The Efficacy of Insider Trading Regulation

by

Matthew Spiegel

and

Avanidhar Subrahmanyan

October 1995
RESEARCH PROGRAM IN FINANCE AT THE
WALTER A. HAAS SCHOOL OF BUSINESS,
UNIVERSITY OF CALIFORNIA, BERKELEY

The Research Program in Finance in the Walter A. Haas School of Business at the University of California has as its purpose the conduct and encouragement of research in finance, investments, banking, securities markets, and financial institutions. The present reprint and working paper series were established in 1971 in conjunction with a grant from the Dean Witter Foundation.

INSTITUTE OF BUSINESS AND ECONOMIC RESEARCH
Carl Shapiro, Director

The Institute of Business and Economic Research is an organized research unit at the University of California, Berkeley, whose mission is to promote research by faculty and graduate students in the fields of business and economics. The Institute carries out its mission by organizing programs and activities that enrich the research environment, administering extramural research awards, publishing working papers, and making direct grants for research.
The Efficacy of Insider Trading Regulation

Matthew Spiegel

Haas School of Business
University of California, Berkeley

and

Avanidhar Subrahmanyam

Anderson Graduate School of Management
University of California, Los Angeles

October 1995

Finance Working Paper #257

Abstract

Regulatory authorities often lack a "smoking gun" (i.e., hard evidence such as a note or a memorandum) when prosecuting individuals for illegal insider trading. As a result, many insider trading cases depend solely on circumstantial evidence, which is usually obtained by associating trades with "unusual" price moves. However, insiders with the most accurate information (the ones most likely to possess "material, non-public" information) are the ones best able to modify their trading strategy in response to prosecution strategies based on price moves. This is a major obstacle to the efficacy of insider trading regulation. Thus, if legislation discourages strategic insiders with relatively precise information from trading, then in all likelihood any investor who is prosecuted will possess only the weakest (most imprecise) information. Strategic behavior by insiders in response to insider trading regulations can thereby lead to a situation where the pool of prosecuted traders contains a large fraction of innocent individuals (i.e., individuals with relatively poor information).

We thank Tony Bernardo, Mike Fishman, Simon Gervais, David Levine, Francis Longstaff, and N.R. Prabhala for helpful comments and discussions. We are also grateful to the John M. Olin Foundation at the Anderson Graduate School of Management, University of California at Los Angeles, for financial support.
Introduction

Existing papers on the social desirability of insider trading arrive at varied conclusions. For example, Manne (1966) and Carlton and Fischel (1983) provide arguments in favor of insider trading, Ausubel (1990), Bhattacharya and Spiegel (1991), and Fishman and Hagerty (1992) argue against the practice, and Leland (1992) concludes that the effect of insider trading on social welfare is ambiguous. In this paper, we ask a distinctly different, and hitherto unaddressed, question: Suppose that after weighing the pros and cons, society decides to restrict trading by corporate insiders who possess material, non-public information, how effective can a regulatory authority be in doing so?

It is evident that restricting trading on the basis of significant private information requires more than the passage of legislation. The regulatory authorities must identify and prosecute suspected malfeasors, and the courts must then mete out some type of punishment to the individuals that are finally convicted. Thus, without both an effective mechanism to prosecute insiders and a viable punishment scheme, insiders with proprietary information can, and presumably will, trade in financial markets. The arguments presented here are designed to illustrate the issues involved in designing a mechanism that deters insiders with material, non-public information, and simultaneously avoids prosecuting large numbers of innocent individuals.

Insider trading has been illegal for at least half a century now, and the Securities and Exchange Commission (SEC) is entrusted with enforcing the relevant laws. Since the act of trading per se is not illegal, enforcing the law requires distinguishing legal trades from illegal ones. As documented in Meulbroek (1992), the SEC uses a multi-pronged strategy for this purpose. One source derives from individuals informing on other people. Another takes the form of a “smoking gun” such as notes, memorandums, or telephone conversations which indicate that an investor traded while in possession of proprietary information. This paper does not concern itself with the costs and benefits of either of the above types of evidence. Rather, we are concerned with a third strategy often used by the SEC, namely, circumstantial, or statistical, evidence (e.g., “unusual price movements
on insider trading days” – Meulbroek (1992, p. 1680)) to detect and prosecute insiders.

The SEC not only has the authority to prosecute on the basis of circumstantial evidence, but does so frequently. During the 1983 Congressional Hearings to amend the Securities and Exchange Act of 1934 there was a proposal to raise the standard of proof for an insider trading conviction. At one point, (then) SEC Chairman John Shad was asked if he could have successfully prosecuted a particular case under the proposed higher standard. He responded that “it would be difficult, because that case, like most of these cases, was built on circumstantial evidence.”¹ Thus, based on the SEC’s own testimony it seems that many, if not most, insider trading prosecutions rely on statistical evidence.

Since evidence based on associating price moves and trades plays such an important role in the process, the question arises as to whether such a burden of proof is likely to lead to outcomes that are socially desirable. Our analysis indicates that this may not be the case. The issue is that the best informed insiders are the most difficult to prosecute with such evidence, as these agents are the ones best able to adapt their strategy in financial markets to avoid investigation.² To take a simple example, suppose the regulatory authority will prosecute any corporate executive who trades when the price of his stock changes by more than 10% the same day. Then, a perfectly informed insider never triggers the rule, since he simply refrains from trading unless the price will move by less than 10%. In this situation only those with inferior information can be prosecuted.³ For example, an executive with no significant private information may base his trade on the belief that the stock price will only rise by 2% next period. If it goes up

²Note that insider trading is inherently unlike most other crimes. For example, possession of cocaine is itself the criminal act. But trading is not in itself criminal, so observing the act does not prove a person has committed a crime. Thus, to prosecute acts of insider trading, the SEC must also find evidence that this act was induced by the possession of proprietary information. In reality, this translates into a policy that challenges people who trade shortly before a major change in a stock’s price. Now, who can best avoid triggering such an investigation? The answer must be the best informed insiders, since they possess the best technology for avoiding detection.
³Our argument is reminiscent of the Lucas (1976) critique about econometric models that neglect the effects of agents’ rational reaction to anticipated of future macroeconomic policy decisions.
by, say, 11%, he will be both surprised by the price jump, and find himself indicted by the regulatory authority.

It is evident that any rule based on statistical evidence will, at times, convict innocent individuals. Note, however, that the example above points out a very significant departure from the analogy with statistical tests. This is the feature that insiders with accurate private information behave rationally to modify their strategy in response to the rules set by the regulatory authority, which significantly limits the efficacy of such rules. Thus, if a rule based on statistical evidence is designed to discourage strategic insiders from trading on accurate information, then most of those actually prosecuted will have the poorest (most inaccurate) information. Conversely, if a rule is designed to mostly ensnare well informed individuals then again strategic behavior dictates that such a rule will likely not discourage insider trading, and may even discourage those with little private information from trading, which is exactly the opposite result from what one generally seeks from insider trading regulation.

