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Insider Trading: Regulation, Securities Markets, and Welfare under Risk Aversion

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I analyze in this article the impact of insider trading regulation (ITR) on a securities market and on social welfare, and argue that the imposition of ITR forces a reallocation of wealth and risk that decreases social welfare. Three reasons explain this result: First, ITR increases the volatility of securities prices; second, it worsens the risk sharing among investors; and, third, it diverts resources from the productive sector of the economy. Further, although I formally establish conditions under which ITR makes society better off, I argue that those conditions are not useful to justify the imposition of this regulation.

I am very much aware that many economists whom I respect and admire will not agree with the opinions I have expressed and some may even be offended by them. But a scholar must be content with the knowledge that what is false in what he says will soon be exposed and, as for what is true, he can count on ultimately seeing it accepted, if only he lives long enough.

—*Ronald Coase, The Institutional Structure of Production*,
1991 Nobel Lecture in Economic Sciences.

There is no doubt that liquidity and informational efficiency, among others, are important characteristics of a securities market. However, it is clear that these characteristics are not, or should not be, ends in themselves. There seems to be little doubt that, from a normative point of view, the ultimate goal (hence, the ultimate concern of policy makers) is, or should be, to maximize social welfare.

The literature on speculative trading under asymmetric information has focussed its attention on the analysis of market liquidity and informational efficiency,[1] but has paid relatively little attention to the issue of insider trading and its regulation.[2] Those studies that do consider insider trading, on the other hand, have usually omitted welfare analyses. To the best of my knowledge, only Ausubel

(1990) and Leland (1992) have addressed the critical question: *Does insider trading regulation (ITR) make society better off or worse off?* Note that this question does not focus on the effects of ITR on liquidity, informational efficiency, or other characteristics of a securities market; rather, it focusses on the impact of ITR on social welfare. Further, it does not focus on the welfare of a given type of agents; rather, it focusses on the welfare of society as a whole.

Ausubel (1990) considers the impact of ITR on social welfare within the framework of a competitive market and concludes that society is better off when insider trading is restricted. However, his analysis neglects a fact that has become widely accepted: if expectations are rational, a trader with private information is never small.[3] Hence, price-taking behavior is not the adequate framework to analyze issues of informed trading. Leland (1992), on the other hand, also considering the impact of ITR on social welfare, arrives at an ambiguous result: if production is not responsive to securities prices, then ITR is beneficial; otherwise, it is harmful.

The major difference between this article and those of Ausubel (1990) and Leland (1992), among others, is that this article addresses in detail the relationship between risk and the welfare effects of ITR. Two out of the three reasons for which ITR is socially detrimental in the model presented below follow from risk-related arguments. Further, the risk reallocation generated by ITR, largely ignored in previous analyses, is also examined in detail below. Finally, the third reason for which ITR will be shown to be detrimental, related to the cost of monitoring the behavior of insiders, is also ignored by both Ausubel (1990) and Leland (1992), as well as by most other studies in the literature.

I consider in this article an economy under two policy regimes: one in which insider trading is restricted (the regulated market), and one in which it is not (the unregulated market). After deriving an equilibrium for each regime, I evaluate the impact of ITR on a securities market and on social welfare. Due to the lack of research on the relationship between ITR and social welfare, I pay special attention to the welfare issue.

The model features three types of traders (insiders, outsiders, and liquidity traders) interacting with a market maker in a market for a risky asset. Insiders and outsiders possess private information about the future price of the risky asset; hence, their trading is informationally motivated. Liquidity traders, on the other hand, are uninformed and trade for exogenous reasons. Besides trading in the risky asset, all traders engage in the production of a commodity.

Besides insiders, outsiders, liquidity traders, and a market maker, the model features a group of agents that do not participate in speculative activities. These individuals, referred to as workers, invest all their wealth in a risk-free asset and engage in production of the commodity. Further, if insider trading is restricted, some of these workers are diverted to perform the task of enforcing ITR; that is, they act as regulators.

The informational structure of the model reflects the fact that not only the insiders of a firm have access to nonpublic information that affects the future price of that firm's securities. Outsiders whose activities are related to the activities of the firm under consideration also possess such information. Thus, the model considers a framework in which informed traders acquire information about the future price of a risky asset as a byproduct of their activities. That is, information is costlessly acquired.

An example might help. Let the risky asset under consideration be IBM stock. The price of this stock is affected by factors that affect IBM itself; for example, by the invention of a new mainframe created by IBM researchers. I refer to this type of information, when known by only a few traders related to IBM, as inside information. Further, I refer to those few traders that observe this (private) information as insiders. The price of IBM stock is also affected by factors that affect firms related to IBM; for example, by the invention of a new computer chip created by Intel researchers. I refer to this type of information, when known by only a few traders related to Intel, as outside information. Further, I refer to those few traders that observe this (private) information as outsiders.[4]

I assume below that all traders (and workers) are risk averse. Under this assumption, the mathematical structure of the model is significantly more complicated than under risk neutrality. In particular, a tractable closed-form equilibrium for each regime cannot be derived. Therefore, numerical analysis is used to evaluate the impact of ITR on a securities market and on social welfare.

I show in this article that ITR has both beneficial and detrimental effects on a securities market. In particular, I show that ITR has a beneficial effect on market liquidity and current-price volatility, and a detrimental effect on future-price volatility, informational efficiency, and price predictability. In terms of welfare, I show that ITR makes insiders and workers worse off, outsiders and liquidity traders better off, and society as a whole worse off. I argue below that three reasons explain this last result: First, in an unregulated market the volatility of securities prices is lower; hence, this market is less risky. Second, in an unregulated market insiders bear a part of the risk of the variability in securities prices; hence, there is a superior risk sharing among investors in this market. And, third, in an unregulated market no resources are diverted to the enforcement of ITR; hence, no production of goods and services is foregone in this market. Further, I show that most of the previous results are valid for a wide range of values of the parameters of the model, and that the conditions under which ITR makes society better off are not very useful to justify the imposition of this regulation.

The rest of this article is organized as follows. In part I, I introduce the model and derive two equilibria (one for the unregulated market and another for the regulated one). In part II, I evaluate the impact of ITR on a securities market and on social welfare for the base case of the model. In part III, I perform a sensitivity analysis in order to determine the generality of the results established in part II. And, finally, in part IV, I summarize the most important conclusions of the analysis. An appendix at the end contains several figures and tables.

I. THE MODEL

Market Microstructure

Consider a two-date (one-period) economy where 0 denotes the present (the beginning of the period) and 1 denotes the future (the end of the period). There are two investment opportunities in this economy: a risk-free asset (F) that yields a certain return (ρ), and a risky asset (x); the analysis is focussed on the latter. Three types of traders interact in the market for the risky asset: insiders (indexed by N), outsiders (indexed by T), and liquidity traders (indexed by Q). All these traders interact with a market maker either in an unregulated market (indexed by U) or in a regulated market (indexed by R); that is, a market that restricts insider trading. Finally, there is a group of agents that do not participate in speculative activities. These agents, referred to as workers (indexed by K), simply invest their wealth in the risk-free asset.[5]

Insiders, outsiders, liquidity traders, and workers are endowed with (certain) initial wealth w_i^0, which they can use to purchase a portfolio containing the risk-free asset and the risky asset. Yet, if insider trading is restricted, all these agents will be forced to forgo a proportion t_j ($0 \leq t_j \leq 1$) of their initial wealth to bear the cost of ITR. Thus, let t_R be the rate at which traders and workers are taxed in the regulated market, and $t_U = 0$; that is, no taxes are paid in the unregulated market. Hence, the budget constraint of traders and workers is given by:

$$(1 - t_j)w_i^0 = F_{ij} + p_{0j}\tilde{x}_{ij}, \quad i = N, T, Q, K \quad j = U, R \tag{1}$$

where F_{ij} is agent i's demand for the risk-free asset in the jth market, p_{0j} is the price of the risky asset in the jth market at the beginning of the period, and $\tilde{x}_{ij}$ is agent i's demand for the risky asset in the jth market. Since workers do not trade in the risky asset, then $x_{Kj} = 0$.

Between the beginning and the end of the period, all traders and workers engage in the production of a commodity. Thus, let Y_{ij} be (the monetary value of) agent i's production of this commodity in the jth market. It is assumed that all traders produce the same amount of Y regardless of the type of market in which they trade; that is, $Y_{iU} = Y_{iR}$, for $i = N, T, Q$. However, this cannot be the case for everybody in the economy. For, if insider trading is restricted, someone has to perform the task of enforcing ITR, thus foregoing production of the commodity. It is assumed that, if the market is regulated, (some) workers will perform this task. Hence, workers' production of the commodity will be larger when insider trading is not restricted; that is, $Y_{KU} > Y_{KR}$.

