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# Insider Trading: Should It Be Prohibited?

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Insider trading moves forward the resolution of uncertainty. Using a rational expectations model with endogenous investment level, I show that, when insider trading is permitted, (i) stock prices better reflect information and will be higher on average, (ii) expected real investment will rise, (iii) markets are less liquid, (iv) owners of investment projects and insiders will benefit, and (v) outside investors and liquidity traders will be hurt. Total welfare may increase or decrease depending on the economic environment. Factors that favor the prohibition of insider trading are identified.

## I. Introduction

Is insider trading good for financial markets? In 1934, the U.S. Congress decided “no,” and insider trading in the United States has been regulated by the Securities and Exchange Commission since that time. Not all countries have followed the U.S. example, and the debate continues: some countries without regulation are now considering it, whereas in academic circles, the benefits of regulating insider trading are still being contested (see, e.g., Manne 1966; Carlton and Fischel 1983; Easterbrook 1985; Glosten 1988; Bajeux and Rochet 1989; Manove 1989).

The merits of insider trading have been debated on two levels: (i) Is it “fair” to have trading when individuals are differentially informed? (ii) Is it economically efficient to allow insider trading?

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The Securities Exchange Act of 1934 justifies the regulation of insider trading on the presumption that such activity is "unfair" to outside investors (see, e.g., Brudney 1979). Critics point out that trading is always unfair whenever one investor is better informed than another. Yet no one has advocated that all trading based on private information should (or could) be restricted. The line between what information is fair and what information is unfair has been the subject of considerable legal argument. Recent U.S. cases have emphasized breach of fiduciary duty by employees using privileged information rather than unfairness.

Because there is no commonly accepted definition of "unfair," this aspect of insider trading is not directly addressed. But the second aspect of insider trading, its impact on economic efficiency and welfare, is more susceptible to economic analysis. One can show which parties gain, which lose, and how much is gained or lost. When the sum of monetary gains and losses can be associated with economic welfare, this analysis also provides a measure of the net benefits (or costs) that result from prohibiting insider trading.<sup>1</sup>

To understand the nature of the current debate, it is useful to review the common arguments cited pro and con insider trading.

*Pro.*—(a) Insider trading will bring new and useful information into asset prices. Decision makers—both portfolio managers and firms making real investment decisions—can reduce risk and improve performance when prices reflect better information. (b) Because of reduced risk, asset prices will be higher and more real investment will occur.

*Con.*—(a) Outside investors will invest less because the market is "unfair." Asset prices will be lower and less real investment will occur. (b) Market liquidity will be reduced, thereby disadvantaging traders who must trade for life cycle or other reasons not related to information. (c) Insider trading will make current stock prices more volatile, further hurting traders with liquidity needs.

Note that all these points can be true simultaneously—with one exception. The pro-insiders argue that asset prices will rise when insider trading is permitted; the anti-insiders maintain that asset prices will fall.

Elements of a reasonable model to analyze these concerns should include the following: (i) Insiders, who by virtue of their privileged position have more precise information about future stock prices than

<sup>1</sup> If transfer payments are possible between parties, then the environment in which the sum of monetary benefits is greater will be Pareto superior to any alternative.

outside investors. It seems reasonable to presume that insiders will recognize the impact of their purchases on the current stock price. (ii) Outsiders, who have less precise information about future stock prices. Such investors recognize that the current price may reflect (at least partially) the information of insiders. Outsiders are risk averse and, being numerous, behave as perfect competitors. (iii) Liquidity traders who trade for exogenous reasons, such as intertemporal smoothing of income flows. (iv) Real investment, financed by a supply of new shares, which depends on the issuing price per share. A higher current stock price will lead to the issuance of a larger number of shares and to greater real investment.

A model is developed below that contains these elements in as simple a form as possible. The objective is to assess the validity of the arguments pro and con insider trading. Equilibrium prices and welfare are compared in markets in which insider trading is either permitted or restricted. It is assumed that if insider trading is prohibited, the inside information will not be reflected in prices or decisions.

The analysis begins with a model that includes differentially informed investors. The modeling draws from Grossman (1976), Grossman and Stiglitz (1980), Hellwig (1980), and Bray (1981). In recognition of the monopoly power of the inside trader, the model is similar in spirit to those of Grinblatt and Ross (1985) and Kyle (1985). However, there are important differences that permit a more appropriate analysis of insider trading.

First, the number of shares issued (and real investment) is endogenously determined. The amount of investment will be affected by prices, which in turn will be affected by information when insiders can trade. Endogenously determined and price-sensitive investment is required of any model that examines the full costs and benefits of insider trading.

Second, the model looks at the impact of insider trading on the welfare of each class of participants rather than simply on the degree to which prices reflect information. Informational efficiency is not an end in itself. It is generally thought to improve welfare, but, as Hirshleifer (1971) pointed out, this will not always be the case.

My model can be contrasted with other recent work addressing questions of insider trading. Glosten (1988) and Bajeux and Rochet (1989) have examined welfare in markets with insider trading but without production. They show that insider trading hurts liquidity traders. Their models, following Kyle (1985), assume that prices are set by risk-neutral market makers. But this assumption precludes consideration of an important aspect of insider trading: the impact of reduced future price volatility on the *level* of current asset prices.

These authors do not examine the potentially positive impact of insider trading on the efficiency of investment.<sup>2</sup>

Manove (1989) examines insider trading in which all participants are risk neutral. Manove's description of markets seems somewhat unusual: when information is favorable, rationing by lottery rather than price is assumed. Fishman and Hagerty (1989) examine a model in which all investors are risk neutral but recognize their influence on prices. They focus on the extent to which prices reflect information. In their model, insider trading is harmful only if it induces outsiders to gather less information, which in turn will be the case only if outsiders behave noncompetitively.

In contrast, my results suggest that insider trading may be undesirable even when investment is flexible, and risk-averse outsiders behave competitively and cannot alter their information. My results confirm that many of the arguments both pro and con insider trading are correct.

1. Stock prices will more fully reflect information when insider trading is permitted. Average stock price will rise, firms' average profits from financing new real investment will be higher, and the level of real investment may increase. However, this alone does not guarantee that welfare will increase.

2. Insider trading decreases both the expected return and risk to outsiders' investment. Under some circumstances, outside investors will demand more shares on average when insider trading is permitted. Nonetheless, I find that outside investors' welfare will always be lower, even when their average demand increases.

3. Liquidity of markets will be reduced when insider trading is permitted, and liquidity traders will suffer welfare losses.

4. Total welfare may increase or decrease with insider trading. Welfare will tend to increase when the amount of investment is highly responsive to the current stock price. In this case the gains from greater investment efficiency more than offset the costs to outside investors and liquidity traders. If investment is inflexible to current stock price, net welfare tends to be lower when insider trading is permitted.

Finally, I show that asymmetric information is likely to impose

<sup>2</sup> Interesting work by Dennert (1989) and Ausubel (1990) has come to my attention since this research was completed. Dennert addresses the impact of insider trading on investment using an overlapping generations model. In his model, as in Ausubel's, the proportion of inside investors affects investment levels, but the actual realization of their information does not. In contrast with my results, the level of investment in these models does not reflect information more fully when insiders are present. Their models also assume that insiders behave as perfect competitors.

greater welfare costs when the better-informed are employees of the firm itself rather than external investors. This distinction has escaped other economic models of insider trading.

## II. Markets with Insiders and Endogenous Supply: An Overview

Investors choose a portfolio consisting of a risk-free asset (with interest rate normalized to zero) and shares of a risky asset. Investors maximize expected utility of future wealth, conditional on the information they possess when they make their choice.

Future price per share  $p$  is given by  $p = \underline{p} + e$ , where  $\underline{p}$  is the mean future price, which is common knowledge, and  $e$  is a random variable with (unconditional) mean zero.

