Insider Trading, Costly Monitoring, and Managerial Incentives

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Abstract: In this paper we show, in an incomplete contracts framework that combines asymmetric information and moral hazard, that by permitting insiders to trade on personal account the equilibrium level of output can be increased and shareholder welfare can be improved. There are two reasons for this. First, insider trading impounds information regarding the costs and benefits of effort and perk consumption into asset prices, which allows shareholders to choose more efficient portfolio allocations. Second, allowing insider trading can induce managers to increase their stake in the firm beyond that obtained through bargaining with shareholders. This effect leads to a reduction in managerial perk consumption and/or increased managerial effort. Insider trading can also be costly for shareholders' intermediate range of monitoring costs and project difficulty because, in such cases, the efforts of managers are quite sensitive to the exact level of fractional shareownership, which managers can endogenously change if they are able to trade on personal account. Interestingly, when monitoring and effort costs are low, managers may prefer restrictions on their ability to trade as such restrictions will force shareholders to offer them a larger fraction of output.

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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 using firm-specific private information. 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 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. There is, however, another aspect of security trading by corporate officers discussed by Manne that 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.

Much of the subsequent literature on insider trading has been devoted to examining the arguments of Manne in a rigorous analytical fashion. The results of this analysis have not, in general, been supportive of Manne's conclusions. 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. Manne's second argument in favor of insider trading has also been critiqued in Noe (1995) who demonstrates that, even if managerial short sales are prohibited, endogenous changes in the pattern of managerial compensation in response to a relaxation of insider trading restrictions may actually lower the equilibrium level of managerial effort.

This paper develops a model that links moral hazard and informational transmission aspects of insider trading and shows that the beneficial effects of insider trading, which are not entirely apparent when the

informational and moral hazard arguments for insider trading are modeled separately, become apparent when the two problems are interlinked. More specifically, we show that when managers have private information regarding the scope of the private benefits they can earn from consuming perks and/or avoiding effort and managerial ex-post bargaining power allows managers to extract rents from corporate owners, permitting insider trading can both increase firm output and increase the welfare of shareholders.

The mechanism through which shareholder welfare is improved is as follows: permitting insider trading leads managers to take positions in the firm's stock. These positions are long positions when managers are able to extract only a small fraction of firm output from negotiations with owners and short when managers can extract large fractions. The size of the manager's position is independent of his private information. To induce this uniform pattern of portfolio holdings across the range of private signals, share prices must vary with the manager's information signal. Thus, managerial trading increases the informativeness of prices and the welfare of shareholders and, when managers extract only a small fraction of firm value in explicit compensation, it also increases the fraction of the firm's cash flows held by managers.

The above argument thus implies that, when projects have fairly low average effort costs and monitoring managerial effort is not very costly, shareholders can concede to managers only a small fraction of firm rents and rely on insider trading to induce large managerial holdings. These shareholdings, in turn, augment the manager's incentive to increase output. In this scenario, permitting insider trading increases shareholder welfare for two reasons: it both provides low-cost incentives for managerial effort and makes prices more informative. When monitoring is very costly or applying effort to the project is also costly, insider trading also improves owner welfare. In this case, owners recognize that, regardless of the insider trading regime, they wil be able to extract only a small fraction of the firm's output for themselves. By permitting insider trading, owners can at least reduce their exposure to the risks associated with the manager's private information. Permitting insider trading is only disadvantageous when effort is fairly sensitive to monitoring policies and optimal monitoring requires offering managers a large, but not exclusive, fraction of firm output. In this case, the short positions insiders optimally take in their capital market transactions negate some of the incentive effects of monitoring, adversely impacting effort. If this effect is large enough it can more than compensate for the positive impact of insider trading on price informativeness. The effect of insider trading on managerial welfare is somewhat at odds with its effect on shareholder. When monitoring is relatively costless and effort costs to managers are, on average, low, shareholders will adopt very rigorous monitoring policies when they permit insider trading. Such polices, by curtailing management's ability to extract wealth, lower managerial welfare. Thus, the ability of shareholders to substitute insider trading opportunities for direct compensation may adversely affect managerial welfare and lead managers to prefer ex ante to be deprived of insider trading

opportunities.

These results are related to, but do not overlap, the results of a number of recent papers on insider trading. Bebchuk (1994) also considers the consequences of insider trading for managerial behavior. He shows that insider trading opportunities provide managers with an incentive to increase project risk. Our work differs from Bebchuk's in two important respects. First, we model a costly effort decision by the manager, rather than a costless choice of project variance. More importantly, we model the process of price determination. Bebchuk, in contrast, assumes that insiders capture an exogenously specified fraction of the difference between true and expected project value. By modeling the process of price determination, we are able to compute the welfare effects of insider trading on all agents in the economy and analyze the effect of trading on price informativeness. Our work is also related to Shin's (1996) analysis in that it focuses on the optimal regulation of insider trading. However, the trade-offs determining optimal regulatory policy in our analysis are very different than in Shin's. In our analysis all gains and losses from insider trading are absorbed by insider managers and shareholders. In Shin, an exogenous group of liquidity traders subsidize insider trading through their trading losses. Thus, Shin's objective function for determining optimal insider trading policies—minimizing the losses of liquidity traders—has no analog in our framework. In addition, the variables he considers are market structure variables while we consider the sort of firm-specific variables typically utilized in corporate finance research.

The paper is organized as follows. Section 2 outlines the basic model of costly monitoring under conditions of moral hazard and informational asymmetry. Section 3 introduces insider trading into the analysis and considers its effects on managerial effort and the pricing of securities. Section 4 considers the effect of insider trading on the ex ante welfare of shareholders and identifies those parameterizations of the model under which insider trading increases shareholder welfare and thus identifies parameterizations of the model that would lead shareholders to permit managers to engage in informed trading. Section 5 provides a graphical welfare analysis of the effects of insider trading on managerial welfare, shareholder welfare, and economic efficiency.

