THE HARM FROM INSIDER TRADING AND INFORMED SPECULATION*

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Insider traders and other speculators with private information are able to appropriate some part of the returns to corporate investments made at the expense of other shareholders. As a result, insider trading tends to discourage corporate investment and reduce the efficiency of corporate behavior. In the context of a theoretical model, measures that provide some indication of the sources and extent of the investment reduction are derived.

I. INTRODUCTION

This paper advances the commonly held view that insider traders and informed speculators appropriate some part of the returns to corporate investments made at the expense of other shareholders. This misappropriation, it is argued, tends to discourage corporate investment and reduce the economic efficiency of corporate behavior.

Using a fairly simple economic model, I attempt to formalize and extend the reasoning of laymen and members of the financial community who claim that insider trading impairs the functioning of financial markets. The argument put forward here arises naturally from recent theoretical research, but it runs counter to much of the law-and-economics literature, which holds insider trading to be benign or even salutary.

The basic intuition applies to trading by insiders and other speculators with private information concerning the value of a particular corporation. For our purposes, it does not matter whether the information originates within the firm or whether it is generated by external observers of the firm. In the presence of informed trading, outsiders who lack the information will find their purchases subject to adverse selection: at any given price, shares are more likely to be available to outsiders when, unbeknownst to them, the economic value of the corporation is low than when it is high. This is because insider traders are more likely to buy up shares when the value is high than when it is low. If outsiders are

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sophisticated and aware of the existence of insider trading, they will take account of adverse selection in calculating expected returns. Consequently, the willingness of sophisticated outsiders to pay for shares will be less than the unconditional expected per share value of the company.

Corporate shareholders support corporate investments because their shares convey the rights to the proceeds of those investments. But suppose that corporate investments are risky and that outsider shareholders need to sell their shares before the value of those investment proceeds becomes known. If insider trading or informed speculation is known to be pervasive, then future outsider buyers of shares, knowing themselves subject to adverse selection, will be unwilling to pay for the full expected value of forthcoming investment proceeds. This means that incumbent shareholders will not be able to recover the full expected value of the returns to corporate investments. As a result, insider trading will tend to dampen shareholder support for corporate investment. If outsider shareholders control corporate behavior, then corporate investment will tend to fall below its economically efficient level.

This intuition captures the main theme of this paper, but it does not tell the whole story. The formal model, presented and analyzed below, yields the following results: the *more often* the average outsider trades, the *smaller* the effects of insider trading will be. When corporate investment is inherently risky, insider trading induces corporate underinvestment. But when corporate investment is less risky, insider trading can, in principle, lead to corporate overinvestment.

In Section II we discuss insider trading and informed speculation in general terms. The basic structure of the formal model is presented in Section III. In Section IV we analyze the behavior of sophisticated outsiders; in Section V, of naive outsiders. In Section VI we examine the effects of insider trading on corporate investment. Section VII contains conclusions.

II. Insider Trading, Fairness, and Efficiency

The problem of insider trading has attracted public attention recently in the wake of SEC charges against Dennis Levine, Ivan Boesky, and others.[1] These cases may convince some people that

1. Herzel and Katz [1987] offer a helpful summary of the legal issues surrounding these cases. Also, see Posner and Scott [1980] for a useful selection of excerpts from relevant academic research.

insider trading is an important factor in U. S. and other securities markets, but systematic evidence is hard to come by. In an empirical study of the relationship between corporate announcements and trading by corporate officials, Elliott, Morse, and Richardson [1984] present some evidence that insider trading motivated by the desire to profit from advance knowledge is widespread, though most trading by insiders seems to be motivated by other concerns. Since trading based on insider information can be a criminal offense, it is plausible that much of this trading is difficult to detect. In any event, a number of empirical studies [Seyhun, 1986; Finnerty, 1976, and others] have indicated that informed insiders do earn excess profits from their trading.

Much of the aversion to insider trading found among laymen, members of the financial community, regulators, lawyers, and judges seems to be based on the idea that such trading, by giving insiders an unfair advantage, will discourage ordinary investors. Consider, for example, a director who is informed that her company, after a costly search, has made a major discovery of valuable petroleum reserves. She then goes out and buys a large quantity of her company's stock from unsuspecting shareholders. These shareholders, as former owners of the company, have paid for the search that yielded the oil discovery. But the director will reap the reward in the form of dividends and capital gains. Manne [1966a, p. 4] quotes law professor H. L. Wilgus[2] writing in 1910 as follows: [For a director to] "take advantage of his position to *secure the profits that all have won,* offends the moral sense; ... that the law yet allows him to do this, does more to discourage legitimate investment in corporate shares than almost anything else, and allows the fiction of corporate entity to obstruct instead of advance justice [italics added]." But Manne, himself, does not find this statement convincing. Manne argues that most outsider investors are helped by the price changes brought about by insider trading and that the losers are mainly short-term speculators.[3] Carlton and Fischel [1983] amplify another Manne argument: high-ranking employees who profit from insider trading will internalize the losses they impose by accepting reduced remuneration. Scott [1980, pp. 808–09] points out that many outsider investors are sophisticated and will anticipate insider trading. This will cause prices to adjust so that outsiders can realize a fair rate of return. Scott concludes that

2. H. L. Wilgus, "Purchase of Shares of Corporation by a Director from a Shareholder," *Michigan Law Review,* VIII (1910), 267.

3. See Chapter VII of Manne's book [1966a] and his summary article [1966b].

"from a private standpoint, then, the fairness concern proves to have surprisingly little substance, when viewed in terms of the game as a whole rather than as a single, isolated play."

These arguments reflect an overly narrow view of the impact of insider trading on the market. Manne contemplates the outsider seller who gets a better price when insiders buy, but he neglects the effects of insider trading on the timing of outsider purchases and sales. Insider traders buy at the right time and sell at the right time. As we demonstrate below, it follows that on the average, outsider traders are being induced to do the opposite. When corporate employees routinely use inside information to speculate in their company's stock, there may well be some associated reduction of remuneration—just as there might be if they routinely embezzle. But Carlton and Fischel's notion that the size of these reductions would approach or even exceed that of their direct gains is predicated on the questionable assumption that the property rights to relevant information are transferred within a well-functioning market.[4] Scott may be right in asserting that outsiders will eventually anticipate the presence of insider traders and discount accordingly in purchasing stock. But then the losses would be incurred by those who were holding shares at the time the presence of insider traders became public knowledge.

