(nt) = Max[p_e\,(\bar{x} - Max[(s_o + \varepsilon)/p_e,\ \bar{\imath}\,]),\ p_n\,\bar{x} - s_o]. \qquad (VO)$$

4.2 The Effect of Insider Trading

Next we consider the effect of giving the shareholder the option of allowing the managers to trade on his effort decisions. First, note that the effort-assuring compensation policy of providing bonus $\bar{\imath}$ is available both when insider trading is prohibited and when it is permitted. If this compensation policy is followed, the manager shirks with probability 0 regardless of the firm's insider trading policy. On the other hand, if $i < \bar{\imath}$ the manager will never exert effort in the absence of insider trading opportunities. However, if such trading opportunities are present, the manager may exert effort with positive probability. Thus, for any fixed level of incentive compensation, allowing insider trading never diminishes, and sometimes improves, managerial incentives. This implies that precluding insider trading always reduces the welfare of the shareholder. As is demonstrated in the appendix, when insider trading is allowed, only the two "extremal" compensation policies are viable candidates for optimality: (i) setting managerial compensation so as to equate manager's equilibrium utility with reservation utility, allowing insider-trading profits to provide incentives for partial effort, or (ii) bonding the manager to full effort through an effort-assuring incentive payment, $\bar{\imath}$. The key to a firm's tradeoff in making this decision is the level of shirking when the manager's compensation just meets his reservation constraint. As shown in Proposition 3, allowing insider trading does not increase the *ex ante* utility of the manager. Thus, the incentive payment that satisfies the reservation constraint as an equality is $i = s_o/p_n$. The probability of shirking under this compensation scheme is given by $\lambda_L \equiv \lambda^*(\pi, s^o/p_n)$, where $\lambda^*(\cdot)$; the equilibrium shirking probability in the effort/trading subgame is defined in Lemma 1, Lemma 2, and Proposition 3. When this probability of shirking, λ_L, is less than 1, the firm may find the low-compensation strategy optimal when insider trading is allowed even though, if insider trading were precluded, ,the firm would prefer paying effort-assuring compensation to the minimal compensation rate and the attendant certain shirking. This implies that a blanket prohibition on insider trading may improve effort incentives. The key to this result is that, although for any fixed compensation level i, insider trading improves managerial effort incentives, allowing insider trading leads to an endogenous downward shift in the equilibrium level of managerial compensation that more than offsets the improvement in effort incentives at any fixed compensation level. This result is summarized below.

Proposition 5. *Suppose the firm is supermarginal (that is, if EE holds) then, (a) if* $P(\lambda_L)\,\bar{x} - s_o > p_e(\bar{x} - \varepsilon/\Delta p)$*, and* $s_o \in (\bar{i}\,p_n - w < s_o < \bar{i}\,p_n)$ *, the prohibition of insider trading reduces shirking, increases output, lowers share value, and increases managerial ex ante utility. If (b)* $s_o \notin (\bar{i}\,p_n - w < s_o < \bar{i}\,p_n)$ *or* $P(\lambda_L)\,\bar{x} - s_o \leq p_e(\bar{x} - \varepsilon/\Delta p)$*, then, at equilibrium compensation levels, managers have no incentive to engage in insider trading and the prohibition of insider trading has no economic effects.*

On the other hand, for marginal firms, the prohibition on insider trading is counterproductive in that it serves only to eliminate the managerial effort incentives provided by insider trading opportunities.

Proposition 6 *If the firm is marginal (that is, if IE holds), then, if (a)* $s_o \in (\bar{i}\,p_n - w < s_o < \bar{i}\,p_n)$*, the prohibition of insider trading increases shirking, lowers share value, and has* *no impact on the manager's ex ante utility. If (b)* $s_o \notin (\bar{i}\,p_n - w < s_o < \bar{i}\,p_n)$*, then, at equilibrium compensation levels, managers have no incentive to engage in insider trading and the prohibition of insider trading has no economic effects.*

A consequence of the above results is that manager interests are, in some sense, *ex ante* weakly aligned with social interests with regard to insider trading. The manager's welfare is never reduced by prohibiting insider trading. Further, the manager only strictly gains from prohibition when prohibition leads to a higher levels of managerial effort at equilibrium compensation rates.