2 Basic model

First, we delineate a three-date model of manager-shareholder interaction in an incomplete contracting setting. At date -1, the firm is owned by a single shareholder and managed by a manager. At this date, the shareholder makes a decision regarding an investment in monitoring technology. The import of this decision will be delineated later. At date 0, the manager makes an effort decision, e. Later we will incorporate an opportunity for the manager and the shareholder to trade securities at date 0 into the basic, no-trade scenario outlined here. The manager's decision will impact the date 1 value, V, of the firm. This value is

then divided between the shareholder and the manager. Although firm value is observable at date 1, it is not contractible at date 0. The lack of contractability follows because the firm cannot pre-commit to retaining the manager and the manager cannot pre-commit to remaining with the firm. At date 1, the manager has the opportunity to negotiate the terms of his contract. The manager's negotiating position is based on the fact that he possesses firm-specific skills which render the value of the firm without the manager, V_-, different than its value with the manager, V. We model bargaining by allocating all bargaining power to the manager, implying that in a Nash-type bargaining solution, the manager will give the shareholders nothing more than the value of the firm without his firm-specific skills. We represent this value by V_-. Thus, the date 1 share of value received by the shareholder will equal V_- and the date 1 share of value received by the manager will equal $V - V_-$. As in Aghion, Dewatripont, and Rey (1994), we consider the ability of agents (the shareholder in our case) to influence V_- by making an investment $c \geq 0$ in monitoring technology at date -1. The investment in the monitoring technology, combined with the firm value, determines the value of the firm without the manager's firm-specific human capital. That is, $V_- \equiv V_-(c, V)$. An example of such a monitoring technology would be investing in control systems that carefully record firm actions during the period, thus making it easier for a new manager to step in at date 1 to manage the firm and thereby increasing the value of the shareholder's exit option in the date 1 negotiations. The timing of events is displayed below.

date -1	date 0	date 1
The shareholder makes an investment in monitoring technology, c.	Manager makes unobservable effort decision, e. If financial markets are open, manager and shareholder also make trading decisions.	Value, V, is observed and divided.

For simplicity, we assume the multiplicative form for the valuation function: $V_-(c, V) = (1 - \beta(c))V$, where $\beta(\cdot)$ is a twice-differentiable function of c, with $\beta' < 0$, $\beta'' > 0$, $\beta(0) = 1$, and $\lim_{c\to\infty} \beta(c) = 0$. The terminal cash flow to the manager is thus given by $\beta(c)V$. We assume that, at date 0, when the manager makes his effort decision, V is a random variable that is positively dependent on managerial effort. More specifically, we assume that $V \equiv V(e) = e + \tilde{N}$, where $\tilde{N}$ is a unit-normal random variable. The manager's preferences over risky date-1 prospects, $\tilde{X}$, and effort choices, e, are given by the expectation of the function $u : \Re \times \Re \times \Re \to \Re$ defined as

$$u(\delta, e, x) \equiv -\exp\{-[-e^2 + (r + \delta)e + x]\},$$

where δ is a managerial preference parameter known to the manager at date 0 but unknown to other agents. However, all other agents have prior distribution over δ, under which $\tilde{\delta} \sim \mathrm{N}(0, \sigma_\delta^2)$; σ_δ represents the degree of ex ante uncertainty regarding the manager's effort incentives, and r captures the manager's "expected"

preference for effort. The random variables, $\tilde{\delta}$ and $\tilde{N}$, are independent. The shareholder has preferences over terminal wealth that are given by a constant absolute risk aversion expected utility function with a risk aversion parameter of 1.

2.1 The manager's effort decision

The manager's effort problem is, thus,

$$\max_{e \in \Re} E[u(\delta, e, \beta \tilde{V})].$$

The solution to this problem as a function of δ and β is given by

$$e^*(\delta, \beta) = \tfrac{1}{2}(\beta + r + \delta).$$

Note that the optimal effort level for the manager is increasing in his bargaining power (β), his expected effort preference (r), and the shock to his effort preference (δ).

2.2 Shareholder monitoring policies

The shareholder maximizes ex ante (date - 1) wealth over choices of c. As β maps $[0, \infty)$ monotonically into $(0, 1]$, instead of viewing β as a function of c, we can view $c \in [0, \infty)$ as a function of $\beta \in (0, 1]$. Thus we can maximize the shareholder's utility over $\beta \in (0, 1]$ instead of $c \in [0, \infty]$, and, after solving for the optimal level of β, denoted by β_N^*, we can determine the optimal investment in monitoring, c_N^*, using β_N^*. This approach greatly simplifies the proofs of the results and will be followed in the sequel.

The shareholder determines β at date -1. Thus, the utility of the shareholder at date 0 is given as follows. For a fixed $\tilde{\delta}$, the date 1 payoff to the shareholder (in utility terms) is

$$-\exp\left\{-[-c(\beta) + (1-\beta)e^*(\tilde{\delta}, \beta) - \tfrac{1}{2}(1-\beta)^2]\right\}.$$

Taking expectations over $\tilde{\delta}$ yields

$$-\exp\left\{-[-c(\beta) + \tfrac{1}{2}(1-\beta)(\beta + r) - \tfrac{1}{2}(1-\beta)^2(1 + \frac{\sigma_\delta^2}{4})]\right\}.$$

Thus, up to a monotone transformation, the utility of the shareholder at date 0 when managerial trading is not allowed is given by

$$W_N(\beta) = -c(\beta) + \tfrac{1}{2}(1-\beta)(\beta + r) - \tfrac{1}{2}(1-\beta)^2(1 + \frac{\sigma_\delta^2}{4}).$$

Thus the optimal monitoring policy for the shareholder when there are no trading opportunities is the solution to the problem

(NTP) $$\max_{\beta \in (0,1]} W_N(\beta).$$

In order to render our analysis transparent, we utilize the following simple exponential functional form for the monitoring cost function:

$$c(\beta) \equiv -\tfrac{\gamma}{4}\log(\beta),\ 0 < \gamma < 2(1+r). \tag{1}$$

In (1) the parameter γ is inversely proportional to the return, in terms of an increased share of project cash flows, from increased monitoring. Thus, γ measures the *inefficacy of monitoring*. The parametric restriction $\gamma > 0$ in (1) implies that increased investment in monitoring actually increases the share of value obtained by the shareholder. The parametric restriction $\gamma < 2(1+r)$ is imposed to avoid corner solutions in which monitoring is so costly that shareholder utility is maximized by simply giving the project to the manager, i.e., setting $\beta = 1$. Given the functional form specified in (1), characterizing the solution to this problem is a simple exercise. The required characterization is provided below.