Trading by insiders and informed speculators may be an efficient method of bringing some kinds of private information to the market where it appropriately affects the allocation of real resources. This is likely to be the case when the information consists of an expert opinion (say, of an experienced securities analyst) of corporate strategies and policies. Such expert opinion would have little credibility if it were simply announced, but the opinion is communicated effectively when its holder purchases shares. As with other forms of infomed trading, such trading leads to adverse selection and inefficiency, but the economic value of the information communicated may more than counterbalance both these losses and the costs of acquiring the information.

However, private information often consists of advance knowledge that would become public in due course, or could be cheaply

4. Carlton and Fischel pose the following question: if insider trading by management is so bad for the bulk of stockholders, then why do firms not generally prohibit this behavior in their corporate charters and employee contracts? One of many possible answers: in an environment in which most firms tolerate insider trading by management, a partially enforceable corporate prohibition might select for dishonest executives. And, as the authors themselves point out, a fully enforceable prohibition would be very costly to operate.

and credibly disclosed by public announcement or other nonmarket means.[5] Such foreknowledge probably conforms with what most people mean by insider information. In this paper we use the term "insider trading" to describe trading by those in possession of this type of foreknowledge.[6] Little or no social advantage is gained when this information is transmitted by trading.

Although insider traders may be employees of the corporation whose shares they trade, there is nothing in our definition of insider trading to suggest that this need be the case. As we and many others use the term, insider traders may be members of the public who have come upon information fortuitously[7] or even through very costly diligent research. As an example of the latter, consider an arbitrageur who, by dint of careful detective work, uncovers important information bearing on a company's prospects shortly before that information is to be made public. Although trading by such an informed speculator may not violate one's sense of fair play, its negative economic effects resemble those of insider trading more narrowly defined. Additionally, the labor of this arbitrageur would be a deadweight loss.

III. The Model Structure

At the core of any theoretical study of insider trading, there must be an analysis of how unevenly distributed information affects securities markets. Several recent papers [Jaffe and Winkler, 1976; Copeland and Galai, 1983; Glosten and Milgrom, 1985] have shown that informed speculation can increase the bid-ask spread. Their

5. See Hirshleifer [1971] for the landmark elaboration of the distinction between foreknowledge and socially useful information.

6. A classical example of insider trading based on private foreknowledge is provided by the *SEC v. Texas Gulf Sulphur Company,* 401 F.2d 833 [2d Cir. 1968]. Manne [1966a, pp. 39–46] and Scott [1980] provide interesting discussions of this case. In 1963 as a result of test drilling, the Texas Gulf Sulphur Company (TGS) discovered an extremely valuable deposit of mineral ore. After the discovery was made but before it was announced publicly, TGS directors, employees, and their friends purchased large quantities of TGS stock. Once the discovery was announced, the value of the stock approximately doubled. The SEC sued TGS personnel in 1965 to compel the divestiture of all profits resulting from the insider trading. In 1968 the Court of Appeals upheld the SEC and ruled that "anyone in possession of material inside information must either disclose it to the investing public, or, if he . . . chooses not to do so, must abstain from trading in or recommending the securities concerned while such inside information remains undisclosed." This has come to be known as the "disclose or abstain" rule.

7. The classic example is provided by the *United States vs. Chiarella.* The subject of *Chiarella* worked for a financial printing company. He learned about planned corporate takeovers from proofs of documents being prepared for submission to the SEC, and he then purchased shares in the takeover targets. See Scott [1980] and Herzel and Katz [1987] for discussions of this case.

models feature three groups of traders: well-informed speculators, liquidity traders, and market makers (specialists) who set prices.[8] All of these papers focus on the role of information in the microstructure of capital markets.

In order to highlight the effect of insider trading on the economic efficiency of corporate behavior, we use a model that is much simpler than those cited above. We represent only two groups of traders: insiders and outsiders; prices are set by an auctioneer (see below) in a manner consistent with a conventional model of supply and demand. This structure is sufficiently rich to capture the market forces that are material to our problem.

In our model, outsiders trade with insiders and trade among themselves. Outsiders are assumed to maintain a willingness to pay for shares (a bid price), but sales by outsiders are always nondiscretionary. This is consistent with a story in which outsiders are free to choose among the shares of different companies when they buy, but for reasons of liquidity are forced to sell from time to time without regard to price.[9]

If insider traders are to profit, then their trading must take place at prices that do not fully reflect the foreknowledge in question. In situations where insider traders collectively trade too much in too short a period of time (perhaps because there are too many insider traders or informed speculators), then before their attempted transactions are completed, share prices will have changed to reflect the foreknowledge they have; i.e., their foreknowledge will have effectively become public knowledge. Consequently, if insider trading is to be effective, it must be restrained. Where possible, insider traders may attempt to exercise collective self-restraint. Otherwise, external factors may restrain their trading. Insider traders may be risk averse—afraid to take too large a

8. The process they analyze works like this. Market makers set prices at which they are willing to buy and sell, and they are assumed to take account of insider trading in so doing. Well-informed speculation subjects market makers to adverse selection: the expected value of the corporation when a market maker is selling exceeds the expected value of the corporation when he is buying. Thus, the profit-maximizing market maker will choose to set his selling price above his buying price. This creates (or increases) the bid-ask spread. In a setting where the market marker also has private information, Gould and Verrecchi [1985] show that the market maker may have an incentive to set prices that do not completely reveal his information.

9. In this context the concepts of the asking price and the bid-ask spread are not defined, but the ultimate effect of insider trading does not change as a result. A bid-ask spread would function like a turnover tax on outsider traders. If these traders are to earn the market rate of return, then the share price must fall short of the preshare value of the firm. Empirical evidence of this occurrence is provided by Amihud and Mendelson [1986]. In our model the share price also falls short of the per share value of the firm, as we show below.

position in the market in case something goes wrong. Or they may have only limited amounts of capital at their disposal. Finally, in cases where insider traders are knowingly contravening the law, they may restrain their trading for fear of later detection by the regulating authorities. In order to reflect these restraints in our model, we specify an exogenous upper limit to the proportion of all shares that insider traders collectively can purchase.