Throughout this paper, we focus on the issue of whether a regulatory body such as the SEC can effectively use statistical information (in the absence of hard evidence) to identify and deter corporate insiders who may trade on material, non-public information. Thus, unlike DeMarzo, Fishman, and Hagerty (1995), we do not attempt to address what prosecution policies should be pursued when hard evidence can be obtained. Further, we ignore the complex legal issues involved in attempting to obtain a conviction in a court of law. In fact, the paper makes no distinction between "prosecution" and "conviction," as there are non-trivial dead-weight costs associated with prosecuting innocent individuals (regardless of whether they are finally acquitted).^4

Finally, while we do not focus upon a specific social welfare function in this paper, we do address what appears to be a significant necessary condition for a law to be welfare enhancing to society: namely, that most of the individuals convicted must in fact be

^4These costs include the possible reputational loss to innocent individuals of being prosecuted for illegal insider trading.
guilty. Thus, one can view the analysis in this paper as asking whether one can set up insider trading laws that meet this condition. Society will presumably reject any law (regardless of its other avowed benefits) that generally convicts only innocent individuals.

The paper is organized as follows. The next section provides a description of the regulatory environment in which insider trading regulations are enforced. Section II informally discusses the desirable features of effective insider trading legislation and illustrates the problems in designing efficacious insider trading rules which are based on statistical evidence. Section III argues that explicit consideration of strategic behavior by the insider further complicates the design problem. Section IV argues that the central results of Section III are robust to extensions of the basic framework, while Section V concludes.

I. Legal Background

According to SEC rule 10b-5, illegal insider trading is defined as trading by an individual in a security for which he is a fiduciary while in possession of information that is material and non-public (Langevoort (1991)). In practice, courts typically use the price move on the day of the announcement to determine whether the information was material (Elkind v. Liggett Myers, 1980, as described in Langevoort (1991); see also the discussion in Meulbroek (1992)). Further, whether the information was non-public at the time of trading is typically determined by demonstrating that the insider traded ahead of the information becoming public, e.g., proving that he traded at the beginning of the day, while the public information was released at the end of the day. Finally, the law also requires the demonstration of “scienter,” i.e., that the defendant knew the information was material and thus traded with intent to defraud. In the case of corporate insiders, however, scienter usually does not need to be proved, as insiders are presumed to have knowledge of the content of an impending public announcement (Monarch vs. SEC, 1979, as described in Langevoort (1991)).
With regard to the actual enforcement of these rules, Meulbroek (1992, p. 1680) states that 41% of all insider trading investigations are due to public complaints (individuals informing on others). The second major category is referrals by stock exchanges (31%), and the rest are due to SEC initiations, broker or bidder referrals, and so on. She further states that investigations for reasons other than public complaints are the ones most likely to be triggered by statistical evidence. For further confirmation that the SEC relies heavily on statistical evidence in its insider trading cases, consider the following statement by former NYSE Chairman John J. Phelan, Jr. on exchange referral policy:

An ... unusual or concentrated activity in a stock or significant price movement could indicate that advance non-public information had been circulated. ... We look at customer trading to determine if it is consistent. That is, does the customer usually trade in the amounts of the transactions in this instance? Has he traded in this issue before? What was the timing of the transaction in relation to the takeover announcement?\(^5\)

No doubt, hard evidence plays a role in many insider trading cases. Nevertheless, it appears that a significant number of investigations are triggered simply because a transaction takes place just prior to a "large" price change.

Once the SEC becomes suspicious of a trader, whether through an informant or statistical evidence, it attempts to obtain more concrete evidence. However, the SEC often prosecutes even if such a "smoking gun" cannot be found. In April 1983, a Subcommittee of the Committee on Telecommunications, Consumer Protection, and Finance held a hearing on H.R. 559, a bill to amend the Securities Exchange Act of 1934 to increase the penalty for illegal insider trading from the amount of the realized profits to three times the profits. At issue was the secondary question of whether the burden of proof criterion in insider trading prosecutions should be raised from a 'preponderance of evidence' to

'clear and convincing evidence.' The following extract from an SEC memorandum illustrates that many insider trading prosecutions rely on statistical evidence and that the SEC was particularly concerned that the burden of proof not be raised to a higher level.

...the burden of proof in Commission injunctive actions is proof by preponderance of evidence. Commentators have suggested that in light of the possibility of a judge imposing a higher sanction, a higher burden of proof should be required in actions seeking the proposed civil penalty.

On the other hand it should be noted that the proof in many of the Commission's insider trading cases depends heavily on circumstantial evidence. A higher burden of proof, such as a clear and convincing standard, would make it more difficult for the Commission to prove its case, particularly in insider trading cases where most cases are built on circumstantial evidence.6

To take an example of an actual case based on circumstantial evidence, consider SEC v. Saul, et al. (United States District Court, Northern District of Illinois, No. 90 C 2633, October 12, 1990.) B. Francis Saul planned to take B.F. Saul Real Estate Investment Trust private and the SEC alleges that he informed his son (Saul III) of this in advance of the transaction. Saul's son then supposedly told his friend, which led to four "tippies" purchasing the Trust's stock, who made $60,000 in total when the Trust went private. The SEC had no evidence in this case except the knowledge that these people all talked to each other on a regular basis, and that they all made money on this transaction.7

It is evident that prosecutions based on statistical evidence will, at times, lead to false positives. However, the more significant issue is that insiders with very significant and accurate (i.e., material) information are in the best position to estimate whether their trades will trigger prosecution by the SEC and therefore will optimally modify

6From an SEC memorandum dated April 12, 1983 from Office of the General Counsel to Chairman John Shad.

7Other examples cases which involved prosecutions solely on the basis of circumstantial evidence are SEC v. Carl Karcher et. al., 1988 and SEC v. Helberg, 1990. Details are available from the authors upon request.
their strategy to minimize the probability of prosecution. This limits considerably the efficacy of rules designed to limit insider trading on the basis of material information. The following sections consider this issue in more detail.

II. On Ideal Insider Trading Legislation

One way to analyze the problem of regulation design is to see how various rules impact a specified welfare function. However, in our context, this approach suffers from two significant drawbacks. First, this paper concerns itself with situations in which only statistical evidence exists. With prosecutions based on statistical data, some innocent individuals will inevitably trigger the punishment rule. Thus, any welfare analysis will depend critically upon the (exogenous) cost attributed by society to the conviction of these individuals, and on the (exogenous) proportion of innocent individuals in the population. In response to these problems, our analysis takes a different tack. Instead of using an explicit welfare function, we instead specify the elements that would go into such a function. Rules can then be judged relative to how well they satisfy each element. The reader can then impose his own weighting scheme to determine whether a rule helps or hinders welfare.