The current price  $p_0$  is determined by the supply of and demand for shares. Demand for shares comes from three sources: insiders, outsiders, and liquidity traders.

i) Insiders observe  $e$  precisely and thus know future price exactly at the time they choose their portfolio.<sup>3</sup> However, their purchases or sales  $d_i$  will be tempered by the recognition that these activities will affect price. Insiders also observe the current price  $p_0$ .

ii) Outsiders cannot observe  $e$ . They can observe the current price  $p_0$  and therefore can determine the net supply from this price. However, they cannot exactly infer  $e$  from insider trading since net supply depends on liquidity trading as well as insider trading. Thus the current price is a noisy signal of the future price, and outsiders will use this information to condition their expectations.

iii) Liquidity traders demand a random amount  $v$ , which is independent of price.<sup>4</sup> No market participants observe  $v$  directly, but insiders will be able to impute  $v$  from observing the current market price  $p_0$ . So it does not matter whether we allow them to observe  $v$  directly or not.

Supply comes from entrepreneurs or firms issuing shares:

iv) Firms offer an endogenously determined number of shares  $q$ , each share providing a random future value  $p$ . The cost of providing such shares,  $C(q)$ , is increasing and strictly convex. The firm chooses

<sup>3</sup> I could extend the model to include imperfect observation by insiders. This would reduce both the benefits and costs associated with insider trading, but the nature of the effects examined would not be affected.

<sup>4</sup> A more complex model would allow liquidity traders to reduce their activities as the cost of such trading rises. This would moderate the costs that insider trading imposes on liquidity traders, affecting the magnitude but not the nature of the results.

the number of shares issued to maximize its profit  $\pi$  from this activity, where  $\pi = p_0q - C(q)$ .<sup>5</sup>

Let us presume that the firm behaves competitively and takes  $p_0$  as given.<sup>6</sup> Note that whatever information the firm might have with respect to the future price  $p$  does not directly affect its decision to issue shares  $q$ : the current rather than the future price uniquely determines the share issuance decision. This assumption is relaxed in Section VII below.

A *rational expectations equilibrium* (REE) is a price function with the following properties.

i) It is a price function in which insider information enters only through insiders' demand. Since other participants cannot distinguish liquidity demand  $v$  from insider demand  $d_i$ , the price function must have the form

$$p_0 = f(v + d_i, \mathbf{w}), \quad (1)$$

where  $\mathbf{w}$  is the vector of all other commonly observed (or directly inferable) parameters.<sup>7</sup>

ii) Given the REE price function (1),  $d_i$  is chosen to maximize net insider wealth

$$W_i = (\underline{p} + e - p_0)d_i. \quad (2)$$

Insiders behave as monopolists: they recognize that  $p_0$  depends on  $d_i$  through (1).

<sup>5</sup> For example, consider an entrepreneur or firm that can produce a good in a competitive market with constant returns to scale (exclusive of the costs of installing capacity). Let  $q$  denote the number of units the firm chooses to produce and also the number of shares issued. The future profit per unit of production, and therefore per share, is random and equals  $p$ . The current price per share is  $p_0$ , implying that total revenue from issuing shares is  $p_0q$ . The cost of installing capacity is  $C(q)$ , and the firm will issue a number of shares  $q$  that sets  $p_0 = C'(q)$ , where  $C'(q)$  is the marginal cost of installing capacity. Profit to the original owner(s) is  $\pi = p_0q - C(q)$ . Bray (1985) uses a related formulation in examining production decisions by farmers.

<sup>6</sup> In fact, the firm's choice of  $q$  will have a small impact on  $p_0$  via the rational expectations price equilibrium. A change in  $q$  will have a much smaller impact on price than an unobserved change in supply  $d_i$  (or  $v$ ) since the choice of  $q$  (unlike the choice of  $d_i$ ) is known not to contain inside information. In the linear model examined subsequently, we could allow the firm's choice of  $q$  to affect price, with a resulting decrease in the variable  $z$  introduced below.

<sup>7</sup> We can think of the market as follows. Outside investors have a "willingness to pay" (inverse demand) function that depends on the supply of shares that must be absorbed. In the REE model developed below, this function has the form  $p_0 = r - sq + tX$ , where  $X = v + d_i$ , the sum of the (separately unobservable) demands from liquidity and informed traders. The term  $q$  is a linear, deterministic function of  $p_0$  in this model. Substituting for  $q$  and rearranging terms give  $p_0 = a + c(v + d_i)$ . By requiring that price be measurable with respect to insiders' demand, this approach restricts the set of insiders' equilibrium strategies relative to those considered in Grinblatt and Ross (1985) and Laffont and Maskin (1989), who allow price functions in which  $e$  can enter the REE price function independent of insider demand  $d_i$ .



iii) Given the REE price function, outsiders choose to purchase a number of shares  $d_o$  that maximizes expected utility of future wealth, conditional on the price  $p_0$ . Thus  $p_0$  serves two roles for outsiders: determining the cost of each share and influencing their expectations about future stock price  $\underline{p} + e$ .

iv) Firms choose to issue a number of shares  $q$  that maximizes the net proceeds to original shareholders,  $p_0q - C(q)$ , where  $p_0$  is the REE price.

v) The REE price function equates supply and demand for every possible value of the random variables  $e$  and  $v$ .

### III. Markets with Inside Traders and Production: A Mean-Variance Rational Expectations Model

A simple model with mean-variance preferences is constructed along the lines suggested above. Ex ante distributions of future price shock  $e$  and liquidity demand  $v$  are given by

$$e: N(0, \Sigma_e),$$

$$v: N(0, \Sigma_v),$$

$e, v$  are independent.

Let us postulate a linear REE price function of the form (1) above:

$$p_0 = a + c(v + d_i). \quad (3)$$

I shall show that for appropriate choices of  $a$  and  $c$ , (3) will indeed satisfy the earlier definition of a REE price function.

#### A. Demand

Assume a single inside investor (or cartel of investors), negligible in number relative to outside investors. Inside investors observe  $e$  precisely and thus have no uncertainty about the future price  $p = \underline{p} + e$ . They will choose  $d_i$  to maximize their final wealth, recognizing that their demand affects price through the equilibrium relationship (3):<sup>8</sup>

$$\begin{aligned} \text{maximize } W_i &= (\underline{p} + e - p_0)d_i \\ &= \{\underline{p} + e - [a + c(v + d_i)]\}d_i, \end{aligned} \quad (4)$$

<sup>8</sup> Despite being few in number, insiders will have substantial investment demand because they face no risk and therefore act "risk neutrally."

using (3).<sup>9</sup> This implies

$$d_i = \frac{p - a}{2c} + \left(\frac{1}{2c}\right)e - \frac{1}{2}v. \tag{5}$$

Observe that the optimal  $d_i$  depends on both the inside information  $e$  and the liquidity demand  $v$ . Although  $v$  cannot be observed directly, the insider can impute  $v$  directly from observing  $p_0$  and knowing the REE function (3).<sup>10</sup>

Substituting for  $d_i$  from (5) into (3) gives

$$p_0 = A + Be + Cv, \tag{3'}$$

where  $A = (a + p)/2$ ,  $B = 1/2$ , and  $C = c/2$ . The insiders' demand for stock (5) can be rewritten as

$$d_i = \frac{p - A}{2C} + \left(\frac{1}{4C}\right)e - \frac{1}{2}v. \tag{6}$$

Note that insider demand does not depend on risk aversion, since by assumption there is no risk at the time insiders choose  $d_i$ . While clearly an exaggeration, the assumption of perfect observability reflects the notion that insiders have a "sure thing" when they trade.