Corollary 7. *Managers never lose, in an expected value sense, from the prohibition of insider trading and only strictly gain from such a prohibition when insider trading leads to socially suboptimal effort probabilities but does not induce project liquidation.*

PROOF. See Appendix.

5 Conclusion

In this paper the relationship between moral hazard in the manager-shareholder agency relationship and managerial insider trading is analyzed. The analysis yields the conclusion that, while permitting insider trading improves managerial effort incentives for any fixed compensation level, allowing shareholders to permit insider trading may actually exacerbate the shareholder-manager agency problem. The increase in the costs of moral hazard when insider trading opportunities are present results from shareholders reducing managerial incentive compensation to such an extent as to more than offset the positive effect of insider trading on managerial effort at any fixed compensation level.

This analysis has a number of implications. First, because prohibiting insider trading is shown to actually increase *ex ante* managerial welfare, the analysis offers a possible explanation for the stylized fact that professional managers, as a class, have not resisted the imposition of insider trading restrictions. A related prediction is that, when the state does not explicitly regulate insider trading by managers, total managerial compensation will be smaller.

Second, the optimal social policy toward insider trading was also shown to be crucially dependent on the sophistication of the managerial labor market, measured by the manager's market value outside the firm. Severe agency conflicts are likely to arise whenever the opportunity cost of hiring the manager is not high enough to ensure that the manager's compensation aligns managerial and shareholder interests. In this case, allowing firms unrestricted latitude in fixing insider trading policies can lead to large welfare losses. It can be argued that, over time, the increased sophistication of managerial labor markets and the increasing professionalization of management leads to increased substitutability between managers. If this is the case, the increased sophistication of managerial labor markets would reduce the costs of allowing firms discretion in setting insider trading policy. In the limiting case of very "professionalized" managerial teams whose reservation salary greatly exceeds their personal wealth, regulatory policy toward insider trading becomes irrelevant because, in equilibrium, such trade will never occur.

Finally, increases in the liquidity of the financial market structure are shown to have a positive effect on managerial effort when insider trading is permitted. Thus, in environments in which the state does not completely preclude insider trading, increasing the efficiency and size of contingent claim markets should, *ceteris paribus*, increase real economic output.

Two salient assumptions in the analysis are that insider-managers can only trade on "good" news and that managers trade in derivative, as opposed to primary, securities markets. These assumptions were made to abstract away from the adverse effects of insider trading that have already been identified in the literature and, thus, to show that the costs of insider trading identified in this analysis are in no way engendered by these costs. However, it is worthwhile to consider the effect of relaxing these assumptions.

First, consider allowing trading on "bad" news. If managers are allowed to trade on both good and bad news, that is, engage in "two-sided" trading, for example, because shareholders are unable to police the direction of insider trades, insider trading smoothes rather than increases managerial effort, increasing managerial effort when compensation is low and decreasing effort when compensation is high. This reduces the attractiveness of allowing insider trading to shareholders relative to the one-sided regime analyzed in this paper. This potentially adverse effect on effort incentives may provide shareholders with an incentive to prohibit insider trading. On the other hand, when managers can trade on both sides of the market, the manager's *ex ante* utility at a fixed compensation package may be increased through permitting insider trading. Thus, shareholders can use the profits from insider trading to meet the manager's reservation compensation constraint. When the managerial reservation payoff constraint is binding, this provides a new incentive to stockholders to allow managers to trade. Again, since insider trading necessarily involves choosing inefficient operating policies with positive probability, this effect can lead shareholders to adopt insider trading polices inconsistent with social optimality.