At the end of the period, when both trading and production are finished, traders and workers possess (random) terminal wealth given by:

$$\tilde{w}_{ij}^1 = (1 + \rho)F_{ij} + Y_{ij} + p_1\tilde{x}_{ij}, \quad i = N, T, Q, K \quad j = U, R \tag{2}$$

where $\tilde{w}^1_{ij}$ is agent i's terminal wealth in the jth market, and $\tilde{p}_1$ is the price of the risky asset at the end of the period. This terminal price, which is exogenously determined, is given by:

$$\tilde{p}_1 = \bar{p}_1 + \tilde{\varepsilon} + \tilde{\eta} \tag{3}$$

where $\bar{p}_1$ is the expected price of the risky asset given all publicly available information, and $\tilde{\varepsilon}$ and $\tilde{\eta}$ are two random variables such that $\varepsilon \sim N(0, \sigma^2_\varepsilon), \eta \sim N(0, \sigma^2_\eta)$, and $Cov(\tilde{\varepsilon}, \tilde{\eta}) = 0$. That is, the future price of the risky asset is determined by all publicly available information and by two independent, normally-distributed random shocks.[6]

The behavior of liquidity traders is not explicitly modelled. They are assumed to demand a random quantity $\tilde{x}_Q$ of the risky asset, such that $\tilde{x}_Q \sim N(0, \sigma^2_Q)$. This demand is assumed to be independent from the type of market (regulated or unregulated) in which liquidity traders trade.[7] It is further assumed that $Cov(\tilde{\varepsilon}, \tilde{x}_Q) = Cov(\tilde{\eta}, \tilde{x}_Q) = 0$; that is, liquidity trading has no information content.

Unlike liquidity traders, insiders and outsiders trade for informational reasons. All traders observe all publicly available information about the future price of the risky asset, summarized in the parameter $\bar{p}_1$. Further, insiders privately (and costlessly) observe a realization of the random variable $\tilde{\varepsilon}(\varepsilon_1)$, and outsiders privately (and also costlessly) observe a realization of the random variable $\tilde{\eta}(\eta_1)$.[8] The first random shock ($\tilde{\varepsilon}$) arises in the firm that issues the risky asset under consideration; hence it is observed only by insiders. The other random shock ($\tilde{\eta}$) may be thought of as arising somewhere else in the economy, perhaps in a firm whose activities are related to the activities of the firm under consideration; hence, it is observed only by outsiders. Following Fishman and Hagerty (1992), it is assumed that insiders have access to information of higher quality; that is, $\sigma^2_\varepsilon < \sigma^2_\eta$.

Insiders, outsiders, and liquidity traders are assumed to be risk averse. The market maker is assumed to be risk neutral and to make zero profits when selecting the price that clears the market for the risky asset.[9] Finally, for the sake of completeness, workers are also assumed to be risk averse.

Solving Equation 1 for F_{ij} and substituting into Equation 2 yields:

$$\tilde{w}^1_{ij} = (1 + \rho)(1 - t_j)w^0_i + Y_{ij} + [\tilde{p}_1 - (1 + \rho)\tilde{p}_{0j}]\tilde{x}_{ij}, \qquad i = N, T, Q, K, j = U, R \tag{4}$$

However, it is not the expected value of this terminal wealth (conditional on their private information) that insiders and outsiders are assumed to maximize.[10] This is due to the fact that, under risk aversion, unlike under risk neutrality, the variance of these investors' terminal wealth needs to be considered.

Insiders, outsiders, liquidity traders, and workers are assumed to have a negative exponential utility function (V), thus displaying constant absolute risk aversion; that is:

$$V_i(\tilde{w}_i^1) = 1 - e^{-a_i \tilde{w}_i^1} \qquad i = N, T, Q, K \tag{5}$$

where a_i $(a_i > 0)$ is the absolute risk aversion parameter.[11] Since $\tilde{w}_i^1$ is normally distributed, conditional on each trader's (private) information set $(\tilde{\omega}_i)$,[12] then the expected value of V conditional on $\tilde{w}_i$ is given by:

$$E\left[V_i(\tilde{w}_i^1)\middle|\omega_i\right] = 1 - e^{-a_i\left[E(\tilde{w}_i^1|\tilde{\omega}_i) - \left(\frac{a_i}{2}\right)Var(\tilde{w}_i^1|\tilde{\omega}_i)\right]} \qquad i = N, T, Q, K \tag{6}$$

Thus, insiders and outsiders (but not liquidity traders and workers) are assumed to select, conditional on their private information, the demand for the risky asset that maximizes Equation 6. It is clear, though, that maximizing this expected utility function is equivalent to maximizing the certainty equivalent of wealth (CE), which is given by:

$$CE_i = E(\tilde{w}_i^1 | \tilde{\omega}_i) - \left(\frac{a_i}{2}\right)Var(\tilde{w}_i^1 | \tilde{\omega}_i) \qquad i = N, T, Q, K \tag{6}$$

This follows from the fact that Equation 6 is monotonically increasing in Equation 7. Therefore, in what follows, insiders and outsiders will be assumed to select the demand for the risky asset that maximizes their certainty equivalent of wealth.

Strategies and Equilibria

DEFINITION:

An equilibrium is a realization of the random variable $\tilde{p}_{0j}$ such that the following two conditions hold:

$$x_{ij}^* = \underset{x_{ij}}{argmax}\, E[V_i(\tilde{w}_{ij}^1) | \tilde{\omega}_i = \omega_i], \quad i = N, T \quad j = U, R \tag{i}$$

$$p_{0j} = E(\tilde{p}_1 | x_{Nj}^* + x_{Tj} + x_Q), \quad j = U, R \tag{ii}$$

That is, an equilibrium is a (current) price of the risky asset that: first, arises from demands that maximize the utility of insiders and outsiders, conditional on their private information;[13] and, second, is efficient in the sense that it is equal to the expected (terminal) price of the risk asset, conditional on all the information available to the market maker.

The timing of the model is as follows. At the beginning of the period, endowments are distributed, information is revealed, and demands are submitted to the market maker, who sets the price that clears the market for the risky asset. At the end of the period, all uncertainty is resolved, the payoffs of the portfolios are realized and the production of the commodity is finished. Trading, in particular, is structured in two steps: First, insiders and outsiders observe a realization of $\tilde{\varepsilon}$ and $\tilde{\eta}$, respectively, and submit their demand for the risky asset conditional on such a realization. At the same time, liquidity traders submit their demand for the risky asset. Second, the market maker determines the price that clears the market for this asset. Following Kyle (1985), it is assumed that, when so doing, the market maker sets this price efficiently, thus making zero profits. That is, he sets the current price of the risky asset by taking into account all publicly available information and the order flow.[14] This implies that the market maker sets the current price of the risky asset according to the expression:

$$\tilde{p}_{0j} = E(\tilde{p}_1 | \tilde{x}_{Nj} + \tilde{x}_{Tj} + \tilde{x}_Q) = \bar{p}_1 + \alpha_j(\tilde{x}_{Nj} + \tilde{x}_{Tj} + \tilde{x}_Q), \quad j = U, R \tag{8}$$

where α_j is a parameter whose reciprocal measures the liquidity of the market.

When selecting their portfolio, insiders and outsiders take this pricing function (but not the price of the risky asset) as given. That is, insiders and outsiders behave strategically in the sense that they take into account the effect of their demand on the (current) price of the risky asset, and they do so by incorporating into their maximization problem the market maker's pricing function. Note that this implies that neither insiders nor outsiders observe the (current) price at which they will trade. However, they both have a rational expectation of what this price will be. A rational expectations equilibrium exists when these expectations become self-fulfilling.

Further, when selecting their portfolio, insiders (outsiders) make a conjecture about what the outsiders' (insiders') demand for the risky asset will be. This yields the following two conjectures:

Conjecture 1: *An insider's demand for the risky asset is given by* $\tilde{x}_{Nj} = \beta_j\tilde{\varepsilon}$, *for a given parameter* β_j. *That is, an insider's demand is a linear function of his private information.*

Conjecture 2: *An outsider's demand for the risky asset is given by* $\tilde{x}_{Tj} = \gamma_j\tilde{\eta}$, *for a given parameter* γ_j. *That is, an outsider's demand is a linear function of his private information.*[15]

In this framework, the market maker selects the parameter that determines the liquidity of the market, and insiders and outsiders select the parameter that determines their demand. That is, the market maker selects α_j, insiders select β_j, and outsiders select γ_j.

