Insider Trading In A Rational Expectations Economy

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It is often argued that efficiency considerations require society to freely permit insider trading. In this article, an opposing efficiency argument is formalized. The model incorporates an investment stage followed by a trading stage. If "outsiders" expect "insiders" to take advantage of them in trading, outsiders will reduce their investment. The insiders' loss from this diminished investor confidence may more than offset their trading gains. Consequently, a prohibition on insider trading may effect a Pareto improvement. Insiders are made better off if they can precommit not to trade on their privileged information; government regulation accomplishes exactly this. (*JEL* 022, 026, 313)

The traditional rationale articulated for insider trading regulation and other securities law is that such rules promote confidence in markets. Indeed, President Franklin D. Roosevelt justified the first major U.S. securities legislation by saying: "It should give impetus to honest dealing in securities and thereby bring back public confidence".[1] Similar language is still invoked half a century later, in connection with enforcement efforts against insider trading and in proposals for tightened stock market regulation.

Yet the weight of academic law-and-economics commentary has been opposed to the regulation of insider trading. Scholars have argued that permitting trade on the basis of inside information creates desirable incentives and, for a variety of reasons, improves economic efficiency. At the same time, it has been maintained that the fact of prices reflecting information would prevent insiders from earning significant trading profits at the expense of outsiders or that, in any event, outsiders are not harmed by insider trading.

My objective in the current article will be to reformulate the confidence rationale as an economic argument for insider trading regulation. I develop a two-stage model, consisting of an investment stage followed by a trading stage. In the initial period, agents make their investment decisions based on their expected second-period returns, which in turn hinge on whether they will be "insiders" or "outsiders" and on whether insiders will be permitted to trade on their private information. The second period is a pure exchange economy (of endowments determined by the first-period investments) in which it is feasible for insiders to exploit their private information in a partially revealing rational expectations equilibrium.

For many plausible specifications of the model, the outcome when society regulates insider trading is a Pareto improvement over the outcome when insider trading is permit-

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[1] 77 Congressional Record 937 (March 29, 1933). The quote is taken from President Roosevelt's message to Congress in proposing legislation that became the Securities Act of 1933. This act requires the disclosure of information in connection with the initial offering of a security. The legislative underpinnings of federal insider trading regulation are contained in the closely related Securities Exchange Act of 1934 (see Section I).

ted.[2] Under such scenarios, economic efficiency would require the banning of insider trading. The intuition for this conclusion, which contradicts most previous economic analyses of insider trading, is as follows. Abolition of insider trading in an exchange situation will typically improve the expected return on investment of outsiders. If the quantity of investment increases in the expected return,[3] then insider trading regulation promotes investment by outsiders. To the extent that insiders are helped by increased outside investment,[4] insiders thus also benefit from insider trading regulation. In other words, insiders are made better off if they can somehow precommit not to trade on their privileged information; government regulation and enforcement accomplish exactly this.

My analysis thus provides an economic formalization of the notion of confidence in markets. Let "confidence" be interpreted as the rational belief by outsiders that their return on investment is not being diluted by insiders' trading. Then, perhaps, the goal of insider trading regulation and securities law truly is to foster confidence in markets. When confidence is promoted, outsiders and insiders may benefit alike.

The article is organized as follows. In Section I, I define insider trading and critically discuss the related literature. Section II provides an overview of the structure and essential ingredients of the model. In Section III, I formally develop the trading stage when insider trading is permitted; in Section IV, I formally develop the investment stage. Section V modifies the model to treat a regulatory regime in which insider trading is banned. Section VI contains a welfare analysis of insider trading regulation for a set of parameter values in the model economy. Section VII provides my conclusions.

I. A Brief Review

A. *Insider Trading Defined*

Insider trading occurs when an individual (commonly called an "insider") buys or sells securities on the basis of material, nonpublic information. American law imposes an *abstain or disclose* requirement on insiders. Suppose that an individual has privileged access to corporate information which is not generally available and which materially affects investment decisions concerning the company's stock. Under the doctrine of *In re Cady, Roberts & Co.* [5] and *SEC* v. *Texas Gulf Sulphur Co.*, [6] the insider is required to choose between two options: he may either abstain from engaging in any trading activity in the security in question until such time that the information becomes public; or he may, himself, publicly disclose the information to the marketplace before trading. Failure to abstain or disclose may subject the insider to civil liability and criminal prosecution under Rules 10b-5 or 14e-3, which were promulgated by the Securities and Exchange Commission under rule-making authority granted by Congress in Sections 10(b) and 14(e) of the Securities Exchange Act of 1934.[7]

[2]The reader should be alerted to the words "many plausible specifications of the model" in this sentence. This article demonstrates that, in *some* specifications, a ban on insider trading effects a Pareto improvement. In others, regulation works to help outsiders but harm insiders. See Sections VI and VII.

[3]Contemporary government policies designed to promote investment and savings seem to be premised on the notion that the quantity of investment increases in the expected return (i.e., that investment is not a Giffen good).

[4]Traditional corporate insiders (e.g., officers and directors) benefit from outside investment, because this investment is a source of needed capital for their organizations. Nontraditional insiders (e.g., investment bankers and arbitrageurs) also benefit from outside investment, because this investment is the origin of initial public offerings and secondary trades, which again contribute to the insiders' livelihoods.

[5]40 SEC 907 (1961).

[6]401 F.2d 833 (2d Cir. 1968) (en banc), *cert. denied*, 394 U.S. 976 (1969).

[7]Rule 10b-5 is a general prohibition on fraudulent acts and practices connected with the trading of securities: the subsequent case law (beginning with the *Cady, Roberts* and *Texas Gulf Sulphur* cases) has interpreted this rule to proscribe insider trading. Rule 14e-3 is a ban on fraudulent or deceptive acts and practices specifically connected with tender offers.

The term "insider," as used here, refers not merely to a traditional corporate insider but more broadly to any individual whose actions are confined by the insider trading laws. Whether an individual is considered to be an insider, and thus whether he is bound by the abstain-or-disclose requirement, may depend on which of Rules 10b-5 or 14e-3 is being applied. In order to violate Rule 10b-5, the individual must be linked with the firm whose security is traded or with the nonpublic information in such a way that the use of the information in his trading is deemed to breach some fiduciary duty. Under limitations set forth in *Chiarella* v. *United States* [8] and affirmed in *Dirks* v. *SEC*, [9] the insider's fiduciary duty may derive from: (a) working inside the firm (e.g., employment as an officer or director of the company whose securities are traded); (b) working outside the firm in a capacity which nevertheless leads to an obligation to shareholders (e.g., employment as an investment banker, lawyer, or accountant for the company whose securities are traded); or (c) receiving information from another individual whose conveyance of the information itself constitutes a breach of duty (e.g., receiving a tip from a corporate officer who expects to benefit from the disclosure). Alternatively, under the so-called *misappropriation theory*, if an individual trades on the basis of information misappropriated from its source (typically, taken from the individual's employer), the misuse of information may itself constitute the breach of fiduciary duty that is required for conviction under Rule 10b-5.[10]

In contrast, Rule 14e-3 does not contain any duty requirement in its notion of who is an "insider." (It does, however, retain the notion from Rule 10b-5 that "willful misconduct" is a prerequisite to any violation.[11]) If *any* individual (not necessarily a person who has breached a fiduciary duty) trades while in possession of material, nonpublic information *connected with a tender offer* by another party,[12] he may be subject to prosecution for insider trading under Rule 14e-3.[13,14]

B. *The Classic Law-and-Economics View*

The classic law-and-economics view on insider trading can be briefly summarized as follows. Insider trading is banned today out of considerations of *fairness*. In an unregulated environment, insiders might be able to earn trading profits by utilizing information that outsiders cannot legally obtain. Out of some sentimental attachment to fairness, we enact insider trading regulations in order to level the securities market playing field, so that all traders have relatively equal access to information.

Unfortunately, considerations of economic *efficiency* work in the opposite direc-

[8] 445 U.S. 222 (1980).

[9] 463 U.S. 646 (1983).

[10] The misappropriation theory was adopted by the U.S. Court of Appeals, 2nd Circuit, in *United States* v. *Newman*, 664 F.2d 12 (2d Cir. 1981), *cert. denied*, 104 S.Ct 193 (1984). It was considered inconclusively by the U.S. Supreme Court in *Carpenter* v. *United States*, 108 S.Ct. 316 (1987). Divided in a 4–4 vote, the Court failed to overturn the insider trading convictions of *Wall Street Journal* reporter R. Foster Winans (and others) for prepublication trading on the basis of information that would appear in his "Heard on the Street" column.

[11] *United States* v. *Chestman*, 704 F. Supp. 451 (S.D.N.Y. 1989); *United States* v. *Marcus Schloss & Co., Inc.*, 710 F. Supp. 944 (S.D.N.Y. 1989).

[12] A party planning to make a tender offer (or his agent) is permitted to purchase shares on the open market in advance of a public announcement—provided he does not run astray of other provisions of the Williams Act.

[13] It should be added that there exists another federal rule under which (only civil) insider trading liability is possible. A traditional insider (an officer, director, or major shareholder) is liable to his company for any profits he earned from *matched purchases and sales of securities within the same six-month period* (irrespective of whether it can be shown that he possessed material, nonpublic information), under Section 16 of the Securities Exchange Act of 1934. The presumption behind this provision on "short swing" trading seems to be that, whenever an insider buys and sells in close proximity, it is likely to be on the basis of (possibly unidentifiable) private information.