Theorem 1. *The equilibrium fraction of firm value appropriated by the manager, β^*, when managerial insider trading is precluded, is given by*

$$\beta_N^* = \frac{(6+\sigma_\delta^2-2r)+\sqrt{(6+\sigma_\delta^2-2r)^2+4(8+\sigma_\delta^2)\gamma}}{2(8+\sigma_\delta^2)}.$$

Proof. The first-order condition for (NTP) is

$$(1-\beta)\left[1+\frac{\sigma_\delta^2}{4}\right]-\frac{\beta+r}{2}+\frac{1-\beta}{2}+\frac{\gamma}{4\beta}=0. \tag{2}$$

The second-order condition is clearly satisfied at any point satisfying the first order condition; moreover. (1) ensures that there exists a unique $\beta^* \in (0,1)$ satisfying (2). From the quadratic formula, Theorem 1 follows. □

The trade-offs underlying Theorem 1 are apparent. The shareholder has one incentive for increasing her investment in monitoring: higher levels of monitoring improve her bargaining position and thus increase the share of rents that can be extracted from the manager in contract negotiations. The countervailing incentive is that investment in monitoring, while increasing the bargaining power of shareholders, attenuates managerial effort incentives. This attenuation of incentives from reduced bargaining power is consistent with standard results in the incomplete contracting literature (see, for example, Hart 1988) which have established that efficiency is furthered by maximizing the ex post bargaining power of the agents making the most crucial action choices. The trade-off between two effects, the increase in the share of value resulting from monitoring versus the reduction in total output due to effort attenuation, determines the shareholder's optimal monitoring investment.

2.3 Comparative statics when trading is prohibited

The three exogenous parameters of determining the optimal monitoring policy are the average managerial effort parameter, r, uncertainty regarding managerial effort preferences, σ_δ, and the monitoring inefficacy

parameter, γ. It is also evident that higher levels of managerial managerial effort preference, r, induce larger investments in monitoring. This follows because higher average managerial effort preference reduces the cost, in terms of lost effort, from increasing shareholder bargaining power. Increased uncertainty regarding the manager's effort preferences increases project risk and thus lowers project value, leading to a reduction in the optimal investment in appropriating value. Thus, increased uncertainty increases the share of value captured by the manager and reduces monitoring investment, consequently increasing the fraction of firm value captured by the manager. The effect of increasing monitoring inefficacy on equilibrium monitoring investment is more subtle. Increasing the inefficacy of monitoring investments always increases β^*, the fraction of the firms cash flows that the manager can capture given an optimal monitoring policy. This reduction in β lowers monitoring costs. However, the reduction in the efficacy of the monitoring technology implies that the cost of even this reduced level of β may exceed the costs of the higher level of β associated with the more efficacious monitoring technology. Thus, reductions in the efficacy of monitoring technology may lead either to increases or decreases in monitoring costs. The nonmonotonic relationship between the quality of monitoring technology and equilibrium monitoring costs is illustrated in Figure 1. These comparative statics are summarized in the following Lemma.

Lemma 1. *When insider trading is prohibited, increasing average managerial effort preference, r, increases the level of monitoring and lowers β, the fraction of rents captured by the manager. Increasing uncertainty regarding managerial effort preferences, σ_δ, increases the fraction of value captured by the manager and lowers monitoring expenditure. Reducing the efficacy of the monitoring technology (i.e., raising γ) increases the fraction of firm value captured by the manager and may raise or lower optimal monitoring expenditures.*

Proof. All of the comparative statics follow from the relationship between β^* and c^* and applying the implicit function theorem to the first-order condition given by (2).

3 The effect of insider trading on the agency problem

The aim of this section is to consider the impact of opening a financial claims market at date 0 in which both the manager and the shareholder can trade their claims on firm output. In this market, claims on the firm's stock, along with a riskless bond, trade on an anonymous securities market. The price of the riskless bond and the firm's stock are observable at date 0. Moreover, agents can condition their asset demands and effort decisions on these prices. Rational expectations characterize equilibrium in the securities market at date 0.[1] More specifically, assume that the firm has one share outstanding and let $\theta_m(\theta_s)$ be the net trade

[1] By utilizing a rational expectations framework to analyze insider trading we follow Leland (1992) and diverge from Shin (1996) and Noe (1995) who use a market microstructure model featuring uniformed liquidity traders with exogenous security demands.

vector of the manager (shareholder) after trade. The total date 1 payoff to the manager is thus given by

$$\beta V + \theta_m((1-\beta)V - P).$$

The payoff to the shareholder at date 1 is

$$(1+\theta_s)((1-\beta)V - P).$$

The date 0 market clearing price in the capital market is determined via a rational expectations equilibrium: agents take the price as given; shareholders conjecture a relationship between P and the manager's effort parameter, δ; the manager maximizes simultaneously over effort, e, and portfolio holdings, θ_m. In equilibrium, the shareholder's conjectures are confirmed and markets clear, that is, net trades in the stock sum to zero, i.e.,

$$\theta_s + \theta_m = 0.$$

3.1 The date 0 trading/effort decision

At date 0 the manager, given his private information regarding the effort preference parameter, δ, chooses a net trade position, θ_m, and an effort level, e. The manager solves this optimization problem taking the market price of the firm's stock, P, as given. The manager's utility is given by

$$E\left[-\exp^{e^2-(r+\delta)e-\beta\tilde{V}(e)-\theta_m[(1-\beta)\tilde{V}(e)-P]}\right].$$

Thus, up to a monotone-increasing transformation, the manager's date 0 utility, when he is able to trade shares in security markets, can be represented as

$$U_0^T(e,\theta_m;c,P) = -e^2 + (r+\delta)e + \beta e + \theta_m(1-\beta)e - \theta_m P - \tfrac{1}{2}(\beta + \theta_m(1-\beta))^2.$$

The manager's optimization problem thus becomes

$$(MTP) \qquad \max_{(\theta_m,e)\in\Re^2} U_0^T(e,\theta_m;c,P).$$

Solving this simple optimization problem yields the following optimal effort/trading decision:

$$\text{(MET-e)} \qquad e^* = r + \delta - \frac{P}{1-\beta};$$

$$\text{(MET-t)} \qquad \theta_m^* = \frac{r+\delta}{1-\beta} - \frac{2P}{1-\beta} - \frac{\beta}{1-\beta}.$$

The shareholder maximizes his expected date 0 utility conditional on his information. The only information the shareholder has at date 0 is the clearing price, P. The conditional expectations of the shareholder are

determined via rational expectations. That is, we first assume that the shareholder conjectures that the following relationship holds between the stock's price, P, and managerial effort, e:

(REE) $$e = \frac{P}{1-\beta} + \frac{1}{2}.$$

Given this price conjecture, the manager's effort decision is measurable with respect to the shareholder's information set. Thus, the shareholder's date 0 utility under the REE conjecture is

$$E\left[-\exp^{(1-\beta)(1+\theta_s)\tilde{V}(e)+\theta_s P+c(\beta)}\right].$$

Differentiating this expression with respect to the shareholder's net trade, θ_s, yields the following necessary and sufficient condition for an optimal net trade vector, θ_s^*:

$$-(1-\beta)e + P + (1+\theta_s^*)(1-\beta)^2 = 0.$$

Thus, the optimal net trade vector for the shareholder is given by

(ST) $$\theta_s^* = \frac{(1-\beta)e - P}{(1-\beta)^2} - 1.$$

Plugging the (REE) condition into the managers and shareholder's net demand functions shows that if agents conjecture that (REE) holds and maximize their utility under this conjecture, then their net trades are given by

$$\theta_m^* = \frac{1}{2(1-\beta)} - \frac{\beta}{1-\beta}, \quad \theta_s^* = \frac{\beta}{1-\beta} - \frac{1}{2(1-\beta)}.$$

Thus, the market clearing condition, $\theta_m^* + \theta_s^* = 0$, is satisfied, verifying that demand functions induced by the conjectured relationship between actions and prices, in fact, clear markets. Inspection of MET-e shows that the shareholder's conjecture of the equilibrium effort-price relationship is correct. Thus, the conditions for a rational expectations equilibrium are satisfied.