Outsiders can predict the insider's demand relation (6) and therefore recognize that (3') as well as (3) describes the REE price function. Outsiders do not observe  $e$  but can use (3') to form a probabilistic estimate for  $e$  given  $p_0$ , which in turn allows them to compute the conditional expectation and variance of the future price  $p$  given  $p_0$ :

$$\begin{aligned} E(p|p_0) &= \underline{p} + \left[ \frac{\text{cov}(p, p_0)}{\text{var}(p_0)} \right] [p_0 - E(p_0)] \\ &= \underline{p} + \left(\frac{K}{B}\right)(p_0 - A); \end{aligned} \tag{7}$$

$$\text{var}(p|p_0) = \Sigma_p(1 - K),$$

where

$$K = \frac{B^2 \Sigma_p}{B^2 \Sigma_p + C^2 \Sigma_v}.$$

<sup>9</sup> Final wealth is given by  $W_i = \underline{W}_i + pd_i + y(1 + \rho)$ , where  $\underline{W}_i$  is initial wealth,  $y$  is the holding of the risk-free asset paying interest rate  $\rho$ , and the budget constraint is  $p_0d_i + y = \underline{W}_i$ . Normalizing  $\underline{W}_i = 0$  and  $\rho = 0$  gives (4).

<sup>10</sup> Alternatively, we could postulate that the monopolist observes neither  $v$  nor  $p_0$  at the time he makes his demand decision  $d_i$ . In this case, if the monopolist is risk neutral, it is easy to show  $d_i = (p + e - a)/2c$  and  $p_0 = A + Be + Cv$ , where  $A = (a + p)/2$ ,  $B = .5$ , and  $C = c$ . (Compare with eq. [3'], in which the only difference is  $C = .5c$ .) The nature of the results will be little affected by the choice of what the monopolist observes.

Outsiders have mean-variance preferences over ending wealth  $W_o$ .<sup>11</sup> For any current price  $p_0$ , outsiders choose between investing in the stock and investing in a risk-free asset so as to maximize the certainty equivalent of  $W_o$ ,

$$U(W_o|p_0) = E(W_o|p_0) - \left(\frac{R}{2}\right) \text{var}(W_o|p_0), \quad (8)$$

where  $W_o = (p - p_0)d_o$ ,  $d_o$  is outsiders' share purchase of the risky stock, and  $R$  reflects outsiders' aversion to risk.

Maximizing (8) with respect to  $d_o$  yields

$$d_o = \frac{E(p|p_0) - p_0}{R \text{var}(p|p_0)}. \quad (9)$$

Using (7), rewrite (9) as

$$\begin{aligned} d_o &= \frac{\underline{p} + (K/B)(p_0 - A) - p_0}{R\Sigma_p(1 - K)} \\ &= m + np_0, \end{aligned} \quad (10)$$

where

$$\begin{aligned} m &= \frac{\underline{p} - (KA/B)}{R\Sigma_p(1 - K)}, \\ n &= \frac{(K/B) - 1}{R\Sigma_p(1 - K)}. \end{aligned}$$

Liquidity traders provide a third source of demand. While it is possible to endogenize aspects of their decisions (e.g., Bajeux and Rochet 1989), let us take the simplest possible route and assume that they demand a random amount  $v$ , whose distribution is exogenously given.

Summing the three sources of demand (6), (10), and  $v$  gives total demand as a function of the exogenous variables and the coefficients  $A$ ,  $B$ , and  $C$  of the hypothesized REE price function (3')

$$\begin{aligned} D &= \frac{\underline{p} - A}{2C} + \left(\frac{1}{4C}\right)e + \frac{1}{2}v \\ &\quad + \frac{\underline{p} + (K/B)(p_0 - A) - p_0}{R\Sigma_p(1 - K)} \end{aligned} \quad (11)$$

Let us turn now to the supply of securities.

### B. Supply

The firm (or entrepreneur) issues an endogenously determined number of shares  $q$  to the market. These shares promise an identical future value  $p$  per share, independent of the number of shares  $q$  that are offered. The cost of providing shares represents the real investment required to provide the returns to the  $q$  shares. Assume a convex cost function for providing additional shares, given by

$$\begin{aligned} C(q) &= 0, & 0 \leq q \leq Q, \\ &= c_0 + c_1 q + .5c_2 q^2, & q > Q, \end{aligned}$$

where  $c_1 = -Qc_2$ ,  $c_0 = .5Q^2c_2$ , and  $c_2 > 0$ . This functional form has the following properties. Shares can be created without cost up to a level given by  $Q$ . Thereafter, marginal cost rises from zero with a speed that depends on the magnitude of  $c_2$ . The condition determining  $c_0$  assures that the cost function is continuous at  $q = Q$ .

The firm must decide how many shares to supply. It can sell shares for  $p_0$  per share, where  $p_0$  is the current price. It issues shares to maximize profit (for its original shareowners)

$$\begin{aligned} \pi &= p_0 q - C(q) \\ &= p_0 q - c_0 - c_1 q - .5c_2 q^2, \end{aligned}$$

implying an optimal share issuance (supply) of

$$q = zp_0 + Q, \quad (12)$$

where  $z = 1/c_2$ .<sup>12</sup> Because the cost of providing shares is zero up to  $q = Q$ , the firm will always provide this level no matter how rapidly marginal cost increases beyond  $Q$ .<sup>13</sup> Note that the special case in which production is inflexible corresponds to the limiting case in which  $z \rightarrow 0$  and  $q = Q$  for all  $p_0$ .

### C. The REE Price Function

Recall that an REE price function must equate supply and demand for each possible resolution of the random variables  $e$  and  $v$ . That is,

<sup>12</sup> Note that with this criterion the firm will make the same share issuance decision whether or not managers directly observe the inside information variable  $e$ . Nonetheless,  $e$  does affect investment through the REE price function  $p_0$ . For an alternative firm objective in which inside information can directly affect share issuance  $q$ , see Sec. VIIC below.

<sup>13</sup> I ignore the possibility of negative  $P_0$ , which technically is possible with normal distributions but for reasonable specifications of parameters (see table 1 below) is highly unlikely—a six- (or more) standard-deviation event.

total demand from (11) must equal total supply from (12), or

$$\begin{aligned} & \frac{p-A}{2C} + \left(\frac{1}{4C}\right)e + \frac{1}{2}v \\ & + \frac{p + (K/B)(p_0 - A) - p_0}{R\Sigma_p(1-K)} - (zp_0 + Q) = 0, \end{aligned} \quad (13)$$

for all  $e, v$ . This equation can be solved for  $p_0$ , and the resulting constant term and coefficients of  $e$  and  $v$  must equal the coefficients  $A, B$ , and  $C$  of the postulated REE function (3').

**THEOREM 1.** A linear REE exists in our model with

$$p_0 = A + Be + Cv, \quad (14)$$

where

$$B = \frac{1}{2},$$

$$C = \frac{1}{2M},$$

$$A = \frac{p(z + 2g) - Q}{2(z + g)},$$

$$M = \left(\frac{R\Sigma_v}{2}\right) \left\{ -1 + \left[ \frac{1 + 4(z + g)}{R\Sigma_v} \right]^{.5} \right\},$$

$$g = \frac{1}{R\Sigma_p}.$$

*Proof.* See the Appendix.

Several conclusions can be drawn about prices in the REE setting: (i) The sensitivity  $B$  of price to inside information  $e$  is constant. Half of the future price surprise will be reflected in the current price, regardless of liquidity supply volatility  $\Sigma_v$  or future price uncertainty  $\Sigma_p$ . This constancy reflects the nature of the insiders' response to observations of  $e$  and  $v$ . (ii) The ex ante expected current price,  $A$ , is independent of the supply volatility  $\Sigma_v$ . It can readily be verified that the expected current price is decreasing in risk aversion  $R$  and in future price volatility  $\Sigma_p$ . (iii) The liquidity of the market (as measured by the inverse of  $C$ , the price impact of a liquidity trade) increases as production becomes more sensitive to price ( $z$  increases) and decreases as the volatility of future price ( $\Sigma_p$ ) increases. For reasonable ranges of parameters, liquidity also increases with the volatility of liquidity trading  $\Sigma_v$ .