[14] The discussion of fiduciary duty contained in the second and third paragraphs of this section is largely drawn from Chapters 3, 6, and 7 of Donald Langevoort (1990).

tion as those of fairness. First, if insiders are permitted to trade freely on their private information, then information becomes more rapidly reflected in securities prices. Insider trading thus contributes to efficient markets and so to allocational efficiency, as proper capital-asset pricing leads to the optimal allocation of capital resources. Second, "profits from insider trading constitute the only effective compensation scheme for entrepreneurial services in large corporations" (Henry Manne, 1966b p. 116). As Manne viewed the world, individuals do little innovation except when they are afforded the opportunity to share in the value they create; in large organizations, insider trading is basically the only mechanism for employees to obtain compensation for their innovations.

Furthermore, the fairness considerations are misplaced, as insider trading is effectively a victimless crime:

> The insiders' gain is not made at the expense of anyone. The occasionally voiced objection to insider trading—that someone must be losing the specific money the insiders make—is not true in any relevant sense.
> [Manne, 1966a p. 61]

Even if the redistributional concerns are real, they are difficult for economists to evaluate (or are irrelevant) because any profit derived from insider trading is an essentially costless transfer payment. Finally, the fact that insider trading by the company's own management is typically not banned by explicit provisions of the corporate charter may be taken as evidence that governmental insider trading regulation does not enhance shareholder value (Dennis Carlton and Daniel Fischel, 1983).

C. *Some Criticisms of the Classic View*

The model described in the following sections of the article does not directly address some of the above arguments. Instead, I stake out a new argument which cuts in the opposite direction. Thus, before proceeding with the new model, it may prove useful to review and articulate some direct responses to the classic view.

In a very general sense, there exists a fundamental tension in the viewpoint that insider trading promotes economic efficiency. As Manne recognized in the first sentence of his 1966 treatise (but which remains equally true today), "Probably no aspect of modern corporate life has been more roundly condemned than insider trading." It is somewhat awkward to reconcile his view (of insider trading as the guarantor of efficient markets and the protector of entrepreneurship in the modern corporation) with the almost universal opprobrium that society directs toward practitioners of insider trading.

If insider trading is efficient (or even if insiders as a group benefit from the practice), there remains a political economy puzzle as to why insider trading regulations are ever promulgated. As David Haddock and Jonathan Macey (1987 p. 312) observe:

> Modern public-choice theory suggests that regulatory actions, including the decisions of the SEC, will divert wealth from relatively diffuse groups toward more coalesced groups whose members have strong individual interests in the regulation's effect. Yet, if one adopts the conventional view that the battle lines of insider trading regulation are drawn between insiders and ordinary shareholders (or the general public), the SEC would seem to be channeling wealth that otherwise would be captured by a group with relatively cohesive interests (insiders) toward those with extremely weak and diffuse interests (ordinary shareholders or the general public).

The fact that, empirically, we witness proscriptions against the practice becomes much less a mystery if insiders have a group interest in precommitting not to trade on

their private information, as I will argue below.[15]

More specifically, Manne's incentive argument has been criticized on account that insider trading, as a compensation device, creates a moral hazard problem.[16] An individual who has the abilities both to generate and to trade on inside information is given the perverse incentive to generate "bad" news, which is easier to create than "good" news yet equally profitable to trade on (by selling short, instead of buying long).[17] Meanwhile, a company-granted call option is probably a more finely tuned instrument for giving an employee a stake in the value of the corporation's stock than is legalized insider trading (also avoiding the moral hazard problem). In any case, the incentive argument would not appear to be especially relevant to the recent rage of insider trading, which has mostly involved market professionals (e.g., investment bankers and arbitrageurs), rather than traditional corporate "insiders" engaging in entrepreneurial activities.

Researchers have also challenged the notion that insider trading necessarily increases the rapidity with which information becomes reflected in stock prices. Victor Brudney (1979 note 43), Frank Easterbrook (1981) and others have noted that the prospect of insider trading may give corporate insiders an incentive to delay the disclosure of information to the marketplace. In a recent paper, Michael Fishman and Kathleen Hagerty (1989) argue that the presence of insider trading may discourage outsiders (e.g., stock analysts) from independently generating information, perhaps leading to less informative securities prices.

Finally, it has been observed that the failure of firms to ban insider trading on their own does not constitute conclusive evidence that public regulation is inefficient. One retort is offered by Richard Posner (1986 p. 393), who notes that "if the probability of detection is so low that heavy penalties—which private companies are not allowed to impose—would be necessary to curtail the practice, it might not pay companies to try to curtail it." Examples of "heavy penalties" available only to public enforcers include prison terms and lifetime debarment from the securities industry. Moreover, if insider trading is forbidden by the government and if such laws are not expected to change, then the presence of trading restrictions in corporate charters would be redundant and unnecessary.

D. *Other Related Literature*

There exists a fairly extensive empirical and experimental literature on insider trading. James Lorie and Victor Niederhoffer (1968), Jeffrey Jaffe (1974), Nejat Seyhun (1986), and others have examined the profitability of trading rules based on the actual purchases and sales of corporate officers, directors and major stockholders (who are required, by Section 16 of the Securities Exchange Act of 1934, to report their transactions). The studies have found that insiders can, in fact, earn extranormal trading profits. Extensive (unpublished, but widely publicized) experimental work on insider trading was conducted in the mid-1980's by R. Foster Winans, Dennis Levine, Ivan Boesky, Drexel Burnham Lambert Inc., and others. The experimental studies were able

[15]As evidence that insiders may actually wish to quash insider trading, see the recent comments of Arthur Levitt, Jr., chairman of the American Stock Exchange: "If the investor thinks he's not getting a fair share, he's not going to invest and that is going to hurt capital formation in the long run" (quoted in *Business Week*, April 29, 1985, p. 79). Also observe that the Insider Trading and Securities Fraud Enforcement Act of 1988, which greatly increased the monetary penalties and jail terms for these crimes, ultimately gained the backing of the Securities Industry Association, a leading industry group (as reported in *The New York Times*, October 23, 1988, pp. 1, 15). Finally, it is interesting that both the 1988 act and the Insider Trading Sanctions Act of 1984 (which stiffened penalties and plugged the options loophole) passed the U.S. Congress without any dissenting votes.

[16]For a longer discussion of the moral hazard problem, see Joel Seligman (1985 pp. 1094–6). For a general discussion of the relative merits of compensating managers by allowing them to trade on private information, see Ronald Dye (1984).

[17]It is worth observing here that Section 16 of the Securities Exchange Act of 1934 prohibits short selling by officers and directors of shares in their own company.

to replicate the conclusions that had been reached by the earlier empirical articles.

A long line of theoretical articles has addressed the issue of information revelation in an asymmetrically informed market with a large number of traders. In Beth Allen (1981), Douglas Diamond and Robert Verrecchia (1981), Sanford Grossman and Joseph Stiglitz (1980), James Jordan (1983), Roy Radner (1979), and other models, some or all of the informed agents' private information is revealed to uninformed agents via the inversion of the rational expectations equilibrium price function. I have provided a more thorough review of the microeconomic rational expectations equilibrium literature in the introduction of a previous article (Ausubel, 1990).

Some other theoretical articles have examined information revelation in a market in which only a single agent possesses a relevant piece of information. Some of this literature also explicitly discusses insider trading. Douglas Gale and Martin Hellwig (1987), Richard Kihlstrom and Andrew Postlewaite (1983), Albert Kyle (1985), Jean-Jacques Laffont and Eric S. Maskin (1990), and others have studied the strategic revelation of information, which necessarily becomes an issue in this context.[18]

II. An Overview of the Model

Consider a two-period model with two goods, two components to the state of the world, and two types of representative agents, who are denoted *insiders* and *outsiders*. In the first period, which occurs before any agent has received private information, insiders individually decide how much labor to invest in producing good x and outsiders individually decide how much labor to invest in producing good y. Between the first and second periods, insiders are privately informed of the state of the world, while outsiders receive no private information. (The state affects agents by entering into their state-dependent utility functions.) In the second period, insiders and outsiders trade in a pure exchange economy, where agents' "endowments" (which are now treated as exogenous) equal their investment decisions of the first period.

Even in a trading process where insiders are permitted to trade freely on the basis of their private information, outsiders learn at least some of the insiders' information, via the rational expectations equilibrium (REE) price function. However, since there are *two* components to information but only *one* relative price to reveal it, the REE is only *partially revealing*. As a consequence, outsiders make nontrivially inferior decisions to those they would make under full information. Finally, after the second period, all information becomes public, and utilities are realized based on the state of the world and agents' holdings of the two goods at the end of the second period. The timing of events is illustrated in Figure 1.

I now introduce a modeling device which is meant to represent insider trading regulation. Any agent who has been designated an insider is given the choice between two alternatives in the trading round: he may either abstain from trade and, hence, consume precisely his endowment brought forward from the investment round; or he may publicly disclose his information to the marketplace before trading. This modeling device is intended to capture the essential empirical details of the first paragraph of Section I, while abstracting away from any of the legal technicalities in the second and third paragraphs of that section. Under a regulatory regime where insider trading is banned in this manner, each of the representative insiders in the model is induced to disclose his information, so that the trading round is transformed into one of complete information. The outcome of the trading round is thus changed, and in anticipation of that change, the outcome of the investment round also changes.

