

INCENTIVES FOR PUBLIC DISCLOSURE BY CORPORATE INSIDERS[†]

Steven Huddart, *Pennsylvania State University*
John S. Hughes, *University of California at Los Angeles*
and
Michael Williams, *University of California at Los Angeles*

It is well understood that when corporate insiders trade shares in their firms stock for the sole purpose of maximizing trading profits, they benefit from asymmetric information, and consequently, favor minimal corporate financial disclosure requirements. We demonstrate that when insiders are risk-averse and have other motives for trade, such as liquidity needs, they can actually be harmed by asymmetric information, which increases trading costs. Consequently, insiders could favor full disclosure over nondisclosure, and generally prefer an intermediate level of disclosure, in which they give up some but not all of their information advantage.

JEL Classification: D81 J33 M12

Keywords: compensation, insider trading, risk aversion, sunshine trading, regulation, accounting

this draft: April 5, 2001

[†] Sunil Dutta, Jerry Feltham, Paul Fischer, Jesse Fried, Ro Verrecchia, and seminar participants at Berkeley, Carnegie-Mellon, Duke (micro-theory), Penn State, UCLA, the 2000 American Accounting Association meetings, and the 2000 Michigan Financial Economics and Accounting Conference provided many useful comments.

Send correspondence to:

Steven Huddart
Smeal College of Business
Pennsylvania State University
Box 1912
University Park, PA 16802-1912
telephone: 814 865-3271
facsimile: 814 863-8393
e-mail: huddart@psu.edu
web: <http://www.smeal.psu.edu/faculty/huddart>

INCENTIVES FOR PUBLIC DISCLOSURE BY CORPORATE INSIDERS

It is well understood that when corporate insiders trade shares in their firms stock for the sole purpose of maximizing trading profits, they benefit from asymmetric information, and consequently, favor minimal corporate financial disclosure requirements. We demonstrate that when insiders are risk-averse and have other motives for trade, such as liquidity needs, they can actually be harmed by asymmetric information, which increases trading costs. Consequently, insiders could favor full disclosure over nondisclosure, and generally prefer an intermediate level of disclosure, in which they give up some but not all of their information advantage.

I. INTRODUCTION

Corporate officers, directors, and other insiders routinely trade in the stock of the company with which they are affiliated. While seeking to exploit their private information provides a motive for such trades, there are other motives to consider. Insiders often receive compensation in the form of stock and stock options. To enjoy their income, they must, of course, exercise options and sell stock. In addition, like other investors, insiders may buy or sell stock to shed risk, rebalance their portfolios, maintain or achieve ownership targets set by their employers, meet personal liquidity needs, manage taxes, acquire control or influence over firm affairs, or undertake estate planning.¹ Moreover, it is unlikely that market makers can distinguish among these motives in setting prices at which insiders' demands will be met.

The presence of these other motives and an inability of market makers to separate order flow based on insiders' motives creates a tension regarding an insider's attitude toward mandated public disclosure such as that embodied in financial accounting standards. On one hand, less public disclosure implies more scope to profit from private information and less risk of price changes prior to trade. On the other hand, greater public disclosure implies lower trading costs from price adjustments induced by inferences drawn from the order flow at the time of trade. The extent to which insiders bear these trading costs depends on the degree of anonymity afforded their demands by the presence of noise traders. The model in this paper captures this tension within a rational expectations model of insider trading, and examines its implications for insiders' preferences toward mandated public disclosure policies such as those embodied by financial accounting standards.

Although the tension regarding public disclosure is likely to be present in any setting where insiders choose demands based in part on their private information and market makers draw only imperfect inferences from the order flow, it is likely to be most prominent for firms where that flow offers the insider little anonymity. For example, we perceive that the insights available from our analysis are especially germane to smaller firms with large insider holdings. They are also germane to firms for which The

uninformed order flow is high, but market makers go to greater lengths to identify those with whom they are dealing.

Abstracting from settings such as these where insiders lack substantial anonymity, we believe that the effects of public disclosure on insider welfare are most usefully exhibited in the case where market makers can, in fact, fully distinguish the identity of insiders, a case we term “sunshine trading.” This modeling choice both simplifies the analysis and allows us to highlight the conflicting incentives that arise when insiders have non-information-based motives for trading. Of course, in reality partial anonymity currently afforded insiders, even for firms with relatively illiquid markets, is likely to blunt these incentives. Nevertheless, we believe that the effects of such conflicts on insiders’ views toward public disclosure policies are important to consider.

Under sunshine trading, insiders bear the full measure of trading costs associated with their private information, implying that they cannot profit from that information in expectation. The market does not breakdown in this case given that the insiders’ other motives for trading are not entirely predictable by the market maker. In our model, we represent other motives as a private benefit affecting the utility an insider attaches to each share he holds after trading is complete. This benefit is a random variable whose distribution is common knowledge, but whose realization is known only to the insider. We also consider a setting in which the insider’s endowment is a random variable and his only non-information-based motive for trading is risk aversion.²

Apart from its usefulness as a modeling choice, sunshine trading has been proposed in the legal press by Klein (1983); in law review articles by Gilson and Kraakman (1984), Samuelson (1988), and Fried (1998 and 2000); and to a congressional subcommittee by United States Senator John Chafee. Proponents of sunshine trading by insiders have focused on the effects of such a rule in reducing trading costs on the uninformed and in furthering price discovery by prompting price adjustments that reflect insiders’ private information or discouraging insider trading based on such information.³ However, the debate on sunshine trading has not considered the impact that it could have

on the trading strategies and welfare of insiders and their posture toward public disclosure policies when market makers cannot separate demands based on private information from those driven by other motives.

Given sunshine trading and market makers who set prices so as to break even, an insider cannot, in expectation, profit from his private information. Despite this inability to profit, an insider nevertheless has incentive to exploit private information. This incentive causes an insider to distort his trades away from otherwise optimal demands (i.e., the demands that he would submit in the absence of private information). In turn, the implicit disutility to the insider from such distortions may be sufficient for the insider to prefer to preclude trade based on private information by committing to disclose private information before trade. Financial accounting standards constitute one device for implementing this type of commitment. Counter-balancing the preference for public disclosure is the prospect of price changes that the insider cannot hedge.

Initially, we consider insider trading behavior in the extreme settings of no public disclosure and full public disclosure. In the no disclosure regime, the insider trades in part to hedge “signal risk,” the residual risk that the future value of the firm will vary from its expected future value conditional on his private information. Such trades involve an implicit trading cost associated with price adjustments by the market maker to compensate for the prospect that the insider may also be trading to exploit his private information. Accordingly, the insider’s equilibrium trades provide only a partial hedge. This distortion from a perfect hedge is greater when signal risk is low. In the full disclosure regime, the insider’s information advantage is dissipated thereby eliminating this incentive to trade and, hence, the trading costs that impede a perfect hedge of the remaining signal risk. However, the insider now bears greater “fundamental risk,” the risk that revelation of his private information will prompt price adjustments by the market maker before he has an opportunity to trade.

The variance of the noise component of the insider’s private signal measures signal risk. Fundamental risk increases in the prior variance of firm value; however, an increase in the prior variance of firm value also increases the information asymmetry between

the insider and market maker. Greater information asymmetry implies higher trading costs, hence a higher cost to hedge signal risk. In turn, a higher cost to hedge favors full disclosure. *Ceteris paribus*, with random benefits insiders prefer no (full) disclosure when the variance of the noise component of the insider's private signal is high (low) relative to the prior variance of firm value.

A further element of the tradeoff the insider faces between no disclosure and full disclosure is the disguise for information-based trades provided by either the unpredictable component of his private benefit or endowment, as measured by the variance of that component. *Ceteris paribus*, the larger this variance, the lower is the trading cost and related imperfection in the insider's hedge of signal risk under no disclosure, leading to greater expected utility.

Having investigated preference orderings over these extremes, we consider public disclosure policies that only partially reveal the insider's private information, and identify settings in which the insider prefers partial disclosure to either no disclosure or full disclosure. Adding noise traders increases the insider's disguise and leads insiders to prefer less public disclosure; however, the basic tension the insider faces is preserved whenever market makers cannot disentangle such other motives for trading cannot from information-based incentives.

Others have considered the consequences of public disclosure of private information on the welfare of insiders, although the tensions that prompt such disclosure are very different. In Bushman and Indjejikian (1995), corporate insiders prefer to commit to disclose a portion of their private information to discourage competition from other traders in possession of less precise private information. Ausubel (1990) also provides conditions under which insiders are better off committing to disclose their private information before trading. Unlike our pure exchange setting, Ausubel considers a production stage before exchange and shows through numerical examples that public disclosure may lead to an increase in production by uninformed market participants due to resolution of uncertainty. In turn, this added production increases the equilibrium value of the insider's production.

The basic idea that insiders may prefer to not receive private information before trading follows from Hirshleifer's (1971) seminal notion that risk-averse individuals prefer to insure against risky events before information about outcomes is made public. In our model, trade is the only vehicle for hedging risk; however, trading comes too late if the information is released, and uncertainty is resolved, before trading takes place. When information disclosure does not precede trade, there is price risk associated with the portion of private information revealed via the insider's order flow, but this risk is less than when information disclosure precedes trade.

There are similarities between our characterization of insiders' motives for trading and those of Glosten (1989), and Bhattacharya and Spiegel (1991). Both consider a setting similar ours in which risk averse insiders with random endowments trade to hedge risks as well as to exploit private information. In Glosten (1989), as in our analysis, market makers recognize that they are dealing with insiders; i.e., sunshine trading, but cannot distinguish their motives for trading. Unlike our study, Glosten (1989) focuses on the comparison of a monopolist specialist providing liquidity by averaging profits over successive trades with competitive market makers who may more frequently shut down the market for lack of liquidity, while Battacharya and Speigel (1991) focus on conditions under which a market breakdown occurs because the adverse selection problem faced by strategic uninformed traders is too great. Neither of these papers consider preferences of insiders with respect to public disclosure policies such as those embodied in financial accounting standards.