As noted in the introduction, there is a second difficulty with any analysis that adopts a general social welfare function. Laws stipulate that the standard of proof in civil cases is guilt by a preponderance of the evidence. If a law does not convict mostly guilty individuals, it cannot meet this social welfare condition. Thus, it seems useful to begin any analysis with the question: Does the population of individuals convicted consist mostly of guilty people? If the answer to this question is in the negative, then it does not seem desirable to adopt the regulation, regardless of the specific social welfare function considered. The following analysis begins a direct examination of the conditions needed to meet this requirement.
A. The Criteria

Insider trading legislation in reality typically takes the following form. A regulatory authority (such as the SEC) first specifies a rule and a penalty designed to reduce the incidence of insider trading on the basis of significant inside information. Traders then optimize given the authority’s initial move. What complicates the authority’s problem is that the population of potential suspects is very large. The set of traders that may have the opportunity to use inside information includes nearly every corporate employee, and any friends or relatives that may become tippees. Adding to the difficulty of tracking down malfeasors is that these potential suspects often trade for completely legal reasons. Thus, outsiders cannot ascertain if a trader was in the possession of material information at the time he initiated a transaction.

The above observations suggest that insider trading legislation should seek to satisfy the following criteria:

1. The detection scheme and the penalty should discourage insiders from illegal trading. We term such a rule to be effective.

2. The detection scheme should not lead to the prosecution of innocent traders (i.e., those who do not trade illegally). Such a rule is termed benevolent.

3. The detection scheme should not discourage people without significant inside information from trading. Such a rule is termed useful.

The first criterion, namely, effectiveness, appears to be the very least a regulatory rule should accomplish. Thus, if the law does not discourage insiders from trading, it does not benefit society to have such a rule. In fact, the resources wasted as a result of the staffing of an agency to enforce the law will reduce social welfare in this case.

Benevolence also appears to be a trait any law should possess. Society generally disapproves when the legal system punishes individuals for offences they did not commit.
Of course this is not to claim that the legal system does not tolerate some errors. Any system should, however, seek to minimize these errors. Further, it is not clear that society will, or should, tolerate any system in which a very large number of convictions involve innocent traders. Our legal system requires us to convict individuals on criminal charges only if they are guilty beyond a reasonable doubt. For civil suits, such as those involving insider trading, the prosecution must still prove its case with a preponderance of the evidence. A law that leads primarily to the conviction of innocent traders must, by definition, violate this legal requirement.

Finally, society wishes to discourage insider trading in order to encourage trading by other individuals. Any rule that actually reduces trading activity by outsiders seems counterproductive. As noted in the SEC Chairman’s memorandum which was cited in the previous section, an important attribute of insider trading regulation should be the following:

Legitimate traders and analysts should be able to profit from their diligence without having to speculate, at the risk of substantial penalties, whether they violate a duty by trading while in the possession of material, non-public information.

A rule that does not meet the usefulness criterion not only expends wasteful resources on a regulatory agency, but produces a less active market as a result!

Since the regulatory authority (denoted henceforth by RA) must move first, via the establishment of legislation defining both insider trading and its enforcement, this paper takes as given the following sequence of events. First, the RA establishes a rule, which stipulates that if a certain random variable (e.g., the price move during a trading day) exceeds a certain exogenous threshold, and the trader in question has traded during the day, he will be prosecuted for illegal insider trading. Second, investors obtain information and trade. Third, the RA observes the size of each investor’s trade and the transaction price. The RA also observes any subsequent price changes. However, the RA cannot see
the information the investor had, or its quality, when he initiated the transaction. Based upon these observations, and the rule established in the first stage, the RA determines whether or not to prosecute particular individuals. While the paper examines several models, each one is considered within this sequence of events.

In the remainder of this section and the next section, we focus on the tradeoffs between the effectiveness and benevolence criteria. We bring back the usefulness criterion in Section VA.

B. The Basic Issues

Any prosecution strategy based on statistical evidence will lead to false positives. As a preliminary, this subsection states two claims which indicate that it will be difficult to design efficacious rules against insider trading. In Section III, we highlight the fact that the root cause of the problem lies in the insider’s strategic response to regulatory rules.

B.1 On the Non-Existence of a Perfect Rule

We first state a claim demonstrating that the three criteria described above are at such odds with each other that a perfect rule does not exist. In formulating this claim we assume that if a statistical rule does not discourage all outsiders from trading (note that this is a weaker requirement than the usefulness criterion above) then some outsider will eventually trigger it with probability one.\(^8\)

Claim 1 There does not exist a rule which perfectly meets all three criteria stated above. Specifically, no rule will simultaneously prevent all insiders from trading on illegal information (Criterion 1), and only result in the prosecution of guilty individuals (Criterion 2).

Justification: Suppose there exists a detection rule and prosecution scheme such that all insiders with material, non-public information refrain from trading. Then it must be

---

\(^8\)As a simple example, suppose outsiders trade randomly in terms of time and quantity. Then they will trip any statistical rule based upon trading activity with some probability.
the case that anyone who triggers the detection rule must not be an insider with such information, violating Criterion 2. Now suppose there exists a detection rule that never entraps an innocent investor. Then such a rule cannot prosecute anyone, since innocent people will inevitably trigger any rule by accident, and thus the rule cannot discourage insiders from trading. □

The above claim represents society’s quandary and it resembles the familiar problem arising from statistical errors of types I and II. Just as statistical tests can never eliminate both error types, society is unable to formulate rules that are both perfectly effective and socially implementable.

**B.2 Large Populations and Insider Strategies**

Society may not be able to formulate perfect rules, but can it construct “reasonably good” rules? Naturally, the answer must depend upon the environment to some degree. If the RA has some exogenous evidence that somehow ensures it has not erred in its prosecution, then clearly it may be able to do some good. However, this goes against the spirit of what it means to prosecute on circumstantial evidence. If price changes and trades are the sole source of evidence then it would seem that one must begin with a population that contains mostly uninformed traders. This notion can be formalized via the following assumption.

**Assumption 1 Nonexistence of hard evidence:** The regulatory authority does not possess evidence that allows it to identify a subpopulation that primarily contains people with material inside information. As a result, the unconditional probability of a randomly selected trader possessing information of a given accuracy is declining in the accuracy.

The question now arises as to whether or not the RA can meet its social goals when Assumption 1 holds. Prior to the institution of an insider trading rule one can think of the RA as simply a detection mechanism that does not impose any costs on “convicted” insiders. Let \( p_I \) equal the probability that an insider is detected when the RA cannot impose any penalties, and \( p_U \) the corresponding probability for the uninformed traders.
For an insider trading rule to be effective it must reduce insider trading and thus lower the probability of catching an insider to \( p_I < p^*_I \). Simultaneously, if the regulation is useful it must not discourage none insiders from trading and will thus weakly increase the chance of catching an uniformed trader to \( p_U > p^*_U \). This leads to the following claim.