[18]Insider trading research by Roland Benabou and Guy Laroque (1989), Utpal Bhattacharya and Matthew Spiegel (1989), Jurgen Dennert (1989), and Michael Manove (1989) has also come to my attention since the initial preparation of the current article. These papers use a wide diversity of modeling techniques but share with the current article a healthy degree of skepticism toward the efficiency claims of proponents of insider trading.

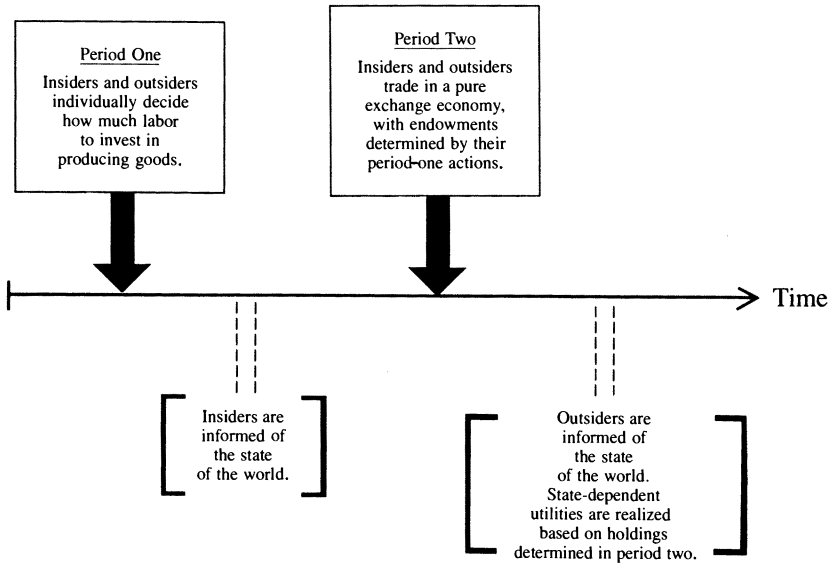


FIGURE 1. TIMING OF EVENTS IN THE INSIDER TRADING MODEL

This analysis makes three basic methodological advances over previous research on insider trading. First, I examine the *ex ante* efficiency of two regulatory regimes, comparing agents' expected utilities before the start of both trading and the underlying investment. Previous analyses have ignored incentive effects on the level of investment activity, only examining utilities preceding a trading round.[19] Second, I fully specify all agents' utility functions and perform a complete welfare comparison. In contrast, earlier work typically specified trading rounds utilizing "noise traders" (who are not explicitly given utility functions) and linear-quadratic functional forms (which yield prices that are sometimes negative); inclusion of either of these features makes welfare analysis problematical. Third, I prove that my model exhibits a unique equilibrium. Other articles on the subject have frequently chosen a convenient (i.e., linear) solution without resolving whether there exist other equilibria possessing possibly different qualitative characteristics.

Rational expectations equilibrium in a competitive economy specifically models a situation in which there are large numbers of insiders and large numbers of outsiders. In particular, insiders act not only as price-takers but also as information-takers; the modeling technique has insiders ignore that they are affecting the aggregate amount of information available to outsiders when the insiders determine their use of information. This modeling device might fairly well describe a situation such as the November 1988 takeover of Triangle Industries by Pechiney, for which it has been reported that at least eight separate buyers independently bought stock in advance of the acquisition announcement (on the basis of material nonpublic information).[20]

[19]Some earlier commentators have informally taken an *ex ante* view in discussing the fairness of insider trading. For example, Kenneth Scott (1980 p. 809) writes: "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." Just as Scott used an *ex ante* approach to counter the usual fairness argument, I use an *ex ante* approach to counter the usual efficiency argument.

[20]See, for example, *The New York Times*, January 30, 1989, p. 28. The reader may initially react to the exchange-economy formulation of the trading round in

The REE modeling device would not so well describe a scenario in which a single trader uniquely possessed the private information. However, it seems evident that substitution of a trading round along the latter lines would only exacerbate the efficiency problem. If the insider need not behave as an information-taker, his trading profits would presumably increase, further inhibiting outsiders from investing. Competitive use of information is apparently the most friendly terrain for favoring insider trading; monopolistic use of information would seem only to strengthen the case against it.

It is illuminating to highlight briefly the ingredients of the model that drive the results. First, in order for insiders to profit at the expense of outsiders, it is necessary that the equilibrium of the trading round be only partially revealing. Second, in order for the disparity of information in the trading round to make a difference, it is necessary that insiders and outsiders have different preferences on the underlying commodities.[21] Third, in order to obtain the strong welfare result that banning insider trading makes *everybody* better off (in some examples), it is useful that: (a) income effects are such that the quantity of investment by outsiders increases as the return on investment increases; and (b) insiders derive some benefit from the investment of outsiders. I will formally outline the model by first giving a description of the second stage of the model and then giving a description of the initial stage.

III. The Trading Stage When Insider Trading Is Permitted

When insider trading is permitted, the second period is modeled as an example of my (1990) partially revealing rational expectations model. The state of the world consists of two independent random variables: a continuous random variable, $\tilde{\beta}$, which is uniformly distributed on the unit interval $I \equiv [0,1]$; and a dichotomous random variable, $\tilde{\gamma}$, which takes on the two elements of $\Gamma \equiv \{\mathrm{H}, \mathrm{T}\}$ ("heads" or "tails") with probabilities h assigned to H and $1-h$ attached to T. The realization, (β, γ), is payoff-relevant to agents because it enters into their (state-dependent) utility functions.

Agents are divided into two types, according to their private information. There is a continuum of identical insiders (whose utilities, endowments, and demands are subscripted by 1) and a continuum of identical outsiders (subscripted by 2), each indexed by the unit interval. Insiders privately learn precisely the true realization of $(\tilde{\beta}, \tilde{\gamma})$ between periods one and two, while outsiders do not directly learn the realization until after period two. However, as we shall see, outsiders will indirectly infer some information about the state by observing the price (which, in turn, is influenced by the insiders' actions).

Section 4 as bearing little relation to a corporate takeover context such as Pechiney/Triangle. The relation becomes much clearer if the terms of the model are reinterpreted. The state-dependent utilities in my model could be viewed as representing the conditional expected utilities that shareholders obtain from holding Triangle's stock. The two components of the state of the world could be thought of as a continuous random variable, $\tilde{\beta}$, representing the intrinsic earnings potential of Triangle's capital assets, and a dichotomous random variable, $\tilde{\gamma}$, representing whether or not Pechiney is planning a takeover.

[21] This is a natural assumption to make in the market for commodities I use here, since different agents can easily have different preferences over the two commodities. It may not be so obvious to the reader that heterogeneity of preferences is as natural an assumption to make in a market for stocks, since everybody prefers a high return to a low return. In fact, some recent papers have argued that heterogeneity of preferences for stocks is quite natural. Laurie Bagwell (1988) and Yves Balcer and Kenneth Judd (1987) show that, in the presence of a capital gains tax which is imposed upon the realization (rather than the accrual) of a gain, current (taxable) shareholders who purchased the stock at different prices have different objectives. Bagwell and Judd (1988) demonstrate that shareholders with different levels of risk aversion and different marginal propensities to consume have different objectives. Empirical work is also beginning to confirm this assumption. Andrei Schleifer (1986) finds that demand curves for the purchase of stock (which are added to the S&P 500 Index) are downward sloping, as opposed to horizontal. Bagwell (1989) finds that supply curves for the sale of stock (in Dutch-auction repurchases) are upward sloping, as opposed to horizontal.

There are two goods, denoted x and y. Prices for the two goods are assumed to be nonnegative and are normalized to sum to one. I usually only explicitly mention the price of good x, which I denote by the function $p(\cdot,\cdot)$ and the scalar ϕ. A representative insider begins period two with an exogenous endowment $(\bar{x}_1, \bar{y}_1)$, where $\bar{x}_1, \bar{y}_1 \geq 0$, and trades to a consumption of (x_1, y_1), where $x_1, y_1 \geq 0$. Similarly, a representative outsider begins period two with an exogenous endowment $(\bar{x}_2, \bar{y}_2)$ and trades to a consumption of (x_2, y_2). Since each of the two types of agents is indexed by an interval of length one, the aggregate endowments and demands are also given by $(\bar{x}_1, \bar{y}_1)$, (x_1, y_1), $(\bar{x}_2, \bar{y}_2)$, and (x_2, y_2). In the next section, endowments will be endogenized when we introduce period one; we will then have $\bar{x}_1 > 0$, $\bar{y}_2 > 0$, and $\bar{x}_2 = 0 = \bar{y}_1$.