Spiegel and Subrahmanyam (1992) model a market with two classes of market participants; privately informed insiders and risk averse uninformed traders who are willing to bear some trading costs in order to share risks. Spiegel and Subrahmanyam are concerned with liquidity, price, and welfare effects of varying numbers of informed and uninformed traders. In contrast, we are mainly concerned with price and welfare effects of varying the precision of the insider's private signal and the role of public disclosure in mitigating the dysfunctional consequences of private information.

The concept of ex ante price risk prominent in our study is also present in Naik, Neuberger, and Viswanathan's (1999) analysis of dealership markets in which a privately informed investor trades with a dealer, who then trades with other dealers. The focus in their study is on the welfare effects of greater transparency of first-stage trades in the inter-dealer market. In particular, the authors show how transparency raises the price risk of the investor. Their result that greater transparency may reduce welfare is analogous to our result that requiring public disclosure *and* sunshine trading by corporate insiders imposes price risk that can diminish insiders' expected utility. In Naik et al., the opposing force is the effect of transparency in reducing adverse selection and consequent improvement in risk sharing, whereas in ours it is the effect of public disclosure in precluding costly distortions induced by sequentially rational, but ex ante costly exploitation of private information.

Finally, Fishman and Hagerty (1995), John and Narayanan (1997), and Huddart, Hughes, and Levine (2001) consider the effects of ex post public reporting of trades by corporate insiders, as currently required under U.S. securities regulation, on equilibrium trading strategies and prices in multi-period settings.⁴

This paper is organized as follows: Section II describes the basic model, characterizes an ex post equilibrium given no disclosure of the insider's private information, and steps back to consider ex ante expected utility under this regime; section III characterizes an ex post equilibrium under full public disclosure, and compares ex ante expected utility across the two regimes; section IV extends the model to consider uncertainty about the insider's pre-trade stock position; and, section V concludes the paper.

II. NO PUBLIC DISCLOSURE

Basic model

The setting is similar to the single-period version of Kyle (1985) in which a privately informed insider places an order with a break-even market maker. In Kyle, random orders by non-strategic (exogenous) liquidity traders provide disguise for the insider in the sense that the combined observable order flow allows the market maker only imperfect inferences regarding the insider's private information. We assume a further source of noise in the form of a random private benefit to the insider per share held. The underlying notions are that corporate insiders trade for motives other than the exploitation of their private information; and the benefits underlying such motives are subject to uncertainty, the resolution of which is only observable to the insider.⁵ Additionally, we assume the insider is risk-averse, thereby adding risk sharing to his motives for trade.

There is one round of trading in a single risky asset with liquidation value, v , where v is normally-distributed with mean p_0 and variance Σ_0 . Before trading, the insider learns the realization of an imperfect private signal $\eta = v + \epsilon$, where ϵ is normally distributed with mean 0 and variance σ_ϵ^2 . There is no loss of generality in further assuming that $p_0 = 0$. The insider has an endowed position in his firm's stock of z shares, and obtains a private benefit of b per share held after trading. In keeping with the practice of firms reporting the holdings of corporate insiders, we assume that $z \geq 0$ is common knowledge. However, b is the realization of a normally distributed random variable with mean $\bar{b} > 0$ and variance, σ_b^2 , and is unobservable to the market maker.

The insider places an order for x shares conditioned on the realizations η and b . Random variables v and b are independent. The market maker chooses a price, p_1 , based on either x , or, x and η , as appropriate to the case under consideration.

The timeline in figure 1 summarizes the model.

[Figure 1]

Ex post equilibrium

Derivation of endogenous parameters

Recall the insider is endowed with z shares and trades x shares at price p_1 . Consistent with sunshine trading, we assume the market maker observes x before setting p_1 . Each share held by the insider at the conclusion of trade provides the insider with a fundamental value of v and a private benefit of b , so that after trade, the insider's portfolio is worth $(v + b)(x + z) - xp_1$. We assume that the insider has negative exponential utility with risk aversion parameter ρ . Given normality, maximizing expected utility is the same as maximizing the following certainty equivalent

$$\begin{aligned} & E[(v + b)(x + z) - xp_1 \mid \eta, b] \\ & \quad - \frac{\rho}{2} \text{Var}[(v + b)(x + z) - xp_1 \mid \eta, b] \\ & = (M\eta + b)(x + z) - xp_1 - \frac{\rho}{2}(x + z)^2 V, \end{aligned} \tag{1}$$

where

$$M = \frac{\Sigma_0}{\Sigma_0 + \sigma_\epsilon^2}, \quad \text{and} \quad V = \frac{\Sigma_0 \sigma_\epsilon^2}{\Sigma_0 + \sigma_\epsilon^2} = M \sigma_\epsilon^2.$$

The quadratic form of the certainty equivalent implies that the first-order condition with respect to x defines the unique global optimum provided the second-order condition is also satisfied. We focus on linear equilibria for which

$$x = \alpha + \beta\eta + \gamma(b - \bar{b}), \tag{2}$$

and, initially,

$$p_1 = p_0 + \lambda(x - \mu), \tag{3}$$

where $\mu = E(x)$.

Proposition 1: Given no disclosure, and uncertain private benefit, b , an equilibrium can be characterized by the following endogenous parameters:

$$\lambda = \frac{\rho V \Sigma_0 M}{\sigma_b^2 - \Sigma_0 M}, \quad (4)$$

$$\alpha = \left(\frac{\bar{b}}{\rho V} - z \right) \left(\frac{\sigma_b^2 - M \Sigma_0}{\sigma_b^2} \right), \quad (5)$$

$$\beta = \frac{1}{\rho \sigma_\epsilon^2} \left(\frac{\sigma_b^2 - M \Sigma_0}{\sigma_b^2 + M \Sigma_0} \right), \quad \text{and} \quad (6)$$

$$\gamma = \frac{1}{\rho V} \left(\frac{\sigma_b^2 - M \Sigma_0}{\sigma_b^2 + M \Sigma_0} \right), \quad (7)$$

provided the second-order condition

$$\sigma_b^2 - \Sigma_0 M > 0 \quad (8)$$

is satisfied.

Proof: The first-order condition on (1) with respect to x for an arbitrary realization of the private benefit, b , and private signal, η , is

$$M\eta + b - 2\lambda x + \lambda\mu - \rho(x + z)V = 0. \quad (9)$$

Equation (9) implies

$$x = \frac{M\eta + b - \rho z V + \mu\lambda}{2\lambda + \rho V}. \quad (10)$$

In equilibrium,

$$\mu = \alpha = \frac{\bar{b} - \rho z V}{\lambda + \rho V}, \quad (11)$$

$$\beta = \frac{M}{2\lambda + \rho V}, \quad \text{and} \quad (12)$$

$$\gamma = \frac{1}{2\lambda + \rho V} = \frac{\beta}{M}. \quad (13)$$

Furthermore, from the market maker's breakeven condition,

$$p_1 = E(v | x) = E(v) + \frac{\text{Cov}(x, v)}{\text{Var}(x)}(x - \mu),$$

we have

$$\lambda = \frac{\beta \Sigma_0}{\beta^2(\Sigma_0 + \sigma_\epsilon^2) + \gamma^2 \sigma_b^2}. \quad (14)$$

Solving (11) through (14), we obtain,

$$\lambda = \frac{\rho \sigma_\epsilon^2 \Sigma_0^3}{(\Sigma_0 + \sigma_\epsilon^2) (\sigma_b^2 (\Sigma_0 + \sigma_\epsilon^2) - \Sigma_0^2)}$$

which reduces to (4). Substituting (4) into (11) through (14) gives

$$\begin{aligned} \alpha &= \frac{\sigma_b^2 (\Sigma_0 + \sigma_\epsilon^2) - \Sigma_0^2}{\rho \sigma_b^2 \Sigma_0 \sigma_\epsilon^2 (\Sigma_0 + \sigma_\epsilon^2)} (\bar{b} (\Sigma_0 + \sigma_\epsilon^2) - \Sigma_0 \sigma_\epsilon^2 \rho z) \\ \beta &= \frac{\sigma_b^2 (\Sigma_0 + \sigma_\epsilon^2) - \Sigma_0^2}{\rho \sigma_\epsilon^2 (\sigma_b^2 (\Sigma_0 + \sigma_\epsilon^2) + \Sigma_0^2)}, \quad \text{and} \\ \gamma &= \frac{(\Sigma_0 + \sigma_\epsilon^2) (\sigma_b^2 (\Sigma_0 + \sigma_\epsilon^2) - \Sigma_0^2)}{\rho \Sigma_0 \sigma_\epsilon^2 (\sigma_b^2 (\Sigma_0 + \sigma_\epsilon^2) + \Sigma_0^2)}, \end{aligned}$$

which reduce to (5), (6), and (7), respectively. The second-order condition is

$$-2\lambda - \rho V \leq 0. \quad (15)$$

By substitution and rearrangement, (15) becomes

$$\frac{\rho \sigma_\epsilon^2 \Sigma_0 (\sigma_b^2 (\Sigma_0 + \sigma_\epsilon^2) + \Sigma_0^2)}{(\Sigma_0 + \sigma_\epsilon^2) (\sigma_b^2 (\Sigma_0 + \sigma_\epsilon^2) - \Sigma_0^2)} \geq 0,$$

which reduces to (8). \blacksquare

In words, inequality (8) implies that the uncertainty surrounding the private benefits the insider receives from stock ownership must exceed the prior uncertainty about the asset's value multiplied by $M \in (0, 1)$, a measure of the degree of perfection of the insider's private information. It is analogous to the market breakdown condition in Glosten (1989). When (8) does not hold, no trade takes place. Intuitively, the motivation to trade, apart from private information, must be strong enough for the market maker to set marginal trading costs low enough for the insider to trade. Given that the second-order condition is met, $\beta > 0, \lambda > 0, \gamma > 0$, and $\alpha < \bar{b}/(\rho V)$, since $z > 0$.