3.2 The date -1 investment-in-monitoring decision

Given the equilibrium date 1 trading and action decisions, the ex ante utility of the shareholder is given by

$$E\left[-e^{\frac{1}{8}+\frac{1}{2}(1-\beta)(r+\tilde{\delta})-\frac{1}{4}\beta+c(\beta)}\right].$$

Taking expectations yields

$$-e^{\frac{1}{8}-\frac{1}{2}r(1-\beta)+\frac{1}{8}(1-\beta)^2\sigma_\delta^2-\frac{1}{4}\beta+c(\beta)}.$$

Thus, up to a monotone transformation, the shareholder's ex ante utility can be expressed as

$$W_T(\beta) = \tfrac{1}{2}r(1-\beta) - \tfrac{1}{8}(1-\beta)^2\sigma_\delta^2 + \tfrac{1}{4}\beta - \tfrac{1}{8} - c(\beta).$$

The above problem is a simple optimization problem whose solution is characterized below.

Theorem 2. *The optimal monitoring policy when the shareholder permits the manager to engage in insider trading is given by* $\beta_T^* = 1$ *if* $\gamma > 2r - 1$ *and by*

$$\beta_T^* = \frac{(1 - 2r + \sigma_\delta^2) + \sqrt{(1 - 2r + \sigma_\delta^2)^2 + 4\gamma\sigma_\delta^2}}{2\sigma_\delta^2}$$

otherwise.

Proof. The proof is virtually identical to the proof of Theorem 1 and thus will be omitted.

3.3 Comparative statics when trading is permitted

The comparative statics describing the effects of the three exogenous parameters, r, σ_δ, and γ, on the optimal monitoring policies followed by the firm are identical to those obtained when insider trading is prohibited. For completeness, this fact is recorded in the next lemma.

Lemma 2. *When insider trading is permitted, increasing average managerial effort preference,* r*, increases the level of monitoring and the fraction of rents captured by the shareholder. Increasing uncertainty regarding managerial effort preferences,* σ_δ*, increases the optimal fraction of value captured by the shareholder and lowers monitoring expenditure. Reducing the efficacy of the monitoring technology (i.e., raising* γ*) lowers the fraction of firm value captured by shareholders and may raise or lower optimal monitoring expenditures.*

Proof. The proof is virtually identical to the proof in the case in which insider trading is prohibited and thus will be omitted.

4 The effect of allowing insider trading on shareholder welfare

The difference in ex ante shareholder welfare when insider trading is permitted versus when it is prohibited is given by

$$W_N(\beta) - W_T(\beta) = \tfrac{1}{8} - \tfrac{1}{2}\beta(1 - \beta) - \tfrac{1}{2}(1 - b(c))^2 - \tfrac{1}{4}\beta = -\tfrac{3}{8} + \tfrac{5}{4}\beta - \beta^2. \tag{3}$$

Expression (3) is quadratic in β. From the quadratic formula we see that (5) has two roots, one at $\beta = \frac{1}{2}$ and the other at $\beta = \frac{3}{4}$. This establishes the following basic characterization of the insider trading decision.

Theorem 3. *The firm will permit managerial insider trading if and only if it chooses an investment in monitoring that induces either a large or small share of the firm value to be captured by management. That is, permitting insider trading is optimal if and only if the optimal fraction of value to concede to the manager,* β^**, satisfies* $\frac{1}{2} \leq \beta^* < \frac{3}{4}$.

4.1 Comparative statics of the shareholder-preferred policy

Our next result describes the shareholder's optimal monitoring/insider trading policy as a function of the exogenous parameters of the model. Our basic result is that, when the shareholder optimizes over

insider trading policies, the relationships between the fraction of value to concede to the manager, β, and the exogenous parameters of the model inherit monotonicity from the monotonicity of the relationship between β and the exogenous parameters found when the insider trading policy is fixed. However, in contrast to the fixed insider trading regime case, when the firm is allowed to choose an insider trading policy, the β-parameter relationships are discontinuous at those levels of the parameters in which the optimal insider trading regime shifts. Such regime shifts always occur at some point when the mean managerial effort parameter is varied across its admissible range. However, regime shifts need not always occur with variations in the other parameters of the model. To formalize these ideas, we first need to formalize the set of admissible parameters for the model. To this end, define R (Γ) to represent the values of r (γ) satisfying the admissibility condition $0 < \gamma < 2(1+r)$. Thus, R and Γ represent the feasible range of the mean managerial effort, r, and inefficacy of monitoring, γ. The dependence of each of these sets on the value of the other parameter is suppressed in the notation. The basic comparative static result is given below.

Lemma 3. *(a) There exist r_-, $r_+ \in \Re$ such that insider trading is prohibited if and only if $r \in (r^-, r^+)$. The optimal fraction of the firm that permits the manager to appropriate (β) is a decreasing function of r defined on R. Further, this function is discontinuous at r_- and r_+. (b) There exist γ_-, $\gamma_+ \in \Re$ such that insider trading is prohibited if and only if $\gamma \in \Gamma \cap (\gamma_-, \gamma_+)$. The optimal fraction of the firm that permits the manager to appropriate is a decreasing function of γ defined on Γ. Further this function is discontinuous in at γ_- and γ_+, whenever γ_-, $\gamma_+ \in \Gamma$. (c) There exist $\sigma_{\delta-}$, $\sigma_{\delta+} \in \Re$ such that insider trading is prohibited if and only if $\sigma_\delta \in [0, \infty) \cap (\sigma_{\delta-}, \sigma_{\delta+})$. The optimal fraction of the firm that permits the manager to appropriate is a decreasing function of σ_δ defined on $[0, \infty)$. Further, this function is discontinuous at $\sigma_{\delta-}$ and $\sigma_{\delta+}$, whenever $\sigma_{\delta+}$, $\sigma_{\delta+} \in [0, \infty)$.*