Agents' utilities derived from consumption are given by state-dependent, Cobb-Douglas utility functions. Let the representative insider's utility function be given by

$$(1)\quad U_1(x_1, y_1; \beta, \gamma) = \begin{cases} x_1^{\alpha_{\mathrm{H}}(\beta)} y_1^{[1-\alpha_{\mathrm{H}}(\beta)]} & \text{if } \gamma = \mathrm{H} \\ x_1^{\alpha_{\mathrm{T}}(\beta)} y_1^{[1-\alpha_{\mathrm{T}}(\beta)]} & \text{if } \gamma = \mathrm{T} \end{cases}$$

where $\alpha_{\mathrm{H}}(\beta) \equiv \beta^{\mu_{\mathrm{H}}}$, $\alpha_{\mathrm{T}}(\beta) \equiv \beta^{\mu_{\mathrm{T}}}$, and μ_{H} and μ_{T} are unequal positive constants. Let the representative outsider's utility function be given by

$$(2)\qquad U_2(x_2, y_2; \beta, \gamma) = x_2^{\beta} y_2^{1-\beta}$$

for $\gamma = \mathrm{H}, \mathrm{T}$.

It can immediately be shown that this competitive model, as specified, does *not* possess any fully revealing rational expectations equilibrium. The reasoning is as follows. Suppose that there were a fully revealing REE, in other words, an equilibrium with the property that an outsider, by observing the market-clearing price, could infer the precise state (β, γ). Then, the forms of the utility functions in equations (1) and (2) imply that good x is valueless when $\beta = 0$ and that good y is valueless when $\beta = 1$. Consequently, $p(0, \mathrm{H})$ [i.e., the price when the state is $(0, \mathrm{H})$] would equal zero, $p(1, \mathrm{H})$ would equal one, and the "heads branch" of states would occupy all prices between. Similarly, $p(0, \mathrm{T})$ would equal zero, $p(1, \mathrm{T})$ would equal one, and the "tails branch" of states would occupy all prices between. Now choose any price ϕ such that $0 < \phi < 1$. Then ϕ would be the price associated with two states $[(\beta, \mathrm{H})$ and $(\beta', \mathrm{T})]$, contradicting the hypothesis that an outsider could infer the precise state from observing the market-clearing price.

The argument of the previous paragraph further suggests that equilibria of this competitive model will be pairwise revealing (i.e., the outsider should be able to infer from price that the state is one of exactly two possibilities). Indeed, one can prove using a variation of theorem 5 in Ausubel (1990) that any REE of this model is necessarily characterized by a monotone continuous price function[22] which, moreover, is pairwise revealing.[23] Taking this fact as given, I will now provide existence and uniqueness results by direct construction.

Observe that the representative insider has full information. For a given price ϕ, let $w_1 \equiv \phi \bar{x}_1 + (1-\phi)\bar{y}_1$ denote the insider's wealth. Then, in any state (β, γ), the insider seeks to maximize $U_1(x_1, y_1; \beta, \gamma)$ subject to the budget constraint $\phi x_1 + (1-\phi) y_1 \leq w_1$. Since utility is Cobb-Douglas, the insider's demand for each good is given by his wealth, divided by the good's price and multiplied by the exponent to which the good's con-

[22] It is easy to see that, within the class of monotone and continuous REE price functions, only pairwise-revealing equilibria are possible. Consider any price function, $p(\cdot, \gamma)$ that is monotone and continuous for each of $\gamma = \mathrm{H}$ and T. As in the main text, $p(0, \mathrm{H}) = p(0, \mathrm{T}) = 0$ and $p(1, \mathrm{H}) = p(1, \mathrm{T}) = 1$; therefore for every $\phi (0 < \phi < 1)$, there exists unique $\beta [0 < \beta < 1]$ and unique $\alpha(\beta) [0 < \alpha(\beta) < 1]$ such that $p(\beta, \mathrm{H}) = p(\alpha(\beta), \mathrm{T}) = \phi$.

[23] The reasoning behind theorem 5 of Ausubel (1990) establishes that, within the class of (Borel measurable) REE price functions, only pairwise-revealing equilibria are possible. Borel measurability should be considered part of the definition of rational expectations equilibrium. Existence is treated more generally in theorem 2 and corollary 1 of Ausubel (1990).

sumption is raised:

$$(3)\quad x_1(\phi,\bar{x}_1,\bar{y}_1;\beta,\gamma)=[w_1/\phi]\alpha_\gamma(\beta)$$

$$y_1(\phi,\bar{x}_1,\bar{y}_1;\beta,\gamma)$$

$$=[w_1/(1-\phi)][1-\alpha_\gamma(\beta)].$$

Define $\alpha(\beta)\equiv\alpha_{\mathrm{T}}^{-1}(\alpha_{\mathrm{H}}(\beta))=\beta^{\mu_{\mathrm{H}}/\mu_{\mathrm{T}}}$. Using the fact that $\alpha_{\mathrm{H}}(\beta)=\alpha_{\mathrm{T}}(\alpha(\beta))$, it is easy to see that if the price ϕ is identical in states (β,H) and $(\alpha(\beta),\mathrm{T})$, then an insider will display identical demands in those two states.

Now suppose that equilibrium price ϕ is uniquely associated with the states (β,H) and $(\alpha(\beta),\mathrm{T})$. Then, upon observing price ϕ, any outsider cannot determine which of these two states has actually occurred. It is tempting to conclude that the conditional probabilities to place on (β,H) and $(\alpha(\beta),\mathrm{T})$ should merely equal the prior probabilities of H and T, respectively. However, this intuition is misleading and ignores the fact that the two branches of the price function typically have different slopes at a given price observation. Hence, the observation confers additional information. To gain a better intuition for the conditional probabilities, it is helpful to refer to Figure 2. In the Appendix, it is formally demonstrated that

$$(4)\quad \pi(\beta)$$

$$\equiv\Pr[(\tilde{\beta},\tilde{\gamma})=(\beta,\mathrm{H})\,|\,p(\tilde{\beta},\tilde{\gamma})=p(\beta,\mathrm{H})]$$

$$=\frac{h}{h+[1-h]\alpha'(\beta)}$$

is the correct conditional probability attached to (β,H), and therefore, $1-\pi(\beta)$ is the conditional probability attached to the state $(\alpha(\beta),\mathrm{T})$. A representative outsider thus determines his demands $x_2(\phi,\bar{x}_2,\bar{y}_2;\beta,\mathrm{H})$ and $y_2(\phi,\bar{x}_2,\bar{y}_2;\beta,\mathrm{H})$ for the two goods in state (β,H) by solving

$$(5)\quad \max\{\pi(\beta)U_2(x_2,y_2;\beta,\mathrm{H})$$

$$+[1-\pi(\beta)]U_2(x_2,y_2;\alpha(\beta),\mathrm{T})\}$$

subject to $\phi x_2+(1-\phi)y_2\leq\phi\bar{x}_2+(1-\phi)\bar{y}_2$

which equally determines his demands $x_2(\phi,\bar{x}_2,\bar{y}_2;\alpha(\beta),\mathrm{T})$ and $y_2(\phi,\bar{x}_2,\bar{y}_2;\alpha(\beta),\mathrm{T})$ in state $(\alpha(\beta),\mathrm{T})$. This maximization problem

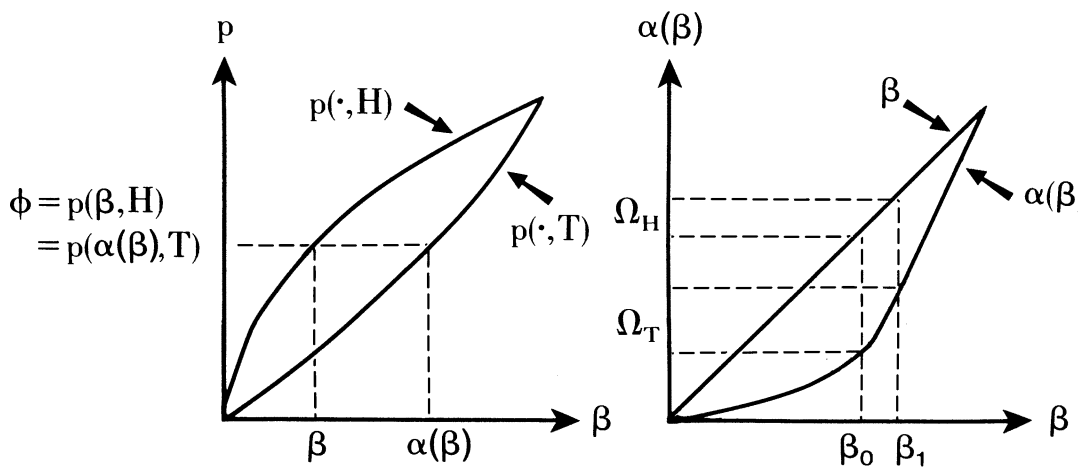


FIGURE 2. INFERENCE FROM A PRICE FUNCTION WITH TWO BRANCHES

yields

$$(6)\quad x_2(\phi,\bar{x}_2,\bar{y}_2;\beta,\mathrm{H}) = x_2(\phi,\bar{x}_2,\bar{y}_2;\alpha(\beta),\mathrm{T}) = [w_2/\phi]\{\pi(\beta)\beta+[1-\pi(\beta)]\alpha(\beta)\}$$

$$y_2(\phi,\bar{x}_2,\bar{y}_2;\beta,\mathrm{H}) = y_2(\phi,\bar{x}_2,\bar{y}_2;\alpha(\beta),\mathrm{T}) = [w_2/(1-\phi)]\{\pi(\beta)[1-\beta] + [1-\pi(\beta)][1-\alpha(\beta)]\}$$

where $w_2 \equiv \phi\bar{x}_2+(1-\phi)\bar{y}_2$. It may assist the intuition to observe that $\{\pi(\beta)\beta+[1-\pi(\beta)]\alpha(\beta)\}$ and $\{\pi(\beta)[1-\beta]+[1-\pi(\beta)]\times[1-\alpha(\beta)]\}$ are, respectively, the expected values of the exponents to which the consumptions of goods x and y are raised in the outsider's Cobb-Douglas utility function. Hence, similar to (3), an outsider's demand for each good is given by his wealth, divided by the good's price and multiplied by the expected value of the exponent to which the good's consumption is raised.