Comparative statics

From (4) to (7), note that the insider's expected trade, α , includes two multiplicative terms. The first term is the difference of two components: the first component reflects the insider's expected private benefit per share adjusted for risk; and, the second component reflects the insider's desire to avoid risk by undoing his endowed position. The second term captures the distortion of the insider's desired position caused by his incentive to exploit his private information. This term approaches unity as the insider's private information becomes less precise (i.e., as σ_ϵ^2 increases).⁶

The expressions for β and γ imply that some imprecision in the insider's private information, i.e., $\sigma_\epsilon^2 > 0$, is necessary for his trading intensities to be well-defined. With perfect information, the insider faces no risk at the time he places his submits his order, and hence that order would be unbounded.

From the expressions for the endogenous parameters, we obtain the next proposition.

Proposition 2: *A change in the precision of the insider's private information affects his trading strategy and market depth as follows:*

$$\begin{aligned}\frac{\partial \alpha}{\partial \sigma_\epsilon^2} &= \frac{1}{\sigma_\epsilon^4 \sigma_b^2} \left[\frac{\bar{b}}{\rho} (\Sigma_0 - \sigma_b^2) - zV^2 \right], \\ \frac{\partial \beta}{\partial \sigma_\epsilon^2} &= \frac{1}{\rho \sigma_\epsilon^4 (\sigma_b^2 + M\Sigma_0)^2} [M^2 \Sigma_0^2 - \sigma_b^4 + 2\sigma_b^2 \sigma_\epsilon^2 M^2], \\ \frac{\partial \gamma}{\partial \sigma_\epsilon^2} &= \frac{1}{\rho \sigma_\epsilon^4 (\sigma_b^2 + M\Sigma_0)^2} [M^2 \Sigma_0^2 - \sigma_b^4 + 2\sigma_b^2 \sigma_\epsilon^2 M - M^2 \Sigma_0 \sigma_\epsilon^2], \quad \text{and} \\ \frac{\partial \lambda}{\partial \sigma_\epsilon^2} &= \frac{\rho \Sigma_0^3}{(\Sigma_0 + \sigma_\epsilon^2)^2 [\sigma_b^2 (\Sigma_0 + \sigma_\epsilon^2) - \Sigma_0^2]^2} [\sigma_b^2 (\sigma_\epsilon^2 - \Sigma_0) (\sigma_\epsilon^2 + \Sigma_0) + \Sigma_0^3].\end{aligned}$$

Proof: Follows from differentiation of (4)–(7) with respect to σ_ϵ^2 . ■

The first expression indicates that the insider's expected demands, α , increase in σ_ϵ^2 unless his endowment, z , the posterior variance, V , or the variance of private benefits, σ_b^2 , is large. From (12) it is evident that the insider's expected demands, α , ceteris paribus, decrease in the posterior variance, V , and trading costs, λ . Since V increases in σ_ϵ^2 and, as we explain shortly, λ increases in σ_ϵ^2 when σ_b^2 is large, then either a large V , or a large σ_b^2 could cause α to decrease in σ_ϵ^2 . Intuitively, the greater the risk implied by the posterior variance, the lower the insider's desired position; and the higher the trading costs, the less aggressively the insider trades on his realized private benefits.

Both insider trading intensities, β and γ , increase in the variance of the insider's private signal, σ_ϵ^2 , unless the variance of private benefits, σ_b^2 , is large. In this case, β and γ decrease in σ_ϵ^2 . A reversal occurs because, when σ_b^2 is large, the insider has incentive to take large positions; and, more noise in the insider's private information implies greater risk on those positions. This, in turn, dampens the insider's demands from either source. The potentially offsetting effect of lower trading costs imposed by the market maker is insufficient to compensate for the added risk.

There are two effects of increasing σ_ϵ^2 on the price adjustment, λ , set by the market maker. On one hand, an increase in residual risk induces an increase in trading costs since now it takes more extreme news to generate the same level of insider's demands. On the other hand, an increase in σ_ϵ^2 also implies less private information, causing the market maker to reduce trading costs. When the variance of private benefits, σ_b^2 , is large and σ_ϵ^2 is small relative to Σ_0 , an increase in risk from an increase in σ_ϵ^2 has a greater effect in reducing the private benefits component of the insider's demands than the private information component. The market maker therefore infers that a larger portion of the insider's demands are driven by private information, so he increases trading costs. Otherwise, the market maker draws the opposite inference, so a decrease in precision of the insider's private signal induces a reduction in trading costs.

Cases in which price adjustments increase and trading intensities decrease in σ_ϵ^2 are interesting, but less plausible than those in which less precise private information implies smaller trading costs and higher trading intensities. In particular it seems unlikely that

the variance σ_b^2 would exceed the prior variance of firm value, which may produce these effects. Most interesting is the effect of an increase in σ_ϵ^2 on the risks the insider faces at the time he makes his trading decisions. Holding effects on trading costs aside, greater residual risk dampens demands based on either private benefits or private information; and, as we have indicated, may also change the relative impact of those incentives on trading decisions.

Ex ante expected utility

Stepping back in time, we now consider the insider's expected utility prior to learning the realizations of his private signal and private benefit. Note that for the market maker to breakeven, it must be the case that the insider cannot profit in expectation from his private information, i.e.,

$$E[x(v - p_1)] = 0.$$

This condition can be confirmed by substituting the equilibrium values of λ , α , β , and γ from equations (4) to (7) into the definitions of x and p_1 . Continuing with the computation of the expected value of the insider's position,

$$\begin{aligned} & E((v + b)(x + z) - xp_1) \\ &= E(x(v - p_1)) + E(b(x + z)) \\ &= \frac{\bar{b}zM\Sigma_0}{\sigma_b^2} + \frac{\sigma_b^2 + \bar{b}^2(\sigma_b^2 + M\Sigma_0)}{\rho M\Sigma_0} \frac{\sigma_b^2 - M\Sigma_0}{\sigma_b^2 + M\Sigma_0}. \end{aligned} \tag{16}$$

The insider's private information induces a distortion in his demands away from those that would be optimal in the absence of such information. This distortion combined with the fact that the insider bears his own trading costs implies that the insider would prefer not to receive private information were this an option. The expected value related to the private benefit, $E(b(x + z))$, includes the expected private benefit of the insider's after-trade position, $(\alpha + z)\bar{b}$, and the gains to trade vis-à-vis those benefits.

As we will depict later in figures 2 and 3, taking all effects into account, including those pertaining to risk, the insider's expected utility can increase in σ_ϵ^2 and decrease in

Σ_0 . The improvement in expected utility from a reduction in the information incentive, whether because of more noise in his signal or less prior variance, may outweigh the consequences of greater residual risk associated with positions taken to exploit private benefits. Expected utility may be increasing or decreasing in σ_b^2 , depending on the parameterization. The main insight at this stage is that the insider may be made better off from a reduction in his information advantage. Under appropriate circumstances, the insider may prefer mandated public disclosure of his private information in advance of trade.

III. PUBLIC DISCLOSURE

Ex post equilibrium

Corporate insiders could preclude trading distortions due to private information by publicly disclosing that information prior to trading.⁷ In this section, we begin by considering the consequences of full prior disclosure. While this alternative to no disclosure is extreme, it is useful because it shows how greater disclosure can mitigate the dysfunctional consequences to insiders of their information advantage. Later in the section, we characterize partial disclosure equilibria and demonstrate the insider's preference for an interior choice of precision for the public signal in a numerical example.

By publicly disclosing his private signal, the insider induces price adjustments that fully reflects his posterior beliefs; i.e.,

$$p_1 = M\eta. \tag{17}$$

Substituting into the insider's objective function at the time of trade we obtain

$$\begin{aligned} & E [(v + b)(x + z) - xM\eta \mid \eta, b] \\ & \quad - \frac{\rho}{2} \text{Var} [(v + b)(x + z) - xM\eta \mid \eta, b] \\ & = (x + z)(M\eta + b) - xM\eta - \frac{\rho}{2}(x + z)^2 V. \end{aligned} \tag{18}$$

Hence, optimal demands are now

$$x = \frac{b}{\rho V} - z.$$

Proposition 3: *Given full disclosure, and uncertain private benefit b , an equilibrium can be characterized as follows:*

$$\begin{aligned} \lambda &= 0, \\ \alpha &= \frac{\bar{b}}{\rho V} - z, \\ \beta &= 0, \quad \text{and} \\ \gamma &= \frac{1}{\rho V}. \end{aligned} \tag{19}$$

The expectation of insider demands, (19), can be compared with the corresponding expression in (5) given no disclosure. The values differ by a factor of

$$\frac{\sigma_b^2 - M\Sigma_0}{\sigma_b^2}$$

that reflects the distortions in the insider's trading strategy induced by his private information when that information is not disclosed.

Ex ante expected utility

Again, stepping back to consider the insider's ex ante expected utility, we first look at the expected value of his position,

$$E((v + b)(x + z) - xM\eta) = \frac{\sigma_b^2 + 2\bar{b}^2}{\rho V}. \tag{20}$$

The right-hand side of (20) is greater than the analogous expected value under no disclosure because the gains to trade related to private benefits are undiminished by a dysfunctional incentive to exploit an information advantage. Returning to the effects of σ_ϵ^2 on the insider's expected utility, it is evident that with full disclosure there is no distortion caused by private information. However, an increase in σ_ϵ^2 is still relevant to

expected utility because an increase in residual risk has a similar dampening effect on trading responses to realized private benefits as noted in the previous subsection, and because a less informative public signal implies smaller price adjustments and hence less ex ante price risk.

Comparing disclosure regimes

To compare full disclosure and non-disclosure regimes, we created a series of numerical examples within which we vary the variance of the noise component of the insider's private information, σ_ϵ^2 , and plot ex ante expected utility under both no disclosure and full disclosure.⁸ Figure 2 displays our results.