#### IV. Comparison of REE Prices: Markets with and without Insider Trading

My objective is to compare the REE price function with insider trading, as described in theorem 1, with the REE price function in a similar market that prohibits insider trading. Insiders now behave as outsiders, but since they have negligible mass, their trading, now limited by risk aversion, will be negligible.

Demand from the outside investors is given by

$$\begin{aligned} d'_o &= \frac{p - p_0}{R\Sigma_p} \\ &= m' + n'p_0, \end{aligned} \tag{10'}$$

where  $m' = p/R\Sigma_p$  and  $n' = -1/R\Sigma_p$ . It can be readily verified that the REE price function in the absence of insider trading has the form

$$p'_0 = A' + B'e + C'v, \tag{15}$$

where  $A' = (pg - Q)/(z + g)$ ,  $B' = 0$ , and  $C' = 1/(z + g)$ . Comparing this price function with (15), we obtain the following results.

1. The average stock price will be higher when insider trading is permitted. This can be seen immediately from

$$A - A' = \frac{pz + Q}{2(z + g)} > 0.$$

The controversy of how insider trading affects the level of stock prices is resolved: prices will rise.

2. The average amount of real investment (or, equivalently, shares  $q$  issued) will be higher with insider trading. This follows immediately from (12) and the fact that the average stock price will be higher.

3. For "reasonable" parameter levels, the liquidity of the market is reduced by insider trading. Liquidity is greater when a liquidity trade has a smaller impact on price, that is, when the magnitude of  $C$ , the coefficient of  $v$ , is smaller. It can be shown that  $C$  exceeds  $C'$  (implying lower liquidity with insider trading) whenever

$$z + g > 2R\Sigma_v. \tag{16}$$

This will be the most difficult to satisfy when  $z = 0$  (no flexibility of production), in which case (16) reduces to

$$1 > 2R^2\Sigma_v\Sigma_p. \tag{17}$$

Realistically, it is unlikely that the risk aversion factor  $R$  will exceed six, the volatility (standard deviation) of the liquidity supply will exceed 20 percent of total supply, or the volatility of prices will exceed

50 percent.<sup>14</sup> For such extremes, the right-hand side of (17) is .72, and the inequality is satisfied. We can conclude that, under reasonable parameter specifications,  $C > C'$  and insider trading reduces market liquidity.<sup>15</sup>

4. For reasonable parameter levels, current prices will be more volatile when insider trading is permitted. Note that

$$\text{var}(p_0) = B^2 \Sigma_p + C^2 \Sigma_v > (C')^2 \Sigma_v = \text{var}(p'_0).$$

This follows directly from the lower liquidity levels for reasonable parameters ( $C > C'$ ) and the positive sensitivity of  $p_0$  to  $e$  ( $B > 0$ ) in the equilibrium with insider trading.

5. Future price volatility given current prices ( $\text{var}(p|p_0)$ ) will be lower when insider trading is permitted. Note that

$$\text{var}(p|p_0) = \Sigma_p \left( 1 - \frac{B^2 \Sigma_p}{B^2 \Sigma_p + C^2 \Sigma_v} \right).$$

Since  $B = 0$  when there is no insider trading, the result follows immediately.

These last two results show a key aspect of insider trading: it accelerates the resolution of uncertainty from the terminal period to the present period. A related consequence follows.

6. Current prices will be more highly correlated with future prices when insider trading is permitted. The actual correlation  $\rho$  is given by

$$\rho = \frac{B \Sigma_p}{(B^2 \Sigma_p^2 + C^2 \Sigma_p \Sigma_v)^{.5}}.$$

Without insider trading, the correlation is zero. For reasonable parameter values (see the example in Sec. VI), the correlation of current and future prices in the presence of insider trading will be on the order of .7.

The preceding results show that, in the presence of insider trading, investment (which depends on current price  $p_0$ ) will be larger when

<sup>14</sup> Ibbotson and Sinquefeld suggest that the Standard & Poors 500 return has averaged about 6–8 percent higher than the risk-free return, with a standard deviation of about 20 percent. The certainty equivalent of such a return would be consistent with an  $R$  of 1.5–2 in this model.

<sup>15</sup> Gennotte and Leland (1990) also show that the presence of a few asymmetrically informed investors (i.e., insiders) dramatically reduces the liquidity of markets in comparison to the case in which no insiders are present. Their model assumes that insiders behave competitively and that the supply of shares is fixed. It is interesting to note that additional insiders (behaving competitively) may improve liquidity relative to the case in which only a few insiders are present.

the future value  $p$  per unit of that investment is greater. This increased "informational efficiency" of investment is potentially desirable. It is desirable not for its own sake, however, but rather for how it contributes to the welfare of the economic agents. Welfare in the equilibria with and without insider trading is affected not only by investment decisions but by the distribution of risks and returns among the agents. Let us turn now to analyzing these issues.

## V. Welfare

My objective is to examine the welfare of each class of participants in the rational expectations equilibria developed above. The question of welfare must be posed prior to knowledge of the random variables  $e$  or  $v$ . That is, let us ask the following question: Before knowing the actual information that insiders will receive, are participants better or worse off with insider trading? Assume that all classes of participants have mean-variance preferences of the form

$$U(W) = E(W) - \left(\frac{R}{2}\right) \text{var}(W).$$

Note that utility  $U$  can be interpreted as certainty equivalent wealth.

### A. Inside Investors

At the time they make their decisions  $d_i$ , insiders can observe both  $e$  and  $p_0$  (implying knowledge of  $v$ ). Their wealth given these observations is

$$\begin{aligned} W_i &= (\underline{p} + e - p_0)d_i \\ &= (\underline{p} + e - p_0)\left(\frac{\underline{p} - A}{2C} + \frac{e}{4C} - .5v\right) \end{aligned}$$

using (6). Substituting for  $p_0$  from (14) allows us to express insider wealth (ex post) as

$$W_i = w_1 + w_2e + w_3v + w_4e^2 + w_5v^2 + w_6ev, \quad (18)$$

where

$$\begin{aligned} w_1 &= \frac{(\underline{p} - A)^2}{2C}, \\ w_2 &= \frac{(\underline{p} - A)(3 - 2B)}{4C}, \\ w_3 &= -(\underline{p} - A), \end{aligned}$$



$$w_4 = \frac{1 - B}{4C},$$

$$w_5 = \frac{C}{2},$$

$$w_6 = -\frac{3 - 2B}{4}.$$

While insider profits  $W_i$  are certain ex post, they are uncertain ex ante. From (18), we can immediately derive the ex ante mean and variance of insider wealth:

$$E(W_i) = w_1 + w_4 \Sigma_p + w_5 \Sigma_v,$$

$$\text{var}(W_i) = w_2^2 \Sigma_p + w_3^2 \Sigma_v + 2w_4^2 \Sigma_p^2 + 2w_5^2 \Sigma_v^2 + w_6^2 \Sigma_p \Sigma_v.$$