Our analysis also abstracts from another important effect that insider trading has when such trade occurs in primary securities markets. Informed trading can increase implicit bid-ask spreads and make the raising of investment capital more difficult. This follows because purchasers of the securities will discount the initial equity issue by the bid-ask spread they will have to pay when liquidating their holdings. Such effects might also provide shareholders with an incentive to prohibit insider trading or at least restrict managerial trading to the sort of derivative markets modeled in this paper.

Appendix

PROOF OF LEMMA 1. Consider a pure strategy equilibrium in which the contestant plays e with probability 1, then $\lambda^* = 0$. The Nash equilibrium conditions are satisfied if, and only if,

$$[i + w\,\mathbf{R}(0)\,p_e - \varepsilon] \geq w + p_n\,i.$$

Because $[i + w\,\mathbf{R}(0)\,p_e - \varepsilon = i\ p_e - \varepsilon$, this condition is equivalent to $i \geq \bar{i}$. Uniqueness follows from the fact that $[i + w\,\mathbf{R}(\lambda)\,p_e - \varepsilon] - (w + p\,_n\,i)$ is a strictly increasing function of λ and from the fact that in any equilibrium in which $\lambda < 0$ it must be the case that $[i + w\,[\mathbf{R}(\lambda)\,p_e - \varepsilon] < (w + p_n\,i)$. □

PROOF OF LEMMA 2. Completely symmetric to the proof of Lemma 1. □

PROOF OF PROPOSITION 3. (a) Existence follows from the intermediate value theorem. The explicit functional firm follows from algebra. (b) These comparative statics are straightforward consequences of differentiating λ^*. (c) follows because mixed strategies are only best replies when the payoff from the shirking and the effort strategy is equal. The manager's payoff from the shirking strategy is $w + p_n\,i$. The fact that $i < \bar{i}$ implies that $\mathrm{Max}\{\,u(nt, \lambda, i)\colon \lambda \in [0, 1]\} = w + p_n\ i$. □

PROOF OF LEMMA 4. First, note that for any optimal policy $(\lambda^*(nt), i^*(nt))$, it must be the case that $\lambda^*(O)$ equals either 0 or 1. This follows because at any incentive payment level i under which $\lambda < 1$ is a best response, $\lambda = 0$ is also a best response. However, for a fixed compensation level, the smaller the shirking probability, the larger the shareholder's payoff. Further, if $((\lambda^*(O), i^*(O))$ with $\lambda^*(O) = 1$ is optimal, it must be the case that the participation constraint (P) is satisfied with equality. Otherwise, one could lower the incentive payment, leaving the effort decision, which in any case is to shirk with probability 1 unchanged, and increasing the payoff to the outside shareholder. Thus, $((\lambda^*(O), i^*(O))$, and $\lambda^*(O) = 1$ implies that $((\lambda^*(O), i^*(O)) = w + p_n\, i^*(O) = w + s_o$, that is, $i^*(O) = s_o/p_n$. For this policy to induce only shirking with probability 1, it must be the case that $i^*(O) < \bar{i}$. Thus, a necessary condition for $\lambda^*(O) = 1$ to be a component of an optimal policy is for $s_o/p_n < \bar{i}$.