Suppose that there is a function $p(\beta,\gamma)$ from states of the world to prices that is continuous and strictly monotone in β, with $p(0,\mathrm{H})=p(0,\mathrm{T})$ and $p(1,\mathrm{H})=p(1,\mathrm{T})$. Then for every ϕ satisfying $p(0,\mathrm{H})\le\phi\le p(1,\mathrm{H})$, precisely two states are associated with ϕ. We will define a *pairwise revealing rational expectations equilibrium* to be a price function of this form, together with demand functions from equations (3) and (6) that satisfy

$$(7)\quad x_1(p(\beta,\gamma),\bar{x}_1,\bar{y}_1;\beta,\gamma) + x_2(p(\beta,\gamma),\bar{x}_2,\bar{y}_2;\beta,\gamma)\equiv\bar{x}_1+\bar{x}_2$$

for every β $(0<\beta<1)$ and $\gamma=\mathrm{H},\mathrm{T}$; that is to say, agents optimize using the correct rational expectations inference, and markets always clear.[24]

[24]Observe that, if the market for good x clears in every state, then by Walras' Law, the market for good y must also clear in every state.

It is straightforward to solve for a closed form of the price function. Substituting (3) and (6) and the definitions of w_1 and w_2 into (7) and solving for $(1-\phi)/\phi$ (i.e., for $[1-p(\beta,\mathrm{H})]/p(\beta,\mathrm{H})$) yields

$$(8)\quad \psi(\beta)\equiv\frac{1-p(\beta,\mathrm{H})}{p(\beta,\mathrm{H})} = \frac{\bar{x}_1\{1-\alpha_{\mathrm{H}}(\beta)\}+\bar{x}_2\{1-\pi(\beta)\beta-[1-\pi(\beta)]\alpha(\beta)\}}{\bar{y}_1\{\alpha_{\mathrm{H}}(\beta)\}+\bar{y}_2\{\pi(\beta)\beta+[1-\pi(\beta)]\alpha(\beta)\}}$$

where $\pi(\cdot)$ is given by equation (4). It is easy to see that the price function implied by $\psi(\cdot)$ [in eq. (9), below], is always continuous and satisfies $p(0,\mathrm{H})=p(0,\mathrm{T})$ and $p(1,\mathrm{H})=p(1,\mathrm{T})$. If $\psi(\cdot)$ is also a strictly monotone function, then we have constructed a pairwise revealing REE. This establishes the following theorem.

THEOREM 1: *If period one results in endowments $\bar{x}_1,\bar{x}_2,\bar{y}_1$, and $\bar{y}_2$ such that $\psi(\cdot)$ of equation (8) is strictly monotone in β, then period two has a unique rational expectations equilibrium. In this event, the price function is pairwise revealing and is given by*

$$(9)\quad p(\beta,\gamma) = \begin{cases} 1/[1+\psi(\beta)] & \text{if } \gamma=\mathrm{H}\\ 1/[1+\psi(\alpha^{-1}(\beta))] & \text{if } \gamma=\mathrm{T}\end{cases}$$

where $\alpha^{-1}(\beta)=\beta^{\mu_{\mathrm{T}}/\mu_{\mathrm{H}}}$.

If $\psi(\cdot)$ is not monotone, then period two does not possess any REE.

IV. The Investment Stage When Insider Trading Is Permitted

The first period is modeled quite simply. Agents individually decide how much labor to invest in producing endowment for the second period. At the time of their decisions, agents know whether they will be insiders or outsiders in the second period but do not yet possess any private information (and so they apply the prior distributions on $\tilde{\beta}$ and $\tilde{\gamma}$). To simplify the subsequent analysis, assume that insiders can only produce good x and outsiders can only pro-

duce good y. The disutility of labor for a representative insider producing x units of endowment is given by $L_1(x)$, and for a representative outsider producing y units of endowment is given by $L_2(y)$. We assign $L_1(\cdot)$ and $L_2(\cdot)$ the following functional forms:

$$(10)\quad L_1(x) = \omega_1 x^{\rho_1} \text{ and } L_2(y) = \omega_2 y^{\rho_2}$$
$$\omega_i > 0, \quad \rho_i > 1 \quad (i = 1,2).$$

The solution concept for the two-stage game will essentially require the play to be a Nash equilibrium in the first period and a rational expectations equilibrium in the second period. Sequential rationality is imposed in the sense that agents in the first period compute payoffs assuming equilibrium play in the second period (i.e., the solution is required to be a backward induction equilibrium).

As indicated above, insiders (and outsiders) are indexed by the unit interval. Hence, if all representative insiders (outsiders) decide in period one to produce $\bar{x}_1$ ($\bar{y}_2$), then their aggregate endowment entering period two equals $\bar{x}_1$ ($\bar{y}_2$). Moreover, any individual agent's investment decision has absolutely no effect on aggregate endowment (nor on the REE price function), and so he takes aggregate endowments (and the resulting REE price function) as given when selecting his investment.

In order to state the first-period optimization problems, expressions are needed for the second-period payoffs from individual choices of endowment when aggregate endowment is expected to equal $(\bar{x}_1, \bar{y}_2)$. Let $\tilde{V}_1(x)$ ($\tilde{V}_2(y)$) denote the *ex ante* expected utility—excluding the $L_i(\cdot)$ term—to a representative insider (outsider) who has carried forward x (y) units of endowment into period two, before learning anything about the state. Formulas for $\tilde{V}_1(x)$ and $\tilde{V}_2(y)$ are derived in equations (A2)–(A5) of the Appendix.

Now let $X_1(\bar{x}_1, \bar{y}_2)$ signify the optimal endowment for an insider to produce individually in the first period if he expects aggregate endowment in the second period to equal $(\bar{x}_1, \bar{y}_2)$. Then $X_1(\bar{x}_1, \bar{y}_2)$ solves

$$(11)\qquad \max_{x \geq 0} \{-L_1(x) + \tilde{V}_1(x)\}$$

where $\tilde{V}_1(\cdot)$ is derived using the price function from aggregate endowments $(\bar{x}_1, \bar{y}_2)$. Similarly, let $Y_2(\bar{x}_1, \bar{y}_2)$ signify the optimal endowment for an outsider to produce under these circumstances. Then $Y_2(\bar{x}_1, \bar{y}_2)$ solves

$$(12)\qquad \max_{y \geq 0} \{-L_2(y) + \tilde{V}_2(y)\}.$$

I will say that $(\bar{x}_1, \bar{y}_2)$ corresponds to a *competitive equilibrium* of the two-stage game if, given that the aggregate endowments will be $(\bar{x}_1, \bar{y}_2)$, each representative insider optimizes by producing $\bar{x}_1$ and each representative outsider optimizes by producing $\bar{y}_2$. In the above notation

$$(13)\qquad \bar{x}_1 = X_1(\bar{x}_1, \bar{y}_2)$$

and

$$\bar{y}_2 = Y_2(\bar{x}_1, \bar{y}_2).$$

This notion of competitive equilibrium requires that $(\bar{x}_1, \bar{y}_2)$ determines a strictly monotone function $\psi(\cdot)$ in equation (8). Otherwise, there does not exist any REE in the second stage (see Theorem 1). I will say that $(\bar{x}_1, \bar{y}_2)$ corresponds to a *candidate competitive equilibrium* if each of the prerequisites for competitive equilibrium is satisfied, except possibly the monotonicity requirement.

The following theorem is proved in the Appendix.

THEOREM 2: *The two-stage model in which insider trading is permitted has a unique candidate competitive equilibrium.*

Let aggregate endowments in the candidate equilibrium be given by $(\bar{x}_1, \bar{y}_2)$. If the function $\psi(\cdot)$ implied by $(\bar{x}_1, \bar{y}_2)$ in equation (8) is monotone decreasing in β, then the two-stage model has a unique competitive equilibrium. If the function $\psi(\cdot)$ implied by $(\bar{x}_1, \bar{y}_2)$ is not monotone, then there does not exist any competitive equilibrium.