**Claim 2** Consider any detection rule used by the RA and the distribution of trades that will occur absent a penalty for detection. Suppose that conditional on any particular trade size or price change the set of traders consists of a majority of uninformed individuals. Then any effective and useful rule will fail the benevolence criterion.

**Justification:** If a rule is effective then \( p_I <= p^*_I \) and if it is useful \( p_U >= p^*_U \). If \( p^*_I < p^*_U \) then \( p_I < p_U \). □

As noted earlier society requires convictions based upon a preponderance of the evidence. However, as the above claim shows unless the RA begins in an environment where the innocent traders have been winnowed out by evidence other than price changes and trades, most individuals convicted will actually be uninformed. By definition, they cannot be guilty by a preponderance of the evidence since they are more likely than not to be innocent.

Of course Claim 2 only affects society's problem to the degree that illegal insider trading is difficult to detect in the absence of a rule. This seems likely in general. To illustrate, let us divide all traders into insiders and uninformed traders. Assume that for every insider there exist \( N \) uninformed traders. The insiders are denoted by \( I \) and the uninformed by \( U_j, j = 1, \ldots, N \). Then, given a trade of size \( x \), the probability that it was initiated by an insider can be written as

\[
\frac{f(x, I)}{f(x, I) + \sum_{j=1}^{N} f(x, U_j)}
\]

Here \( f(x, I) \) and \( f(x, U_j) \) are the probability densities for a trade of size \( x \) given investor types of informed and uninformed respectively. What problems does the above equation pose for the RA? First, if \( f(x, U_j) \) exceeds \( f(x, I) \) for any individual uninformed trader
$j$ then most convicts will be innocent. Second, even if $f(x, I)$ exceeds $f(x, U_j)$ for all $j$ there cannot exist "too" many uninformed traders such that $f(x, U_j)$ exceeds any fixed positive finite number. Otherwise, the denominator will exceed twice the numerator and again most individuals prosecuted will be innocent. Third, society cannot necessarily surmount these problems by simply penalizing large trades. Suppose, for example, that any investor’s demand can be described as a normally distributed random variable. Additionally, suppose that any uninformed trader’s demand has a higher variance than the informed trader’s demand. Then as $x$ goes to plus or minus infinity one again obtains the result that most individuals prosecuted will be innocent. In all of the above cases, insider trading regulation fails to produce suspects that are guilty beyond a preponderance of the evidence. For society to produce a viable insider trading law, it must somehow address these problems effectively.

The next section explicitly addresses our primary issue. When a statistician seeks to test a hypothesis, the process generating the data does not alter its behavior to avoid rejection or acceptance. It is evident that this is not the case with rules designed to preclude trading by rational individuals on the basis of non-public information. Thus, the three problems described in the previous paragraph are not easily overcome.

III. Strategic Considerations

Absent a more formal setting, it becomes difficult to advance beyond Claims 1 and 2. Thus, in this section, we consider a one-period setting in which the accuracy of information varies across insiders. We then ask which individuals a feasible detection rule will prosecute. Our basic result is that the best informed insiders are in fact the least likely to get prosecuted. This is stronger than the conclusion drawn from Claim 1. That claim shows that a perfect rule does not exist. This section shows that within a more detailed model even a "second best" rule may have deleterious social consequences.
A. "Guilt" Versus "Innocence"

Thus far, we have not provided percise definitions of "innocence" and "guilt" in our context. However, this exercise is necessary in order to perform a formal analysis. At this point, a significant difference between insider trading and other types of criminal activities is worth reiterating. In order to discourage certain specific types of criminal activities such as drug possession and usage, society can increase the penalty to high levels (e.g., to the death penalty as in Malaysia), which should deter such activities almost completely. Note though that there is typically no ambiguity about whether someone was in the possession of a controlled substance: these individuals are usually caught in the act. Insider trading on the basis of material, non-public information, however is not discernible perfectly; thus the criteria for prosecution have to be based, in many cases, on statistical evidence. While it is true that increasing the penalty for insider trading will deter insiders more effectively, this will also imply that traders without any significant private information will, at times, be forced to pay the same high penalty.

Society, however, does not expect rules to be "perfect;" thus, it may be socially acceptable for insider trading regulations to occasionally ensnare innocent traders, so long as the resulting rule discourages disruptive trading while simultaneously convicting people who have a deleterious effect on the market. This raises the issue of what type of trading harms the market. As several market microstructure papers have demonstrated, insiders with the most precise information are the ones that cause the most damage to the trading environment.\footnote{Among the many papers on the subject are Admati and Pfleiderer (1988), Bhattacharya and Spiegel (1991), and Glosten (1989).}\footnote{We do not consider the oft-cited benefit of insider trading, namely, that of enhancing price efficiency, for two reasons. First, the very fact that the SEC expends considerable resources in attempting to prosecute insiders implies that regulatory authorities are more concerned about the liquidity reduction effect than the efficiency enhancing effect. Second, as observed by Rubinstein (1992) and Ausubel (1990), the price efficiency benefits from insider trading are likely to be small, as insiders typically commence trading on the information only a short time-period before the information is made public.} Intuitively, people with highly precise or accurate information reap the largest profits and thus create the greatest incentive for others to invest elsewhere. These profits derive from two separate sources. First, those with the most precise information
will be the ones most likely to see a signal indicating a large price change in the stock.\footnote{Intuitively one can see this by considering somebody with worthless information. Then no matter what his signal, he never believes that prices will move by more than enough to provide a benchmark (e.g., the market) rate of return.} Second, they bear little residual risk, and so can take very aggressive positions in the market.

In view of the above observations, and to avoid a potentially unproductive debate concerning both the threshold level of information accuracy above which a person is guilty, and the distribution of innocent and guilty people in the population, we define "innocence" and "guilt" in a relative sense. It seems reasonable to expect that people with relatively imprecise information are "more innocent" than those with precise information. Thus, the analysis simply assumes that all else equal, society prefers to convict those with better quality information. These concepts of "guilt" and "innocence" require the redefinition of the benevolence and effectiveness criteria in relative terms. Thus, a rule which discourages those with the most accurate inside information from trading will be termed \textit{marginally effective}, while a rule that causes the probability of individuals getting prosecuted to increase in the quality of their information will be termed \textit{marginally benevolent}. Finally, a rule that causes the probability of trade by an individual to decline in the accuracy of his information will be termed \textit{marginally useful}. These appear to be the desirable criteria a "second best" rule should possess.