The model we develop refers to the following example, suggested by the *Texas Gulf Sulphur* case. A prospecting firm engages in only one activity—searching for minerals. This search activity is carried out repeatedly. When a deposit is found, the firm sells the rights to that deposit at a profit. Outsider stockholders exercise ownership control of the firm, and they are free to choose the level of firm investment into the search process. The more invested in a given time period, the greater the probability of discovering minerals. The insider traders are informed of discoveries in advance of the general public and are able to purchase a limited amount of stock before a discovery is publicly announced.

A. Notation

The basic unit of time in this model is the search period, and elapsed time is measured in terms of the number of periods passed. All financial quantities are specified on a per share basis.

States of nature:

- G good state: a discovery was made in the previous period
- B bad state: no discovery was made in the previous period
- Q a given outsider acquires a share.

Parameters and variables:

- ϕ probability that a discovery will be made in a given period
- α proportion of shares held by insiders during a period with a discovery announcement
- θ probability that a given outsider who holds a share will sell it at the end of the current period
- β,δ proportional reduction in the probability of a discovery announcement when an outsider has acquired a share
- γ ratio of total outstanding shares to number of outsider traders bidding for shares
- V value of mineral discovery

C investment in search each period
A financial assets
D dividends
P outsider willingness to pay (bid); the market price
W expected discounted value of the firm
r market rate of return and discount rate.

B. The Firm

The prospecting company operates by purchasing mineral rights to a tract of land at the beginning of a search period, test drilling during the period, and if a deposit is discovered, selling those rights at the end of the period. The probability of finding a deposit, ϕ, depends on the amount C expended at the beginning of a period (per share) for mineral rights and search. If a deposit is found, the mineral rights are sold for a fixed sum V per corporate share; the mineral rights are worthless if no discovery is made. Thus, the firm will earn revenue V with probability ϕ and zero revenue with probability $1 - \phi$.

The company holds only one type of financial asset. These are safe, highly liquid assets that earn interest at the market rate of return, r. The company's investment in search is internally financed by drawing down these assets, and all company revenues are added to them. Each period the firm pays dividends in an amount determined so as to bring financial assets to a constant per share level A. For simplicity, we assume that A is sufficiently large for all costs to be financed from interest payments. This means that the firm cannot lose money in an accounting sense, so that we need not concern ourselves with the problem of limited liability.

Let G (as in "good") and B (as in "bad") denote a positive and negative discovery announcement, respectively, during the current period (corresponding to a discovery or lack thereof in the previous period). In a G-period the pre-dividend value of the firm's assets are $(1 + r)(A - C) + V$, so that dividends are given by

$$D_G = rA + V - (1 + r)C. \tag{1}$$

In a B-period pre-dividend assets are $(1 + r)(A - C)$, so that dividends will be

$$D_B = rA - (1 + r)C. \tag{2}$$

The unconditional expected value of dividends, $\overline{D} = E(D)$, is given by

$$\overline{D} = rA + \phi V - (1 + r)C. \tag{3}$$

Consequently, with r as the discount rate as well as the market rate of return, the expected per share discounted value of the firm just before dividends are paid is given by

$$W = (1 + r)\,(A + \frac{1}{r}[\phi V - (1 + r)C]). \tag{4}$$

C. Stock Trading

In this model only two classes of traders exist: insiders (including informed speculators) and outsiders. Market makers play no role. All traders are risk neutral.[10] Trading of the company's stock takes place at the beginning of each search period. Trading occurs after the results of the previous search have been determined, but before those results have become public knowledge. It is this model characteristic that reflects the potential for profitable insider trading. Just after trading occurs, the results of the previous search are announced, and dividends are paid accordingly. The firm then invests in search for the current period. This chronology of the company's productive and financial activities is summarized in Figure I.

The rules of trading are as follows: at trading time all would-be sellers offer shares for sale at any price. Would-be buyers place bids, each bid seeking one share at a specified price (or less). An "auctioneer" sets a market price at the intersection of the perfectly inelastic supply curve and the demand curve determined by the bids. If the supply curve turns out to intersect a perfectly elastic segment of the demand curve, the auctioneer allocates shares to bids at or above the market price at random. Any bid that equals or exceeds the market price will be said to "qualify" for receiving a share. All qualifying bids are awarded shares with the same probability.

In a given trading period insider traders act in a coordinated fashion, as one person. They know about discoveries before trading occurs, so that at the time of trading, they, alone, know the value that dividend payments will take in the current period. Therefore, they can purchase shares at the start of high-dividend G-periods for less than their true value. In principle, insider traders would like to hold all outstanding shares during G-periods, but as explained above, they must be quantity-constrained to be effective. Conse-

10. Herzel and Katz [1987] argue against insider trading on the grounds that it creates costly uncertainty in financial markets. This possibility is not analyzed here.