This concludes the basic analytical structure in an unregulated market; that is, in a market where insider trading is allowed. In such a framework, the following theorem holds:

Theorem 1: *When all traders are risk averse and insider trading is allowed, there exists an equilibrium characterized by the parameters:*

$$\alpha_U = \frac{\beta_U \sigma_\varepsilon^2 + \gamma_U \sigma_\eta^2}{\beta_U^2 \sigma_\varepsilon^2 + \gamma_U^2 \sigma_\eta^2 + \sigma_Q^2} \tag{9}$$

$$\beta_U = \frac{1}{2\alpha_U + a_N[(1-\alpha_U\gamma_U)^2\sigma_\eta^2 + \alpha_U^2\sigma_Q^2]} \tag{10}$$

$$\gamma_U = \frac{1}{2\alpha_U + a_T[(1-\alpha_U\beta_U)^2\sigma_\varepsilon^2 + \alpha_U^2\sigma_Q^2]} \tag{11}$$

PROOF:

Using Equations 3, 4 and 8, along with Conjecture 2, a representative insider's terminal wealth can be written as:

$$\tilde{w}_{NU}^1 = w_N^0 + Y_{NU} + [\tilde{\varepsilon} + (1-\alpha_U\gamma_U)\tilde{\eta} - \alpha_U x_{NU} - \alpha_U \tilde{x}_Q]x_{NU} \tag{12}$$

The expected value and variance of Equation 12, both conditional on the insider's private information, are given, respectively, by:

$$E(\tilde{w}_{NU}^1 \mid \tilde{\varepsilon} = \varepsilon_1) = w_N^0 + Y_{NU} + (\varepsilon_1 - \alpha_U x_{NU})x_{NU} \tag{13}$$

$$Var(\tilde{w}_{NU}^1 \mid \tilde{\varepsilon} = \varepsilon_1) = [(1-\alpha_U\gamma_U)^2\sigma_\eta^2 + \alpha_U^2\sigma_Q^2]x_{NU}^2 \tag{14}$$

Thus, substituting Equations 13 and 14 into Equation 7, the insider's problem becomes:

$$\underset{x_{NU}}{Max}\left\{w_N^0 + Y_{NU} + (\varepsilon_1 - \alpha_U x_{NU})x_{NU} - \left(\frac{a_N}{2}\right)[(1-\alpha_U\gamma_U)^2\sigma_\eta^2 + \alpha_U^2\sigma_Q^2]x_{NU}^2\right\} \tag{15}$$

Taking derivatives and solving for the insider's demand yields:

$$x_{NU}^* = \frac{\varepsilon_1}{2\alpha_U + a_N[(1-\alpha_U\gamma_U)^2\sigma_\eta^2 + \alpha_U^2\sigma_Q^2]} = \beta_U\varepsilon_1 \tag{16}$$

from which Equation 10 follows directly.

Similarly, using Equations 3, 4, 8, and Conjecture 1, a representative outsider's terminal wealth can be written as:

$$\tilde{w}_{TU}^1 = w_T^0 + Y_{TU} + [(1-\alpha_U\beta_U)\tilde{\varepsilon} + \tilde{\eta} - \alpha_U x_{TU} - \alpha_U \tilde{x}_Q]x_{TU} \tag{17}$$

The expected value and variance of Equation 17, both conditional on the outsider's private information, are given, respectively, by:

$$E(\tilde{w}^1_{TU}|\ \tilde{\eta} = \eta_1) = w^0_T + Y_{TU} + (\eta_1 - \alpha_U x_{TU})x_{TU} \tag{18}$$

$$Var(\tilde{w}^1_{TU}|\ \tilde{\eta} = \eta_1) = \left[(1-\alpha_U\beta_U)^2\sigma^2_\varepsilon + \alpha^2_U\sigma^2_U\right]x^2_{TU} \tag{19}$$

Thus, substituting Equations 18 and 19 into Equation 7, the outsider's problem becomes:

$$\underset{x_{TU}}{Max}\left\{ w^0_T + Y_{TU} + (\eta_1 - \alpha_U x_{TU})x_{TU} - \left(\frac{a_T}{2}\right)[(1-\alpha_U\beta_U)^2\sigma^2_\varepsilon + \alpha^2_U\sigma^2_Q]x^2_{TU} \right\} \tag{20}$$

Taking derivatives and solving for the outsider's demand yields:

$$\overset{*}{x}_{TU} = \frac{\eta_1}{2\alpha_U + a_T\left[(1-\alpha_U\beta_U)^2\ \sigma^2_\varepsilon + \alpha^2_U\sigma^2_Q\right]} = \gamma_U\eta_1 \tag{21}$$

from which Equation 11 follows directly.

Equations 10 and 11 form a system in β_U and γ_U whose solution yields the equilibrium of the model. This equilibrium, however, must satisfy the restriction that the market maker sets prices efficiently. This implies that:

$$\begin{aligned} p_{0U} &= E(\tilde{p}_1|\ \tilde{x}_{NU} + \tilde{x}_{TU} + \tilde{x}_Q = \overset{*}{x}_{NU} + \overset{*}{x}_{TU} + x_Q) \\ &= (\bar{p}_1 + \alpha_U(\overset{*}{x}_{NU} + \overset{*}{x}_{TU} + x_Q)) \end{aligned} \tag{22}$$

Finally, applying the projection theorem on Equation 22 to solve for α_U yields Equation 9. ■

Note from Equations 10 and 11 that insiders and outsiders' demand for the risky asset depends on their degree of risk aversion. This implies, as will be seen below, that market liquidity, price volatility, informational efficiency and price predictability also depend on the risk aversion of these traders. Note, further, that the equilibrium derived is not in closed form.

It is assumed that ITR is fully effective in the sense that it fully prevents insiders from trading; that is, under ITR, $x_{NR} = \beta_R = 0$.[16] Thus, in a regulated market, the following theorem holds:

Theorem 2: *When all traders are risk averse and insider trading is restricted, there exists an equilibrium characterized by the parameters:*

$$\alpha_R = \frac{\gamma_R \sigma_\eta^2}{\gamma_R^2 \sigma_\eta^2 + \sigma_Q^2} \tag{23}$$

$$\beta_R = 0 \tag{24}$$

$$\gamma_R = \frac{1}{2\alpha_R + a_T(\sigma_\varepsilon^2 + \alpha_R^2 \sigma_Q^2)} \tag{25}$$

PROOF:
Similar to the proof of Theorem 1. ■.

II. SIMULATION OF THE MODEL: BASE CASE

The complexity of the equilibria derived above precludes a tractable analysis in closed-form. Therefore, the impact of ITR on a securities market and on social welfare is evaluated using numerical analysis. The impact of ITR on a securities market is evaluated through its effect on market liquidity, price volatility, informational efficiency, and price predictability.[17] Further, its impact on social welfare is evaluated through its effect on the welfare of insiders, outsiders, liquidity traders, and workers. I perform below an *ex-ante* analysis; that is, an analysis of the impact of ITR before the realization of the random variables of the model.

The Expressions to be Evaluated

The liquidity of the market (L), which is inversely related to the change in price that follows the arrival of an order, can be measured by the inverse of the parameter α_j of the market maker's pricing function; that is:

$$L_j = (\alpha_j)^{-1}, \quad j = U, R \tag{26}$$

The volatility of current prices (CV) can be measured by the (unconditional) variance of $\tilde{p}_{0j}$; that is:

$$CV_j = \alpha_j^2(\beta_j^2 \sigma_\varepsilon^2 + \gamma_j^2 \sigma_\eta^2 + \sigma_Q^2), \quad j = U, R \tag{27}$$

The volatility of future prices (*FV*), on the other hand, can be measured by the variance of $\tilde{p}_1$, conditional on the equilibrium value of $\tilde{p}_{0j}$; that is:

$$FV_j = \sigma_\varepsilon^2 + \sigma_\eta^2 - \frac{(\beta_j\sigma_\varepsilon^2 + \gamma_j\sigma_\eta^2)^2}{\beta_j^2\sigma_\varepsilon^2\gamma_j^2\sigma_\eta^2 + \sigma_Q^2}, \quad j = U, R \tag{28}$$

The informational efficiency of the market (*IE*) reflects the amount of information revealed by securities prices, and can be measured by the inverse of the volatility of future prices; that is:

$$IE_j = (FV_j)^{-1}, \quad j = U, R \tag{29}$$

Finally, a measure of price predictability is given by the correlation coefficient between $\tilde{p}_{0j}$ and $\tilde{p}_1$ (r); that is:

$$r_j = \frac{\beta_j\sigma_\varepsilon^2 + \gamma_j\sigma_\eta^2}{\sqrt{(\sigma_\varepsilon^2 + \sigma_\eta^2)(\beta_\varepsilon^2\sigma_\varepsilon^2 + \gamma_j^2\sigma_\eta^2 + \sigma_Q^2)}}, \quad j = U, R \tag{30}$$

As stated above, due to the scarcity of research on the relationship between ITR and social welfare, special emphasis is placed on the welfare issue. The welfare analysis is performed in terms of a representative agent of each type, and is performed *ex-ante*. Hence, the expectations taken below are unconditional expectations.