Proof. We only prove (a), the proofs for (b) and (c) being virtually identical. Let $B^* : R \to (0, 1]$ represent the function that maps mean levels of managerial effort preference, $r \in R$, into optimal factions of value to concede to the manager β^*, under the optimal insider trading policy (dependence on the other parameters being suppressed in the notation for simplicity). Let $B_T^* : R \to (0, 1]$ represent the function that maps mean levels of managerial effort, $r \in R$, into optimal fractions of value to concede to the manager, β^*, when insider trading is permitted. Define $B_N^* : R \to (0, 1]$ analogously for the case where insider trading is prohibited. Let $W_T^*(\cdot; r) : (0, 1] \to \Re$ represent, for each fixed r, the function mapping the fraction of firm value conceded by the manager to the ex ante payoff to the shareholder when insider trading is permitted. Define $W_N^*(\cdot; r) : (0, 1] \to \Re$ analogously for the case where insider trading is not allowed, and define $W(\cdot; r) : (0, 1] \to \Re$ by $W(\beta; r) = \max\{W_T(\beta; r), W_N(\beta; r)\}$.

We first show that B^* is decreasing. To see this, first note that B_N^* and B_T depend continuously on

r. Next, note that B^* never attains the values $\frac{1}{2}$ or $\frac{3}{4}$. To see this note that if $B^* = \frac{1}{2}$, for example, then, because the ex ante wealth function under trade and no trade are the same at this point, we prove that $B_T^* = B_N^* = \frac{1}{2}$. Thus, both first-order conditions are satisfied at this point, i.e. $W_T'(\frac{1}{2}; r) = W_N'(\frac{1}{2}; r) = 0$. Thus $W_T'(\frac{1}{2}; r) - W_N'(\frac{1}{2}; r) = 0$. But this is impossible, as can be seen from inspecting the derivative of expression (3). A similar argument shows that B^* never attains the value $\frac{3}{4}$.

To see this, first note that B_N^* and B_T depend continuously on r and both of these expressions are decreasing. Thus, by Theorem 3 and the above observation, we have that B^* must be 1-1.

Because B^* is not continuous, the fact that B^* is 1-1 does not prove that it is monotone. However, monotonicity results from the following argument. Let $R^o = \{r \in R : B^*(r) \in (\frac{1}{2}, \frac{3}{4})\}$; let $R^+ = \{r \in R : B^*(r) > \frac{3}{4})\}$, let $R^- = \{r \in R : B^*(r) < \frac{1}{2}\}$. As B^* can have at most two points of discontinuity and is monotone decreasing at continuity points, the sets, R^o, R^+, and R^- are intervals because $B^*(r) = B_N^*(r)$; whenever $r \in R^+ \cup R^-$ we have that $R^- > R^+$. As the union of the three intervals exhausts R we must have that $R^- \geq R^o \geq R^+$. Thus, the function B^* is monotonically decreasing.

Because both B_N^* and B_T^* converge to 1 as $r \downarrow \underline{r}$ and converge to 0 as $r \uparrow \infty$, we have that R^- and R^+ are both nonempty. Because $B^* = B_T^*$ on $R^+ \cup R^-$, and B_T^* is a continuous function, we must also have that R^o is nonempty. For, if R^o were empty, then we would have that $R = R^+ \cup R^-$ and that $B^* = B_T^*$ everywhere. But, B_N^* is continuous, and R^o being empty means that B^* never attains the values of β in the interval $(\frac{1}{2}, \frac{3}{4})$, violating the intermediate value property of continuous functions. □

A typical example of the functional relationship between the exogenous parameters, r, σ_δ, and γ, and the optimal insider trading /monitoring policy for the firm is diagrammed in Figures 2-4. Consistent with the results in the theorem, these relationships are monotonic but not continuous.

5 Welfare Analysis

The earlier analysis has identified situations in which the welfare of owners is improved by permitting insider trading. Thus, if allowed to determine corporate insider trading policies, owners will permit insider trading under certain circumstances. Is it the case that allowing owners to determine insider trading policies improves overall welfare? To answer this question we need to consider both the channels through which insider trading impacts the welfare of agents as a whole and how welfare impacts are allocated across agents. Insider trading impacts welfare via three routes: first, it impacts price informativeness, second, it impacts the manager's optimal effort decision and thus the level of output; third, it impacts shareholder's optimal monitoring policy and thereby impacts monitoring costs and the division of output between the firm and the manager. The twin effects of permitting insider trading on price informativeness and on effort incentives are the two effects considered in classical law and economics defense of insider trading. We can see that the

effect of insider trading on price informativeness is positive, almost by definition in our rational expectations model of capital markets. The effect of insider trading on effort incentives, given a fixed monitoring policy resulting in the fraction β of firm value accruing to the manager, is given by $\frac{1}{2} - \beta(c)$. This implies that, when sufficient resources are invested in monitoring to allow shareholders to capture most of corporate value, output is higher when insider trading is permitted. Thus, the direct effect of permitting insider trading on output and price informativeness appear to be favorable, at least when the firm is following fairly aggressive monitoring policies. However, monitoring policies are endogenous and, as we have seen earlier, permitting insider trading impacts the firm's optimal monitoring policy, and this effect can reverse the earlier conclusions reached under the assumption of a fixed monitoring policy.

As the above discussion elucidates, the routes through which insider trading impact agents in the economy are fairly intricate and this makes welfare analysis complex. Fortunately, given our model structure we need only consider how these factors impact two types of agents—managers and owners. Our analysis does not introduce unaffiliated "noise traders" into the picture who absorb trading losses from trading with the informed manager. Moreover, on the output side, there are no externalities from production which might benefit other firms or agents in the economy. Thus, if permitting insider trading improves the welfare of both shareholders and managers, it unambiguously improves overall welfare. The trade-offs involving the welfare effects of insider trading on shareholders have already been considered in the previous section in which the conditions under which shareholders would permit managers to engage in insider trade were elucidated. However, to facilitate the discussion of the relative effects of insider trading on managers and shareholders, we provide, in Figure 5, a diagrammatic presentation of the welfare effect of insider trading on shareholders.[2]

To understand the effect on managers, note that by permitting trade shareholders can induce fairly high levels of output from managers even if these managers are allowed only a small portion of firm output as part of their employment agreement. If monitoring costs are low, extracting this large portion of output is not very costly for shareholders. When trade is prohibited, on the other hand, even when monitoring is cheap, shareholders will be forced to concede a large fraction of project rents to managers in order to provide them with an incentive to produce. Thus, when monitoring is cheap, permitting insider trading allows shareholders to profitably capture a much larger fraction of firm output. This bargaining effect more than offsets the gains to managers from trading on their information. On the other hand, when monitoring is costly, the strategy of permitting insider trading while forcing managerial rents down through extensive monitoring is no longer cost effective. Thus, insider trading induces only insignificant redistribution of project value between

[2] Numerical computations and formulae underlying these graphs are available from the authors upon request. Graphs were prepared using *Mathematica*.

managers and shareholders. In this case, the portfolio benefits of permitting insider trading ensure that managerial welfare is always higher if trade is permitted. These effects on managerial welfare are illustrated in Figure 6.