One also needs to address the relationship between discouraging insiders with precise information from trading and discouraging trade on the basis of "material, non-public information" (the goal usually stated for insider trading regulations). The SEC defines "material" information as information about an event that indicates prices will change by more than some specified amount (see, for example, Meulbroek (1992)). Thus, there is an issue of identifying informational events associated with large price moves. For example, significant earnings surprises or the announcement of mergers can be expected to have a large impact on the stock price, whereas an event such as the hiring of a new upper level executive a relatively small one. It is reasonable to suppose that the SEC would most
intensively focus its investigations into illegal insider trading activity around the former category of events. However, after deciding which classes of events will "materially" affect security values, there still remains the problem of which individuals to prosecute around such events. From the RA's perspective, it appears natural to have a policy goal of prosecuting those individuals who have the most precise information about the event, as these are the individuals which have the most deleterious impact on market liquidity.\textsuperscript{12}

B. The Model

This section of the paper examines the difficulties involved in prosecuting strategic insiders. To concentrate on this single issue, the model holds everything but the insider's ability to manipulate the system fixed. The goal is to highlight how the insider's strategies work to thwart the RA. Since this insight will hold true within any model, this simple setting helps obtain insights about the basic source of the problem faced by the RA.

Assume that after the RA has set up its rules, traders receive information via a signal $s$, of accuracy $a$. (We will provide a precise definition of "accuracy" shortly.) Next, each trader decides whether to trade in the market. Though the RA does not directly observe $a$, after trading takes place, the RA draws a signal $e$ concerning the existence of illegal insider trading. If the insider does not trade, the signal received by the RA equals $-\infty$, and the insider earns a payoff of zero.\textsuperscript{13} If the insider does trade and the signal $e$ exceeds a number $e^*$, then the RA prosecutes the trader, and he earns $\pi_c < 0$.\textsuperscript{14} If the signal does not exceed $e^*$, the RA does not prosecute, and the trader earns $\pi_n > 0$.\textsuperscript{15} The RA's

\textsuperscript{12}See, for example, Admati and Pfleiderer (1988).

\textsuperscript{13}Setting the RA's signal to $-\infty$ if no trade takes place just simplifies the notation. Alternatively, one can allow the RA to see a separate signal indicating whether or not the investor traded. In the event of no trade, the RA then declines to prosecute whatever its value of $e$. This is completely equivalent to the specification given here.

\textsuperscript{14}Prosecution need not always lead to conviction in reality. As mentioned earlier, however, the mere commencement of prosecution proceedings by the SEC will doubtless lead to significant reputational losses and legal costs for the insider. By postulating that $\pi_c < 0$, we are implicitly assuming that these losses, in monetary terms, are larger than the profits made by the insider on his securities trades.

\textsuperscript{15}The specification that prosecution occurs only if $e$ exceeds $e^*$ is without loss of generality. Suppose instead the RA will prosecute if $e$ lies in the set $E$. Simply, renumber the elements in $E$ and its complement so that elements in $E$ lie entirely above those in its complement. Now $e^*$ simply represents
rule thus requires the ex ante stipulation of the threshold $e^*$ and the penalty $\pi_e$.\textsuperscript{16} Also, the $\pi$’s do not necessarily derive solely from trading profits. If a trader has a hedging or liquidity reason for trading, then the $\pi$’s include the benefits induced by these motives.

Let $p(e > e^*|s, a)$ denote the probability that $e > e^*$, given the insider has received a signal $s$, of accuracy $a$. In reality, inside information helps the insider predict future stock prices. It also seems reasonable to suppose that the RA will use stock prices to detect insider trading. Thus, any signal that helps the insider to predict stock prices should also help the insider to predict the signal received by the RA. We therefore assume that higher values of $s$ imply higher values of $e$, so that $\partial p / \partial s > 0$. To concentrate on how insider strategies interfere with society’s goals we assume that neither $s$ nor $e$ influence $\pi_n$; however, this restriction will be relaxed in the next section.

Given this basic setup, the insider will only trade if he believes there exists a reasonable chance that he will not be prosecuted. Formally, the insider will only trade if

$$\pi_n[1 - p(e > e^*|s, a)] + \pi_e p(e > e^*|s, a) > 0$$

(1)

Now rearrange (1) and solve for $p$ to obtain the result that the insider only trades if

$$p(e > e^*|s, a) < \frac{\pi_n}{\pi_n - \pi_e}$$

(2)

Since $\partial p / \partial s > 0$, the insider only trades if $s < s^*$, where $s^*$ is that value of $s$ that satisfies (2) as an equality.

The above arguments imply that the insider only trades if he receives a sufficiently low signal realization. Since the RA only prosecutes the insider if $e$ is large enough, the unconditional expected profit for an insider can be written as

$$\pi(a) = \pi_n \left[ \int_{-\infty}^{s^*} f(s|a)ds - \int_{-\infty}^{s^*} \int_{-\infty}^{e^*} g(e|s,a)f(s|a)dsde \right] + \pi_e \int_{s^*}^{\infty} \int_{-\infty}^{e^*} g(e|s,a)f(s|a)dsde$$

(3)

the smallest element in $E$.

\textsuperscript{16} A natural issue which arises at this point is whether the cutoff $e^*$ and the penalty $\pi_e$ should be derived endogenously. Such an exercise, however, is likely to depend on parameters exogenous to the model, and therefore will add little to our central ideas. In any event, all our results apply to any $e^*$ and $\pi_e$, including that derived through the optimization by the RA of an explicit objective function.
where \( \pi(a) \) equals the expected profit, \( g \) the density function of \( e \) given \( s \) and \( a \), and \( f \) the density function of \( s \) given \( a \). Recall that \( a \) represents the accuracy of the insider's information, and at this point we need to precisely define "accuracy." We begin by assuming that the maximum value of \( a \), denoted by \( a^m \), is such that if \( a = a^m \), then \( s = e \), and that if \( a < a^m \), then \( s \) is some signal less than perfectly correlated with \( e \). Next, we use a definition that resembles second order stochastic dominance. In particular, we assume that any given insider can duplicate the expected payoff of an insider whose signal is less accurate than his own by adding noise to his own signal, and then following the decision rule used by the insider with the less accurate signal. Formally, if \( a_h > a_i \), then \( f(s|a_i) = f(s+\varepsilon|a_h) \), for a random variable \( \varepsilon \) with mean zero. Given this assumption, one obtains \( \partial\pi/\partial a > 0 \).

Since the RA prosecutes only if \( e > e^* \), an insider can only be prosecuted if \( e > e^* \) and \( s < s^* \). In integral form this implies that the probability of an insider being prosecuted by the RA is

\[
\Pr(e > e^*, s < s^*|a) = \int_{e^*}^{\infty} \int_{-\infty}^{s^*} f(e, s|a) dsde = \int_{-\infty}^{\infty} \int_{-\infty}^{s^*} g(e|s, a)f(s|a)dsde
\]

(4)

where \( f(e, s|a) \) represents the joint density of \( e \) and \( s \), given \( a \). Equation (4) is crucial to the analysis, since it determines the probability that an insider of any particular type \( a \) gets prosecuted. As discussed earlier, insiders with the most precise information do the most harm to the trading process. Thus, society wants to see (4) maximized for those insiders with the best information (high values of \( a \)).