An insider's expected terminal utility in the unregulated market and that in the regulated market are given, respectively, by:

$$E[V_N(\tilde{w}_{NU}^1)] = 1 - e^{-a_N\left\{ w_N^0 + Y_{NU} + (1-\alpha_U\beta_U)\beta_U\sigma_\varepsilon^2 - \left(\frac{a_N}{2}\right)[2(1-\alpha_U\beta_U)^2\beta_U^2(\sigma_\varepsilon^2)^2 + (1-\alpha_U\gamma_U)^2\beta_U^2\sigma_\varepsilon^2\sigma_\eta^2 + (\alpha_U\beta_U)^2\sigma_\varepsilon^2\sigma_Q^2]\right\}} \tag{31}$$

$$E[V_N(w_{NR}^1)] = 1 - e^{-a_N\{(1-t_R)w_N^0 + Y_{NR}\}} \tag{32}$$

An outsider's expected terminal utility in the unregulated market and that in the regulated market, on the other hand, are given, respectively, by:

$$E[V_T(\tilde{w}_{TU}^1)] = 1 - e^{-a_T\left\{ w_T^0 + Y_{TU} + (1-\alpha_U\gamma_U)\gamma_U\sigma_\eta^2 - \left(\frac{a_T}{2}\right)[(1-\alpha_U\beta_U)^2\gamma_U^2\sigma_\varepsilon^2\sigma_\eta^2 + 2(1-\alpha_U\gamma_U)^2\gamma_U^2(\sigma_\eta^2)^2 + (\alpha_U\gamma_U)^2\sigma_\eta^2\sigma_Q^2]\right\}} \tag{33}$$

$$E[V_T(\tilde{w}_{TR}^1)] = 1 - e^{-a_T\left\{ (1-t_R)w_T^0 + Y_{TR} + (1-\alpha_R\gamma_R)\gamma_R\sigma_\eta^2 - \left(\frac{a_T}{2}\right)[\gamma_R^2\sigma_\varepsilon^2\sigma_\eta^2 + 2(1-\alpha_R\gamma_R)^2\gamma_R^2(\sigma_\eta^2)^2 + (\alpha_R\gamma_R)^2\sigma_\eta^2\sigma_Q^2]\right\}} \tag{34}$$

A liquidity trader's expected terminal utility in the unregulated market and that in the regulated market are given, respectively by:

$$E[V_Q(\tilde{w}_{QU}^1)] = 1 - e^{-a_Q\left\{ w_Q^0 + Y_{QU} - \alpha_Q^2 - \left(\frac{a_Q}{2}\right)\left[(1-\alpha_U\beta_U)^2\sigma_\varepsilon^2\sigma_Q^2 + (1-\alpha_U\gamma_U)^2\sigma_\eta^2\sigma_Q^2 + 2\alpha_U^2(\sigma_Q^2)^2\right] \right\}} \tag{35}$$

$$E[V_Q(\tilde{w}_{QR}^1)] = 1 - e^{-a_Q\left\{ (1-t_R)w_Q^0 + Y_{QR} - \alpha_R\sigma_Q^2 - \left(\frac{a_Q}{2}\right)\left[\sigma_\varepsilon^2\sigma_Q^2 + (1-\alpha_R\gamma_R)^2\sigma_\eta^2\sigma_Q^2 + 2\alpha_R^2(\sigma_Q^2)^2\right] \right\}} \tag{36}$$

A worker's (certain) terminal utility in the unregulated market is given by:

$$E\left[V_K(w_{KU}^1) \right] = 1 - e^{-a_K\left\{ w_K^0 + Y_{KU} \right\}} \tag{37}$$

When insider trading is restricted, on the other hand, some workers are diverted to perform the task of enforcing ITR, thus foregoing production of the commodity. Hence, as argued above, workers produce a lower amount of this commodity in a regulated market. Under competitive conditions, the compensation received by those workers diverted to enforce ITR must equal their opportunity cost. Hence, the cost of ITR, borne by traders and workers through the tax system, is given by the value of the production workers forgo when they act as regulators; that is, by $Y_{KU} - Y_{KR} = (w_N^0 + w_T^0 + w_Q^0 + w_K^0)t_R$. Therefore, a worker's (certain) terminal utility in the regulated market is given by:

$$E\left[V_K(w_{KR}^1) \right] = 1 - e^{-a_K\left\{ (1-t_R)\, w_K^0 + Y_{KU} \right\}} \tag{38}$$

This concludes the list of expressions to be evaluated. I turn now to consider the base case of the model with parameters that reflect average market data. These parameters will be used to find an explicit solution for both equilibria, which, in turn, will be used to evaluate the impact of ITR on a securities market and on social welfare.

The Base Case

The values of the parameters for the base case of the model are reported in Table 1. In order to facilitate the comparison to related work, price volatility and risk aversion parameters were taken from Leland (1992).

Although the volatility of $\tilde{p}_1$ ($\sigma_\varepsilon^2 + \sigma_\eta^2 = .04$) is taken from Leland (1992), the partition between σ_ε^2 (.015) and α_η^2 (.025) is arbitrary. Note that this partition satis-

Table 1. **PARAMETERS FOR THE BASE CASE**

σ_ε^2	σ_η^2	σ_Q^2	t_R	a_i	w_i^0	Y_{iU}
0.015	0.025	0.010	0.00002805	2	1	1

Table 2. **EQUILIBRIUM VALUES FOR BEHAVIORAL PARAMETERS**

α_U	β_U	γ_U	α_R	γ_R
0.999893	0.491957	0.493212	0.790298	0.616109

Table 3. **SECURITIES MARKETS**

■	U	R	(U – R)
L	1.00010701	1.26534547	–0.2652384
CV	0.01970782	0.01217273	0.00753508
FV	0.02029219	0.02782725	–0.0075350
IE	49.2800366	35.9359974	13.3440391
r	0.70192249	0.55165092	0.15027156

fies the restriction that the information observed by insiders is more precise than that observed by outsiders; that is, $\sigma_\varepsilon^2 < \sigma_\eta^2$. The variability of liquidity trading (σ_Q^2 =.010) and the risk aversion parameters (a_i = 2) are also taken from Leland (1992). The initial wealth of traders and workers (w_i^0) is normalized to 1, and so is their production of the commodity in the unregulated market (Y_{iU}). The tax rate imposed on traders and workers in the regulated market (t_R) follows from the cost of ITR, which, in turn, follows from the production foregone by the imposition of this regulation. The foregone production in the model attempts to mirror the foregone production in the economy, thus implying a cost of ITR equal to .0001122.[18]

The values reported in Table 1 can be used to compute an explicit solution for the model. The solution of the system for both the regulated and the unregulated market is reported above in Table 2.[19] It is worthwhile to mention that the equilibria reported in this table are highly insensitive to the initial values needed to solve both systems numerically.

These equilibria can now be used to evaluate the impact of ITR on a securities market. Thus, market liquidity, current and future price volatility, informational efficiency and price predictability in both the regulated and the unregulated market are reported above in Table 3.[20]

From a qualitative point of view, all these results, derived under the assumption of risk averse agents, confirm those derived by Estrada (1994a) from a model with risk neutral agents; they also confirm those derived from a different model by Leland (1992). That is, ITR increases market liquidity, decreases the volatility of current prices, increases the volatility of future prices, decreases the informational efficiency

Table 4. **SOCIAL WELFARE (UTILITIES)**

■	U	R	(U – R)
$E(V_N)$	0.98181800	0.98158333	0.00013466
$E(V_T)$	0.98190598	0.98195879	–0.0000528
$E(V_Q)$	0.98130307	0.98137883	–0.0000757
$E(V_K)$	0.98168436	0.98168333	0.00000102
SW	3.92671142	3.92670429	0.00000713

Table 5. **SOCIAL WELFARE (CERTAINTY EQUIVALENTS)**

■	U	R	(U – R)
CE_N	2.00366169	1.99997195	0.00368973
CE_T	2.00608703	2.00754841	–0.0014613
CE_Q	1.98969816	1.99172824	–0.0020300
CE_K	2.00000000	1.99997195	0.00002804
SW	7.99944689	7.99922055	0.00022633

of the market,[21] and decreases the correlation between current and future prices. An intuitive interpretation of these results, under risk neutrality, is provided by Estrada (1994a); under risk aversion, these results are explained on the same lines.

The equilibria reported in Table 2 can also be used to evaluate the impact of ITR on social welfare. To this purpose, let social welfare in the jth market (SW_j) be defined as the joint utility of insiders, outsiders, liquidity traders, and workers; that is, $SW_j = E(V_{Nj} + V_{Tj} + V_{Qj} + V_{Kj})$, where V_{ij} is agent i's utility in the jth market. The utility of each representative agent, as well as social welfare, in both the regulated and the unregulated market are reported below in Table 4.[22]

It follows from Table 4 that ITR makes insiders and workers worse off, and outsiders and liquidity traders better off. Further, when all gains and losses are aggregated, ITR imposes a net cost on society. Therefore, under risk aversion (as well as under risk neutrality), ITR makes society unambiguously worse off.

It is important to determine whether the loss that ITR imposes on society under risk aversion is higher or lower than the loss it imposes under risk neutrality. In order to make the results under risk aversion comparable to those under risk neutrality, the utility of traders and workers has to be recomputed in terms of certainty equivalents. The result of this new computation is shown in Table 5.[23]

It is shown by Estrada (1994a) that, under risk neutrality, the loss that ITR imposes on society is equal to the cost of regulating the market (0001122). Table 5 shows that, under risk aversion, ITR imposes a *higher* social loss (00022633). In fact, for the base case of the model, the *social loss imposed by ITR under risk aversion is more than twice as high than that imposed under risk neutrality.* Therefore, ITR is less desirable under risk aversion than it is under risk neutrality.