As discussed in the previous section, shareholders will tend to permit insider trading when the equilibrium fraction of output extracted by shareholders is either very high or very low. In the case where insider trading is connected to high rent extractions by shareholders. permitting trading is redistributive in that it lowers the welfare of managers while increasing the welfare of shareholders. On the other hand, when shareholders choose to allow insider trading in conjunction with a low-rent extraction monitoring policy, insider trading equilibrium produces a higher level of welfare to both the manager and the shareholder than the the equilibrium monitoring/trading policy in the absence of insider trading opportunities. These observations are illustrated in Figure 7, which identifies the subset of the parameter space over which permitting insider trading is favored by both managers and shareholders (region OY-MY in the figure).

One question unanswered by Figure 7 and the above analysis is exactly why permitting insider trading increases the welfare of both managers and shareholders. As stated earlier, insider trading impacts agent welfare through a number of different routes. Moreover, the price discovery effect is always positive. Thus, a natural question is whether the price discovery effect, in and of itself, accounts for the welfare gain from permitting insider trading. One way to address this issue is to determine the effect of permitting insider trading on net output, the difference between expected output and monitoring costs. If permitting insider trading can be shown to increase net output for some subset of the parameter space then conditions will have been identified under which insider trading is welfare enhancing purely because of its positive effect on managerial incentives. The next diagram investigates this question. The region over which net output is increased if insider trading is permitted is represented by $T = T_1 \cup T_2$. As can be seen by comparing with Figure 5, in both regions T_1 and T_2, shareholder welfare is also higher when trading is permitted. Thus, shareholders will permit insider trading whenever trading leads to higher net output. In region T_1, permitting trade also leads to increased managerial welfare. In this region, the fraction of output captured by management when trading is permitted does not fall significantly relative to the no-trade fraction. Thus, the overall benefits from improved effort incentives and greater price informativeness lead to higher managerial welfare. In contrast, in T_2, although output is higher and shareholder wealth is higher when insider trading is permitted, managerial welfare is lower. This occurs because prohibiting insider trading forces shareholders to rely on granting managers a large share of firm output to increases managerial effort incentives. Thus, permitting insider trading, by allowing firms to move away from these manager-favored divisions of output, lowers managerial welfare. These effects on output are illustrated in Figure 8.

6 Conclusion

Initial arguments in the law and economics literature opposing blanket prohibitions of insider trading offered two arguments for permitting insider trading: trading increases the informativeness of prices, and the potential gains from trading profits improve managerial incentives and thus ameliorate the manager/shareholder moral hazard problem. The extant literature on insider trading considers informativeness of prices in the absence of managerial moral hazard or considers moral hazard in the absence of any informational role for prices. The results of this literature are generally not supportive of the ability of insider trading to induce welfare gains. In contrast, in this paper we develop a model in which moral hazard and price informativeness are linked in that managers have private information about their own potential gains from moral hazard. In this setting, we show that by permitting insiders to trade on personal account, the equilibrium level of output can be increased and shareholder welfare can be improved by permitting insider trading. This result, which contrasts with the negative results found in much of the extant literature on insider trading follows for two reasons. First, insider trading impounds information regarding managerial taste for perk consumption into asset prices, and this allows shareholders to choose more efficient investment portfolios. Second, allowing insider trading can induce managers to increase their stake in the firm beyond the that obtained through bargaining with shareholders. This effect leads to a reduction in managerial perk consumption and/or increased managerial effort. Despite these welfare gains from insider trading, managers may support blanket prohibitions on insider trading because granting shareholders discretionary control over insider trading policy may lead shareholders to follow polices leading to reduced managerial welfare—namely, shareholders may permit trade while reducing the fraction of output captured by management through employment.

7 References

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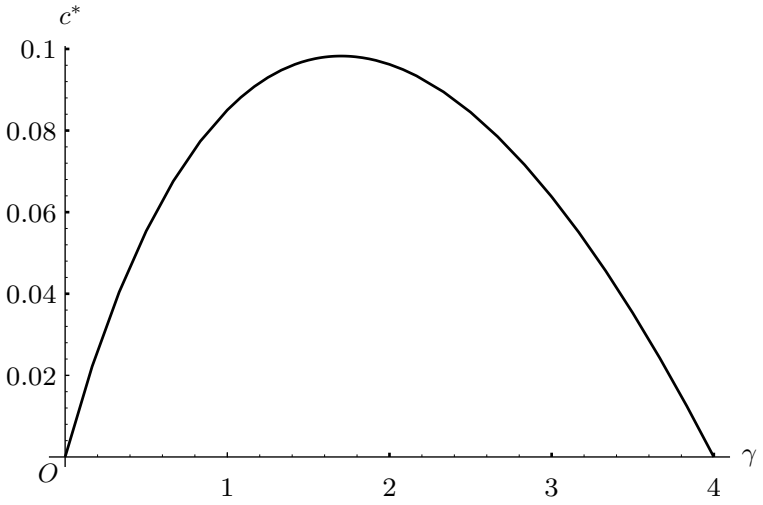

Figure 1. Optimal investment in monitoring and the quality of monitoring technology
In the above diagram, the average managerial effort preference parameter, r, and variance of the managerial effort preference parameter, σ, are both fixed at 1. γ, the parameter representing the inefficacy of the monitoring technology, is plotted over its admissible range, $(0, 4)$. As the graph illustrates, when the monitoring technology is very efficient or very inefficient, the optimal investment in monitoring is small.