Any incentive payment that induces the manager not to shirk must satisfy $i \geq \bar{i}$. Any incentive payment that provides the manager *ex ante* utility, given that he is not shirking, sufficient to meet his participation requirement must satisfy $i\, p_e - \varepsilon \geq s_o$. Because the incentive payment represents a cash outflow to the shareholder, the optimal incentive payment, conditional on the manager shirking with probability 0, is the minimum payment that satisfies both these conditions. Thus, it is given by $\mathrm{Max}[\bar{i}, (s_o + \varepsilon)/p_e]$. Now $i > s_o/p_n$ and $i \geq \bar{i}$ implies that $i\, p_e - \varepsilon \geq s_o$. To see this, note that $i > s_o/p_n$ implies that $p_e = i\, p_n + \Delta p\, i \geq s_o + \Delta p\, i$, and $i \geq \bar{i}$ implies that $s_o + \Delta p\, i \geq s_o + \varepsilon$. Thus we have that $\mathrm{Max}[\bar{i}, s_o/p_n] \geq \mathrm{Max}[\bar{i}, (s_o + \varepsilon)/p_e]$. Thus, when $\bar{i} > s_o/p_n$, the optimal compensation policy, conditional on zero managerial shirking, is $i = \bar{i}$. We term this compensation level the "effort-assuring" wage. In summary, when $s_o/p_n < \varepsilon/\Delta p$, only two policies are candidates for optimality: the policy of setting $\lambda = 1$ and paying compensation $i = s_o/p_n$ and the policy of setting $\lambda = 0$ and setting $i = \bar{i}$. □

PROOF OF PROPOSITIONS 5 AND 6. First, we show that $\bar{v}(t) \geq \bar{v}(nt)$. Let $i_1 \equiv \mathrm{Max}[(s_o + \varepsilon)/p_e, \bar{i}]$, $i_2 \equiv s_o/p_n$. Note that Lemma 4 shows that

$$\bar{v}(nt) = \mathrm{Max}[v(1, i_1), v(0, i_2)]\,.$$

Now $(0, i_1) \in F^t$ and, further, there exists $\lambda_2 \leq 1$ such that $(\lambda_2, i_2) \in F^t$. Because v is decreasing in λ, $v(\lambda_2, i_2) \geq v(1, i_2)$. Thus $\mathrm{Max}[v(1, i_1), v(0, i_2)] \leq \mathrm{Max}[v(\lambda_1, i_1), v(0, i_2)]$.

Because $\bar{v}(t)$ represents the highest possible payoff over compensation policies when insider trading is allowed, and the two policies (λ_1, i_1) and $(0, i_2) \in \mathbf{F}^t$, we have $\text{Max}[v(\lambda_1, i_1), v(0, i_2)] \leq \bar{v}(t)$. This completes the proof that $\bar{v}(nt) \leq \bar{v}(t)$.

To establish the rest of our results, we require a more thorough analysis of the problem **OP**(t). This is performed in the following Lemmas.

Lemma A1. If $s_o/p_n > \varepsilon/\Delta p$, then, for all $(\lambda, i) \in \mathbf{F}^t$, $\lambda = 0$.

PROOF. Suppose that $(\lambda, i) \in \mathbf{F}^t$. Suppose, to obtain a contradiction, that $\lambda > 0$. Note that if $\lambda = 1$, $u_m(t, \lambda, i) = i\, p_n + w \geq w + s_o$. Further, if $\lambda \in (0, 1)$, then $\lambda \in \Gamma^t(\lambda, i)$ requires that the payoff from shirking and effort be equated. Because the manager cannot profit from insider trading when he chooses to shirk (action n), this implies that $u_m(t, \lambda, i)$ again equals $i\, p_n + w$. By the reservation constraint we then have that $i\, p_n + w \geq w + s_o$. Thus it must be the case that $i \geq s_o/p_n$. By hypothesis $s_o/p_n > \varepsilon/\Delta p$. Thus, $i > \varepsilon/\Delta p$. This implies that the unique best response for the manager is to shirk with probability 0, contradicting $\lambda > 0$ being a best response. □

Lemma A2. If $s_o/p_n < \bar{i} - w/p_n$, then

$$(\lambda, i) \in \mathbf{F}^t \text{ and } u_m(t, \lambda, i) = w + s_o \Rightarrow \lambda = 1.$$

PROOF. In order for $\lambda \in \Gamma^t(\lambda, i)$ and $\lambda \in (0, 1)$, it must the be case that $H(\lambda) - (\varepsilon - i\,\Delta p) \geq 0$. Because $H(\lambda)$ is increasing and $H(1) = \Delta p/p_n$ we have

$$\Delta p/p_n - (\varepsilon - i\,\Delta p) \geq 0.$$

As shown in the proof of Lemma A1, if $\lambda \in (0, 1)$, then $u_m(t, \lambda, i) = i\, p_n + w$. Thus, the hypothesis of the Lemma implies that $i = s_o/p_n$. The result then follows from Lemma 2. □