This result is critical and needs to be explained in detail. Recall that a certainty equivalent of wealth is determined by the expected value and the variance of that wealth, and by a risk aversion parameter. Note that, since the imposition of ITR does not affect the risk aversion parameter, then the change in a certainty equivalent of wealth that results from the imposition of ITR must stem solely from changes in the expected value or the variance of that wealth. Note, finally, that the imposition of ITR reallocates the expected profits from insider trading from insiders to outsiders and liquidity traders, *thus reallocating not only wealth but also risk.*

For the base case of the model, it is the case that the sum of the expected values of the terminal wealth of all agents in the unregulated market is larger than such a sum in the regulated market.[24] In fact, the difference between the former and the latter is exactly equal to the cost of ITR. This is, in fact, the result derived by Estrada (1994a) under risk neutrality; that is, the cost of ITR is equal to the opportunity cost of the resources diverted to enforce this regulation. However, under risk aversion, that is not the end of the story.

As argued above, the reallocation of the expected insider trading profits from insiders to outsiders and liquidity traders reallocates not only wealth but also risk. In fact, for the base case of the model, it is the case that the sum of the variances of the terminal wealth of all agents in the regulated market is larger than such a sum in the unregulated market.[25] This result is explained by the fact that ITR prevents inside information from being reflected in securities prices at the beginning of the period. Since, as argued by Manne (1966), this inside information would have corrected securities prices in the right direction, then it would have lowered the volatility of these prices. Put differently, ITR accentuates the price change that follows the arrival of new information. More formally, note that:

$$Var(\tilde{p}_1 - \tilde{p}_{0j}) = (1-\alpha_j\beta_j)^2\sigma_\varepsilon^2 + (1-\alpha_j\gamma_j)^2\sigma_\eta^2 + (\alpha_j)^2\sigma_Q^2, \quad j = U, R \tag{39}$$

Thus, using the parameters in Tables 1 and 2, it follows that $Var(\tilde{p}_1 - \tilde{p}_{0R}) = .02782725 > Var(\tilde{p}_1 - \tilde{p}_{0U}) = .02029219$. In words, when ITR is imposed, securities prices become more volatile; that is, *the regulated market is riskier than the unregulated market.*

In addition, a third perverse effect of ITR is that of forcing outsiders and liquidity traders to bear all the risk of the volatility of securities prices. Thus, it is important to note that ITR not only prevents insiders from trading; it also prevents them from bearing any risk. Put differently, *the risk sharing in the regulated market is inferior to the risk sharing in the unregulated market.* Therefore, even if both the regulated market and the unregulated market were equally risky (and ITR were costless), social welfare would be lower in the former market.[26]

Note that the last two arguments establish that ITR increases the riskiness of the market and worsens the risk sharing among investors, both of which have a negative impact on social welfare. Therefore, the imposition of ITR may be thought of as a reallocation of resources from an activity that creates utility (production) to an activity that destroys utility (regulation).

Table 6. **SOCIAL WELFARE UNDER COSTLESS ITR (UTILITIES)**

■	U	R	(U – R)
$E(V_N)$	0.98181800	0.98168436	0.00013364
$E(V_T)$	0.98190598	0.98195980	-0.0000538
$E(V_Q)$	0.98130307	0.98137988	-0.0000768
$E(V_K)$	0.98168436	0.98168436	0.00000000
SW	3.92671142	3.92670840	0.00000302

In sum, ITR has been shown to have the same qualitative effect on a securities markets as it has under risk neutrality. That is, it increases market liquidity, decreases current-price volatility, increases future-price volatility, decreases the informational efficiency of the market, and decreases price predictability. In terms of welfare, ITR has been shown to force a costly reallocation of wealth and risk. Thus, an unregulated market improves upon a regulated market for three reasons: First, in the unregulated market securities prices are less volatile; hence, this market is less risky. Second, in the unregulated market insiders bear part of the risk of the volatility of securities prices; hence, there is a superior risk sharing in this market. And, third, in the unregulated market no resources are diverted to the enforcement of ITR; hence, no production is foregone in this market.

An Alternative Case

The result that ITR is less desirable under risk aversion than it is under risk neutrality invites speculation about whether ITR may be socially detrimental even if it is costless.[27] In fact, as shown by Table 6, this is precisely the case.

Table 6 shows that when ITR is costless it still makes insiders worse off, and outsiders and liquidity traders better off. Yet, a costless ITR does not make workers worse off (as it does when it is costly) because workers neither trade nor have to bear any tax on their wealth. When all the gains and losses that result from the imposition of a costless ITR are aggregated, the basic result derived above still remains; that is, ITR makes society unambiguously worse off.

The fact that ITR is socially detrimental even if it is costless follows from two arguments outlined above: First, from the fact that ITR increases the volatility of securities prices, thus making the regulated market riskier; this increase in risk, obviously, imposes a cost on risk averse traders. And, second, from the fact that ITR prevents insiders from bearing any risk, thus forcing outsiders and liquidity traders to bear all the risk of the volatility of securities prices; this decrease in risk sharing imposes an additional cost on risk averse traders.

III. SIMULATION OF THE MODEL: SENSITIVITY ANALYSIS

I explore in this part whether the results derived in the previous part are valid only for the base case of the model or they are valid for a wider range of values of the parameters of the model. As before, I divide this inquiry into results related to securities markets and results related to social welfare. I perform the sensitivity analysis with respect to changes in the variability of inside and outside information and in the variability of liquidity trading, as well as with respect to changes in the risk aversion of all traders.[28]

ITR and Securities Markets

It has been shown in the previous part that, for the base case of the model, the imposition of ITR increases market liquidity, decreases the volatility of current prices, increases the volatility of future prices, decreases the informational efficiency of the market, and decreases the correlation between current and future prices. The purpose of the sensitivity analysis is to determine whether these results hold for a wide range of values of the parameters of the model.

Table A1 in part III of the appendix summarizes the results of the sensitivity analysis on securities markets. That table shows that the beneficial effect of ITR on market liquidity and current-price volatility, and its detrimental effect on future-price volatility, informational efficiency, and price predictability do hold for a wide range of values of the parameters of the model. I turn now to discuss the results of the sensitivity analysis on social welfare.[29]

ITR and Social Welfare

As shown above for the base case of the model, the imposition of ITR makes insiders and workers worse off, outsiders and liquidity traders better off, and society as a whole worse off. The sensitivity analysis shows that, except in the specific cases to be considered below, these results hold for a wide range of values of the parameters of the model.

Table A2 in part III of the appendix summarizes the results of the sensitivity analysis on social welfare. A brief explanation for these results is provided below. It is important to notice, however, that the effects described below are only those that are driving each result; a wide variety of second-order effects will be ignored in the discussion. It is also important to notice that, throughout the sensitivity analysis, it is always the case that $E(V_{NU} - V_{NR}) \geq 0$, $E(V_{TU} - V_{TR}) \leq 0$, $E(V_{QU} - V_{QR}) \leq 0$, and $E(V_{KU} - V_{KR}) \geq 0$; that is, ITR never makes insiders and workers better off, or outsiders and liquidity traders worse off. Put differently, changes in the parameters of the model change the magnitude, but not the sign, of the individual gains and losses that result from the imposition of ITR.

It should be noted that changes in the variability of inside and outside information, in the variability of liquidity trading, and in the risk aversion of insiders, outsiders, and liquidity traders have an impact in the welfare of traders and workers through their impact on a securities market. Therefore, since workers do not trade, their welfare (which could only be affected by changes in the cost of ITR) remains constant throughout the sensitivity analysis.[30]

An increase in σ_ε^2 increases the expected profits from insider trading thus increasing $E(V_{NU})$, but has no effect on $E(V_{NR})$ because insiders do not trade in the regulated market. Further, since the expected profits from insider trading are increasing in σ_ε^2, so are the gains that outsiders and liquidity traders obtain from the imposition of ITR. Therefore, the loss that ITR imposes on insiders, as well as the gain that outsiders and liquidity traders obtain from this regulation, are all increasing in the variability of inside information.

An increase in σ_η^2 lowers the liquidity of the market and increases the volatility of securities prices, thus having a negative impact on $E(V_{NU})$; obviously, it has no impact on $E(V_{NR})$. An increase in σ_η^2, on the other hand, increases outsiders' expected profits from trading, thus increasing both $E(V_{TU})$ and $E(V_{TR})$. Since the risk sharing in the regulated market is inferior to that in the unregulated market, then $E(V_{TU})$ increases more rapidly than $E(V_{TR})$. Finally, an increase in σ_η^2 lowers both $E(V_{QU})$ and $E(V_{QR})$ as a result of the decrease in the liquidity of the market and the increase in price volatility. Since the risk sharing in the regulated market is inferior to that in the unregulated market, then $E(V_{QR})$ decreases more rapidly than $E(V_{QU})$. In sum, the loss that ITR imposes on insiders, as well as the gain that outsiders and liquidity traders obtain from this regulation, are all decreasing in the variability of outside information.