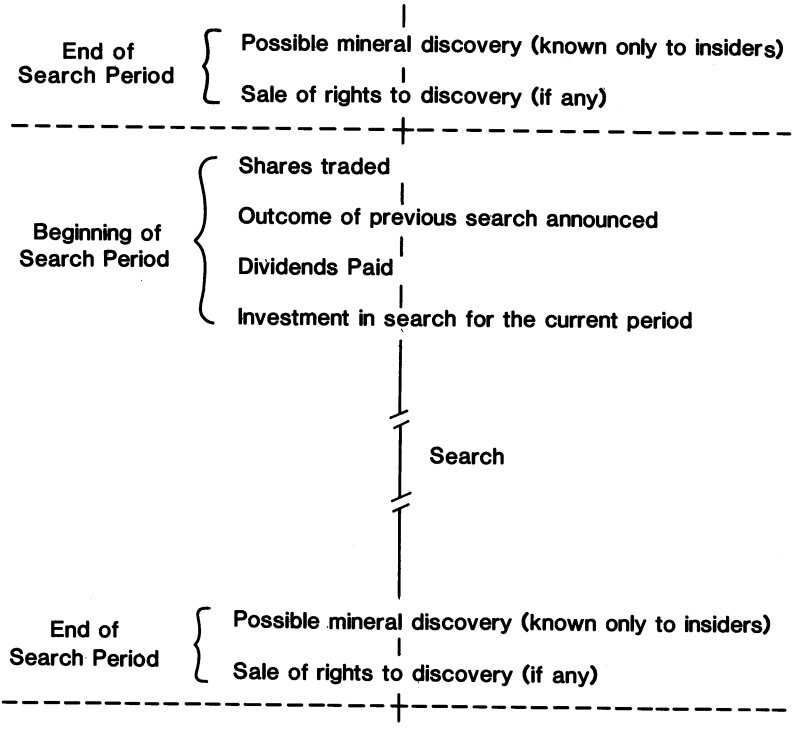

FIGURE I
The Chronology of Search and Associated Financial Transactions

quently, we assume that insiders permit themselves to hold a maximum number of shares, represented here by the fraction α, of all outstanding shares. At the start of each G-period insider traders submit a number of bids that will yield them the fraction α as a result of the auctioneer's random allocation.[11] These shares are always sold at the end of the G-period; if another G-period follows, (possibly other) insiders buy the shares back. Insider traders hold no stock during the low-dividend B-periods.[12]

Before submitting their own bids, insider traders know (or accurately estimate) the market price that would be determined by the outsiders alone. Given the rules of trading, their dominant

11. To the extent that outsider traders will be in the auctioneer's lottery, the number of bids placed by insiders will have to exceed the number of shares they plan to obtain. We assume that the total number of shares in the lottery is very large, so that the insider traders can obtain α with a high degree precision.

12. We do not model the possibility of insiders selling short.

strategy is to place all of their bids at the outsider-induced price. Lower bids would fail to qualify for shares, and higher bids might raise the market price. This means that in our model insider traders will not disturb the market price by their bidding behavior.

An outsider trader can hold at most one share. If he has a share, the outsider has the probability θ of having to sell it for liquidity reasons[13] in any given period.[14] It is assumed that $\theta > \alpha$, so that in a given period the number of shares sold is always greater than the number insiders wish to obtain.

Each outsider not holding stock is prepared to purchase one share, provided that its price implies an expected yield equal to or exceeding r. (Otherwise, the outsider would buy some other security.) The number of potential outsider buyers is much larger than the total number of outstanding shares, so that there will always be excess demand at a sufficiently low share price. All outsiders make the same calculations based on the same information, but they act independently of one another.

Suppose, now, that outsider buyers are price takers; i.e., that each can take the market price to be independent of his own bid.[15] Because insider trading does not affect the market price, the market price is independent of whether a period is G or B. Let P be defined as outsider willingness to pay for a share acquired by means of placing a qualifying bid (with future sales assumed to occur in the same setting). Since a bid qualifies if and only if it equals or exceeds the market price, the outsider's dominant strategy is to bid P. Consequently, outsiders as a group display a perfectly elastic demand at price P for this particular stock, up to some very large total (though their aggregate demand for all securities may be downward sloping). In G-periods insiders will bid P as well. The auctioneer will set the market price at P. All bids will qualify, and shares will be awarded by lottery. In G-periods insiders will receive the fraction α of all outstanding shares, and outsiders will receive the remainder of those brought to market. In B-periods outsiders will receive all shares sold.

13. We assume that the total number of outsiders with shares is very large and that, given either the presence or absence of a discovery, the disposition of each share is stochastically independent from that of other shares. Therefore, θ may be interpreted as the fraction of their holdings that outsiders as a group will sell each period.

14. Of course, the outsider would choose to sell if the expected yield from holding the stock should fall below r, but this situation never arises in our model.

15. In a formal game-theoretic model, price taking would require a continuum of traders. Second-best-type auctions do not work, because insiders buy a large block of shares.

We now derive P in each of two different scenarios, one in which all outsiders are sophisticated (aware of the true extent of insider trading) and one in which all outsiders are naive (unaware that insider trading exists at all). We shall not model any of the possible mixed cases.

IV. Sophisticated Outsiders

Unlike insiders, outsider traders do not know at the time of trading what current dividends will be. But sophisticated outsiders know the values of all other parameters and variables, including ϕ, θ, and α. We proceed to calculate outsider willingness to pay, P, as a function of these parameter values.

For sophisticated outsiders, P may take either of two values in a given period, because the number of shares on sale may take either of two values. Stock sales depend on the current distribution of stock between insiders and outsiders, which in turn is determined by whether the previous period was G or B. Let G_0 and B_0 applied to the current period describe the previous-period states of G and B, respectively. At the start of G_0-periods, outsiders hold the fraction $1 - \alpha$ of outstanding shares and sell the fraction $(1 - \alpha)\theta$; insiders hold and sell α. At the start of B_0-periods outsiders hold all of the shares and sell the fraction θ. If the current period turns out to be B, outsiders will acquire all shares sold; if it turns out to be G, insiders will acquire the fraction α, and outsiders will acquire the remainder.

For different states of nature, the fractions of all outstanding shares that outsiders will acquire in the current period are shown in the tabulation below.