Lemma A3. There exists a continuous decreasing function ς: $(0, 1) \rightarrow [0, \bar{x}]$ such that

$$\lambda \in \Gamma^{t}(\lambda, i) \Leftrightarrow i = \varsigma(\lambda).$$

Moreover, the map $\lambda \to v(\lambda, \varsigma(\lambda))$ is convex.

PROOF. For $\lambda \in (0, 1)$, $\lambda \in \lambda \in \Gamma^{t}(\lambda, i)$ if, and only if, $H(\lambda) - (\varepsilon - \Delta p\ i) = 0$. Simple algebra shows that this equation determines a 1-1 relationship between i and λ, which we represent by the function ς: $(0, 1) \to [0, \bar{x}]$. Simple algebra also verifies the properties of ς asserted in the Lemma. □

Lemma A4. For any, $\lambda'' \in [0, 1]$ and $\lambda' \in (0, \lambda'')$

$$v(\lambda, \varsigma(\lambda)) < \mathrm{Max}[v(0, \varepsilon/\Delta p), v(\lambda'', \bar{\varsigma}(\lambda''))].$$

PROOF. Extend the definition of ς; $(0, 1) \to [0, \bar{x}]$, defined in Lemma A3, to the closed interval by defining $\bar{\varsigma}[0, 1] : \to [0, \bar{x}]$ as follows: $\bar{\varsigma}(x) \equiv \varsigma(x)$, $x \in (0, 1)$. If $x \in \{0, 1\}$ let $\bar{\varsigma}(x) = \lim_{y \to x} \varsigma(x)$. This implies that $\varsigma(0) = \varepsilon/\Delta p$ and $\varsigma(1) = \varepsilon/\Delta p - w/p_n$. Because ς is continuous and monotone, the function $\bar{\varsigma}(\cdot)$ is continuous. Further, the strict convexity of $\lambda \to v(\lambda, \varsigma(\lambda))$ implies, because strictly convex functions attain their maximum only on extreme points, that $v(\lambda, \varsigma(\lambda)) < \mathrm{Max}[v(0, \bar{\varsigma}(0)), v(\lambda'', \bar{\varsigma}(\lambda'))] = \mathrm{Max}[v(0, \varepsilon/\Delta p), v(\lambda'', \bar{\varsigma}(\lambda''))]$. □

Lemma A5. If $s_o/p_n < \varepsilon/\Delta p - w/p_n$ and (λ, i) solves **OP**(t), then $\lambda = 0$ or 1.

PROOF: If $\lambda' \in (0, 1)$, then $\varsigma(\lambda') = i'$. These facts combined with Lemma A4 imply that

$$v(\lambda', i') < \mathrm{Max}[v(0, \varepsilon/\Delta p), v(1, \bar{\varsigma}(1))] = \mathrm{Max}[v(0, \varepsilon/\Delta p), v(1, \varepsilon/\Delta p - w/p_n)].$$

The assumptions of Lemma A5 imply that both $(0, \varepsilon/\Delta p)$ and $(1, \varepsilon/\Delta p - w/p_n)$ are feasible. Thus, it cannot be the case that (λ', i') solves **OP**(t). □

Lemma A6. If $\bar{i}p_n - w \le s_o \le \bar{i}p_n$, then the solution to **OP**(t) is given by either (λ_L, s_o/p_n) or (0, $\bar{i}$).