An increase in σ_ε^2 increases the expected profits from insider trading (due to a camouflage effect), thus increasing $E(V_{NU})$; obviously, it has no impact on $E(V_{NR})$. An increase in σ_Q^2, on the other hand, increases both $E(V_{TU})$ and $E(V_{TR})$, increasing the latter more rapidly than the former due to the more rapid increase in liquidity in the regulated market. Finally, an increase in σ_η^2 lowers both $E(V_{QU})$ and $E(V_{QR})$, lowering the former more rapidly than the latter due, again, to the more rapid increase in liquidity in the regulated market. In sum, the loss that ITR imposes on insiders, as well as the gain that outsiders and liquidity traders obtain from this regulation, are all increasing in the variability of liquidity trading.

The sensitivity analysis shows that an increase in the variability of inside or outside information, or in the variability of liquidity trading, increase the volatility of securities prices, thus increasing the risk to be born by society. Hence both SW_U and SW_R decrease as σ_ε^2, σ_η^2 or σ_Q^2 increase. Further, since the risk sharing in the unregulated market is superior to that in the regulated market, then SW_R decreases more rapidly than SW_U. Therefore, *the social cost of ITR is increasing in the variability of inside and outside information, as well as in the variability of liquidity trading.* This result is illustrated in Figures A1-A3, in part II of the appendix.

The sensitivity analysis also shows that the loss that ITR imposes on insiders is decreasing in their risk aversion. In fact, when insiders are highly risk averse, ITR imposes a negligible loss on them.[31] Further, the gain that outsiders and liquidity traders obtain from ITR is not significantly affected by changes in the risk aversion of insiders.[32] Finally, the social cost of ITR is decreasing in the risk aversion of insiders. Thus, somewhere between $a_N = 2$ and $a_N = 2.5$ the gain obtained by outsiders and liquidity traders begins to outweigh the loss that ITR imposes on insiders and workers; that is, ITR becomes socially beneficial.

This result is explained is as follows. Recall that ITR not only generates a reallocation of wealth from insiders to outsiders and liquidity traders but also generates a reallocation of risk from the former to the latter. Thus, when insiders are more risk averse than outsiders and liquidity traders, ITR reallocates risk to traders (outsiders and liquidity traders) that bear that risk at a lower cost than insiders. Hence, as the risk aversion of insiders increases, the risk reallocation becomes more beneficial. Therefore, *when the risk aversion of insiders is high, ITR is socially beneficial.* This result is illustrated in Figure A4, in part II of the appendix.

The sensitivity analysis also shows that the loss that ITR imposes on insiders, and the gain that liquidity traders obtain from this regulation, are not significantly affected by changes in the risk aversion of outsiders.[33] The gain that outsiders obtain from ITR, on the other hand, is decreasing in their risk aversion.[34] Finally, the social cost of ITR is increasing in the risk aversion of outsiders. Thus, somewhere between $a_T = 1.5$ and $a_T = 2$, the gain obtained by outsiders and liquidity traders ceases to outweigh the loss that ITR imposes on insiders and workers. This is due to the fact that, as the risk aversion of outsiders increases, the risk reallocation becomes more costly. Therefore, *when the risk aversion of outsiders is low, ITR is socially beneficial.* This result is illustrated in Figure A5, in part II of the appendix.

Finally, the sensitivity analysis shows that the loss that ITR imposes on insiders and the gain that outsiders obtain from this regulation are not affected by changes in the risk aversion of liquidity traders.[35] The gain that liquidity traders obtain from ITR, on the other hand, is decreasing in their risk aversion.[36] Finally, the social cost of ITR is *increasing* in the risk aversion of liquidity traders. Thus, somewhere between $a_Q = 1.5$ and $a_Q = 2$, the gain obtained by outsiders and liquidity traders ceases to outweigh the loss that ITR imposes on insiders and workers. This is due to the fact that, as the risk aversion of liquidity traders increases, the risk reallocation becomes more costly. Therefore, *when the risk aversion of liquidity traders is low, ITR is socially beneficial.* This result is illustrated in Figure A6, in part II of the appendix.

Note from Figures A4, A5, and A6 that ITR turns from detrimental to beneficial slightly beyond $a_N = 2$, and from beneficial to detrimental slightly before $a_T = 2$ and $a_Q = 2$. This is due to the fact that, in the sensitivity analysis, the risk aversion of two representative traders is fixed at 2 and the risk aversion of the third representative trader is subject to changes. Hence, levels of risk aversion around 2 become a threshold. In other words, high and low levels of risk aversion should not be interpreted as higher or lower than 2, but as high and low with respect to the risk aversion of other traders. Therefore, the last three results derived above can be summarized as follows: *If insiders are more risk averse than outsiders and liquidity traders, then ITR is socially beneficial.* Put differently, ITR is socially beneficial when it generates a reallocation of risk to traders (outsiders and liquidity traders) that can bear that risk at a lower cost than insiders. Under these circumstances, ITR lowers the social cost imposed by the volatility of securities prices, thus increasing social welfare.

A final important remark is in order. Note that ITR was shown to make society better off *only* when the risk reallocation generated by this regulation lowers the social cost of the volatility of securities prices. As shown above, this occurs when the risk aversion of insiders is high relative to that of outsiders and liquidity traders. However, casual empiricism seems to suggest that the opposite pattern of risk aversion is observed; that is, insiders seem to be less risk averse than outsiders and liquidity traders.[37] Besides, it does not seem plausible to justify the imposition of a regulation on the basis of differences in the risk aversion across traders, when the latter is so difficult (if not impossible) to justify empirically. In other words, the conditions under which ITR makes society better off seem to be either inconsistent with casual empiricism or very difficult to justify from an empirical point of view, and, therefore, they are not very useful to justify the imposition of such a regulation.

IV. CONCLUSIONS

I have evaluated in this article the impact of ITR on a securities market and on social welfare under the assumption that all agents are risk averse. In terms of securities markets, ITR was shown to have both beneficial and detrimental effects. In particular, ITR was shown to increase market liquidity, decrease current-price volatility, increase future-price volatility, decrease the informational efficiency of the market, and decrease the correlation between current and future prices. These results were shown to be valid not only for the base case of the model but also for all values of the parameters used in the sensitivity analysis.

In terms of welfare, ITR was shown to make insiders and workers worse off, outsiders and liquidity traders better off, and society as a whole worse off. The sensitivity analysis validated these conclusions for a wide range of values of the parameters of the model. It was established that the imposition of ITR forces a reallocation of wealth and risk that lowers social welfare for three reasons: First, in an unregulated market securities prices are less volatile; hence, this market is less risky. Second, in an unregulated market insiders bear a part of the risk of the volatility of securities prices; hence, there is a superior risk sharing in this market. And, third, in an unregulated market no resources are diverted to the enforcement of ITR; hence, no production is foregone in this market. The first two arguments explain why under risk aversion, unlike under risk neutrality, ITR is socially detrimental even if it is costless.

Finally, formal conditions were established under which ITR makes society better off. In particular, ITR is socially beneficial when insiders are more risk averse than outsiders and liquidity traders. In this case, ITR forces a reallocation of risk that lowers the social cost of price volatility, thus increasing social welfare. However, such attitudes toward risk, if observable at all, seem to be at odds with casual empiricism. Hence, it is quite arguable that a risk-related argument could be used to support the imposition of ITR.

In sum, I have argued in this article that society should not waste resources in preventing insiders from trading on the basis of their private information. Regardless of the public perception about insider trading, I have shown that its restriction imposes more costs than benefits. Thus, the elimination of ITR would ultimately result in a reallocation of resources to a more efficient use and in a subsequent increase in social welfare. And that is what economics is all about.[38]

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APPENDIX

I. THE COST OF INSIDER TRADING REGULATION

I briefly show in this part the calculations that yield a cost of ITR equal to .0001122 and a tax rate of .00002805.

Let the potential production in the economy be equal to the Gross Domestic Product (GDP) plus the budget of the Securities and Exchange Commission (BSEC). Further, let the actual production in the economy be equal to the GDP. Hence, the difference between the potential and the actual production yields the cost of ITR; that is, the resources allocated to the SEC. It is, of course, a simplification to assume that the whole budget of the SEC is allocated to enforce ITR.

Since each representative agent is assumed to produce 1, then the potential production in the model:

$$(Y_{NU} + Y_{TU} + Y_{QU} + YK_U) = 4.$$

The actual production in the model:

$$(Y_{NR} + Y_{TR} + Y_{QR} + Y_{KR}) = \text{an unknown}.$$

In order for the relationship between the potential and the actual production in the model to be consistent with that relationship in the economy, the actual production in the model must solve from:

$$(Y_{NR} + Y_{TR} + Y_{QR} + Y_{KR}) = (Y_{NU} + Y_{TU} + Y_{QU} + Y_{KU})^*(GDP)/(GDP + BSEC)$$

which yields an actual production of 3.9998878. In 1991, the GDP was \$5,671,800,000,000 (*Economic Report of the President*, 1992, p.298) and the budget of the SEC was \$159,083,000 (*Budget of the United States Government. Fiscal Year 1993*, p. A1-1032). Hence, the cost of ITR is equal to 4-3.9998878 = .0001122. Finally, since the tax rate imposed on each agent's initial wealth solves from:

$$(Y_{NU} + Y_{TU} + Y_{QU} + Y_{KU}) - (Y_{NR} + Y_{TR} + Y_{QR} + Y_{KR}) = t^*R(W^0_N + W^0_T + W^0_Q + w^0_K)$$

where, by assumption, $W^0_N + W^0_T + W^0_Q + W^0_K = 4$, then the tax rate imposed on traders and workers is equal to t_R = .0001122/4=.00002805.