The certainty equivalent of ex ante random insider wealth is given by

$$U(W_i) = E(W_i) - \left(\frac{R}{2}\right) \text{var}(W_i).$$

### B. Outsiders

Outsiders choose a risky investment  $d_o$  to maximize risk-adjusted final wealth, given that they observe  $p_0$ . Their final wealth will be

$$W_o = (p - p_0)d_o,$$

where  $d_o$  is given by (10). Recalling that

$$p - p_0 = \underline{p} + e - (A + Be + Cv)$$

allows us to write

$$W_o = s_1 + s_2 e + s_3 v + s_4 e^2 + s_5 v^2 + s_6 ev, \quad (19)$$

where

$$s_1 = (\underline{p} - A)(m + nA),$$

$$s_2 = Bn(\underline{p} - A) + (1 - B)(m + nA),$$

$$s_3 = C[n(\underline{p} - A) - (m + nA)],$$

$$s_4 = nB(1 - B),$$

$$s_5 = -nC^2,$$

$$s_6 = nC(1 - 2B),$$

and  $m$  and  $n$  are defined in (10) when insider trading is permitted

and in (10') when insider trading is not permitted.<sup>16</sup> From (19) we derive the ex ante mean and variance of  $W_o$ :

$$\begin{aligned} E(W_o) &= s_1 + s_4 \Sigma_p + s_5 \Sigma_v, \\ \text{var}(W_o) &= s_2^2 \Sigma_p + s_3^2 \Sigma_v + 2s_4^2 \Sigma_p^2 + 2s_5^2 \Sigma_v^2 + s_6^2 \Sigma_p \Sigma_v \end{aligned} \quad (20)$$

with certainty equivalent value

$$U(W_o) = E(W_o) - \left(\frac{R}{2}\right) \text{var}(W_o). \quad (21)$$

### C. Liquidity Traders

Liquidity traders trade an amount  $v$  that is random ex ante. On average, liquidity traders expect neither to buy nor to sell:  $E(v) = 0$ . But when they do buy, they will tend to do so at a price greater than average. When they sell, they will tend to do so at a price lower than average. This creates both an expected cost and a volatility of cost.<sup>17</sup> Straightforward calculations yield

$$\begin{aligned} \text{cost} &= -p_0 v \\ &= -(A + Be + Cv)v \\ &= m_1 + m_2 e + m_3 v + m_4 e^2 + m_5 v^2 + m_6 ev, \end{aligned} \quad (22)$$

where  $m_1 = m_2 = m_4 = 0$ ,  $m_3 = -A$ ,  $m_5 = -C$ , and  $m_6 = -B$ . It follows immediately that

$$\begin{aligned} E(\text{cost}) &= m_1 + m_4 \Sigma_p + m_5 \Sigma_v = -C \Sigma_v, \\ \text{var}(\text{cost}) &= m_2^2 \Sigma_p + m_3^2 \Sigma_v + 2m_4^2 \Sigma_p^2 + 2m_5^2 \Sigma_v^2 + m_6^2 \Sigma_p \Sigma_v \\ &= A^2 \Sigma_v + 2C^2 \Sigma_v^2 + B^2 \Sigma_p \Sigma_v, \end{aligned} \quad (23)$$

$$\begin{aligned} U(\text{cost}) &= E(\text{cost}) - \left(\frac{R}{2}\right) \text{var}(\text{cost}) \\ &= \left[ -C - \left(\frac{R}{2}\right) (A^2 + B^2 \Sigma_p + 2C^2 \Sigma_v) \right] \Sigma_v. \end{aligned} \quad (24)$$

<sup>16</sup> In the special case in which  $z = 0$ , it can be shown that  $n = -1/2C$  and  $n' = -1/C$ . The terms for the weights  $s_j$  simplify accordingly.

<sup>17</sup> Alternatively, one could model the welfare of the liquidity trader as equivalent to an investor with future wealth  $W_L = (p - p_0)v$  and estimate his utility as with other investors. This treats the liquidity trades as speculative; this approach is appropriate if trades are viewed as eliminating (hedging) prior positions. Such an alternative formulation would affect welfare levels but not the general nature of the results.

Note that costs are incurred in the first period. Assume the same risk aversion coefficient  $R$  here, although alternative formulations are possible.<sup>18</sup>

*D. Stock Issuers: The Firm or Entrepreneur*

The model considers equilibrium with an endogenous supply of new shares. The returns to the shares are created by real investment. A scenario consistent with this approach is an entrepreneur financing a new firm by selling equity. The amount he realizes as an entrepreneurial profit is  $\pi = p_0 q - C(q)$ .

Alternatively, one can think of the project as being undertaken by a firm with shares currently outstanding, but financing the new venture as a separate firm with its own equity financing. In this case it is the shareholders of the original firm who realize the increase in value  $\pi$ . This alternative becomes important if the shareholders of the new venture overlap with the shareholders of the original firm. This is discussed in Section VII B below. Here, assume no overlap of ownership.

The expected profit and variance of profit to the original owners can be readily determined:

$$\begin{aligned} \pi &= p_0 q - C(q) \\ &= p_0(zp_0 + Q) - c_0 - c_1(zp_0 + Q) - \left(\frac{c_2}{2}\right)(zp_0 + Q)^2 \quad (25) \\ &= \rho_1 + \rho_2 e + \rho_3 v + \rho_4 e^2 + \rho_5 v^2 + \rho_6 ev, \end{aligned}$$

where  $\rho_1 = (zA^2/2) + AQ$ ,  $\rho_2 = zAB + BQ$ ,  $\rho_3 = zAC + CQ$ ,  $\rho_4 = zB^2/2$ ,  $\rho_5 = zC^2/2$ , and  $\rho_6 = zBC$ . It follows directly that

$$\begin{aligned} E(\pi) &= \rho_1 + \rho_4 \Sigma_p + \rho_5 \Sigma_v, \\ \text{var}(\pi) &= \rho_2^2 \Sigma_p + \rho_3^2 \Sigma_v + 2\rho_4^2 \Sigma_p^2 + 2\rho_5^2 \Sigma_v^2 + \rho_6^2 \Sigma_p \Sigma_v, \end{aligned} \quad (26)$$

$$U(\pi) = E(\pi) - \left(\frac{R}{2}\right) \text{var}(\pi). \quad (27)$$

We have now assessed the welfare of the four different agents. Note that the formulas also hold for the expected utility of agents when inside trading is prohibited, provided that we substitute  $m'$ ,  $n'$ ,  $A'$ ,  $B'$ , and  $C'$  for  $m$ ,  $n$ ,  $A$ ,  $B$ , and  $C$ .

<sup>18</sup> Risk aversion to current wealth might be less than risk aversion to future wealth because consumption choice is more flexible when risks are revealed early. I examine the impact of differing group risk aversion in Sec. VII A below.

TABLE 1  
BASE CASE

Ex ante price volatility (variance $\Sigma_p$ ): This is consistent with an annual standard deviation of the stock price of 20%	.04
Ex ante expected future price ( $\underline{p}$ ): This is a normalization	1.00
Volatility of liquidity supply (variance $\Sigma_v$ ): This is consistent with an annual standard deviation of liquidity supply equal to about 10% of total supply	.01
Risk aversion parameter ( $R$ ): This implies a return premium to stocks equal to twice the future price volatility given current price (in this example, a risk premium of 8% over the risk-free rate when supply is normalized to one)	2
Costless supply ( $Q$ ): If production is inflexible to price ( $z = 0$ ), then the production supply is normalized to one	1

## VI. Welfare Compared: Insider versus No Insider Trading

The complexity of the various expressions for utility of the four classes of agents precludes simple analytical results relating welfare with and without insider trading as a function of the exogenous parameters. Nonetheless, we can use numerical analysis to examine welfare effects. Let us start with a "base case" with parameters chosen to reflect average market data. The parameters chosen are given in table 1. Let us first consider agents' welfare as a function of the flexibility of production to price (the parameter  $z$ ).

### A. No Production Flexibility ( $z = 0$ )

In this case,  $Q = 1$  is supplied to the market regardless of price  $p_0$ . Equilibrium values of expected demand, expected supply, and ex ante welfare follow: with no inside trading,

$$\begin{aligned} p_0 &= A' + C'v \\ &= .9200 + .0800v; \end{aligned}$$

with inside trading,

$$\begin{aligned} p_0 &= A + Be + Cv \\ &= .9600 + .500e + 1.020v. \end{aligned}$$

AVERAGE PRICE	AVERAGE SUPPLY	AVERAGE DEMAND		EXPECTED UTILITY (CERTAINTY EQUIVALENCE)				
		Inside	Outside	Inside	Outside	Liquidity	Profit	Total
.9200	1.0000	.0000	1.0000	.00000	.04014	-.00927	.91994	.95081
.9600	1.0000	.0196	.9804	.01055	.01968	-.01973	.93959	.95010

The upper line refers to equilibrium without insider trading, and the lower line to equilibrium with insiders. Averages refer to the case in which  $e = v = E(e) = E(v) = 0$ . As implied by the earlier proposition, the average price is higher with insider trading. Supply is identical since by assumption supply is invariant to price.