[Figure 2]

As we pointed out earlier, an increase in σ_ϵ^2 results in lower trading costs incurred to hedge signal risk under no disclosure, in part, because there is less private information to prompt price adjustments and, in part, because it is less likely that demands are driven by that information. However, only the former has an effect on price adjustments under full disclosure, implying less relative reduction in ex ante price risk under this regime. An increase in σ_ϵ^2 also implies greater residual risk, which dampens trading on realizations of those benefits under either regime. When σ_ϵ^2 is relatively small, there is greater distortion of demands due to private information and less differential price risk, implying higher expected utility under full disclosure for the parameters considered in our numerical examples.⁹

[Figure 3]

Figure 3 depicts the consequences of increasing the prior variance of firm value, Σ_0 . Consistent with our intuition, these effects are qualitatively opposite from those shown in figure 2. Specifically, an increase in Σ_0 decreases the insider's ex ante expected utility under both regimes due to its effect on both fundamental risk and the information incentive to trade. In the case of no disclosure, an increase in Σ_0 , holding constant σ_ϵ^2 , implies greater private information thereby strengthening the incentive to trade on that

basis. This effect becomes more prominent as the ratio of Σ_0 to σ_ϵ^2 increases. When Σ_0 is small, risk effects dominate and are greater under full disclosure. This results in marginally greater expected utility under no disclosure. When Σ_0 is large, however, the implicit cost of the distortion in trades due to relatively better private information forces a reversal in this ordering.

[Figure 4]

Last, figure 4 illustrates the roles of private benefits in providing an incentive to trade, disguising information-based demands, and altering the relative residual risk of positions taken. When the variance of those benefits, σ_b^2 , is small and, hence, the likelihood that trades are motivated by those benefits is low, expected utility is greater under full disclosure. Increasing σ_b^2 implies more ex post gains to trade in order to obtain private benefits under both regimes, albeit modified by greater ex ante risk. The relative flatness of expected utility under full disclosure is because gains from private benefits are largely offset by the residual risk associated with positions taken to obtain those benefits. The more dramatic effects on expected utility in the no disclosure regime are due to the indirect effects of increasing σ_b^2 on trading costs and ex ante price risk. Trading costs decline as the relative incentive to trade on private information diminishes, and price risk declines because less information is revealed through the order flow. Other parameterizations produce declining expected utility due to ex ante risk of lower than mean private benefits.

Partial public disclosure

While the principal tensions are highlighted by comparing the stark extremes of no disclosure and full disclosure, it is natural to consider whether the insider would prefer financial reporting rules that require him to publicly disclose some, but not all, of his information. To study this, we introduce a noisy public signal. Specifically, let s denote a noisy signal of the insider's private information released just prior to trade: $s = \eta + \phi = v + \epsilon + \phi$, where $\phi \sim N(0, \sigma_\phi^2)$, independent of v and ϵ . The market maker

now observes s as well as x before setting price p_ϕ , implying that his portfolio is now worth $(v + b)(x + z) - xp_\phi$ after trade. As before, the insider chooses x to maximize the following certainty equivalent

$$\begin{aligned}
& E[(v + b)(x + z) - xp_\phi \mid \eta, b, s] \\
& \quad - \frac{\rho}{2} \text{Var} [(v + b)(x + z) - xp_\phi \mid \eta, b, s] \\
& = E[(v + b)(x + z) - xp_\phi \mid \eta, \phi, b] \\
& \quad - \frac{\rho}{2} \text{Var} [(v + b)(x + z) - xp_\phi \mid \eta, \phi, b] \\
& = (M\eta + b)(x + z) - xp_\phi - \frac{\rho}{2}(x + z)^2V.
\end{aligned} \tag{21}$$

We again focus on linear equilibria for which

$$x = \alpha + \beta\eta + \gamma(b - \bar{b}), \tag{22}$$

and,

$$p_\phi = p_0 + \lambda(x - \mu), \tag{23}$$

where $\mu = E[x \mid s]$, $p_0 = E[v \mid s] = sK$, and

$$K = \frac{\Sigma_0}{\Sigma_0 + \sigma_\epsilon^2 + \sigma_\phi^2}.$$

Proposition 4: *Given disclosure s , and uncertain private benefit, b , an equilibrium can be characterized by the following endogenous parameters:*

$$\lambda = \frac{\rho V \Sigma_0 M P}{\sigma_b^2 - \Sigma_0 M P}, \tag{24}$$

$$\alpha = \left(\frac{\bar{b}}{\rho V} - z \right) \left(\frac{\sigma_b^2 - \Sigma_0 M P}{\sigma_b^2} \right), \tag{25}$$

$$\beta = \frac{P}{\rho \sigma_\epsilon^2} \left(\frac{\sigma_b^2 - \Sigma_0 M P}{\sigma_b^2 + \Sigma_0 M P} \right), \quad \text{and} \tag{26}$$

$$\gamma = \frac{1}{\rho V} \left(\frac{\sigma_b^2 - \Sigma_0 M P}{\sigma_b^2 + \Sigma_0 M P} \right), \tag{27}$$

where

$$P = \frac{\sigma_\phi^2}{\Sigma_0 + \sigma_\epsilon^2 + \sigma_\phi^2},$$

provided the second-order condition

$$\sigma_b^2 - \Sigma_0 MP > 0 \tag{28}$$

is satisfied.

Proof: See appendix II.

Observe that the expressions for the endogenous parameters above converge to those in Proposition 1 as σ_ϕ^2 becomes large and converge to those in Proposition 3 as σ_ϕ^2 goes to zero.

Computing the insider's ex ante expected utility corresponding to the equilibrium in Proposition 4, and using the same parameters as in our earlier figures shows the insider prefers an interior choice of precision for the noise component of the public signal. Figure 5 depicts a case in which full public disclosure is preferred to no disclosure, yet the insider achieves greater expected utility with partial disclosure. Thus, in appropriate circumstances, insiders could favor disclosure rules (e.g., financial accounting standards) that commit them to release only part of their private information. Of course, exogenous costs of disclosure could also produce this result. The interesting point is that such costs are not required to explain such preferences.

[Figure 5]

Figure 5 also suggests how insiders' preferences for public disclosure could change were sunshine trading implemented. Under the current insider trading regime, insiders' trades are mixed with those of uninformed liquidity traders. Given sufficient disguise afforded by the presence of these traders, insiders prefer less precise pre-trade public disclosure because their utility increases as disclosure become less precise. If extant disclosure rules imply that public signals are noisier than the value of σ_ϕ^2 corresponding to the expected utility function's maximum value in figure 5, then under a regime of sunshine trading, the insider prefers more precise public disclosure. Accordingly, imposing sunshine trading could induce insiders to prefer financial reporting standards that result in more precise public disclosure than presently required, thereby reversing the disclosure preferences that apply in the current insider trading regime.

IV. RANDOM ENDOWMENTS

Another source of uncertainty regarding an insider's motives for trade, distinct from private benefits to shares held, could be the insider's position in his firm's shares prior to trading. Present regulations require that insiders report their beneficial interests, including indirect ownership of shares held in trust or by immediate family members, at least annually. Nonetheless, at any given point in time the insider's current position in his firm's stock is likely to be only imperfectly observable to the market maker. For example, insiders often receive compensation in the form of stock-based awards made during the year. The amount and timing of these awards generally are not publicly revealed at or before the time the insider trades. There may also be vesting provisions that are not entirely transparent. As well, changes in shares held in trust or by relatives may be difficult for market makers to predict.

To analyze this case, we return to the comparison of no disclosure and full disclosure having replaced uncertainty about private benefits the insider may receive from his holdings with uncertainty about his endowment z . Specifically, we assume that z is normally distributed with mean \bar{z} and variance σ_z^2 . From a modeling perspective, this structure has the advantage of reducing the complexity of a three-way tradeoff between private benefit, information, and risk-sharing incentives for insider trading to a two-way tradeoff involving the latter two. Such a reduction in competing incentives simplifies the analysis without altering the orderings of no disclosure and full disclosure in a qualitative sense with respect to the precision of the insider's private information.

No disclosure

The insider's ex post objective function under this structure is

$$E[(x+z)v - xp_1 \mid \eta, z] - \frac{\rho}{2} \text{Var}[(x+z)v - xp_1 \mid \eta, z]. \quad (29)$$

Given linear demand

$$x = \alpha + \beta\eta + \delta(z - \bar{z}), \quad (30)$$

and price

$$p_1 = p_0 + \lambda(x - \mu),$$

where

$$\mu = E[x],$$

the first-order condition for objective (29) characterizes the endogenous parameters.

Proposition 5: *Given no disclosure, and uncertain private endowment, z , an equilibrium can be characterized as follows:*

$$\begin{aligned} \lambda &= \frac{\rho\sigma_\epsilon^2\Sigma_0}{\sigma_\epsilon^2(\rho^2\sigma_\epsilon^2\sigma_z^2 - 1) - \Sigma_0}, \\ \alpha &= \frac{\sigma_\epsilon^2(\rho^2\sigma_\epsilon^2\sigma_z^2 - 1) - \Sigma_0}{\rho^2\sigma_\epsilon^4\sigma_z^2} \bar{z}, \\ \beta &= \frac{\sigma_\epsilon^2(\rho^2\sigma_\epsilon^2\sigma_z^2 - 1) - \Sigma_0}{\rho\sigma_\epsilon^2(\sigma_\epsilon^2(\rho^2\sigma_\epsilon^2\sigma_z^2 + 1) + \Sigma_0)}, \quad \text{and} \end{aligned} \quad (31)$$

$$\delta = -\frac{\sigma_\epsilon^2(\rho^2\sigma_\epsilon^2\sigma_z^2 - 1) - \Sigma_0}{\sigma_\epsilon^2(\rho^2\sigma_\epsilon^2\sigma_z^2 + 1) + \Sigma_0}, \quad (32)$$

provided the second-order condition

$$\rho^2\sigma_\epsilon^2\sigma_z^2V - \Sigma_0 \geq 0,$$

is met.