II. SENSITIVITY ANALYSIS: SELECTED RESULTS

Figures A1-A6 illustrate the response of social welfare to changes in the variability of inside and outside information, the variability of liquidity trading, and the risk aversion of insiders, outsiders, and liquidity traders, respectively.

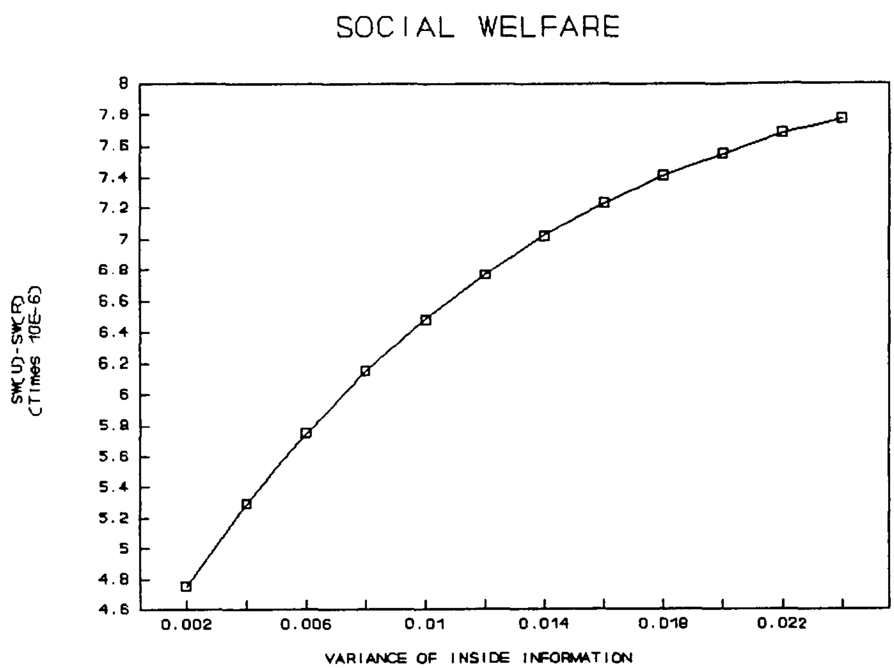

Figure A1. **SOCIAL WELFARE AND INSIDE INFORMATION**

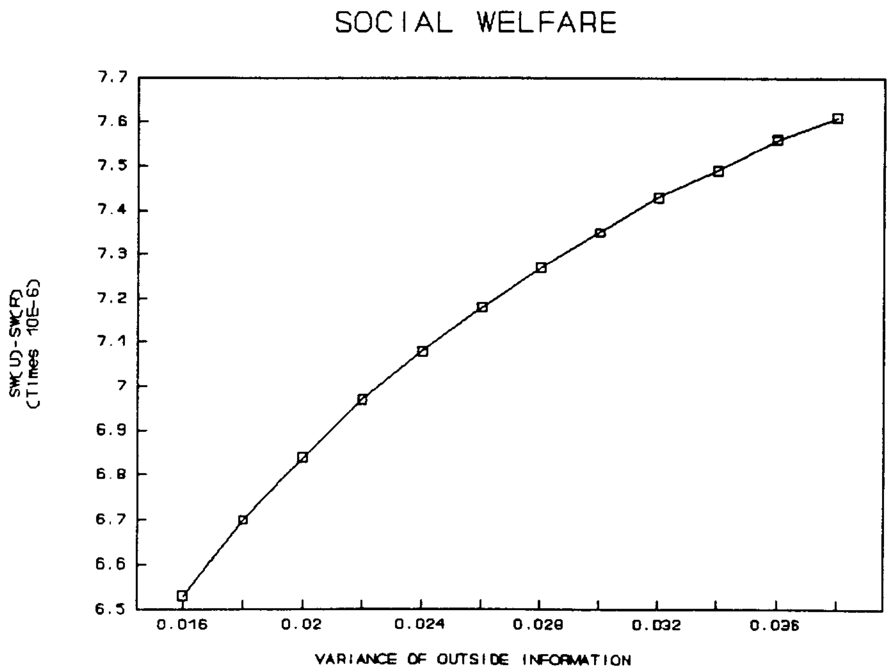

Figure A2. **SOCIAL WELFARE AND OUTSIDE INFORMATION**

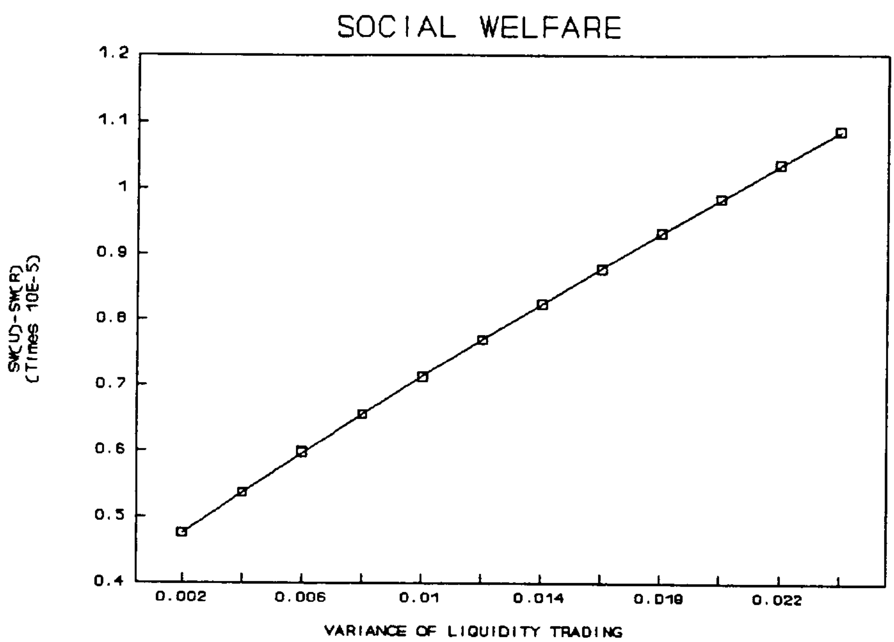

Figure A3. **SOCIAL WELFARE AND LIQUIDITY TRADING**

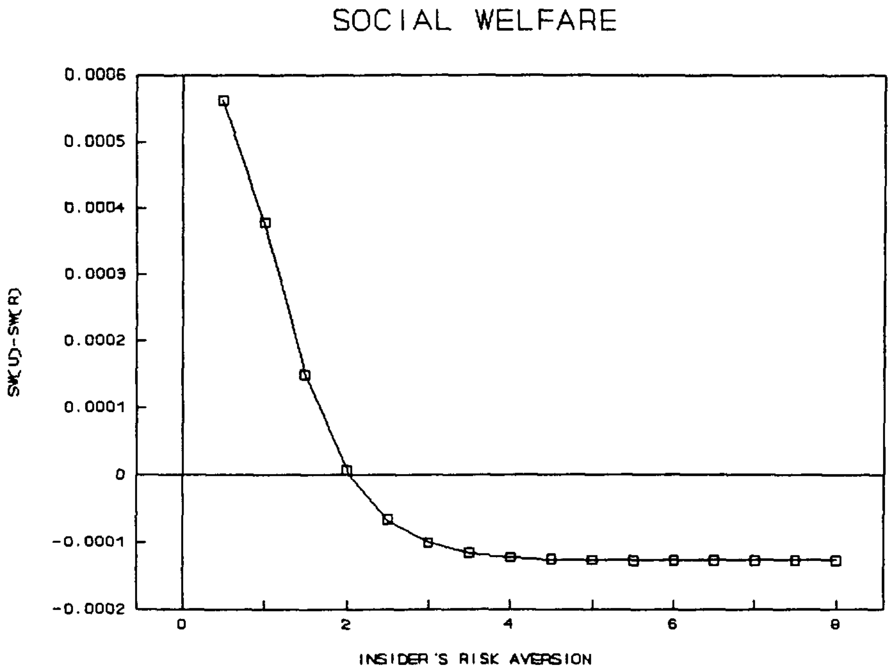

Figure A4. **SOCIAL WELFARE AND INSIDERS' RISK AVERSION**

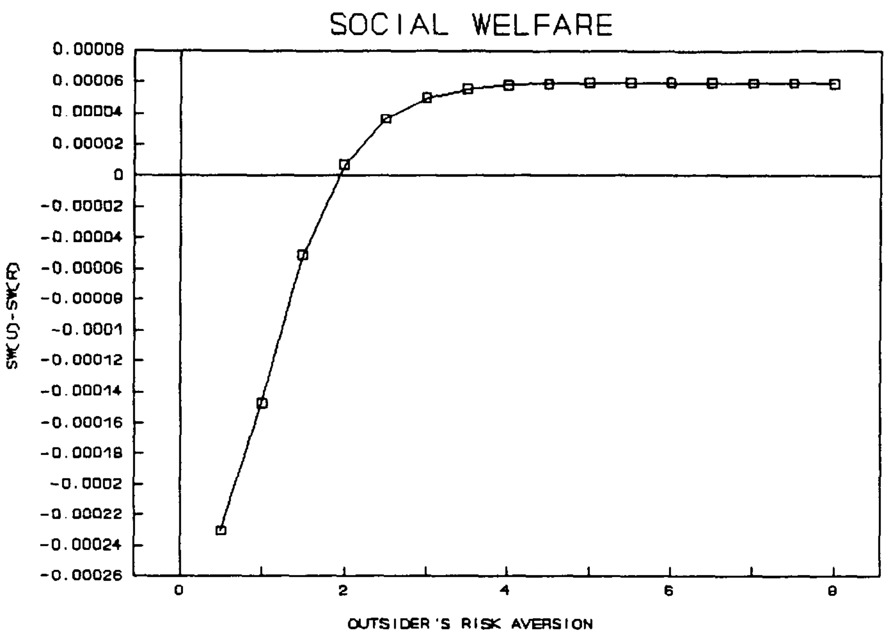

Figure A5. **SOCIAL WELFARE AND OUTSIDERS' RISK AVERSION**

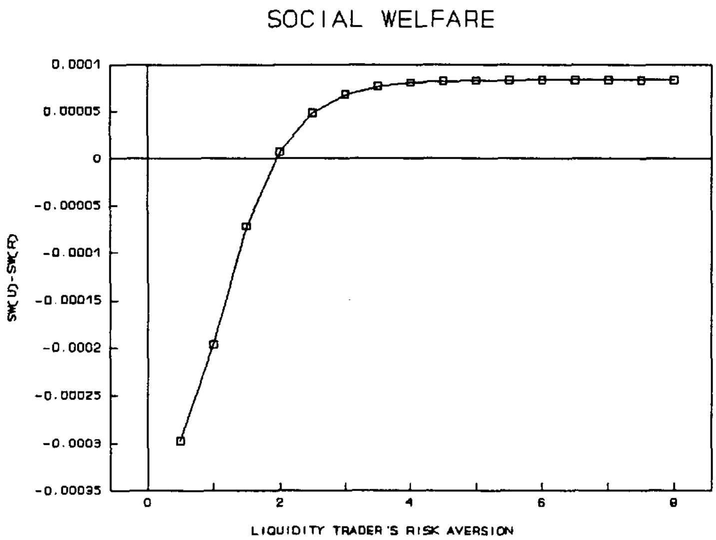

Figure A6. **SOCIAL WELFARE AND LIQUIDITY TRADERS' RISK AVERSION**

III. SENSITIVITY ANALYSIS: SUMMARY OF RESULTS

Table A1. **SECURITIES MARKETS**

	σ^2_ε	σ^2_η	σ^2_Q	a_N	a_T	a_Q
L_U	↓	↓	↑	↑	↑	–
L_R	↑	↓	↑	–	↑	–
L_R-L_U	↑	↓	↑	↓	↑	–
CV_U	↑	↑	↓	↓	↓	–
CV_R	↓	↑	↓	–	↓	–
CV_U-CV_R	↑	↑	↑	↓	↑	–
FV_U	↑	↑	↑	↑	↑	–
FV_R	↑	↑	↑	–	↑	–
FV_R-FV_U	↑	↑	↑	↓	↑	–
IE_U	↓	↓	↓	↓	↓	–
IE_R	↓	↓	↓	–	↓	–
IE_U-IE_R	↑/↓[a]	↓	↓	↓	↑/↓[b]	–
r_U	↓	↓	↓	↓	↓	–
r_R	↓	↑	↓	–	↓	–
r_U-r_R	↑	↓	↑	↓	↑	–

Notes: Table A1 shows whether a given market characteristic (row) increases (↑) or decreases (↓) as a result of an increase in a given parameter (column). More than one arrow in a box indicates a reversion in the direction of the change.

[a] The reversion occurs between σ=.018 and σ=.020.

[b] The reversion occurs between a_T=2 and a_T=2.5.

Table A2. **SOCIAL WELFARE**

	σ_ε^2	σ_η^2	σ_Q^2	a_N	a_T	a_Q
$E(V_{NU})$	↑	↓	↑	↑	–	–
$E(V_{NR})$	–	–	–	↑	–	–
$E(V_{NU}\text{-}V_{NR})$	↑	↓	↑	↓	–	–
$E(V_{TU})$	↓	↑	↑	–	↑	–
$E(V_{TR})$	↓	↑	↑	–	↑	–
$E(V_{TR}\text{-}V_{TU})$	↑	↓	↑	–	↓	–
$E(V_{QU})$	↓	↓	↓	–	–	↑
$E(V_{QR})$	↓	↓	↓	–	–	↑
$E(V_{QR}\text{-}V_{QU})$	↑	↓	↑	–	–	↓
$E(V_{KU})$	–	–	–	–	–	–
$E(V_{KR})$	–	–	–	–	–	–
$E(V_{KU}\text{-}V_{KR})$	–	–	–	–	–	–
SW_U	↓	↓	↓	↑	↑	↑
SW_R	↓	↓	↓	↑	↑	↑
$SW_U\text{-}SW_R$	↑	↑	↑	↓[a]	↑/↓[b,c]	↑[d]

Notes: Table A2 shows whether an agent's (or society's) welfare (row) increases (↑) or decreases (↓) as a result of an increase in a given parameter (column). More than one arrow in a box indicates a reversion in the direction of the change.

[a] ITR turns from harmful to beneficial between $a_N=2$ and $a_N=2.5$.

[b] The reversion occurs between $a_T=5.5$ and $a_T=6$.

[c] ITR turns from beneficial to harmful between $a_T=1.5$ and $a_T=2$.

[d] ITR turns from beneficial to harmful between $a_Q=1.5$ and $a_Q=2$.

NOTES

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1. See, for example, Kyle (1989), Subrahmanyam (1991) and Spiegel and SubSrahmanyam (1992).

2. However, legal scholars have paid a great deal of attention to insider trading. An impressive amount of work, mostly published in law journals, followed the pioneering work by Manne (1966). See, for example, Scott (1980), Carlton and Fischel (1983), Haddock and Macey (1987a,b), and Macey (1991).