One can immediately see from equation (3) that the RA can never prosecute insiders that possess perfect information. An insider with such information, i.e., with \( a = a^m \), can use \( s \) to determine with certainty if \( e \) will or will not exceed \( e^* \). So long as \( \pi_e < 0 \), this insider will never trade if \( e > e^* \) and thus can never be prosecuted.\(^{17}\) The corresponding scenario in the real world might involve an insider whose information enables him to

\(^{17}\)Formally, the right-hand side of (4) is zero if \( a = a^m \) and \( e > e^* \).
forecast the end of day stock price with perfect accuracy, and thus he foresees whether the price will cross the threshold which triggers investigation by the RA. This implies that the insider’s trades only take place when he will not be prosecuted. Note, however, that if \( \pi_c > 0 \), the authorities can indeed prosecute perfectly informed insiders, since in this case insiders will trade even if \( e > e^* \). In this case, unfortunately, all insiders trade all of the time, which means the legislation is not effective at all.

The above arguments indicate that insiders who trade on superior information will be difficult to prosecute. In corroboration of this intuition, the next proposition shows that no rule can simultaneously be both marginally effective and marginally benevolent.

**Proposition 1** If a rule causes better informed traders to trade less often (\( \partial s^*/\partial a < 0 \)), then the probability of an insider being prosecuted varies inversely with the accuracy of his information.

**Proof:** The term

\[
\int_{e^*}^{\infty} \int_{-\infty}^{s^*} g(e|s,a)f(s|a)dsde
\]

in equation (3) equals the probability that the insider’s trading is detected. Call this \( q \equiv p(e > e^*, s < s^*|a) \). We differentiate (3) with respect to \( a \) and use the relationship \( \partial \pi/\partial a > 0 \) to obtain

\[
\frac{\partial q}{\partial a} < \frac{\pi_n}{\pi_n - \pi_c} \left[ \int_{-\infty}^{s^*} \frac{\partial f(s|a)}{\partial a} ds + \int_{s^*}^{\infty} \frac{\partial f(s|a)}{\partial a} ds \right]
\]

(5)

To prove the proposition, one needs to show that \( \partial q/\partial a < 0 \), which requires one to prove that the right-hand side of (5) is negative. Recall that \( \pi_n > 0 \) and \( \pi_c < 0 \), so that the term outside the square brackets is positive. The term inside the brackets equals the change in the probability the insider trades, per unit change in the accuracy of his information. If the rule is marginally effective, this number must be negative, so that the RHS of (5) is indeed negative, proving that \( \partial q/\partial a < 0 \).

Insider trading legislation should discourage individuals with the most precise private information from trading. Any law that does not accomplish this objective will not
be marginally effective. Thus, Proposition 1 asks who the regulation will prosecute if it actually attains the above goal. Unfortunately, the proposition suggests that the individuals ensnared will be those with the poorest information.\footnote{One might argue that in some cases the regulatory authority has exogenous data that can identify a population skewed towards those likely to have high quality information (i.e., those individuals with high values of $a$). However, if the authority can use some exogenous factor to identify a subpopulation that contains only people with material nonpublic information, then it has effectively obtained "hard evidence," a situation which does not arise too often (as per the material in Section I), and which is beyond the scope of this paper's analysis. Thus, the natural assumption seems to be that better informed traders are relatively rare compared to poorly informed traders as per Assumption 1.}

Current legislation seeks to prosecute individuals who use material private information, which can be characterized as those who draw a large value for $a$. Employing Assumption 1, Proposition 1 demonstrates that any individual prosecuted on the basis of circumstantial (statistical) evidence such as correlation of price movements with insider trades, is likely to be innocent, i.e., possess relatively poor information. The rule must therefore violate Criterion 2, in that it is not marginally benevolent.

Suppose society decides to design a scheme to prosecute insiders that has the sole objective of stopping at least some insiders from trading. Again, such a rule would hopefully deter those with the best information from trading. The next proposition shows that any rule of this type can only stop those insiders with the poorest information from trading.

**Proposition 2** Suppose there exists a set of insiders who never trade on their information. Let $a^*$ represent the supremum of this set (in terms of the value of $a$ possessed by each insider). Then any insider with $a < a^*$ never trades.

**Proof:** If a particular insider never trades, then his profits are equal in all states. From the definition of $a$, insiders with $a < a^*$ cannot have expected profits that exceed that of an insider with $a = a^*$. In this case, an insider with $a < a^*$ can earn the same profits as an insider with $a = a^*$ by never trading. Thus, this must be an optimal strategy for the insider with $a < a^*$. \(\square\)
Intuitively, the proposition indicates that insiders with the poorest information are the easiest to prosecute. If an insider has good information, he is likely to use it no matter what the penalty, since the quality of his information makes it unlikely he will ever be prosecuted. In a sense then, insider trading legislation is likely to be ineffective in its primary cause: it will likely not preclude the best informed individuals from trading.

IV. Richer Models

The skeptical reader may believe that the results in the previous section derive from the model’s simplicity and will not hold in more general environments. In this section, however, we consider two generalizations to our analysis, and argue that adding various additional features to the model reinforces the paper’s central results. Subsection A considers a standard mean-variance setting that allows investors to select their order size. While closed-form solutions do not seem possible, our simulations indicate that statistical rules will either be ineffective, or mostly punish individuals with relatively poor information. Subsection B demonstrates that even if the RA employs a randomized strategy, the results of the previous section remain unaltered.

A. A Mean-Variance Model

In Section III of the paper a trader had a binary choice set: he could either trade or refrain from doing so. We now address the issue of whether allowing investors to select their trade size makes the RA’s job more or less difficult. Thus, we examine the RA’s problem in a mean-variance utility maximization framework. Consider a risky security which is exchanged for a riskless security at date 0 and pays off $\delta + \eta$ at date 1. Both $\delta$ and $\eta$ are independent and each is normally distributed with zero mean. The riskless rate is normalized to zero. An informed trader with mean-variance utility given by

$$EU = E(W) - (A/2)\text{var}(W),$$

(6)
where $W$ denotes wealth and $A$ the degree of risk aversion, observes a signal $\delta + \epsilon$, where $\epsilon$ is also normally distributed with zero mean and is independent of $\delta$ and $\eta$. In addition, the informed trader possesses a non-traded endowment $w$ which is perfectly correlated with $\eta$. For simplicity, normalize the price of the security to zero.\textsuperscript{19} The RA observes $\delta$ ex post and sets a rule such that if $\delta^2 > c$ and the informed trader has traded in the same direction as the sign of $\delta$, then the trader is forced to pay a penalty $c_0$.\textsuperscript{20}