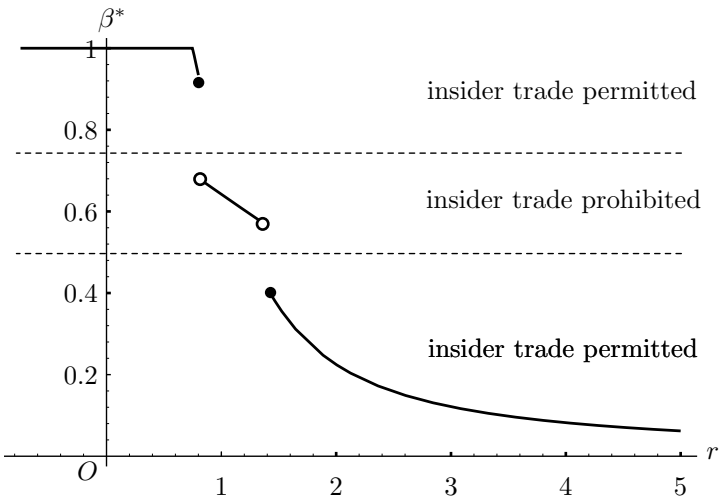

Figure 2. Optimal share of firm value to concede to the manager and optimal insider trading policy as a function of managerial effort preferences

In the above diagram, the optimal share of firm value to concede to the manager, β^*, and the optimal insider trading policy, as a function of mean managerial effort preference (r), is plotted. In the plot, γ is fixed at 0.50 and σ_δ^2 is fixed at 1. The range of values over which permitting insider trading is optimal is given by the horizontal dotted lines.

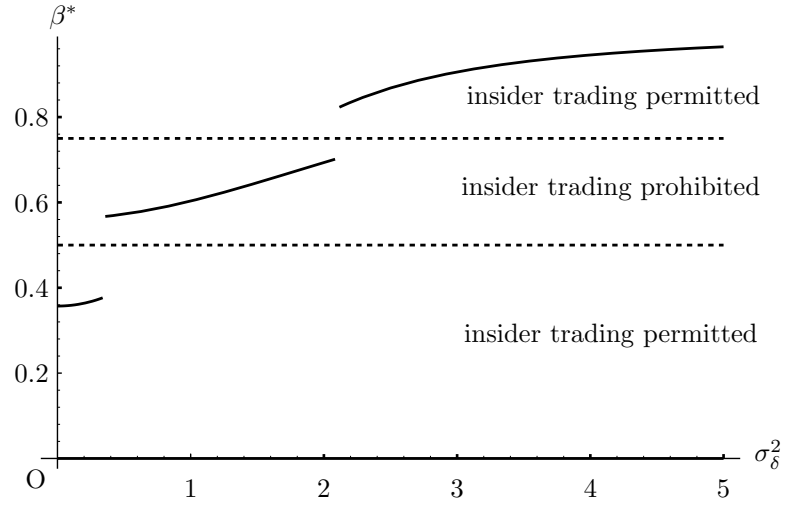

Figure 3. Optimal share of firm value to concede to the manager and optimal insider trading policy as a function uncertainty regarding managerial effort preferences

In the above diagram, the optimal share of firm value to concede to the manager, β^*, and the optimal insider trading policy, as a function of degrees of uncertainty regarding managerial effort preference (σ_δ^2), is plotted. In the plot, r is fixed at 1.20 and γ is fixed at 0.50. The range of values over which permitting insider trading is optimal is given by the horizontal dotted lines.

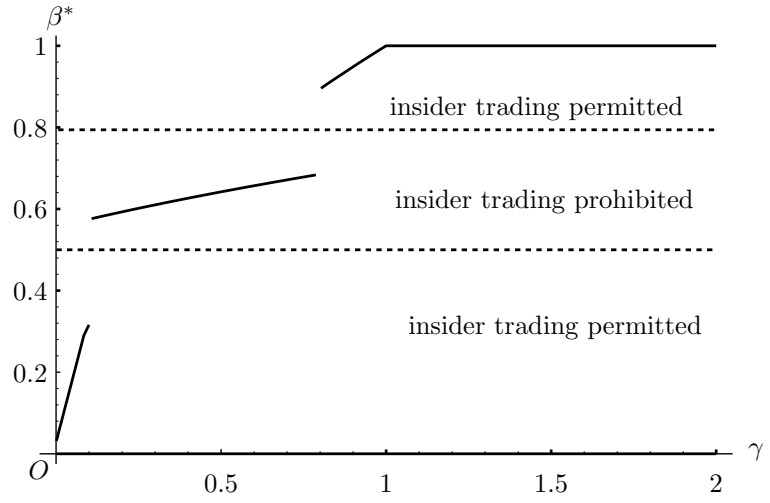

Figure 4. Optimal share of firm value to concede to the manager and optimal insider trading policy as a function uncertainty regarding managerial effort preferences of the monitoring technology

In the above diagram, the optimal share of firm value to concede to the manager, β^*, and the optimal insider trading policy, as a function of the inefficacy of the monitoring technology, is plotted. In the plot, r is fixed at 1.00 and σ_δ^2 is fixed at 1. The range of values over which permitting insider trading is optimal is given by the horizontal dotted lines.

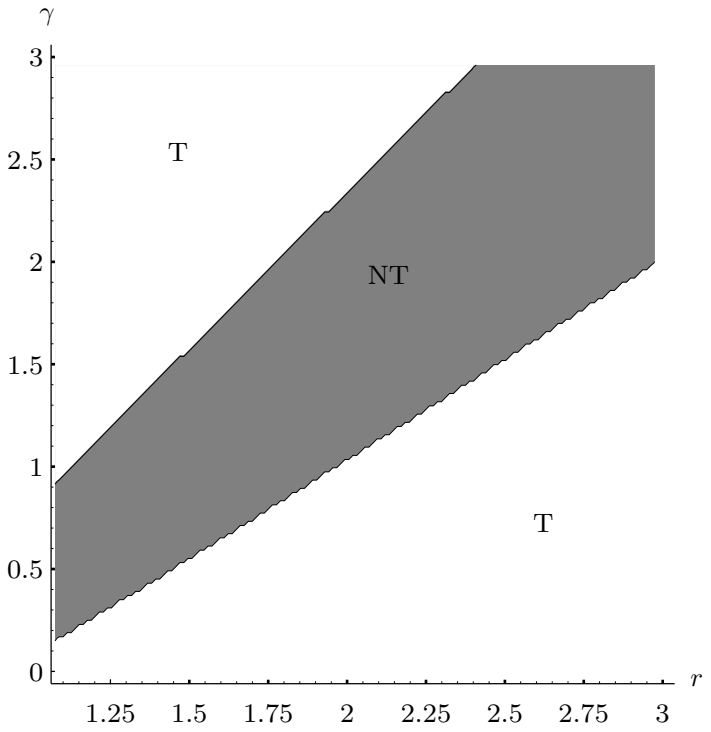

Figure 5. Insider trading and owner welfare
In the above diagram, σ_ϵ is fixed at 1, and average effort preference of managers (r) and monitoring difficulty (γ) are varied. In the regions labeled T permitting insider trading leads to equilibria in which owner welfare is higher. In the region marked NT prohibiting trade leads to higher owner welfare.