Proof: The proof, omitted for brevity, parallels the proof of Proposition 1. ■

Interpreting expression (31), the insider may be expected to sell a fraction of his endowment, the magnitude of which increases in the variance of his private signal. The greater the noise in the insider's private information, the more likely he is trading for risk-sharing purposes.

The second-order condition says that the risk-sharing incentive, as opposed to the private benefit incentive, for trading must be sufficiently large relative to the information incentive for the market maker to set trading costs low enough for trading to take place.

It can be shown that both trading intensities β and δ decrease in σ_ϵ^2 . The former now decreases because, in the absence of private benefits, the effects of lower trading costs is outweighed by the effects of higher residual risk. That is, the incentive to avoid risk by reducing trading intensity is no longer mitigated by another reason to trade.

Full public disclosure

With full public disclosure, the insider's ex post objective function reduces to

$$-\frac{\rho}{2} \text{Var} [(x + z) v],$$

implying demands

$$x = -z$$

and expected demands

$$E[x] = -\bar{z}.$$

In other words, lacking an information incentive, the insider seeks to reduce his ex post (signal) risk by undoing his endowment. Ex ante, the insider faces a tradeoff between demand distortions induced by private information under no disclosure that make it more costly to undo his endowment and greater ex ante price risk under full disclosure similar to that with uncertain private benefits. However, in this setting, this tradeoff is uncomplicated by a further motive to trade. In turn, this implies that the insider's ex ante expected utility is simply $E[U(M(v + \epsilon)z)]$.

Proposition 6: *Given full disclosure, and uncertain private endowment, z , an equilibrium can be characterized as follows:*

$$\begin{aligned} \lambda &= 0, \\ \alpha &= -\bar{z}, \\ \beta &= 0, \quad \text{and} \\ \delta &= -1. \end{aligned}$$

Comparing disclosure regimes

Analogous to the setting with random private benefits, figures 5, 6, and 7 depict ex ante expected utility for changes in σ_ϵ^2 , Σ_0 , and σ_z^2 , respectively. As anticipated, expected utility behaves in much the same fashion as before with respect to an increase in the variance of the noise component of the insider's private signal, σ_ϵ^2 . The ordering of expected utility for an increase in the prior variance of firm value, Σ_0 , is reversed from before due to ex ante price (fundamental) risk playing a more prominent role as Σ_0 becomes large. An increase in the random component of the insider's endowment, σ_z^2 , operates similarly to the random component of private benefits. Again, the more dramatic effects pertain to the no disclosure case. This is because an increase in either enhances the prospect that the insider is trading for reasons other than to exploit his private information, which reduces the distortion due to that information thereby lowering trading costs incurred to hedge signal risk, and fundamental risk. These effects are tempered by the risk of a higher-than-mean endowment that also accounts for the decrease in expected utility under full disclosure.

[Figure 6]

[Figure 7]

[Figure 8]

Thus, the principal observations regarding the role of the insider's private information in distorting his trading strategy, and the consequences on his expected utility remain intact when the source of uncertainty to the market maker pertains to his endowment rather than the private benefits he derives from holding shares in his firm.

V. CONCLUSION

Corporate insiders seek to trade for a variety of non-informational reasons such as shedding risk, portfolio rebalancing, attaining stock ownership targets set by their employers, meeting personal liquidity needs, managing taxes, or undertaking estate planning. Private information leads insiders to distort their trades and acquire positions in their firms' stock that deviate from an otherwise optimal position in the absence of this information incentive. From the insider's point of view, this incentive is dysfunctional given his trades are not anonymous, such as when either uninformed order flow is small or trading rules require sunshine trading. In such circumstances, the insider earns zero (or near-zero) profits from informed trade. Insiders may prefer mandated public disclosure policies that, constructively, remove their information advantage when the incremental price risk from such disclosure is outweighed by the implicit costs of distorting their demands away from those that maximize expected utility associated with private benefits. Higher precision of private information implies lower incremental ex ante price risk from public disclosure and stronger incentive to distort demands in a fruitless attempt to exploit that information. In turn, this implies that the greater an insider's information advantage, the more he stands to gain from removing his information advantage by committing to public disclosure before trade. Mandated financial accounting standards are one such commitment device.

This predisposition toward public disclosure also is present when a stochastic endowment of firm shares replaces stochastic private benefits. Such a change reduces the insider's motives for trading to exploiting private information and shedding risk.¹⁰

To make these tradeoffs transparent, it is convenient to assume the absence of noise traders who might absorb trading costs associated with the insiders' private information, i.e., sunshine trading. Although the absence of noise traders is not crucial to the tradeoffs involved, the addition of another source of noise diminishes the incentive for public disclosure.

Our analysis of the tradeoffs that affect insiders' preferences toward public disclosure has limitations. We do not model the agency issues that may make it optimal for

insiders to be exposed to the risk of stock price fluctuations. In this richer setting, limits on insiders' ability to undo exposure to price risk can be important to the contracting solution. In practice, the vesting and non-transferability provisions of stock options and restricted stock agreements limit the insider's ability to undo price risk, at least for some time. Our model applies to equity positions on which non-transferability conditions have lapsed.

While the stark extremes of no disclosure and full disclosure usefully exhibit the principal forces at work under sunshine trading by insiders, we also consider intermediate cases of partial disclosure parameterized by the precision of a noisy public signal. Interestingly, in settings where the insider prefers full disclosure to no disclosure, we find instances where partial disclosure dominates full disclosure. This suggests that with sunshine trading, even if the dysfunctional consequences of private information are severe, corporate insiders may not favor public disclosure at a level that completely removes their information-based incentive to trade.

Public disclosure choices aside, sunshine trading is important due to the attention it continues to receive from legal scholars and lawmakers. Some advocates of sunshine trading, who believe that either insiders' trades would fully reveal their private information or insiders would choose not to trade, have overlooked the possibility private information underlying insider trade may still be disguised given that insiders have other motives for trade besides exploiting private information and market makers cannot predict the order flow associated with these other motives.

Moreover, the lessons learned in this context also are relevant under the current insider trading rules, notwithstanding that insiders' demands may be commingled with those of liquidity traders. Adding exogenous liquidity demands by non-insiders to the order flow observed by the market maker creates the opportunity for the insider to profit from his private information. Given sufficient exogenous liquidity and insider risk tolerance, the insider may prefer no disclosure to full or even partial disclosure regardless of the precision of his private information. More broadly, this line of reasoning suggests that cross-sectional variation in insider's preferences for financial accounting standards

may be driven in part by cross-sectional variation in non-insider, uninformed liquidity order flow across stocks.

The implications of a policy change from the current regulatory regime of reporting insider trades after the fact to sunshine trading depend on the precision of public signals generated under present financial reporting standards. In the likely circumstance that there is sufficient disguise for insiders to profit from their private information under the current regime, then a move to sunshine trading would reduce expected losses for uninformed liquidity traders.¹¹ More notably, it could induce a preference by the insider for greater public disclosure in advance of trading, all else equal.¹² Thus, given a change in insider trading regulation to sunshine trading, corporate executives could become more inclined to support changes in financial accounting standards that expand public disclosures than they have been under the present regime of ex post reporting of their trades.

APPENDIX I

Motives for Insider Trades

Here are several excerpts from the financial press containing reasons offered for insider trades:

“The latest insider selling, most of which was options-related, reflected a desire by the officers and directors to diversify...” Antec *The Atlanta Journal and Constitution* March 28, 1999.

“In one of the biggest executive votes of confidence in a long time, Microsoft Vice President Steven Ballmer spent \$46.2 million late last month to buy shares in the software maker.” Microsoft *USA Today* April 17, 1989.

“The fact of the matter is that up until a few months ago, insiders in Nona were paid in stock rather than cash for their services ... insiders like Doug have to sell positions in their stock in order to feed their families ...” Nona Morellis II *PR Newswire* April 16, 1996.

“According to the company, the sale of stock in the open market was to repay personal debt and for tax reasons.” Supercuts *Business Wire* December 30, 1992.

“The sale was to fund the construction of a summer camp in Wyoming for disadvantaged and at-risk youth ... It’s his own individual initiative.” Coca-Cola Enterprises *The Atlanta Journal and Constitution* May 24, 1999.

“This arrangement clearly delineates the intentions of our key insiders ... They have flexibility in diversifying their portfolios, but maintain a substantial commitment to their investment in U. S. Robotics.” U.S. Robotics *PR Newswire* August 10, 1993.

“Tuesday, Campbell Soup announced a plan to require CEO David Johnson and 69 other top executives to hold stock worth one-half to three times their salaries.” Campbell Soup *USA Today*, May 5, 1993.

“We are pleased that these principals [referring to corporate insiders] have the confidence in our business to further enhance their stock positions in VTC.” Virtual Technology Corporation *Business Wire*, September 7, 1999.

“... today announced recent purchases of common stock by each of its executive officers. ... All of these transactions were related to the exercise of non-qualified stock options with the intent to hold the stock.” American Healthcorp *Business Wire*, May 4, 1999.

“On the surface, that \$7.5 million worth of buying could have been viewed as evidence that Mr. Goings is confident about the future of Tupperware’s stock price But a closer look indicates that ... the purchase was financed by an \$8 million interest-free loan from the company itself.” Tupperware *Wall Street Journal*, January 13, 1999.