	G	B	Expected value
G_0	$(1 - \alpha)\theta$	$(1 - \alpha)\theta + \alpha$	$(1 - \alpha)\theta + (1 - \phi)\alpha$
B_0	$\theta - \alpha$	θ	$\theta - \phi\alpha$

Let Q denote the event that a given outsider successfully acquires a share. To obtain the probability that Q will occur in a particular state of nature, the appropriate entry in this table must be multiplied by γ, the ratio of total outstanding shares to the number of

outsiders bidding (invariant over G and B). In state G_0 we have

$$Pr(Q|G, G_0) = \gamma(1 - \alpha)\theta$$

and

$$Pr(Q|G_0) = \gamma[(1 - \alpha)\theta + (1 - \phi)\alpha],$$

while for B_0, we have (with a different value of γ, say γ')

$$Pr(Q|G, B_0) = \gamma'(\theta - \alpha)$$

and

$$Pr(Q|B_0) = \gamma'(\theta - \phi\alpha).$$

Because an outsider trader pays for a share if and only if he acquires it (i.e., if Q occurs), he needs to know $Pr(G|Q, G_0)$ and $Pr(G|Q, B_0)$, the probabilities of a current G-period conditional on Q given G_0 and B_0, respectively. Because of insider trading, these probabilities are not the same as the respective unconditional probabilities of G. The relationship between these conditional and unconditional probabilities is defined by

$$Pr(G|Q, G_0) = (1 - \beta_G)Pr(G|G_0) = (1 - \beta_G)\phi \tag{5}$$

and

$$Pr(G|Q, B_0) = (1 - \beta_B)Pr(G|B_0) = (1 - \beta_B)\phi, \tag{6}$$

where β_G and β_B are measures of insider-trading-induced adverse selection. By Bayes Law, $Pr(G|Q, G_0) = Pr(Q|G, G_0)\phi/Pr(Q|G_0)$, so that $\beta_G = 1 - Pr(Q|G, G_0)/Pr(G|Q, G_0)$. Likewise, $\beta_B = 1 - Pr(Q|G, B_0)/Pr(Q|B_0)$. It follows that

$$\beta_G = \frac{(1 - \phi)\alpha}{(1 - \alpha)\,\theta + (1 - \phi)\alpha} \tag{7}$$

and

$$\beta_B = ((1 - \phi)\alpha)/(\theta - \phi\alpha). \tag{8}$$

Note that $\beta_G, \beta_B > 0$, so that as we expected, both $Pr(G|Q, G_0)$ and $Pr(G|Q, B_0)$ are less than ϕ. Thus, the very act of being successful in bidding for stock (state Q) conveys to the sophisticated outsider that a positive discovery announcement with a correspondingly high dividend payment is less likely than its unconditional probability. This is the winner's curse.

With these conditional probabilities, we are able to find the expected discounted value of the dividend stream and the expected

discounted value of the current selling price (see Appendix). Together with the requirement that shares have an expected yield r, this determines P_G and P_B, outsider willingness to pay in G_0-periods and B_0-periods, respectively. The mean willingness to pay, $\bar{P} = \phi P_G + (1 - \phi)P_B$, is given by

$$\bar{P} = (1 + r)\left(A + \frac{1}{r}, [(1 - \bar{\delta})\phi V - (1 + r)C]\right), \tag{9}$$

where $\bar{\delta}$ is defined by

$$\bar{\delta} \equiv \frac{(\theta + r)[\phi\beta_G + (1 - \phi)\beta_B]}{1 + r - \phi\theta(\beta_B - \beta_G)}. \tag{10}$$

From (9) we see that $\bar{\delta}$ measures the proportional reduction in expected corporate revenues reaped by outsiders because of insider trading. Because $\bar{\delta}$ is demonstrably positive for $\alpha > 0$, it follows that $\bar{P}$ is less than the per share value of the firm given by (4). This means that for stock that is regularly the target of insider traders, the recorded rate of return (measured without regard to insider trading) will be greater than the market rate of return, provided that outsider traders are sophisticated.[16]

In Figure II for various values of ϕ, we have graphed $\bar{\delta}$ as a function of θ, the rate that outsiders turn over their shares. Maximum insider holdings, α, is set at 0.25, and the market rate of return, r, is set at 0.2. As explained previously, the results are meaningful only for $\theta > \alpha$.

Figure II shows that the proportion of corporate revenues lost by outsiders rises as the outsider share-turnover rate falls. Outsiders lose the least when they trade all of their holdings in every period. At first thought, this might seem counterintuitive because the adverse selection against outsiders operates for discovery announcements in the period of purchase, while the odds of discovery announcements in subsequent periods are unaffected. The explanation is this. The smaller θ is, the smaller is the proportion of outsider trading to insider trading at any given time, and the greater the degree of adverse selection. If all outsider holdings are marketed each period ($\theta = 1$), to take one extreme, the acquisition of a share by an outsider conveys information that a discovery announcement is somewhat less likely than its unconditional probability. On the other extreme, if outsiders market only enough shares to supply insiders during discovery-announcement periods ($\theta = \alpha$, in B_0-periods), the acquisition of a share by an outsider informs him

16. Demsetz [1986] finds some empirical evidence for this contention.

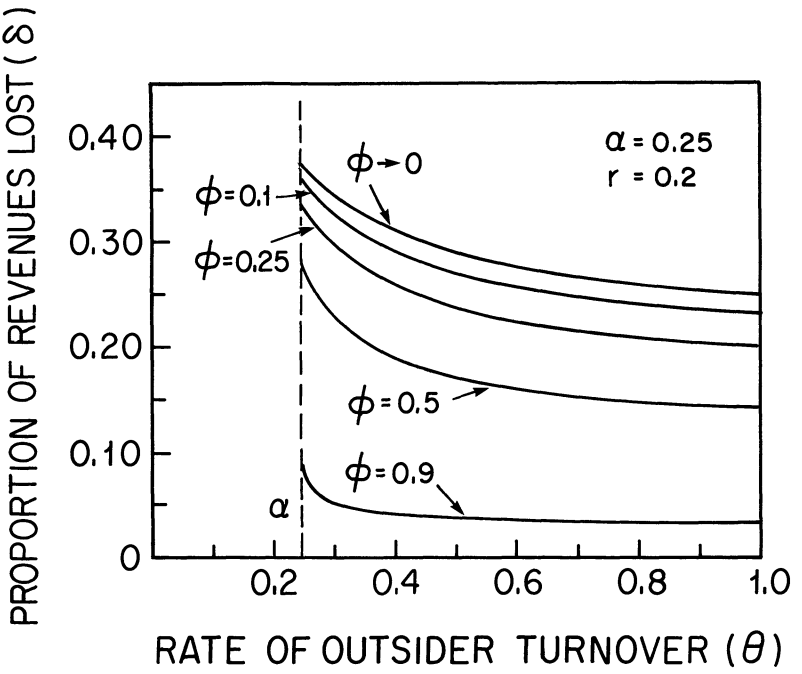

FIGURE II
Proportion of Corporate Revenues Lost by Outsider Traders

that a discovery announcement will definitely not occur during the current period. Therefore, outsider willingness to pay, and thus the market price of the stock, is lower when $\theta = \alpha$ than when $\theta = 1$. If the average market price is $\bar{P}$, then insiders can "rent" a share during discovery periods and receive high dividends at a cost $r\bar{P}$. The lower the market price, the lower the rental cost and greater the net take of the insider. Thus, $\bar{\delta}$ rises as θ falls.[17]