Let the order of the informed investor be denoted by $x$, provided he chooses to trade. Substituting $W = x(\delta + \eta) + w\eta$ into (6) and maximizing the resulting objective yields

$$x = \frac{\mu - A\sigma^2 w}{A(\sigma^2 + \sigma^2_\eta)}$$

where $\mu$ and $\sigma^2$ denote the mean and variance of $\delta$ conditional on $\delta + \epsilon$. Substituting for $x$ into (6), we obtain

$$EU = \frac{\mu^2 - 2A\mu\sigma^2 w - A^2 w^2 \sigma^2 \sigma^2_\eta}{2A(\sigma^2 + \sigma^2_\eta)}$$ \hspace{1cm} (7)

Note, however, that

$$\mu = \frac{\sigma^2_\delta x + \epsilon}{\sigma^2_\delta + \sigma^2_\epsilon}$$ \hspace{1cm} (8)

and

$$\sigma^2 = \frac{\sigma^2_\delta \sigma^2_\epsilon}{\sigma^2_\delta + \sigma^2_\epsilon}$$ \hspace{1cm} (9)

Substituting for $\mu$ and $\sigma^2$ into the expression for $EU$ in (7), we have

$$EU = \frac{\sigma^2_\delta (\delta + \epsilon)^2 - A^2 \sigma^2_\delta \sigma^2_\eta w (\sigma^2_\delta + \sigma^2_\epsilon) - 2A \sigma^2_\delta w (\sigma^2_\delta + \sigma^2_\epsilon) (\delta + \epsilon)}{2A(\sigma^2_\delta \sigma^2_\epsilon + \sigma^2_\delta \sigma^2_\eta + \sigma^2_\epsilon \sigma^2_\eta)(\sigma^2_\delta + \sigma^2_\epsilon)}$$ \hspace{1cm} (10)

Now, note that if the informed investor refrains from trading, he holds his non-traded endowment, so that his utility is given by $-(A/2)w^2 \sigma^2_\eta$. The optimal decision of the

\textsuperscript{19}Explicitly solving for the price endogenously does not add anything significant to our central ideas.

\textsuperscript{20}We assume here that the triggering variable is $\delta^2$. Our formulation accords with the SEC's policy of initiating investigations based on the association of large price moves and trades by corporate insiders (see, for example, Meulbroek (1992)). However, another plausible triggering variable is the ex post profits of the informed trader. Using this alternative trigger would not change the qualitative nature of our results, since the larger is the variable $\delta^2$, all else equal, the larger is the ex post profit. Also, our rule (and the rule based on ex post profits) both accord with the policy goal of prosecuting individuals with high precision information, since it is easily verified that the more precise the signal (i.e., the lower the $\sigma^2_\epsilon$), ceteris paribus, the more the likelihood of the investor trading and the greater his trading profits.
investor is thus to trade if

\[ EU - \Pr(\delta^2 > c, x\delta > 0 | \delta + \epsilon) c_0 > -\frac{A}{2} u^2 \sigma^2 \]  

(11)

where \( EU \) is given by the right-hand side of (10). Denote the left-hand side of inequality (11) by \( \Theta \). Then, the probability of the informed investor being prosecuted is given by

\[ \Pr(\text{Caught}) = \Pr(\delta^2 > c, \Theta > 0) \]

Direct analytical solutions to the above problem are cumbersome. We present below the qualitative results obtained from Monte Carlo simulations of the random variables in the above framework. (100,000 simulations were carried out for the determination of each point in the graphs described below.)

Figures 1 and 2 respectively plot (i) the unconditional probability of being prosecuted and (ii) the unconditional probability that an investor trades, both as a function of \( \sigma^2 \), i.e., the variance of the noise in the informed investor’s signal.

Please insert Figures 1, 2, and 3 here.

As can be seen from Figure 1, so long as \( \sigma^2 \) is sufficiently low, the probability of being prosecuted increases in the variance of signal noise for all levels of the penalty \( c_0 \), indicating that, under the assumption that regulatory authorities prefer to prosecute individuals with more accurate information, the rule is not marginally benevolent in this range of \( \sigma^2 \).\(^{22}\) While the probability of prosecution does decrease in \( \sigma^2 \) for large \( \sigma^2 \), Figure 2 indicates that the probability of trade monotonically declines in \( \sigma^2 \), and falls below 20% for large levels of the penalty and large values of \( \sigma^2 \), thus demonstrating that the rule is not marginally useful.

Figure 3 plots the average absolute value of \( \delta \) expected by a trader undergoing prosecution. Notice that this value generally declines in the signal noise. As noted earlier,

\(^{21}\)Given the concavity of the utility function, it is easy to show that the informed investor will never choose to trade in a direction opposite to that of the sign of \( \delta \).

\(^{22}\)Note that \( \sigma^2 \) is a variable chosen by nature; the RA has no authority over it.
one might argue that information should be considered material if it causes a trader to expect a large change in the stock's price. Using this definition, Figure 3 shows that the lower the precision of a trader's information, the less material his information will tend to be when prosecuted. Combining this result with those derived from Figure 1, insider trading regulation can lead to a very perverse outcome, in the sense that reducing the precision of a trader's information can increase the likelihood he will be convicted for insider trading! One can hence conclude that in this situation, the rule does not meet the marginal benevolence criterion.

Figure 3 also points out another seemingly anomalous result. Increasing the penalty tends to reduce the quality of the information possessed by a trader when prosecuted. Initially, one may think that if the penalty goes up, traders should only trade if they think they possess very important information. However, this reasoning only works for traders with nearly perfect information, and then only for small penalty levels. For most traders, increasing the conviction penalty so discourages them from trading that prosecutions tend to occur only when the investor's ex-ante beliefs are that the stock price will not move by too much. Essentially, the investor is as surprised as the rest of the market by the stock's large unexpected price move. Unfortunately, the trader also finds that this "good" fortune has led to his prosecution by the RA.

Figures 4, 5 and 6 reflect the implications of the RA's attempt to reduce the possibility of catching investors with insignificant amounts of private information ("innocent investors") and thereby encouraging them to trade more often. These figures thus provide the same comparative statics as Figures 1, 2, and 3 except that the level of the cutoff on $\delta^2$ is increased from 1 to 4.

Please insert Figures 4, 5 and 6 here.

A quick comparison of Figures 1 and 4 and Figures 2 and 5 indicates that the probability of being prosecuted is generally lower and the probability of trade is generally higher when the cutoff on $\delta^2$ is raised. However, the tendency for the probability of being prosecuted to
increase in $\sigma_t^2$ is generally stronger in Figure 4 relative to Figure 1, whereas the probability of trade continues to decline in $\sigma_t^2$ for all non-zero penalty levels in Figure 5. Thus, while the effect of increasing the cutoff is to cause all investors to trade more often, this, unfortunately, imposes a dual cost: (i) the probability of prosecuting any given investor uniformly decreases, and (ii) the tendency of the probability of prosecution to increase in the imprecision of information becomes stronger. Figure 6 leads to the same general conclusions as Figure 3 in the sense that the lower the quality of a trader's information the less "material" his information will tend to be when convicted.