APPENDIX II

Proofs

Proof of Proposition 5

The first-order condition on (21) with respect to x for an arbitrary realization of the private benefit, b , and private signal, η , is

$$M\eta + b - p_0 - 2\lambda x + \lambda\mu - \rho(x + z)V = 0. \quad (\text{II.1})$$

Equation (1) implies

$$\begin{aligned} x &= \frac{M\eta + b - p_0 - \rho zV + \mu\lambda}{2\lambda + \rho V} \\ &= \frac{(M - K)\eta + b - K\phi - \rho zV + \mu\lambda}{2\lambda + \rho V}. \end{aligned} \quad (\text{II.2})$$

Condition $\mu = E[x \mid s]$ implies

$$\mu(2\lambda + \rho V) = (M - K)E[\eta \mid s] + \bar{b} - KE[\phi \mid s] - \rho zV + \mu\lambda.$$

Now

$$E[\eta \mid s] = \frac{\Sigma_0 + \sigma_\epsilon^2}{\Sigma_0 + \sigma_\epsilon^2 + \sigma_\phi^2} s,$$

and

$$E[\phi \mid s] = \frac{\sigma_\phi^2}{\Sigma_0 + \sigma_\epsilon^2 + \sigma_\phi^2} s,$$

so,

$$(M - K)E[\eta \mid s] - KE[\phi \mid s] = 0.$$

In equilibrium,

$$\mu = \alpha = \frac{\bar{b} - \rho zV}{\lambda + \rho V}, \quad (\text{II.3})$$

$$\beta = \frac{M - K}{2\lambda + \rho V}, \quad \text{and} \quad (\text{II.4})$$

$$\gamma = \frac{1}{2\lambda + \rho V} = \frac{\beta}{M - K}. \quad (\text{II.5})$$

The vector of random variables

$$\begin{pmatrix} v \\ \epsilon \\ \phi \\ b \end{pmatrix}$$

is jointly normally distributed with mean

$$\begin{pmatrix} 0 \\ 0 \\ 0 \\ \bar{b} \end{pmatrix},$$

and variance-covariance matrix

$$M = \begin{pmatrix} \Sigma_0 & 0 & 0 & 0 \\ 0 & \sigma_\epsilon^2 & 0 & 0 \\ 0 & 0 & \sigma_\phi^2 & 0 \\ 0 & 0 & 0 & \sigma_b^2 \end{pmatrix}.$$

Thus, the vector of random variables

$$\begin{pmatrix} v \\ x \\ s \end{pmatrix}$$

is also jointly normally distributed with mean

$$\begin{pmatrix} 0 \\ \frac{\bar{b} - \rho z V}{\lambda + \rho V} \\ 0 \end{pmatrix}$$

and variance-covariance matrix

$$HMH' = \begin{pmatrix} \Sigma_0 & \beta \Sigma_0 & \Sigma_0 \\ \beta \Sigma_0 & \beta^2(\Sigma_0 + \sigma_\epsilon^2) + \theta^2 \sigma_\phi^2 + \gamma^2 \sigma_b^2 & \beta(\Sigma_0 + \sigma_\epsilon^2) + \theta \sigma_\phi^2 \\ \Sigma_0 & \beta(\Sigma_0 + \sigma_\epsilon^2) + \theta \sigma_\phi^2 & \Sigma_0 + \sigma_\epsilon^2 + \sigma_\phi^2 \end{pmatrix}$$

where $\theta = -K/(2\lambda + \rho V)$, since

$$\begin{pmatrix} v \\ x \\ s \end{pmatrix} = \begin{pmatrix} 0 \\ \frac{\bar{b} - \rho z V}{\lambda + \rho V} \\ 0 \end{pmatrix} + H \begin{pmatrix} v \\ \epsilon \\ \phi \\ b \end{pmatrix}$$

for

$$H = \begin{pmatrix} 1 & 0 & 0 & 0 \\ \beta & \beta & \theta & \gamma \\ 1 & 1 & 1 & 0 \end{pmatrix}.$$

Following DeGroot (1970, p. 55), the variance-covariance matrix for $(v \ x)'$ conditional on s is given by

$$\begin{pmatrix} \Sigma_0 & \beta\Sigma_0 \\ \beta\Sigma_0 & \beta^2(\Sigma_0 + \sigma_\epsilon^2) + \theta^2\sigma_\phi^2 + \gamma^2\sigma_b^2 \end{pmatrix} - \frac{\begin{pmatrix} \Sigma_0 & \beta(\Sigma_0 + \sigma_\epsilon^2) + \theta\sigma_\phi^2 \\ \beta(\Sigma_0 + \sigma_\epsilon^2) + \theta\sigma_\phi^2 & \Sigma_0 + \sigma_\epsilon^2 + \sigma_\phi^2 \end{pmatrix}}{\Sigma_0 + \sigma_\epsilon^2 + \sigma_\phi^2}.$$

Thus,

$$\begin{aligned} \text{Cov}(v, x | s) &= \frac{\Sigma_0}{\Sigma_0 + \sigma_\epsilon^2 + \sigma_\phi^2}(\beta - \theta)\sigma_\phi^2 \\ &= \frac{KM\sigma_\phi^2}{2\lambda + \rho V} \quad \text{and} \\ \text{Var}(x | s) &= \gamma^2\sigma_b^2 + \frac{\Sigma_0 + \sigma_\epsilon^2}{\Sigma_0 + \sigma_\epsilon^2 + \sigma_\phi^2}(\beta - \theta)^2\sigma_\phi^2 \\ &= \gamma^2\sigma_b^2 + \frac{KM\sigma_\phi^2}{(2\lambda + \rho V)^2} \end{aligned}$$

Furthermore, from the market maker's breakeven condition,

$$p_\phi = E(v | x, s) = p_0 + \frac{\text{Cov}(x, v | s)}{\text{Var}(x | s)}(x - \mu),$$

we have

$$\begin{aligned} \lambda &= \frac{\text{Cov}(x, v | s)}{\text{Var}(x | s)} \\ &= \frac{(2\lambda + \rho V)KM\sigma_\phi^2}{(2\lambda + \rho V)^2\gamma^2\sigma_b^2 + KM\sigma_\phi^2} \\ &= \frac{(2\lambda + \rho V)KM\sigma_\phi^2}{\sigma_b^2 + KM\sigma_\phi^2}. \end{aligned}$$

Solving this last equality for λ gives:

$$\lambda = \frac{\rho K M V \sigma_\phi^2}{\sigma_b^2 - K M \sigma_\phi^2}, \tag{II.6}$$

which is (24).

Substituting (24) into (3) through (6) gives (25), (26), and (27), respectively. The second-order condition is

$$-2\lambda - \rho V \leq 0. \tag{II.7}$$

By substitution and rearrangement, (7) reduces to (28). ■

Notes

1. Appendix A lists anecdotes drawn from the business press describing these motives.
2. As we comment later, Glosten (1989) and Bhattacharya and Spiegel (1991) employ a similar characterization of insiders' motives for trading. Given sunshine trading, but absent a source of uncertainty that obscures the insider's information, the no-trade result of Milgrom and Stokey (1982) applies.
3. While rare, at least one firm imposes pre-trade disclosure on insiders. Ameritrade Holding Corp., an online discount brokerage firm, requires company insiders to announce in advance their intention to sell their Ameritrade stock. "Joe Ricketts, Ameritrade's chairman and chief executive . . . said the new policy will ensure that all shareholders are informed before such sales are filed with the Federal Securities and Exchange Commission. 'Our shareholders have placed their trust in us,' Ricketts said, adding that the new policy is 'the right thing to do.'" (Jim Rasmussen "Online Brokerage Ameritrade to Announce Own Insider Selling" *Omaha-World Herald* March 11, 1999)

Another example of preannouncement in practice is the requirement under SEC rules that affiliates (including corporate insiders who received compensation in the form of stock grants) intending to sell restricted stock, announce their intention before the sale. It is estimated that insiders follow through by selling 95% of the time. The relevant form, Form 144, must be filed with the SEC as notice of the

proposed sale when the amount to be sold during any three month period exceeds 500 shares or units or has an aggregate sales price in excess of \$10,000. There is no corresponding requirement to announce most stock purchases before they are effected. Most stock sales that follow the exercise of stock options do not give rise to an obligation to file Form 144.

4. Insiders are required to publicly report most trades within ten days following the end of the month in which the trade was made.
5. The notion that stock ownership confers private idiosyncratic benefits, which can be modeled as random variables and are important to market microstructure, can be traced back at least to Garman (1976).
6. For concision, we prefer σ_ϵ^2 , the variance in the noise component of the insider's private information, to the precision of the insider's private information, $1/\sigma_\epsilon^2$.
7. Many US corporations allow insiders to trade only during prescribed trading windows following earnings announcements. Generally, the windows are defined as the 20 trading days beginning on the third trading day after a quarterly earnings announcement.
8. The ex ante expected utility functions are integrals of the exponential function with a particular argument evaluated over all values of v , ϵ , and b . We derived closed form expressions for these expectations using the same approach as Verrecchia (1982). We are grateful to Jerry Feltham for sharing his notes, which generalize Verrecchia's derivation. These expressions are not amenable to comparative statics. Details are available on request from the authors.

9. In the limit, expected utility under the two disclosure regimes converge.
10. The analysis is quite similar and more straightforward: insider demands under the full public disclosure regime simply undo his endowment, comparative statics on trading intensities under no disclosure are uni-directional, expressions for ex ante expected utility are somewhat simplified under both regimes, and the effects of higher precision for the insider's private information on the orderings of expected utility over disclosure regimes are qualitatively similar.
11. For example, Aboody and Lev (2000) provide evidence that, under present regulations, investors find ex post reports of trades by corporate insiders induce stronger price reactions for firms more heavily engaged in R&D activities than for other firms all else held equal. They attribute such reactions to a greater private information advantage enjoyed by corporate insiders. Current financial accounting standards require that all R&D spending be expensed. Our analysis suggests why, under sunshine trading, corporate insiders might prefer a more informative treatment, such as selective capitalization and subsequent recognition of impairments.
12. At the other extreme, given shares with little liquidity trading to absorb trading costs, insiders may prefer less public disclosure than current financial reporting standards require.