V. Modification of the Model When Insider Trading Is Banned

In this section, I modify the two-period model that has been thus far examined in order to discuss the effects of the abstain-or-disclose requirement that have already been seen in Sections I and II. As said before, the representative insider is accorded two options in the second period: either to abstain from trading (i.e., to consume precisely his endowment brought forward from the first period) or to disclose the state before trading. I now make three additional modeling assumptions about the disclosure technology. First, any disclosure (if made) is constrained to be complete and truthful. Second, while disclosure is costless, insiders lexicographically prefer "not disclosing" to "disclosing" (all other things being equal).[25] Third, outsiders directly learn the true state if and only if an interval (of positive length) of insiders choose to disclose.[26]

These additional assumptions on the disclosure technology exclude the unattractive possibility of equilibria in which insiders voluntarily disclose their information in the "insider trading permitted" regime. Without the lexicographic preference toward nondisclosure, one insider might disclose merely because one or more other insiders were also disclosing. (If he unilaterally deviated by not disclosing, there would still be other agents disclosing, and so his payoff would be unchanged, rendering the deviation unprofitable.) With the additional assumptions, insiders do not disclose their private information unless they are required to do so in order to trade. (Whether or not one single insider chooses to disclose does not change whether an interval of positive length has disclosed and, hence, does not change the trading outcome.) At the same time, there is no inference for outsiders to draw from the fact that insiders have not disclosed their information, except that insiders were not required to disclose (cf. Grossman, 1981).

In the present model, insiders possess an independent reason for wishing to trade in the asset in question: they wish to acquire the commodity y from outsiders. (Observe that, quite generally in a model of this type, insiders will prefer to disclose rather than abstain. Under essentially any set of prices, the insider can attain strictly higher utility by trading than by abstaining from trade.) The abstain-or-disclose regulation therefore induces the informed agents to reveal their information, rendering the trading round an exchange economy with full information.

Thus, the bottom line of the subsequent analysis will be to compare a full-information equilibrium (when insider trading is banned) to that of a partially revealing REE (when insider trading is permitted) in the second round. However, the conclusion is likely to differ from that of standard comparisons of full-information versus partial-information economies, because the second-round equilibrium feeds into the determination of the first-period outcome. Given exogenous endowments $(\bar{x}_1, \bar{y}_2)$, insiders would typically do better when permitted to trade on their private information than in the full-information economy; they would earn trading profits at the expense of outsiders, who typically do worse when insider trading is permitted. However, since endowments are actually endogenous, the welfare comparison may be more complicated than (and different from) this straightforward result.

The analysis of the model when insider trading is banned parallels the analysis of Sections III and IV (where insider trading

[25] This is merely the limit, as $\varepsilon \downarrow 0$, of considering a positive cost ε of disclosure.

[26] To be precise, we assume that outsiders directly learn the true state if and only if a strictly positive measure of insiders chooses to disclose. An assumption along these lines is necessary to make the disclosure stage consistent with the notion that agents are "information takers" (i.e., that any agent should take the market information as given because his individual actions have no effect on the information available in the marketplace). This notion is implicit in competitive rational expectations equilibrium and is used throughout the paper. It would be fairly bizarre to require that a set of measure zero of insiders have absolutely no effect on the information available in the market in the trading and investment rounds, but then to allow that a set of insiders of measure zero could choose to fully inform the market in the disclosure stage.

was permitted), but the problem now becomes easier. As the abstain-or-disclose regulation induces insiders to reveal their information before they trade, outsiders now form full-information demands, which are given by

$$(6') \quad x_2^*(\phi, \bar{x}_2, \bar{y}_2; \beta, \gamma) = [w_2/\phi]\beta$$

$$y_2^*(\phi, \bar{x}_2, \bar{y}_2; \beta, \gamma) = [w_2/(1-\phi)][1-\beta]$$

whereas insiders' demands, x_1^* and y_1^*, are still described by (3). Solving $x_1^* + x_2^* \equiv \bar{x}_1 + \bar{x}_2$ now yields

$$(8') \quad \psi^*(\beta) \equiv \frac{1-p^*(\beta, \mathrm{H})}{p^*(\beta, \mathrm{H})} = \frac{\bar{x}_1\{1-\alpha_\gamma(\beta)\} + \bar{x}_2\{1-\beta\}}{\bar{y}_1\{\alpha_\gamma(\beta)\} + \bar{y}_2\{\beta\}}$$

immediately providing a closed form for $p^*(\beta, \gamma)$. The *ex post* utility functions, V_1^* and V_2^*, are now calculated from (A2) and (A3) using p^*, x_1^*, y_1^*, x_2^*, and y_2^*. The *ex ante* expected utility functions, $\tilde{V}_1^*$ and $\tilde{V}_2^*$, are calculated analogously as in (A4) and (A5). Optimal investment functions, $X_1^*(\cdot, \cdot)$ and $Y_2^*(\cdot, \cdot)$, can be defined analogously as in equations (11) and (12). Any $(\bar{x}_1^*, \bar{y}_2^*)$ is a competitive equilibrium if

$$(13') \qquad \bar{x}_1^* = X_1^*(\bar{x}_1^*, \bar{y}_2^*)$$

and

$$\bar{y}_2^* = Y_2^*(\bar{x}_1^*, \bar{y}_2^*).$$

It is straightforward to modify the argument in the Appendix and prove that the ratio of endowments, $\bar{z}^* \equiv \bar{y}_2^*/\bar{x}_1^*$, in a competitive equilibrium corresponds to the unique fixed point of a particular mapping. It is no longer necessary to worry about whether the resulting price function is monotone, as agents are no longer required to draw any inferences from price. Existence and uniqueness of equilibrium are assured when insider trading is banned. This establishes the following theorem.

THEOREM 3: *The two-stage model in which insider trading is banned has a unique competitive equilibrium.*

VI. Welfare Implications of Insider Trading Regulation in the Model

Theorems 2 and 3 are very easy to apply to examples. While one cannot calculate closed-form solutions, the model is sufficiently simple and well-behaved that numerical approximations to the unique equilibria can be rapidly calculated on a microcomputer. Computations are best done using the reduction from endowment pairs $(\bar{x}_1, \bar{y}_2)$ to ratios $\bar{z} \equiv \bar{y}_2/\bar{x}_1$ developed in the Appendix.

Let $U_1(\cdot, \cdot; \cdot, \cdot), U_2(\cdot, \cdot; \cdot, \cdot), \alpha_{\mathrm{H}}(\cdot), \alpha_{\mathrm{T}}(\cdot)$, etc. be specified as in previous sections. Let $\omega_1 = \omega_2 \equiv \omega$ and $\rho_1 = \rho_2 \equiv \rho$, so that insiders and outsiders are assigned essentially identical disutilities of labor (in an attempt to treat them symmetrically and to avoid predetermining the conclusion).[27]

I report now the quantitative results of an illustrative simulation and the qualitative results when the parameter values from this simulation are varied. Let $\mu_{\mathrm{H}} = 2/5$ and let $\mu_{\mathrm{T}} = 5/2$. Set the probability h equal to $1/2$. Meanwhile, set $\omega = 1/10$ and $\rho = 5/4$. By Theorem 2, the model in which insider trading is permitted has a unique candidate equilibrium; the ratio of endowments is calculated to equal $\bar{z} = 0.882410$. It is easily verified that the resulting price function in equations (8) and (9) is monotone, so there is indeed a unique competitive equilibrium. By Theorem 3, the model where insider trading is banned has a unique competitive equilibrium; a (simpler) computation finds that the ratio of endowments is $\bar{z}^* = 0.947958$. As described in the Appendix, these ratios immediately determine the endowment pairs under each of the two regu-

[27]By giving insiders the same investment incentives as outsiders (as opposed to making insiders' investments inelastic) and by formulating the model so that there are "as many" insiders as outsiders, one makes it quite plausible that banning insider trading would reduce aggregate investment (since, while outsiders would invest more, insiders would seemingly invest less).

TABLE 1—INVESTMENTS AND EXPECTED UTILITIES YIELDED BY THE SIMULATION ($\omega = 1/10$, $\rho = 5/4$, $h = 1/2$, $\mu_H = 2/5$, and $\mu_T = 5/2$)

INSIDER TRADING PERMITTED:	
Investment of Insiders	289.339
Investment of Outsiders	255.315
Expected Utility of Insiders	29.833
Expected Utility of Outsiders	25.514
INSIDER TRADING BANNED:	
Investment of Insiders	295.195
Investment of Outsiders	279.833
Expected Utility of Insiders	30.590
Expected Utility of Outsiders	28.613

latory regimes considered. The simulation yields the investments and expected utilities given in Table 1 [where utility now includes both $\tilde{U}_i(\cdot)$ and $-L_i(\cdot)$, calculated in double precision]. The price functions that arise in the unregulated and regulated regimes are plotted in Figures 3 and 4, respectively.

The qualitative conclusions are as follows. First and most importantly, the banning of insider trading may indeed effect a Pareto improvement. In this example, it raises the representative insider's utility by 2.5 percent and raises the representative outsider's utility by 12.1 percent. Second, the principal mechanism by which this occurs is that the greater return on investment in the regulated regime induces greater investment by the outsiders. This, in turn, improves returns to insiders and actually induces greater investment by the insiders as well. Third, if the trading round had been examined in isolation, we would have instead found that the insider trading ban was merely redistributional; if agents had entered the trading stage with the (unregulated) investments of 289.339 and 255.315, but the abstain-or-disclose rule was now imposed, insiders would earn expected utilities of only 27.085, while outsiders would earn expected utilities of 31.779. Fourth, it should be noted that, in this particular model, insider trading regulation actually improves market efficiency as well; the outsiders attain full information strictly sooner.