Insider trading increases the welfare of insiders—quite naturally, since they are excluded in the other case. More interesting, the outsiders' utility (certainty equivalence) falls by more than half. While both expected returns and risk to outsiders fall, demand contracts only fractionally despite the substantial drop in their welfare.

Expected profit to original owners issuing the securities rises from .92 to .96. However, the increased riskiness of the issuing price in the case of insider trading reduces the expected utility of profits to .9396.<sup>19</sup> Profits to original owners when insider trading is prohibited are not very volatile, and their expected utility is .91994.

Because current prices are much more sensitive to random liquidity trades (i.e., markets are less liquid), the expected utility of liquidity traders drops from  $-.0093$  to  $-.0197$  when insider trading is permitted. The risk-adjusted cost to liquidity traders more than doubles in the presence of insider trading. Total utility (or certainty equivalence) declines slightly, from .9508 to .9501, when insider trading is permitted. *For the base case, with no production flexibility, insider trading decreases welfare.*

I varied the base-case parameters separately, with a range of ex ante price volatility from .01 to .08, volatility of liquidity supply from .001 to .10, and risk aversion from 1 to 4. In all cases, insider trading continued to diminish total utility as well as to increase the welfare of insiders and original owners, and to decrease the welfare of outsiders and liquidity traders.

The welfare advantage (increase in total certainty equivalent wealth) from prohibiting insider trading increases as (1) risk aversion increases, (2) liquidity trading is more volatile, and (3) volatility of future price increases over the range of parameters examined.

<sup>19</sup> This cost associated with greater variability of prices  $p_0$  reflects Hirshleifer's (1971) observation that increased information can have negative as well as positive impacts on welfare.

A bit more insight into these results can be obtained in the case in which  $z = 0$ . Considerable algebraic manipulation shows that

$$s_4 + \rho_4 + m_4 + w_4 = 0,$$

$$s_5 + \rho_5 + m_5 + w_5 = 0,$$

both with and without insider trading. Furthermore, it can be shown that, when  $z = 0$ ,

$$s_1 + \rho_1 + m_1 + w_1 = pQ,$$

regardless of whether insider trading is permitted or not.<sup>20</sup> Thus the *total expected wealth* (which depends only on terms with subscripts 1, 4, and 5) is invariant to the presence of insider trading when production is inflexible to price. This result implies that *total welfare* decreases in the presence of insider trading because of risk effects: The distribution of total risks is less favorable with insider trading.

#### B. Production Is Flexible ( $z = 1$ )

Let us now consider the case in which supply expands with price ( $z = 1$ ). All other parameters remain at their base value. Equilibrium values of expected demand, expected supply, and ex ante welfare follow: with no inside trading,

$$\begin{aligned} p_0 &= A' + C'v \\ &= .8519 + .0740v; \end{aligned}$$

with inside trading,

$$\begin{aligned} p_0 &= A + Be + Cv \\ &= .9259 + .500e + .981v. \end{aligned}$$

AVERAGE PRICE	AVERAGE SUPPLY	AVERAGE DEMAND		EXPECTED UTILITY				
		Inside	Outside	Inside	Outside	Liquidity	Profit	Total
.8519	1.8519	.0000	1.8519	.00000	.13676	-.00800	1.2145	1.3433
.9259	1.9259	.0378	1.8882	.01249	.06992	-.01868	1.2914	1.3552

As before, the second line describes equilibrium with insiders.

In contrast with the earlier result, we can see that although each separate class of agents' welfare increases or decreases in the direction previously observed, the total welfare now increases rather than de-

<sup>20</sup> The comparison requires  $w_1 = w_4 = w_5 = 0$  when insiders are prohibited, since their utility is presumed to be zero when prohibited.

creases with insider trading. This result continues to hold for the range of parameters studied earlier. Indeed, we find that when production flexibility  $z$  exceeds about .06, welfare in the base case will increase when insider trading is allowed. A relatively small amount of production flexibility will cause insider trading to help welfare.

These results suggest that certain kinds of better information might be more damaging to welfare than others. Information that affects price but not production decisions will in general have a more negative effect than information that affects production. For example, consider a situation in which inside information exists about the possibility of a takeover, but a change in stock price will not affect the firm's investment decisions. This example implies  $z = 0$ , and welfare would be negatively affected by insider trading. Contrast this with a situation in which an external investor knows that a firm's potential investment has a very high payoff. Permitting him to trade on this information will raise the share price and lead to cheaper (and therefore greater) financing. Welfare may be positively affected.

## VII. Alternative Formulations and Interpretations

The results of this paper rest on a number of assumptions. In this section some alternative formulations and their likely impact on the conclusions are examined.

### A. Differing Risk Aversion Levels across Groups

The equilibrium pricing function—with or without insider trading—depends only on the risk aversion of the outsider group. The reason is that other groups' behavior is not affected by their degree of risk aversion. But while the equilibrium itself does not depend on other groups' risk aversion, these groups' *welfare* in equilibrium is a function of their risk aversion. How are the welfare conclusions altered by allowing for differences in risk aversion parameters?<sup>21</sup>

Let us fix the risk aversion of the outsider group and therefore the REE price equilibria. Now consider increasing the level of risk aversion of any other group. These groups' risk is affected only by the variability of  $p_0$ , which increases when insider trading is permitted. Increased risk aversion will make the prohibition of insider trading more attractive to these groups.

If all *individual* investors have identical risk aversion, then groups with smaller numbers will have greater aggregate risk aversion. With

<sup>21</sup> I thank Michael Fishman for suggesting this line of inquiry.

preferences linear in the mean and variance of wealth, the risk aversion of the group (more exactly, of an aggregate investor representing the group) is inversely proportional to the number of investors in the group. Thus the aggregate risk aversion  $R_i$  of a group with  $N_i$  investors will be given by

$$R_i = R \left( \frac{N}{N_i} \right),$$

where  $R$  is the aggregate risk aversion of the outside investor group and  $N$  is the number of outside investors. Clearly  $R_i$  will be greater than  $R$  when there are more outsiders than investors in group  $i$ . Since this seems likely to be the case for insider, entrepreneur, and (perhaps) liquidity groups, the assumption of identical group risk aversions may bias results in favor of insider trading.

*B. Uninformed or Informed Investors Are the Firm's Original Owners*

It has been assumed that investors are a different group from the original owners. How does the analysis change when original owners are in fact the same group as the uninformed (outside) investors or, alternatively, the same group as the informed (inside) investors?

The combined investors/original owners will seek to

$$\underset{q,d}{\text{maximize}} U[W|I] = E[W|I] - \left( \frac{R}{2} \right) \text{var}[W|I],$$

where

$$W = (p - p_0)d + p_0q - C(q),$$

$I = p_0$  if the original owners are uninformed, and  $I = e$  if the original owners are informed.

Note that  $W = W_o + \pi$ : the wealth of the combined investor/owner group is equal to the sum of the separate groups' wealths. Of course there is no a priori reason to believe that the combined group will make the same portfolio and share issuance decisions as the groups when separated.

First-order maximizing conditions for the combined group are

$$d = \frac{E[p - p_0|I] + (\delta p_0 / \delta d)(q - d)}{R \Sigma_{p|I}},$$

$$p_0 - C'(q) + \left( \frac{\delta p_0}{\delta q} \right) (d - q) = 0,$$



where  $\delta p_0/\delta d$  and  $\delta p_0/\delta q$  are the perceived marginal impact of decisions on current price. If the original owners are also uninformed investors, then given the competitive assumptions ( $\delta p_0/\delta d = \delta p_0/\delta q = 0$ ), the combined investor/owner group will choose the same output  $q$  and demand  $d$  as when they were separate: see (9) and (12). Therefore, the assumption that uninformed investors and original owners are separate groups does not alter the equilibrium from the one that prevails when the two groups coincide.