V. NAIVE OUTSIDERS

If outsiders are naive (i.e., unaware of the existence of insider traders), they will erroneously assume that the probability of an outsider obtaining a share is independent of the probability of a discovery announcement. This means that if naive outsiders are to project a yield of r, then P_N, the prevailing price (just before

17. Of course, for any given turnover rate of other outsiders, it would pay a particular outsider to hold onto his shares as long as possible.

dividends are paid) in all states of nature, must satisfy

$$(1 + r)(P_N - \bar{D}) = P_N,$$

where $\bar{D}$ is the unconditional expected value of dividends. Therefore, $P_N = (1 + r)\bar{D}/r = W$ as given in (4).

However, the naive expectation of dividends will exceed the true expected value of dividends by the amount $\bar{\delta}\phi V$. Naive outsiders expect to receive the market rate of return, but, unlike sophisticated outsiders, they receive less than that on the average. Consequently, one may wish to take the view that naive outsiders are victimized.

VI. Corporate Investment

Suppose that the relationship between the probability of a discovery, ϕ, and the investment in search, C, is described by the function $\phi = \phi(C)$, where the graph of $\phi(C)$ resembles the illustration in Figure III.[18] Then the socially efficient choice of C must satisfy the first-order condition,

$$\phi'(C)\,V/(1 + r) = 1. \tag{11}$$

The left-hand side of (11) is the expected present value of the marginal (social) product of a one-time investment. The right-hand side is the marginal cost of a one-time investment, which must be one because investment is measured in monetary units. (Multiply both sides of the equation by $(1 + r)/r$ to obtain the marginal social product and social cost of an investment repeated in every period). The socially optimal level of investment, C^*, is the unique value of C that solves (11).

In the presence of insider trading and sophisticated outsiders, the determination of actual corporate investment may be quite complex. To keep our calculations simple, we analyze only the case of $\theta = 1$ (outsiders sell all of their stock holdings each period). With $\theta = 1$, we have that $\bar{\delta}$, β_B, and β_G all reduce to δ, given by

$$\delta = \alpha(1 - \phi)/(1 - \alpha\phi), \tag{12}$$

and $\bar{P}$ becomes

$$P = (1 + r)\,(A + 1/r[(1 - \delta)\phi V - (1 + r)C]), \tag{13}$$

18. More precisely, we assume that $\phi' > 0$, $\phi'' < 0$, $\phi(0) = 0$, and $\phi \to 1$ as $C \to \infty$. We also assume that profits are maximized at some $C > 0$.

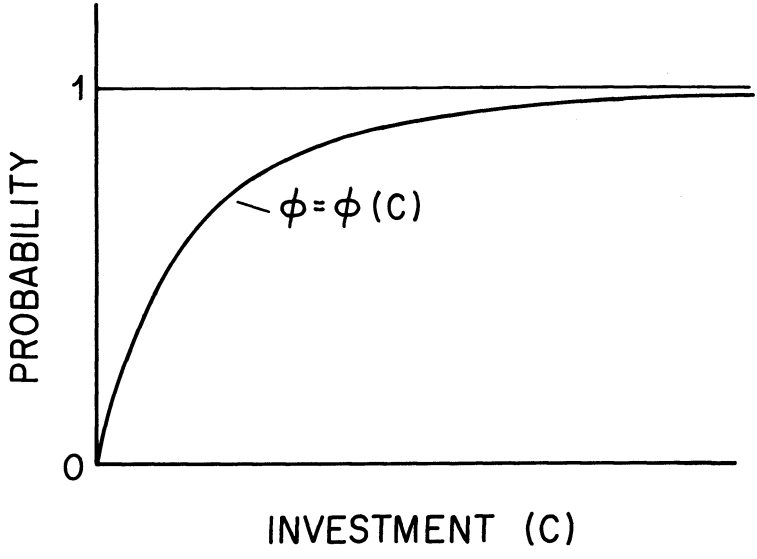

FIGURE III
Probability of Discovery

a selling price that is the same regardless of the current and previous state.

Suppose, now, that management chooses a level of investment C to maximize P and thus the return to present outsider stockholders. (Dividends of *current* stockholders are determined by previous values of C and will not be affected by the current level of investment.) The first-order condition for maximizing P is given by

$$(14) \qquad \left((1-\delta) - \frac{d\delta}{d\phi}\phi\right)\left(\phi'(C)\frac{V}{1+r}\right) = 1.$$

The outsider will choose an investment level $\tilde{C}$, given by the solution of (14) for C, and this will result in a probability of discovery $\tilde{\phi} = \phi(\tilde{C})$.

How does $\tilde{C}$ compare with C^*, the socially optimal investment level given by (11)? To understand the answer to this question, note that the left-hand side of (14) may be interpreted as the expected present value of the marginal private product (*MPP*) of a one-time investment. The right-hand side of (14) is the marginal cost of a one-time investment, which, by construction, must be one. The

level of investment $\tilde{C}$, chosen in the interest of outsiders, equates the *MPP* to the marginal cost.

The *MPP* in (14) is the product of two expressions. The second of these expressions is the expected present value of the marginal social product (*MSP*) as in (11). The first expression is the ratio of the *MPP* to the *MSP*. This ratio is the sum of two terms. The first term, $1 - \delta$, reflects the share of the marginal product lost by outsiders because of insider trading. The second term, $-\phi\, d\delta/d\phi$, reflects the fact that the firm can defend itself against insider traders in this example by increasing its investment in search. This is because investment decreases variability of revenues and thus reduces the value of the insiders' information. The second term is always positive, so that it increases the *MPP*. When $-\phi\, d\delta/d\phi$ exceeds δ, too much corporate investment occurs. Otherwise, too little occurs.