Suppose that, starting from the parameter values of the above example, ω were to unilaterally vary anywhere in the domain

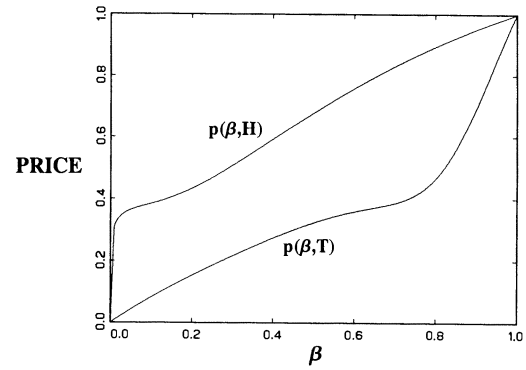


FIGURE 3. EQUILIBRIUM PRICE FUNCTION WHEN INSIDER TRADING IS PERMITTED (PLOTTED FOR $\omega = 1/10$, $\rho = 5/4$, $h = 1/2$, $\mu_H = 2/5$, AND $\mu_T = 5/2$)

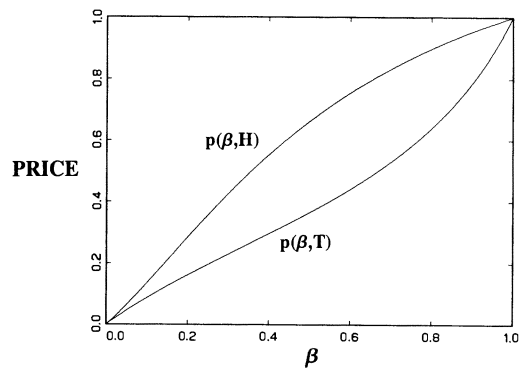
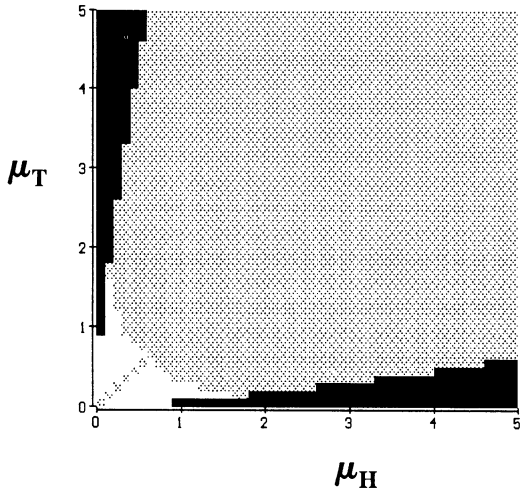


FIGURE 4. EQUILIBRIUM PRICE FUNCTION WHEN INSIDER TRADING IS BANNED (PLOTTED FOR $\omega = 1/10$, $\rho = 5/4$, $h = 1/2$, $\mu_H = 2/5$, AND $\mu_T = 5/2$)

$0 < \omega < \infty$. It is interesting that, for any such variation, the welfare implication that regulating insider trading effects a Pareto improvement is qualitatively preserved. This conclusion is also robust to unilateral perturbations of ρ anywhere in $1 < \rho < \infty$. (If $\rho \leq 1$, the strict convexity of $L_i(\cdot)$ is lost.)

A wider range of welfare conclusions is obtained by instead simultaneously perturbing the exponents μ_H and μ_T. In particular, the welfare implication that insider trading regulation effects a Pareto improvement holds only for some combinations of parameter values. For other combinations, insider trading regulation will help outsiders but



A Pareto improvement is effected when insider trading is banned.

Outsiders are helped but insiders are harmed when insider trading is banned.

No competitive equilibrium exists for these parameter values.

FIGURE 5. WELFARE CONSEQUENCES OF INSIDER TRADING FOR A GRID OF EXPONENTS ($\omega = 1/10$, $\rho = 5/4$, AND $h = 1/2$)

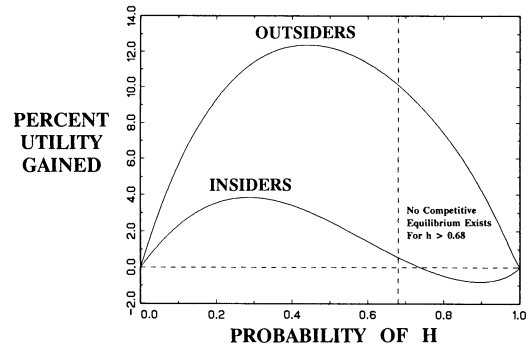


FIGURE 6. WELFARE CONSEQUENCES OF INSIDER TRADING FOR A RANGE OF PROBABILITIES ($\omega = 1/10$, $\rho = 5/4$, $\mu_H = 2/5$, AND $\mu_T = 5/2$)

harm insiders. (Other welfare implications are logical possibilities, but I have not found any examples that lead to these possibilities.) In Figure 5, the welfare implications are calculated on a grid (of width 0.1) of values from the square $\{(\mu_H, \mu_T): 0 < \mu_H \leq 5$ and $0 < \mu_T \leq 5\}$. On most of the square, insider trading regulation indeed helps both outsiders and insiders. In a small region near the origin, outsiders are helped but insiders are harmed; however, when $\mu_H = \mu_T$, insiders and outsiders have identical preferences, the price function is the same regardless of whether insider trading is permitted or banned, and so regulation neither helps nor harms anyone. In two remaining small regions (the symmetrically arranged slivers), the last sentence of Theorem 2 comes into play: the unique candidate price function $\psi(\cdot)$ is nonmonotone, and therefore, no actual competitive equilibrium exists.

Additional insight is obtained by unilaterally varying h in the interval $0 < h < 1$. One would expect that the economic consequences of changing insider trading regulations would be weakest when the informational asymmetry between insiders and outsiders is least (i.e., when h is near 0 or 1) and would be strongest when the informational asymmetry between insiders and outsiders is greatest (i.e., when h assumes intermediate values). This prediction is borne out in Figure 6, where I have perturbed the parameter h and calculated the percentage gain in *ex ante* expected utility for each class of agent. Insiders achieve the greatest percentage gain when $h \approx 0.285$, while outsiders achieve the greatest percentage gain when $h \approx 0.44$. When h is near 0 or 1, welfare effects are fairly negligible. A Pareto improvement is effected when $h \leq 0.74$; for $h > 0.74$, insiders would do better in the equilibrium in which insider trading was permitted, if one in fact existed. However, for $h > 0.68$, monotonicity of the candidate price function fails, and therefore, no competitive equilibrium exists.

If I had wished to write this article as a polemical piece, I might have emphasized another example, with $\mu_H = 1/3$, $\mu_T = 3$, $h = 1/4$, $\omega = 1/2$, and $\rho = 1.01$. With such parameter values, the effect of banning insider trading is to increase insiders' and outsiders' levels of investment each by a factor of five. Utilities of both types of agents are also increased by a factor of five.

VII. Conclusion

This article has attempted to contribute to the economic analysis of insider trading by formalizing "confidence" as an efficiency argument. If outsiders expect that insiders will take advantage of them at later stages, then outsiders may choose to invest less at the beginning. Meanwhile, effective regulation of insider trading at later stages may improve the anticipated return on investment of outsiders and, hence, promote investment by outsiders at the beginning. If insiders are helped by the availability of outside investment, insiders too may benefit from the precommitment created by insider trading regulation. It is noteworthy that the efficiency considerations posed by "confidence" point in exactly the same direction as the traditional fairness considerations, and for almost the same reason.

The confidence argument seems most likely to be decisive in scenarios where the early revelation of information affords little scope for any allocative improvement and where, in particular, the pertinent private information will become public regardless of whether trading occurs. For example, if investment bankers were permitted to trade (for their own personal benefit) shortly in advance of the announcement of tender offers, there would probably be little effect on the timing or success of tender offers. The dominant effect, *ex post*, would then be redistributive from outsiders to insiders; we should principally ask whether the anticipation of this insider trading, *ex ante*, has adverse consequences. Thus, despite the fact that my model literally made use of a commodity market rather than a stock exchange, it may still be a reasonable abstraction for assessing the desirability of insider trading in advance of tender offers.[28]

On the other hand, my model would need to be enlarged in order to depict adequately a situation in which the revelation of private information through trading could play a positive role in determining whether potential investment projects receive funding. Similarly, I would need to introduce additional features in order to examine a situation in which employees of an organization could be given incentives to behave as entrepreneurs.

To conclude, the simple structure of the model, which made the confidence argument relatively transparent, had the cost of allowing little other than the confidence effect to occur. A valuable next step in assessing the desirability of insider trading would be the construction of richer models that have room for both the negative incentives posed by confidence and the positive incentives described by previous authors. Such analysis may eventually give us a better understanding of the specific types of contexts in which insider trading should be permitted or banned.

[28]Hence, this article should be viewed as lending support to Rule 14e-3 of the SEC, which in a very expansive way regulates trading in advance of tender offers (see also Section I).