Welfare, however, will be affected. If the groups are separated, the original owners will sell all their shares at a random price in the first period. This randomness reduces the certainty equivalent value of their shares. Similarly, outside investors purchase shares (from the original owners) at an ex ante random price, also affecting their risk. When the two groups are combined, outside investors coincide with the original owners. If, originally, outside investors purchased *all* issued shares when the groups were separate, all ex ante price risk associated with  $p_0$  would disappear when the groups are combined. Even when outsiders purchase only a fraction of the issued shares, considerable price risk can be avoided.

Welfare can be analyzed by noting that wealth in the combined case is simply the sum of the wealths of the separate classes: outside (uninformed) investors and original owners. Thus define

$$\begin{aligned} t_1 &= s_1 + \rho_1, \\ t_2 &= s_2 + \rho_2, \\ &\vdots \\ t_6 &= s_6 + \rho_6. \end{aligned}$$

Mean, variance, and expected utility of the combined class will be given by

$$\begin{aligned} E[W] &= t_1 + t_4 \Sigma_p + t_5 \Sigma_v, \\ \text{var}[W] &= t_2^2 \Sigma_p + t_3^2 \Sigma_v + 2t_4^2 \Sigma_p^2 + 2t_5^2 \Sigma_v^2 + t_6^2 \Sigma_p \Sigma_v, \\ U[W] &= E[W] - \left(\frac{R}{2}\right) \text{var}[W]. \end{aligned}$$

This expression then replaces  $U[W_o]$  and  $U[\pi]$  in the previous analysis. Because the effect of the risky current price  $p_0$  is reduced in this alternative, we find that welfare effects of insider trading are positive for the base case even with  $z = 0$ . The original owners/uninformed investors are slightly better off when insider trading is permitted:

Gains as original owners more than offset losses as uninformed investors.<sup>22</sup>

Insider trading does not benefit total welfare for all parameter levels in this case. For example, if the standard deviation of liquidity demand in the base case rises from 10 percent to 16 percent (or more), insider trading again lowers welfare when  $z = 0$ .

If informed investors are also the original owners, decisions (when insider trading is permitted) will not be identical to those made when owners and insiders are separate. Now the original owners realize that they can affect  $p_0$ , the price at which shares are originally sold, by their insider trading. This further exploitation of monopoly power is likely to create additional welfare costs when insider trading is permitted, although I have not formally modeled this more complex case.<sup>23</sup>

### C. Managers Possess Inside Information

Let us return to the case in which investors and original owners are treated separately. The model assumes that original owners (or managers operating on their behalf) are interested only in maximizing the current net value of  $\pi$  of issued shares. With this formulation, it does not matter whether managers possess inside information or not, since  $\pi$  and therefore the optimal  $q$  are affected by  $e$  only through  $p_0$ . But a number of authors have asserted that, in the presence of asymmetric information, future as well as current stock value will affect managers' choice.<sup>24</sup> Assume now that the firm chooses share issuance  $q$  to maximize expected  $U(\pi)$ , where

$$\pi = [\alpha p_0 + (1 - \alpha)p]q - C(q),$$

with  $0 < \alpha < 1$ .<sup>25</sup> The optimal  $q$  will be responsive to information  $e$  even when insider trading is prohibited. Share issuance  $q$  will be less

<sup>22</sup> Note that in this case, the firm's shareholders would not vote to prohibit insider trading, since on net they gain. The losses to liquidity traders, however, may still cause insider trading to be detrimental to welfare. This refutes the argument that if shareholders do not prohibit insider trading, it must not be harmful (see, e.g., Carlton and Fischel 1983).

<sup>23</sup> In an alternative formulation, in which informed investors receive a noisy signal but behave as competitors (implying  $\delta p_0 / \delta d = \delta p_0 / \delta q = 0$ ), the separation equivalence would continue to hold.

<sup>24</sup> Several authors (e.g., Ross 1977; Miller and Rock 1985) have assumed that in the presence of asymmetric information, managers choose to maximize a weighted average of current and future stock value.

<sup>25</sup> To remain consistent with the previous approach, we must now require that  $q$  is unobservable by outsiders. Otherwise, outsiders could use  $q$  to back out of the value of  $e$ . In the earlier approach, it did not matter whether  $q$  was observable or not, since  $q$  can be inferred from  $p_0$ .

sensitive to  $p_0$  because (already knowing  $e$ ) managers will not condition their expectation of  $p$  on  $p_0$ . In the limiting case in which  $\alpha = 0$ ,  $q$  will be independent of  $p_0$ .

The information that the current price brings to share issuance (and investment) by firms is therefore less important when firms' managers already possess inside information. That is,  $z$  is smaller. But in the preceding section it was shown that smaller  $z$  causes insider trading to be less desirable. This suggests that it is not only legally appropriate but also economically useful to distinguish trading by a corporate insider from trading by an unaffiliated but informed investor. The former brings costs but little benefits (other than to himself), since the information he imparts through his price impact is already known by the firm; the latter may bring additional benefits to production decisions via his effect on price.

#### *D. Outsiders Can Gather Information*

When outsiders have the possibility of acquiring information, as in Fishman and Hagerty (1989), insider trading may affect this decision. We have seen that outsiders' expected utility suffers when inside trading is permitted. Following Fishman and Hagerty, assume that this reduces the amount of information outsiders gather, which in turn increases their ex ante future price volatility. But earlier examples showed that greater volatility of future prices implies a greater loss from insider trading. When outsiders can gather information, there is further reason to restrict insider trading.

### **VIII. Conclusions**

The analysis of this paper suggests that insider trading may hurt or help markets, depending on the characteristics of those markets. This should not be surprising: the fact that controversy still exists on the issue suggests that there is no single "best" answer regardless of circumstances.

The analysis *does* indicate who gains and who loses. It also identifies the characteristics of those markets that are likely to gain from insider trading and those that are likely to lose.

Liquidity traders are major losers when insider trading is permitted. Markets become less liquid when insiders trade: prices move more in response to unobserved random supply shocks because investors believe that price movements might be coming from informed investor activity. If liquidity traders had a way to inform markets that their trades were indeed information-free, they would be less

harmed.<sup>26</sup> However, liquidity traders who could not inform markets would suffer more, since market liquidity decreases as  $\Sigma_v$  becomes smaller.

Outside investors also are hurt when insider trading is permitted. Their expected return is reduced. Because they are trading against better-informed investors, they own, on average, more shares when expected returns are low and fewer shares when expected returns are high. But outside investors also have reduced risks: Because some risks are revealed through prices, the remaining risks are less. Both the mean and variance of outsiders' returns are reduced by insider trading. Outsiders' demand for stock may increase, but their welfare always decreases.

Gainers from insider trading of course include the insiders themselves. But owners of firms issuing shares also will, on average, benefit from insider trading. The average issuing price will be higher, and there are additional benefits when the firm's investment level is sensitive to future prospects, as reflected (when insider trading is permitted) in current price.<sup>27</sup>

The net impact of these separate consequences of insider trading can be positive or negative. The results indicate that insider trading is less desirable as (1) investment flexibility decreases, (2) investor risk aversion increases, (3) liquidity trading is more volatile, and (4) future price volatility increases.

The single most important factor is the sensitivity of investment to current price. If the sensitivity is great, insider trading is likely to be beneficial.

When firms themselves possess inside information, allowing insider trading for personal profit is likely to have negative effects. Firms will pay less attention to current market price if they already possess information superior to that price. Because the sensitivity of investment to current price is lower, the negative aspects of insider trading will tend to dominate the positive aspects. This may well explain why regulation has focused on prohibiting trading based on superior information emanating from *inside* the firm, as contrasted with superior information generated externally.