In Figure IVa we illustrate the effect of insider trading when the firm's business is inherently high risk.[19] We assumed that ϕ is given by the function

$$\phi(C) = C/(k + C)$$

and set $\alpha = \frac{1}{2}$, $V/(1 + r) = 2.25$, and $k = 1$. In this case, a large loss to insider traders results in significant underinvestment by the firm with a large attendant deadweight loss.

In Figure IVb we illustrate the effect of insider trading when the firm's business is inherently low risk. We modified the parameter values ($k = \frac{1}{3}$, $V/(1 + r) = 1.125$) so that mean revenue would remain the same as above, while its standard deviation would be cut in half. In this case, the desire of the firm to decrease the variation of its revenues leads to overinvestment in search.

With these two examples as background, it is an easy matter to classify the relation of $\tilde{C}$ to C^* for all values of α and ϕ with $\theta = 1$. Substituting (12) into the first factor of the left-hand side of (14) yields

$$MPP/MSP = (1 - \alpha)/(1 - \alpha\phi)^2. \tag{15}$$

If this ratio, evaluated at $\tilde{C}$, is less than one, then $\tilde{C} < C^*$; if the ratio is greater than one, then $\tilde{C} > C^*$. The *MPP/MSP* ratio is classified for all parameter values in Figure V. The upper and lower zones on the graph correspond to the ratio taking values greater than or less than one, respectively. Not surprisingly, underinvestment is most

19. In general, this measure of riskiness is given by $\sqrt{(1 - \phi)/\phi}$.

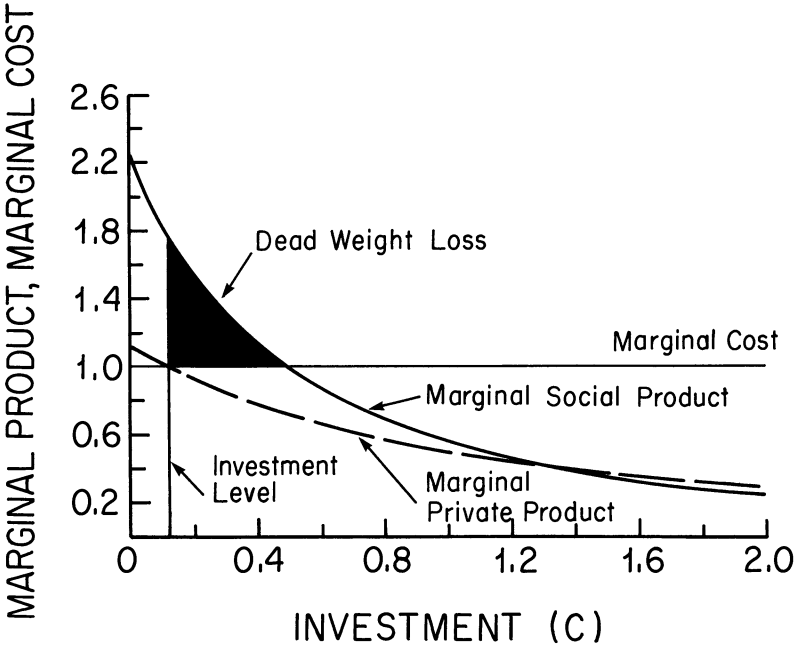

FIGURE IVa
The Private and Social Returns to High-Risk Investment

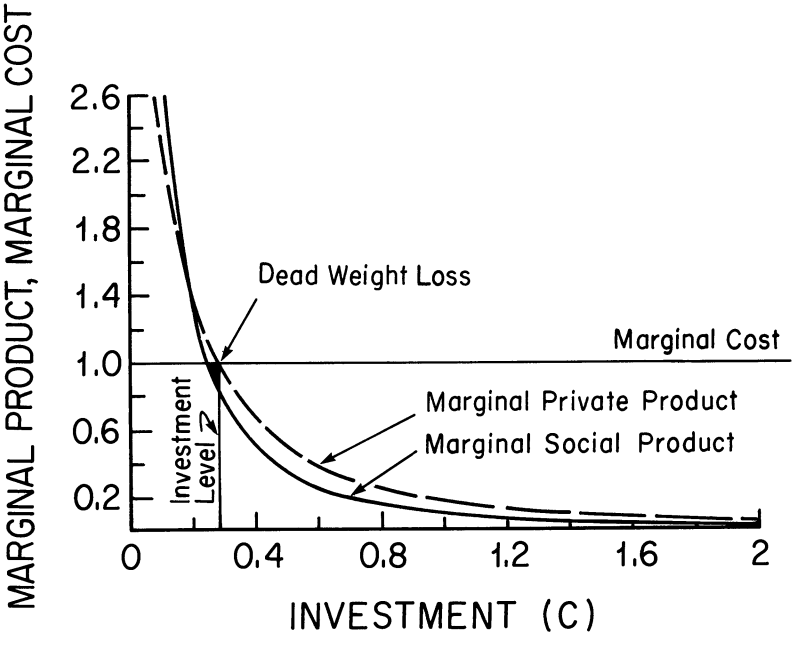

FIGURE IVb
The Private and Social Returns to Low-Risk Investment

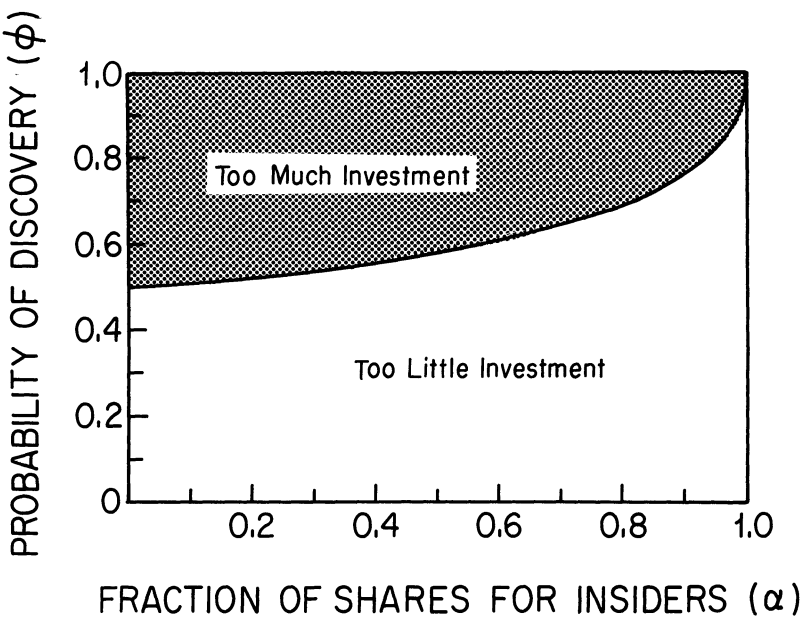

FIGURE V
The Efficiency of Investment Levels

likely to result when ϕ is small, because, controlling for expected revenues, insider information about a low probability event is valuable and the take of insider traders in this situation is large.