REFERENCES

- Aboody, D., and B. Lev. 2000. Information asymmetry, R&D, and insider gains. *Journal of Finance* 55 (December): 2747–2766.
- Ausubel, L. M. 1990. Insider trading in a rational expectations economy. *American Economic Review* 80 (December): 293–316.
- Bhattacharya, Utpal, and Matthew Spiegel. 1991. Insiders, outsiders, and market breakdowns. *Review of Financial Studies* 4 (Summer): 255–282.
- Bushman, R. M., and R. Indjejikian. 1995. Voluntary disclosures and the trading behavior of corporate insiders. *Journal of Accounting Research* 33 (Fall): 293–316.
- DeGroot, M. 1970. *Optimal Statistical Decisions*. New York, NY: McGraw-Hill.
- Fishman, M., and K. Hagerty. 1995. The mandatory disclosure of trades and market liquidity. *Review of Financial Studies* 8 (Fall): 637–676.
- Fried, J. 1998. Reducing the profitability of corporate insider trading through pretrading disclosure. *Southern California Law Review* 71 (January): 303–392.
- Fried, J. 2000. Insider signaling and insider trading with repurchase tender offers. *University of Chicago Law Review* 67 (Spring): 421–477.
- Garman, M. 1976. Market microstructure. *Journal of Financial Economics*, 3 (February): 257–275.
- Gilson, R. J., and R. H. Kraakman. 1984. The mechanisms of market efficiency. *Virginia Law Review* 70 (May): 549–632.
- Glosten, Lawrence R. 1989. Insider trading, liquidity, and the role of the monopolist specialist. *Journal of Business* 62 (April): 211–235.
- Hirshleifer, J. 1971. The private and social value of information and the reward to inventive activity. *American Economic Review* 61 (September): 561–574.
- Huddart, S., J. S. Hughes, and C. B. Levine. 2001. Public disclosure and dissimulation of insider trades *Econometrica* 69 (May): forthcoming.
- John, K., and R. Narayanan. 1997. Market manipulation and the role of insider trading regulations. *Journal of Business* 70 (April): 217–247.
- Klein, M., December 12, 1983. Outsider proposes change in insider trading bill. *Legal Times* 8.

- Kyle, A. 1985. Continuous auctions and insider trading. *Econometrica* 53 (November): 1315–1335.
- Milgrom, P. and N. Stokey. 1982. Information, Trade and Common Knowledge. *Journal of Economic Theory* 26 (February): 17–27.
- Naik, N., A. Neuberger, and S. Viswanathan. 1999. Trade disclosure regulation in markets with negotiated trades. *Review of Financial Studies* 12 (Winter): 873–900.
- Samuelson, S. S. 1988. The prevention of insider trading: a proposal for revising section 16 of the Securities and Exchange Act of 1934. *Harvard Journal on Legislation* 25 (Summer): 511–513.
- Seyhun, H. N. 1992. The effectiveness of insider trading sanctions. *Journal of Law and Economics* 35 (April): 149–182.
- Speigel, M., and A. Subrahmanyam. 1992. Informed Speculation and Hedging in a Noncompetitive Securities Market. *Review of Financial Studies* 5 (Summer): 307–329.
- Verrecchia, R. E. 1982. Information acquisition in a noisy rational expectations economy. *Econometrica* 50 (November): 1415–1430.

FIGURE 1

Timeline

↑	↑	↑	↑	↑	↑
The disclosure regime is established.	The insider learns her private benefit, b , and private information, η .	In the full disclosure regime, η is publicly revealed.	The insider publicly announces his trade, x .	The market maker sets the stock price, p_1 .	Liquidation values are realized.

FIGURE 2

Expected utility as a function of σ_ϵ^2 in the random benefit case

The solid black line is “No Disclosure” the dashed gray line is “Full Disclosure.” In this and each succeeding figure, the horizontal axis is the $-\log(-U)$, where U is the insider’s ex ante expected utility.

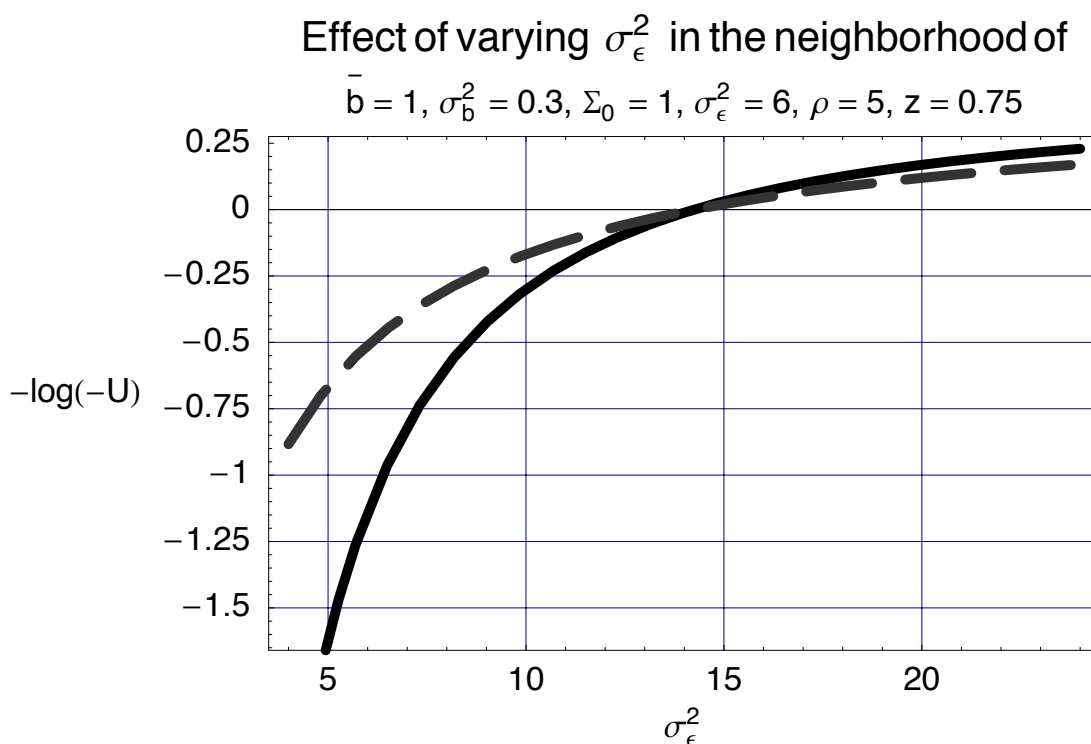


FIGURE 3

Expected utility as a function of Σ_0 in the random benefit case

The solid black line is “No Disclosure” the dashed gray line is “Full Disclosure.”

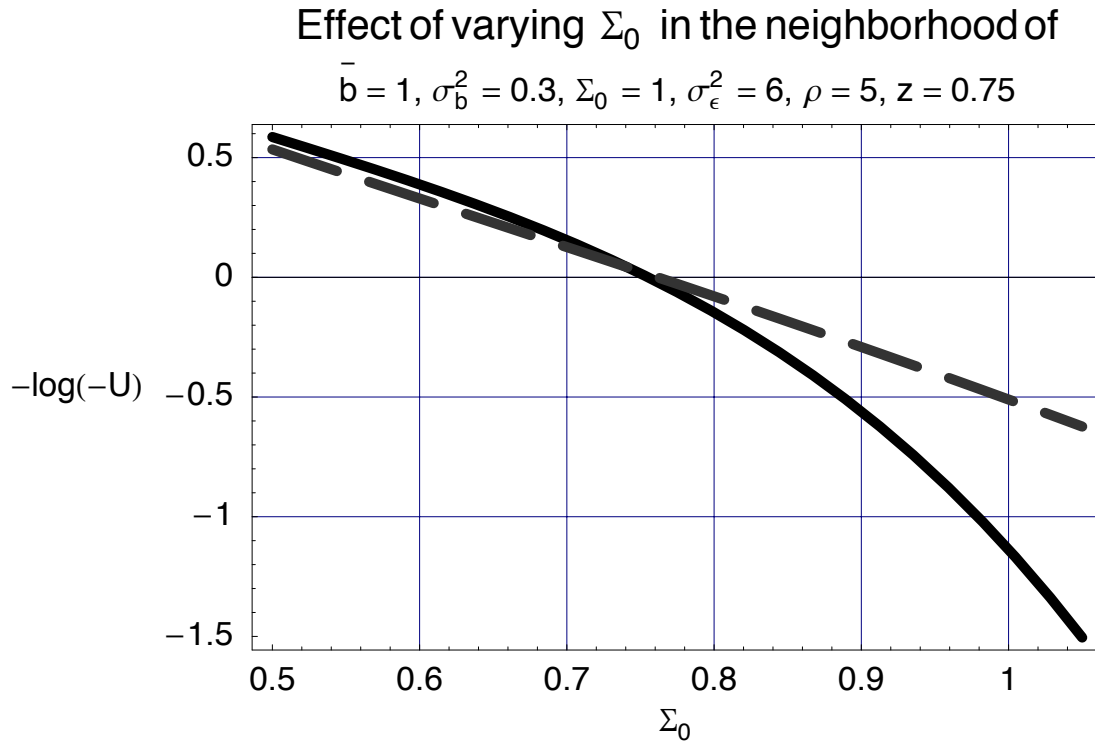


FIGURE 4

Expected utility as a function of σ_b^2 in the random benefit case

The solid black line is “No Disclosure” the dashed gray line is “Full Disclosure.”