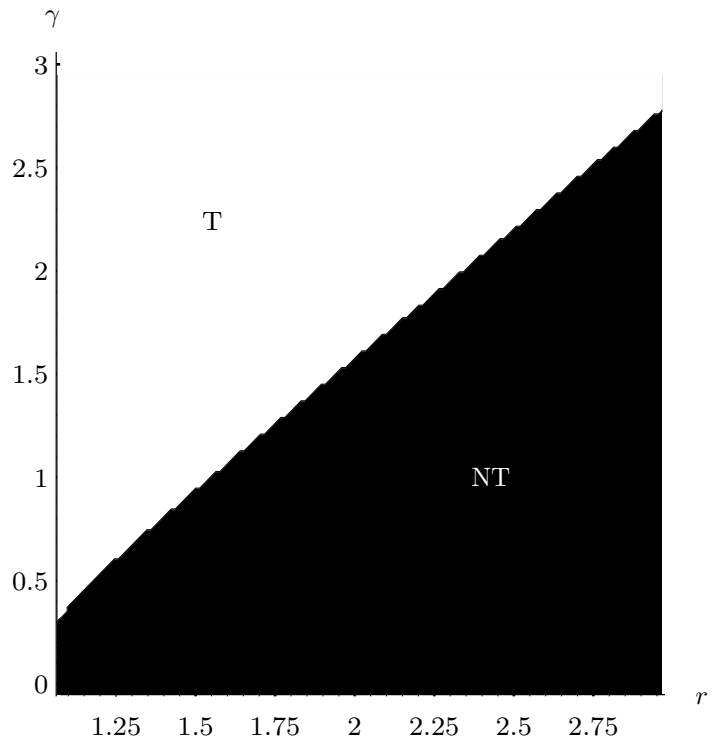

Figure 6. Insider trading and managerial welfare

In the above diagram, σ_δ is fixed at 1, and average effort preference of managers (r) and monitoring difficulty (γ) are varied. In the regions labeled T permitting insider trading leads to equilibria in which managerial welfare is higher. In the region marked NT prohibiting trade leads to higher managerial welfare.

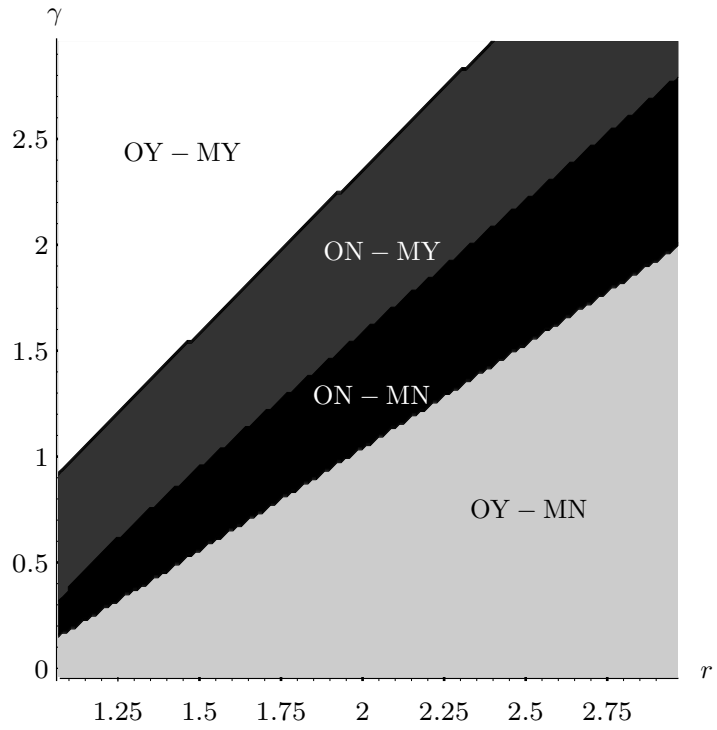

Figure 7. The disparate impact of permitting insider trade on owners and managers

In the above diagram, σ_δ is fixed at 1, and average effort preference of managers (r) and monitoring difficulty (γ) are varied. In the regions labeled OY (ON) permitting insider trading leads to equilibria in which owner welfare is higher (lower). In the region marked MY(MN) prohibiting trade leads to higher (lower) managerial welfare.

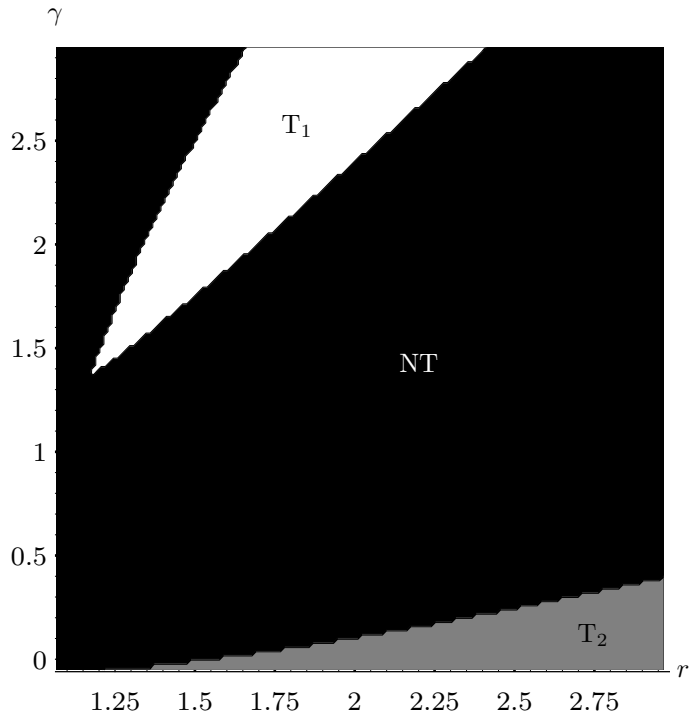

Figure 8. Regions over which permitting insider trade increases net output, the difference between expected firm output and monitoring costs

In the above diagram, σ_δ is fixed at 1, and average effort preference of managers (r) and monitoring difficulty (γ) are varied. In the regions labeled T_1 and T_2 permitting insider trading leads to equilibria in which net output is higher. In the region marked NT prohibiting trade leads to higher net output.