So far in this section we have assumed that outsider traders are sophisticated. What about the efficiency of the firm when outsiders are naive? Recall that $P_N = W$, the present value of the firm at trading time. Therefore, if managers act to maximize the return to existing naive outsider stockholders, they will maximize W and invest at an efficient level.

VII. CONCLUSION

We have argued that insider trading tends to discourage corporate investment when outsiders are aware of its general presence in the marketplace. This is because insider traders are able to appropriate some part of the returns to corporate investments made at the expense of outsider shareholders. In the context of a theoretical model, we have derived measures that provide some crude indication of the sources and extent of the investment

reduction. Our model represents insider trading in the shares of a single corporation, but that corporation could serve as a metaphor for an entire securities market.

The negative role ascribed to insider traders and informed speculators results from their foreknowledge of corporate successes and failures. In the model this foreknowledge cannot be used as a guide toward a more productive allocation of resources. Otherwise, insider trading would have an offsetting positive effect, provided that such trading were sufficiently concentrated to be revealing and thus to affect share prices. Quiet insider trading lacks this beneficial aspect.

Of course, even when insider trading is informative, it would often be preferable if insider information were communicated to the public directly, rather than through the stock market. A headline such as "ABC Discovers Copper" may be a more efficient way of communicating information to the investing public than an unexplained rise in the price of a firm's shares would be. This reasoning lends some support to the "disclose or abstain" rule of *Chiarella.*

Yet, because our argument applies to informed speculators, such as stock market analysts and arbitrageurs, as well is to insiders in the narrow sense, it is doubtful that a satisfactory administrative solution can be found for the problem. Since most informed speculators must operate as short-term traders, an economic penalty applied to short-term trading might be helpful. But much more work remains to be done before firm policy conclusions can be reached.

MATHEMATICAL APPENDIX: THE WILLINGNESS TO PAY FOR SHARES

Each bid-price for sophisticated outsiders, P_G and P_B, must obey the condition that it equal the expected discounted value (at discount rate r) of the dividend stream and the future share selling price. This is equivalent to the requirement that the share investment earn the market rate of return.

Suppose that the previous period was a G-period, and that an outsider acquires a share at the beginning of the current period. Then from (5) and (6), and (1), (2), and (3), the outsider's expected value of dividends for the current period is given by

$$E(D|Q,G_0) = \overline{D} - \beta_G \phi V.$$

His expected selling price at the beginning of the next period is

$$E(P|Q,G_0) = \bar{P} - \beta_G\phi(P_G - P_B).$$

Since the acquisition of a share yields no information about the probability of discovery announcements in future periods, the outsider's expected dividends for each future period is $\bar{D}$. Conditional on selling his share at the start of a future period t, the expected discounted value of the outsider's dividend stream is given by

$$D_{G,t} = [(1 + r)/r]\,(1 - 1/(1 + r)^t)\,\bar{D} - \beta_G\phi V,$$

and the expected discounted value of the selling price is

$$P_{G,t} = \begin{cases} [1/(1 + r)]\,[\bar{P} - \beta_G\phi(P_G - P_B)] & \text{for } t = 1 \\ [1/(1 + r)^t]\bar{P} & \text{for } t > 1. \end{cases}$$

The probability that an outsider who acquired a share currently (in period 0) will sell at the start of period t, is $\theta(1 - \theta)^{t-1}$, so that the expected discounted value of the dividend stream plus share selling price is

$$\sum_{t=1}^{\infty} \theta(1 - \theta)^{t-1}\,[D_{G,t} + P_{G,t}].$$

If the sophisticated outsider is to earn the market rate of return, r, then his bid price P_G must equal this sum. This yields the equation

$$\text{(A.1)}\quad P_G = \frac{1 + r}{r + \theta}\bar{D} + \frac{\theta}{r+\theta}\bar{P} - \beta_G\phi\left(V + \frac{\theta}{1 + r}(P_G - P_B)\right).$$

Likewise, for P_B, we have the equation

$$\text{(A.2)}\quad P_B = \frac{1 + r}{r + \theta}\bar{D} + \frac{\theta}{r + \theta}\bar{P} - \beta_B\phi\left(V + \frac{\theta}{1 + r}(P_G - P_B)\right).$$

Subtracting (A.2) from (A.1) and solving for $P_G - P_B$ yields

$$\text{(A.3)}\qquad P_G - P_B = \frac{(\beta_B - \beta_G)\phi V}{1 - (\phi\theta/(1 + r))(\beta_B - \beta_G)}.$$

Multiplying (A.1) by ϕ, (A.2) by $(1 - \phi)$, summing and applying (A.3) yields

$$\bar{P} = \frac{1 + r}{r + \theta}\bar{D} + \frac{\theta}{r + \theta}\bar{P} - \frac{\phi\beta_G + (1 - \phi)\beta_B}{1 - [(\phi\theta/(1 + r)](\beta_B - \beta_G)}\phi V,$$

Solving for $\bar{P}$ yields

$$\text{(A.4)} \qquad \bar{P} = \frac{1+r}{r}\left(\bar{D} - \frac{(\theta + r)[\theta\beta_G + (1-\theta)\beta_B]}{1 + r - \phi\theta(\beta_B - B_G)}\phi V\right).$$

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