PROOF. Because by definition, λ_L solves

$$w\,H(\lambda_L) - (\varepsilon - (s_o/p_n)\,\Delta p) = 0,$$

and because, whenever $\lambda > 0$, $u_m(t, \lambda, i) = i\,p_n + w$, and because H is increasing, it must be the case if $\lambda > \lambda_L$, then there is no $i \in [0, \bar{x}]$ such that $w\,H(\lambda_L) - (\varepsilon - (s_o/p_n)\,\Delta p) \le 0$ and $u_m(t, \lambda, i) \ge w + s_o$. Thus, for all $(\lambda, i) \in F^t$, we have $\lambda \le \lambda_L \le 1$. For all such $\lambda \ne 0$ and λ_L we have $i = \varsigma(\lambda)$, Lemma A4 then implies that

$$v(\lambda, i) < \mathrm{Max}[v(\lambda_L, \bar{\varsigma}(\lambda_L)), v(0, \bar{i})].$$

Thus if (i, λ) solves **OP**(t), $\lambda = 0$ or $\lambda = \lambda_L \ne 0$.

If $0 < \lambda_L < 1$, then $(\lambda_L, i) \in F^t$ implies that $i = \bar{\varsigma},(\lambda_L) = \varsigma,(\lambda_L) = s_o/p_n$. If $\lambda_L = 1$ then $\bar{\varsigma}(\lambda_L)$ is the smallest feasible incentive payment consistent with this choice of λ; thus if $\lambda_L = 1$ and (1, i) solves **OP**(t) then $i = \bar{\varsigma}(1) = \bar{\varsigma}(\lambda_L) = s_o/p_n$. In either case, we have that (λ_L, i) solves **OP**(t) then $i = s_o/p_n$.

Next, suppose that (i, λ) solves **OP**(t) and $\lambda = 0$. $\bar{i}$ is the smallest incentive payment i such that (0, i) is feasible. Thus, when $\lambda = 0$, i must equal $\varepsilon/\Delta p$ in order to maximize v. Thus, (i, λ) solves **OP**(t) and $\lambda = 0$ implies $i = \bar{i}$. These results taken together establish the lemma. □

Completion of the Proofs of Propositions 5 and 6.

PROOF OF PROPOSITION 5: $v(s_o/p_n, \lambda_L) = P(\lambda_L)\,\bar{x} - s_o$ and $v(0, \bar{i}) = p_e(\bar{x} - \bar{i})$. The assumptions of the proposition imply that $v(s_o/p_n, \lambda_L) < v(0, \bar{i})$. By Lemma A6, ($s_o/p_n$, λ_L) is the optimal policy when insider trading is allowed. Because (EE) holds, Lemma 4 shows that $(0, \bar{i})$ is the optimal policy when insider trading is precluded. Because $\lambda_L > 0$, the proposition follows. Proposition 5 (b) follows from Lemma A1, Lemma A5.

PROOF OF PROPOSITION 6: Proposition 6 (a) follows because, by Lemma 4, if (IE) holds then the optimal policy for the firm absent insider trading is $(s_o/p_n, 1)$. If insider trading is allowed Lemma A6 shows that the optimal policy is $(s_o/p_n, \lambda_L)$ and that $\lambda_L < 1$. This policy produces a higher payoff to the firm than the optimal policy in the absence of insider trading $(s_o/p_n, 1)$ and, thus, will be adopted. Because $\lambda_L < 1$, permitting insider trading increases efficiency. Proposition 6 (a) follows from Lemma A1 and Lemma A5.

PROOF OF COROLLARY 7. From Lemma A2, Lemma A5, and Lemma A6, it is clear that for any optimal policy, when trade is allowed, $(\lambda^*(t), i^*(t)$, and any no-trade optimal policy $(\lambda^*(nt), i^*(nt))$, $u_m(t, \lambda^*(t), i^*(t)) \leq u_m(nt, \lambda^*(nt), i^*(nt))$. These same Lemmas imply that $u_m(t, \lambda^*(t), i^*(t)) < u_m(nt, \lambda^*(nt), i^*(nt))$ only when $\lambda^*(nt) = 0 < \lambda^*(t)$. □

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