B. Randomization

So far, the analysis has focused upon the insider and his strategies. The RA's strategy, however, does not need to be as simple as "prosecute if a signal $e$ is greater than $e^*".$ In particular, the RA can randomize over the value of $e^*$ used to prosecute an investor. For the following discussion the only restriction on the model is that an insider with inferior information observes the same signal as his better informed counterpart plus a white noise error term. Now, assume that the value of $e$ that triggers prosecution is random and can be written as $e^* - \epsilon$. Here $\epsilon$ represents a non-degenerate random variable with zero mean, that is independent of $e$ and $s$. This is equivalent to imposing a mean-preserving spread on the variable $e$ such that the rule now entails prosecution if $e_n > e^*$, where $e_n = e - \epsilon$. In this setting, the following proposition can be derived.

**Proposition 3** Randomization on the part of the RA is equivalent to reducing the accuracy of each insider's information. The ordering of the accuracies, however, does not change.

**Proof:** Write $s_\alpha \equiv e - \eta_\alpha$, with $\eta_\alpha$ accounting for the signal of accuracy $\alpha$ received by the insider. Without randomization, the insider wishes to know if $e > e^*$ given $s_\alpha = e - \eta_\alpha$. Substitute out for $e$ to observe that, equivalently, the insider wishes to know if $s_\alpha + \eta_\alpha > e^*$. 

---

Footnote: It is evident that if the penalty is set at zero, the probability of trade will be invariant to $\sigma_t^2$. 

25
With randomization the insider wishes to know if $e + \epsilon > e^*$. Again substitute out for $e$ to obtain $s_a + \eta_a + \epsilon > e^*$. Then an insider with a signal $s_a$ in an environment with randomization by the RA faces the same inference problem as an insider with signal $s_{ae} = e - \eta_a - \epsilon$ without randomization.

One now needs to prove that randomization does not change the ordering of the accuracies (or precisions). Recall that the model assumes that an insider with less accurate information observes the same signal as an insider with more accurate information plus added noise. This observation still holds, with the additional noise added to $s_{ae}$ rather than $s_a$. □

Does randomizing help? In a sense, yes. The models in the previous sections demonstrated that traders with perfect information will never be prosecuted. If the SEC randomizes over $e^*$, this result disappears. So the positive aspect of randomization is that the best informed insiders can now be prosecuted on occasion.\textsuperscript{24} Unfortunately, the probability that less informed traders will be prosecuted also increases. In fact, the basic conclusions derived thus far remain unchanged. If the legislation is marginally effective (deters the better informed from trading), and if those in possession of high quality information are relatively rare (nonexistence of hard evidence), then any individual convicted is likely to be somebody that traded on poor quality information. Alternatively, if the legislation is socially acceptable, then the individuals deterred from trading will be those with the poorest information sets.

\textsuperscript{24}One should not make too much of this "benefit." The best informed traders face prosecution only because they do not know with certainty when a trade will be considered illegal. A close analogy can be found with speed limits. A perfectly informed trader is equivalent to a motorist with a perfect speedometer. If the motorist knows that going faster than 55 miles per hour always leads to prosecution (with an appropriately high penalty) the motorist never speeds, and so never faces prosecution. Under a random speed limit, prosecutions sometimes take place, but only because the driver can never be sure if he is speeding.
V. Conclusion

The legal environment surrounding insider trading regulation indicates that prosecutions of illegal insider trading cases often rely on circumstantial evidence. The following statement by former SEC Commissioner Bevis Longstreth, reflecting concern about the proposal to raise the level of proof from a preponderance of evidence to "clear and convincing," supports this observation:

I think that if the Congress were now to increase the burden of proof for this violation we are talking about, you simply move the ground from underneath the Commission, and since these cases are all rooted in circumstantial evidence, you are going to make it far more difficult for the Commission to succeed in a case.25

The models presented here constitute, to the best of our knowledge, the first piece of research addressing the efficacy of insider trading legislation, in contrast to the voluminous work addressing the social desirability of the same. The starting point of our analysis is the observation that insiders with the most accurate information will be the most difficult to prosecute by the use of circumstantial evidence. This is because these agents are the ones best able to adapt their strategy in financial markets to avoid being investigated by the regulatory authorities in the first place. The intuition can most easily be illustrated by looking at the extreme case in which the insider has perfect information about the triggering variable (e.g., the end-of-day price) used by the regulatory authority. In this case, the insider will never trade if the variable crosses the threshold, so that the authority is never able to prosecute such an insider.

More generally, our analysis demonstrates that if insider trading regulation is to be effective and useful (i.e., it is to deter the better informed from trading and thereby

25Hearing before the Subcommittee of the Committee on Energy and Commerce on April 13, 1983, with regard to H.R. 559, a bill to increase the sanctions against insider trading in securities while in the possession of material, non-public information.
encourage trade by relatively uninformed traders), then, given strategic behavior by insiders with accurate private information, the individuals prosecuted are likely to be the ones with the poorest information. On the other hand, if the rule is designed to be benevolent, i.e., to not result in the prosecution of traders with relatively imprecise information, then again strategic considerations only deter such individuals from trading. The analysis thus underscores the importance of producing "hard" evidence, such as a memorandum, rather than simply producing a "preponderance of evidence" against an insider, as is often the practice in the current regulatory environment.
References


Figure 1: Traders' Signal Noise (Var(e))

Probability a Trader is Prosecuted

C = 1, A = Var(M) = Var(\eta) = \tau

0.01 0.21 0.41 0.61 0.81 1.01 1.21 1.41 1.61 1.81 2.01

0 0.01 0.05 0.10 0.15 0.20 0.25 0.30
Figure 4

Traders' Signal Noise (Var(e))

0.01 0.21 0.41 0.61 0.81 1.01 1.21 1.41 1.61 1.81 2.01

Penalty

C = 4, A = VAR(M) = VAR(0) = VAR(m) = 1

Probability a Trader is Prosecuted
Figure 5

Traders Signal Noise (Var(e))

0.01 0.21 0.41 0.61 0.81 1.01 1.21 1.41 1.61 1.81 2.01

Penalty

C = 4, A = Var(W) = Var€(Var) = Var(μ) = 1

Probability of Trade

Probability
Figure 6

Traders' Signal Noise (var(e))

0.01 0.21 0.41 0.61 0.81 1.01 1.21 1.41 1.61 1.81 2.01

---

Average Value of $|\mu|$ When Prosecuted

$c = 4$, $A = \text{var}(W) = \text{var}(\varepsilon) = 1$