Appendix

Derivation of the Conditional Probability $\pi(\beta)$ Used by Outsiders. Suppose the representative outsider knew that $\phi_0 \le p(\tilde{\beta},\tilde{\gamma}) \le \phi_1$, where $\phi_0 = p(\beta_0, \mathrm{H})$ and $\phi_1 = p(\beta_1, \mathrm{H})$. He could infer that either $\tilde{\gamma} = \mathrm{H}$, in which case $\beta_0 \le \beta \le \beta_1$, or else $\tilde{\gamma} = \mathrm{T}$, in which case $\alpha(\beta_0) \le \beta \le \alpha(\beta_1)$. Since $\tilde{\beta}$ and $\tilde{\gamma}$ are independent, observe that the unconditional probability of the first event (Ω_{H} in Fig. 2) is $h[\beta_1 - \beta_0]$ and the unconditional probability of the second event (Ω_{T} in Fig. 2) is $[1-h][\alpha(\beta_1) - \alpha(\beta_0)]$. Hence, the conditional probability of the first event is given by

$$\text{(A1)} \quad \Pr\left[\tilde{\gamma} = \mathrm{H} \mid \phi_0 \le p(\tilde{\beta},\tilde{\gamma}) \le \phi_1\right] = \frac{h[\beta_1 - \beta_0]}{h[\beta_1 - \beta_0] + [1-h][\alpha(\beta_1) - \alpha(\beta_0)]}.$$

The probability that $(\tilde{\beta},\tilde{\gamma}) = (\beta, \mathrm{H})$, conditional on $p(\tilde{\beta},\tilde{\gamma}) = p(\beta, \mathrm{H})$, is calculated by setting $\beta_0 = \beta$ and taking the limit as $\beta_1 \to \beta_0$ of the expression in (A1). Using l'Hôpital's rule, this yields equation (4).

Derivation of the Agents' Ex Ante Expected Utility Functions. Let $V_1(x;\beta,\gamma)$ $(V_2(y;\beta,\gamma))$

denote the *ex post* utility attained by a representative insider (outsider) who has carried forward x (y) units of endowment, when the actual state in period two is (β,γ). Insiders and outsiders apply demands from equations (3) and (6), respectively, giving attained utilities of

$$\text{(A2)}\quad V_1(x;\beta,\gamma) = x\{U_1[x_1(p(\beta,\gamma),1,0;\beta,\gamma), y_1(p(\beta,\gamma),1,0;\beta,\gamma);\beta,\gamma]\}$$

and

$$\text{(A3)}\quad V_2(y;\beta,\gamma) = y\{U_2[x_2(p(\beta,\gamma),0,1;\beta,\gamma), y_2(p(\beta,\gamma),0,1;\beta,\gamma);\beta,\gamma]\}.$$

In the above equations, the terms x and y factor out in a linear fashion because of the homogeneity of degree one of the functions $U_i(\cdot), x_i(\cdot)$, and $y_i(\cdot)$. The *ex ante* expected utilities, $\tilde{V}_1(x)$ and $\tilde{V}_2(y)$, are calculated by merely integrating the *ex post* utilities over all possible states, using the correct unconditional probabilities. Using (A2) and (A3), one obtains

$$\text{(A4)}\quad \tilde{V}_1(x) = x\tilde{V}_1(1) = x\left\{h\int_0^1 V_1(1;\beta,\mathrm{H})\,d\beta + (1-h)\int_0^1 V_1(1;\beta,\mathrm{T})\,d\beta\right\}$$

and

$$\text{(A5)}\quad \tilde{V}_2(y) = y\tilde{V}_2(1) = y\left\{h\int_0^1 V_2(1;\beta,\mathrm{H})\,d\beta + (1-h)\int_0^1 V_2(1;\beta,\mathrm{T})\,d\beta\right\}.$$

PROOF OF THEOREM 2:

The rational expectations equilibrium price function, as indicated in equations (8) and (9), is homogeneous of degree zero in aggregate endowment $(\bar{x}_1,\bar{y}_2)$; that is, if aggregate endowments equaled $(\bar{x}_1',\bar{y}_2')$ such that $\bar{y}_2'/\bar{x}_1' = \bar{y}_2/\bar{x}_1$, precisely the same price function would result. This follows from the fact that the utility functions [of (1) and (2)] imply demands [given by (3) and (6)] which themselves are homogeneous of degree one in endowments. Similarly, observe that $X_1(\cdot,\cdot)$ and $Y_2(\cdot,\cdot)$, defined in (11) and (12), are homogeneous functions of degree zero.

Since the important features of the model depend only on the *ratio* of aggregate endowments, define $\bar{z} \equiv \bar{y}_2/\bar{x}_1$ to be the ratio of endowments. Also, define the mapping $T(\bar{z})$ to yield the optimal ratio of endowments for insiders and outsiders to produce individually in the first period if they expect the ratio of aggregate endowments in the second period to equal $\bar{z}$. Utilizing the homogeneity of degree zero, one sees that $T(\cdot)$ is given by

$$\text{(A6)}\quad T(\bar{z}) \equiv Y_2(1,\bar{z})/X_1(1,\bar{z}).$$

I will now establish the existence and uniqueness of a fixed point of $T(\cdot)$.

Consider the trading stage as $\bar{z}\to\infty$. Note, using (8) and (9), that the price function $p(\cdot,\cdot)$ of good x converges to one, pointwise. Therefore, a representative insider with endowment $\bar{x}_1 = 1$ can afford to purchase an arbitrarily large quantity of good y while still consuming $x_1 = 1/2$, implying $\tilde{V}_1(1)\to\infty$. Meanwhile, a representative outsider with endowment $\bar{y}_2 = 1$ can barely afford to purchase any quantity of good x, implying $\tilde{V}_2(1)\to 0$. Extracting the first-order conditions from equations (11) and (12) and substituting from equations (A4) and (A5) yields

$$\text{(A7)}\quad X_1(1,\bar{z}) = \{\tilde{V}_1(1)/\rho_1\omega_1\}^{1/(\rho_1-1)}$$

$$Y_2(1,\bar{z}) = \{\tilde{V}_2(1)/\rho_2\omega_2\}^{1/(\rho_2-1)}$$

and leads to the conclusion that $X_1(1,\bar{z}) \to \infty$ and $Y_2(1,\bar{z}) \to 0$. The definition of $T(\cdot)$ in (A6) thus implies $\lim_{\bar{z}\to\infty} T(\bar{z}) = 0$.

Consider the trading stage as $\bar{z} \to 0$. Analogous reasoning yields that $\tilde{V}_1(1) \to 0$ and, hence, $X_1(1,\bar{z}) \to 0$; similarly, $\tilde{V}_2(1) \to \infty$ and, hence, $Y_2(1,\bar{z}) \to \infty$. Thus, $\lim_{\bar{z}\to 0} T(\bar{z}) = \infty$. This demonstrates that there exist z^1 and z^2, where $0 < z^1 < z^2$, such that $T(z^1) > z^1$ and $T(z^2) < z^2$. Since the mapping $T(\cdot)$ is continuous, the intermediate-value theorem guarantees the existence of a fixed point $\bar{z}$ between z^1 and z^2.

The uniqueness of a fixed point is established by demonstrating that $T(\cdot)$ is monotone decreasing. Consider any two ratios of endowment, $\bar{z}$ and $\bar{z}'$, where $\bar{z}' > \bar{z} > 0$. Let $p(\cdot,\cdot)$ and $p'(\cdot,\cdot)$ be the price functions implied by $\bar{z}$ and $\bar{z}'$, respectively, using equations (8) and (9). Note, for any given state (β,γ), where $0 < \beta < 1$, that $p'(\beta,\gamma) > p(\beta,\gamma)$. Now observe that when the price is $p'(\beta,\gamma)$, the representative outsider's demands, $x_2(p'(\beta,\gamma),0,1;\beta,\gamma)$ and $y_2(p'(\beta,\gamma),0,1;\beta,\gamma)$, are also within the outsider's budget constraint (with some slack in wealth remaining) at the lower price $p(\beta,\gamma)$. Hence, $V_2(1;\beta,\gamma)$, defined in equation (A3), is strictly greater at price $p(\beta,\gamma)$ than at price $p'(\beta,\gamma)$. Since this inequality holds whenever $0 < \beta < 1$, the *ex ante* expected utility $\tilde{V}_2(1;\beta,\gamma)$, defined in equation (A5), is also strictly greater at price $p(\beta,\gamma)$ than at price $p'(\beta,\gamma)$. Using (A7), this establishes that $Y_2(1,\bar{z}) > Y_2(1,\bar{z}')$. Analogous reasoning for the representative insider establishes that $X_1(1,\bar{z}') > X_1(1,\bar{z})$. Using (A6), one concludes that $T(\bar{z}') < T(\bar{z})$. Now suppose there existed two fixed points $\bar{z}$ and $\bar{z}'$, where $\bar{z}' > \bar{z}$. This would imply $T(\bar{z}') - T(\bar{z}) = \bar{z}' - \bar{z}$, contradicting that $T(\cdot)$ is monotone decreasing. Therefore, $T(\cdot)$ has a unique fixed point $\bar{z}$.

Finally, observe that there is a one-to-one correspondence between candidate competitive equilibria of the two-stage game and fixed points of $T(\cdot)$. The aggregate endowments $(\bar{x}_1,\bar{y}_2)$ associated with a candidate equilibrium imply a fixed point by $\bar{z} = \bar{y}_2/\bar{x}_1$; a fixed point $\bar{z}$ yields aggregate endowments of a candidate equilibrium by $\bar{x}_1 = X_1(1,\bar{z})$ and $\bar{y}_2 = Y_2(1,\bar{z})$. This leads to the conclusion that there exists a unique candidate competitive equilibrium, which is also an actual competitive equilibrium if and only if $\psi(\cdot)$ is monotone.

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