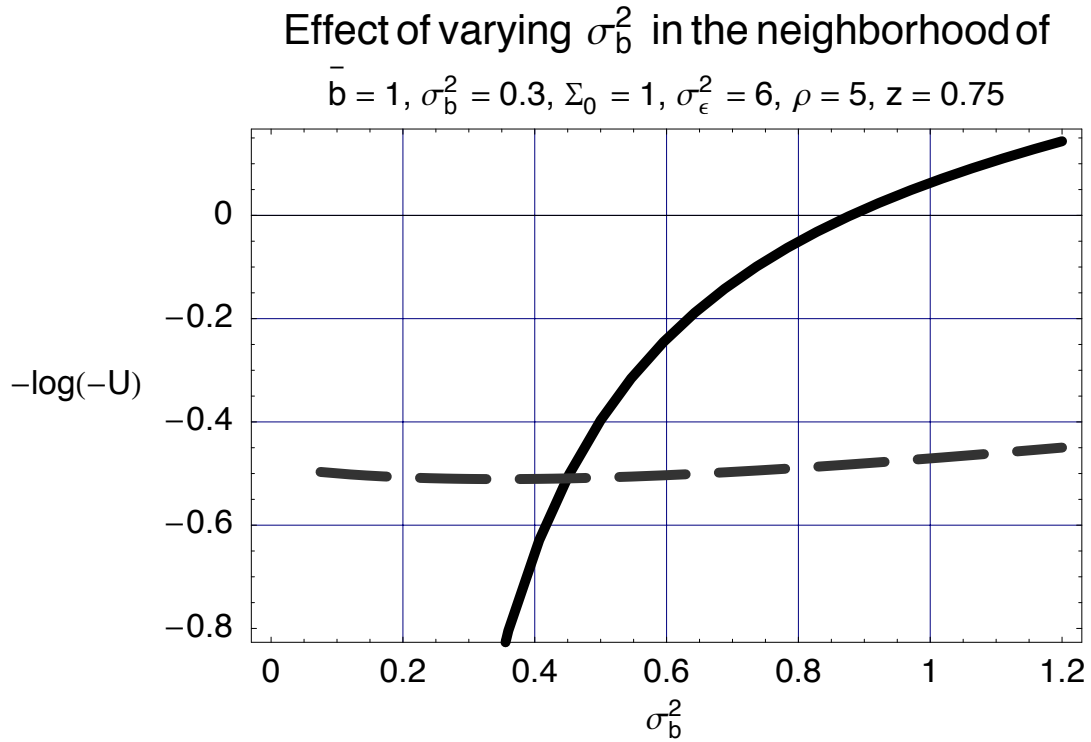


FIGURE 5

Expected utility as a function of σ_ϕ^2 in the random benefit case.

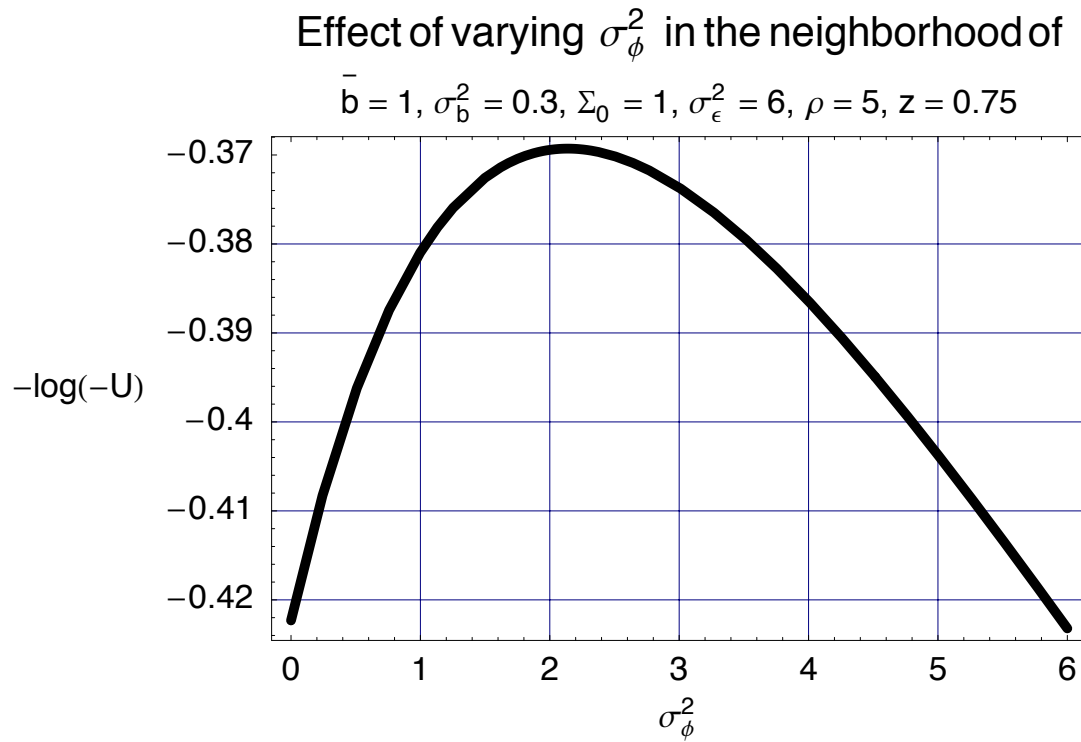


FIGURE 6

Expected utility as a function of σ_ϵ^2 in the random endowment case

The solid black line is “No Disclosure” the dashed gray line is “Full Disclosure.”

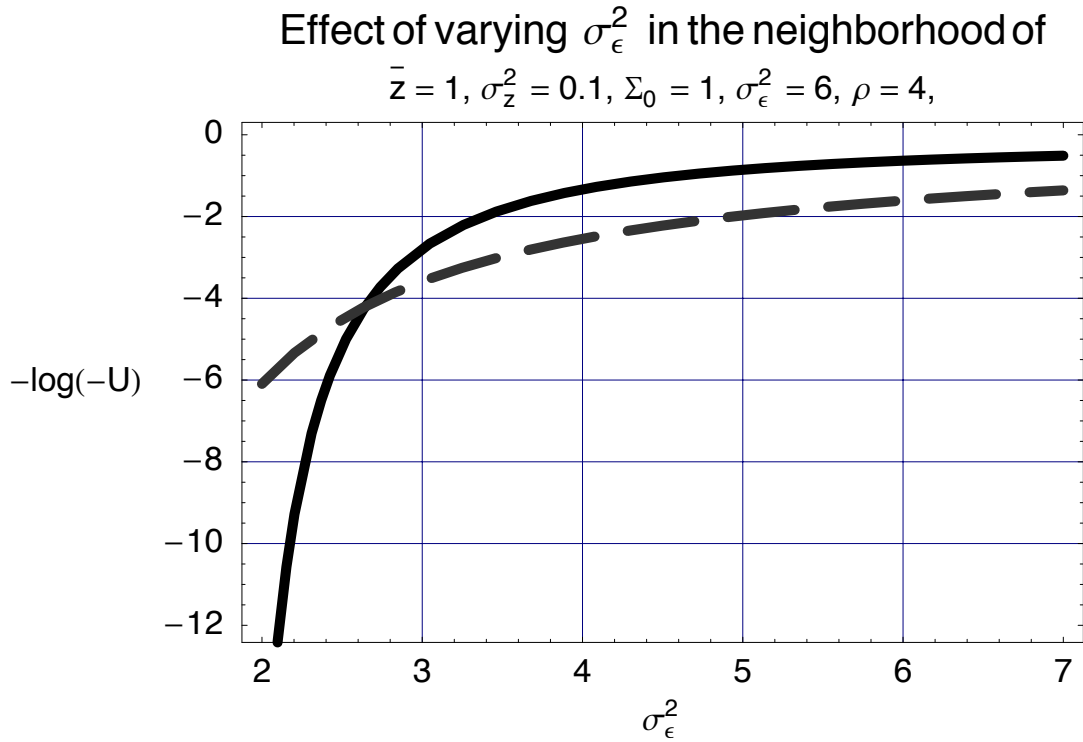


FIGURE 7

Expected utility as a function of Σ_0 in the random endowment case

The solid black line is “No Disclosure” the dashed gray line is “Full Disclosure.”

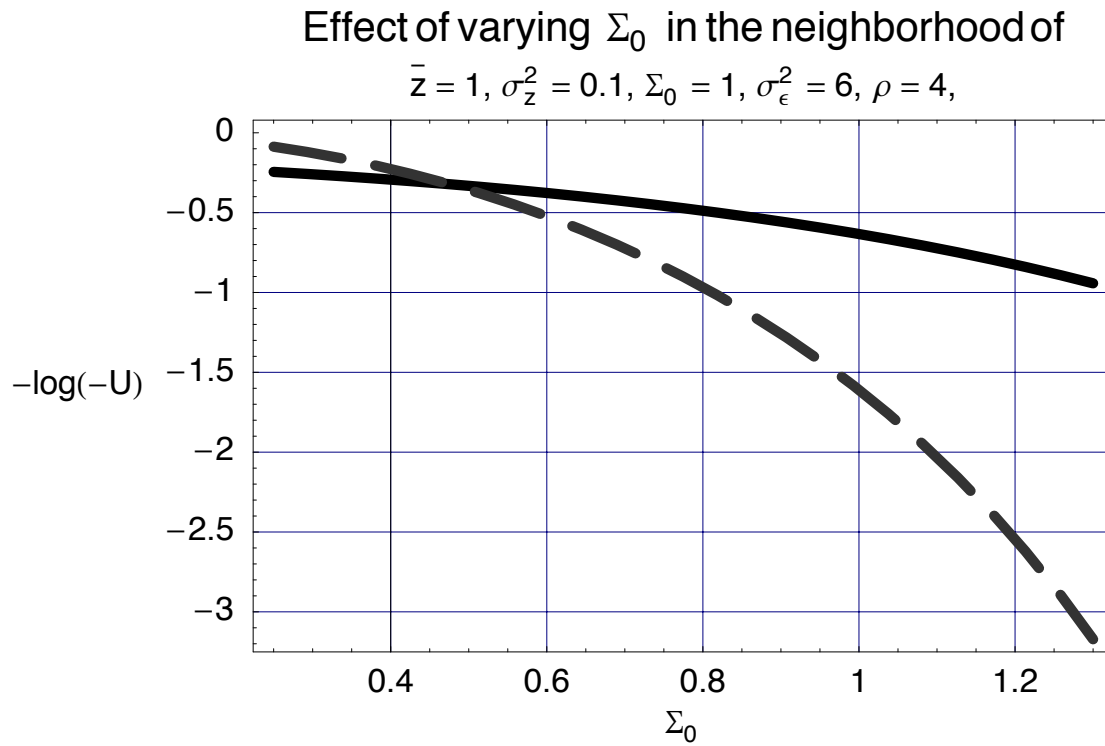


FIGURE 8

Expected utility as a function of σ_z^2 in the random endowment case

The solid black line is “No Disclosure” the dashed gray line is “Full Disclosure.”