Typically, insider trading has been *more* tolerated in less developed financial markets. This is somewhat puzzling in light of the results

<sup>26</sup> See Admati and Pfleiderer (1990). The existence of basket securities could help (well-diversified) liquidity traders to the extent that trading a basket minimizes the likelihood that an investor has firm-specific information (see, e.g., Gorton and Pennacchi 1989).

<sup>27</sup> Note that I focus on producer surplus (from profit) but do not explicitly examine consumer surplus related to the output of the good being produced. Any possible increase in consumer surplus would favor insider trading.

above, if less developed markets are associated with greater future price volatility and, perhaps, greater investor risk aversion as well.

There are a number of possible explanations. First, liquidity trading is likely to be much more important in highly developed capital markets, where investors consider the stock market as a viable alternative for holding assets for retirement and other income-smoothing purposes. Insider trading is particularly harmful to liquidity traders. Second, it is possible (although not obvious) that less developed financial markets have a greater fraction of superior information that is generated outside the firm. Thus the investment level would be more sensitive to stock market price. Third, and most likely, less developed markets may be equally harmed by insider trading, but restrictions are simply impossible to enforce.

The model of this paper captures many of the key ingredients of the insider trading controversy, but it should be extended to multiple time periods. Insider trading "moves up" the resolution of uncertainty. This one-time benefit may be relatively more important in a two-period model than in a multiperiod model. If so, my results may overestimate the benefits of insider trading. But we must await the development of multiperiod rational expectations models to answer this question definitively.

## Appendix

### *Proof of Theorem 1*

From (13), we can group terms into coefficients— $G$  of the future price surprise  $e$ ,  $H$  of liquidity trading  $v$ ,  $F$  of a constant, and  $M$  of price  $p_0$ —as follows:

$$Mp_0 = F + Ge + Hv, \quad (\text{A1})$$

where

$$M = z - \left( \frac{g}{1-K} \right) \left( \frac{K}{B} - 1 \right),$$

$$F = \frac{p - A}{2C} + \left( p - \frac{AK}{B} \right) \left( \frac{g}{1-K} \right) - Q,$$

$$G = \frac{1}{4C},$$

$$H = 1/2,$$

$$g = \frac{1}{R\Sigma_p},$$

$$K = \frac{\Sigma_p}{\Sigma_p + (C/B)^2 \Sigma_v}.$$

For (A1) to be consistent with (14) for every possible  $e$  and  $v$ , it must be the case that

$$A = \frac{F}{M}, \quad (\text{A2})$$

$$B = \frac{G}{M}, \quad (\text{A3})$$

$$C = \frac{H}{M}. \quad (\text{A4})$$

This yields three nonlinear equations in the unknowns  $A$ ,  $B$ , and  $C$ . From (A4),  $MC = H = 1/2$ , implying that  $M = 1/2C$ .

Substituting for  $G$  from (A1) and for  $M$  from above into (A3) gives  $B = 1/2$ . Since  $B = H = 1/2$ , it follows immediately from (A4) that  $C/B = 1/M$ , implying  $(C/B)^2 = 1/M^2$  and  $K = M^2 \Sigma_p / (M^2 \Sigma_p + \Sigma_v)$ . Substituting for  $K$  and  $B$  into the equation for  $M$  in (A1) yields a quadratic equation with positive solution

$$M = \left( \frac{R \Sigma_v}{2} \right) \left\{ -1 + \left[ 1 + \frac{4(z+g)}{R \Sigma_v} \right]^{1/2} \right\}.$$

We may now solve immediately for  $C = 1/2M$  from (A4) and the expression above for  $M$ , and for

$$A = \frac{p(z+2g) - Q}{2(z+g)}$$

from (A1), (A2), and the variables  $B$ ,  $C$ , and  $K$ . Q.E.D.

## References

- Admati, Anat R., and Pfleiderer, Paul. "Sunshine Trading and Financial Market Equilibrium." Research Paper no. 2004. Stanford, Calif.: Stanford Univ., Grad. School Bus., September 1990.
- Ausubel, Lawrence M. "Insider Trading in a Rational Expectations Economy." *A.E.R.* 80 (December 1990): 1022-41.
- Bajeux, Isabelle, and Rochet, J.-C. "Opérations d'initiés: Une analyse de surplus." *Finance* 10 (June 1989): 7-19.
- Bray, Margaret M. "Futures Trading, Rational Expectations, and the Efficient Markets Hypothesis." *Econometrica* 49 (May 1981): 575-96.
- . "Rational Expectations, Information and Asset Markets: An Introduction." *Oxford Econ. Papers* 37 (June 1985): 161-95.
- Brudney, Victor. "Insiders, Outsiders, and Informational Advantages under the Federal Securities Laws." *Harvard Law Rev.* 93 (December 1979): 322-76.
- Carlton, Dennis W., and Fischel, Daniel R. "The Regulation of Insider Trading." *Stanford Law Rev.* 35 (May 1983): 857-95.
- Dennert, J. "Insider Trading and the Allocation of Risks." Manuscript. Basel: Univ. Basel, May 1989.
- Easterbrook, Frank. "Insider Trading as an Agency Problem." In *Principals and Agents: The Structure of Business*, edited by John W. Pratt and Richard J. Zeckhauser. Boston: Harvard Bus. School Press, 1985.

- Fishman, Michael J., and Hagerty, Kathleen M. "Insider Trading and the Efficiency of Stock Prices." Working Paper no. 65. Evanston, Ill.: Northwestern Univ., Kellogg Grad. School Management, Dept. Finance, 1989.
- Gennotte, Gerard, and Leland, Hayne. "Market Liquidity, Hedging, and Crashes." *A.E.R.* 80 (December 1990): 999-1021.
- Glosten, Lawrence R. "Insider Trading, Liquidity and the Role of the Monopolist Specialist." Working paper. Evanston, Ill.: Northwestern Univ., Kellogg Grad. School Management, 1988.
- Gorton, Gary, and Pennacchi, George G. "Security Baskets and Index-linked Securities." Discussion Paper no. 29-89. Philadelphia: Univ. Pennsylvania, Wharton School, Dept. Finance, 1989.
- Grinblatt, Mark S., and Ross, Stephen A. "Market Power in a Securities Market with Endogenous Information." *Q.J.E.* 100 (November 1985): 1143-67.
- Grossman, Sanford J. "On the Efficiency of Competitive Stock Markets Where Traders Have Diverse Information." *J. Finance* 31 (May 1976): 573-85.
- Grossman, Sanford J., and Stiglitz, Joseph E. "On the Impossibility of Informationally Efficient Markets." *A.E.R.* 70 (June 1980): 393-408.
- Hellwig, Martin F. "On the Aggregation of Information in Competitive Markets." *J. Econ. Theory* 22 (June 1980): 477-98.
- Hirshleifer, Jack. "The Private and Social Value of Information and the Reward to Inventive Activity." *A.E.R.* 61 (September 1971): 561-74.
- Kyle, Albert S. "Continuous Auctions and Insider Trading." *Econometrica* 53 (November 1985): 1315-35.
- Laffont, Jean-Jacques, and Maskin, Eric. "The Efficient Market Hypothesis and Insider Trading on the Stock Market." Working Paper no. 8909. Toulouse: Univ. Toulouse, GREMAQ-CRES, 1989.
- Manne, Henry G. *Insider Trading and the Stock Market*. New York: Free Press, 1966.
- Manove, Michael. "The Harm from Insider Trading and Informed Speculation." *Q.J.E.* 104 (November 1989): 823-46.
- Miller, Merton H., and Rock, Kevin. "Dividend Policy under Asymmetric Information." *J. Finance* 40 (September 1985): 1031-51.
- Ross, Stephen A. "The Determination of Financial Structure: The Incentive-Signalling Approach." *Bell J. Econ.* 8 (Spring 1977): 23-40.