3. Bhattacharya and Spiegel (1991) formally prove this result, although it can be traced back to Milgrom and Stokey (1982).

4. Outsiders can alternatively be thought of as security analysts, portfolio managers, brokers, and arbitrageurs, among others. However, most of these "market professionals" acquire information at a cost, unlike the outsiders in the model that do it costlessly. One of the main reasons for including outsiders in the model is to show that they are benefitted by the imposition of ITR. This, in turn, provides support to the argument advanced by Haddock and Macey (1987b) that ITR largely stems from the pressure of market professionals on the SEC.

5. In what follows, subscripts i will be used to index agents ($i = N,T,Q,K$) and subscripts j to index markets ($j = U,R$).

6. Note that the future price of the risky asset does not depend on the type of market in which this asset is traded. However, Leland (1992) shows that securities prices would be, on average, higher when insider trading is allowed, thus encouraging corporate investment. This beneficial effect of insider trading does not arise in the model considered in this article.

7. It could alternatively be assumed that the amount of liquidity trading depends on the type of market in which liquidity traders trade. However, an arbitrary difference in trading across markets would have to be assumed, which could cast doubt on the generality of the results derived below.

8. A model in which outsiders acquire information at a (fixed) cost is analyzed by Fishman and Hagerty (1992).

9. Hence, his welfare is not analyzed.

10. For simplicity, and without loss of generality, the return of the risk-free asset (ρ) is normalized to 0 in what follows.

11. This utility function is usually written without the 1 in front. I have included the 1 with the sole purpose of avoid working with negative utilities. Obviously, the properties of this utility function are not altered by this monotonic transformation.

12. Note that $\tilde{\omega}_N = \tilde{\varepsilon}$ and $\tilde{\omega}_T = \tilde{\eta}$.

13. Note that $\omega_N = \varepsilon$ and $\omega_T = \eta$.

14. The order flow provides the market maker with information beyond that which is publicly available. This is due to the fact that, as will be seen below, the demand of informed traders is based on their private information, which is correlated to the future price of the risky asset.

15. As will be seen below, these conjectures are confirmed in equilibrium. That is, linear strategies are not an assumption but a result. The plausibility of this type of strategies has been strengthened by work by Bhattacharya and Spiegel (1991), who analyze linear and nonlinear strategies and show that, if informed traders had to choose between them, they would choose the former over the latter.

16. This assumption is not crucial for the analysis (that is, its relaxation would not significantly change the results derived below), but it simplifies it substantially.

17. These characteristics are also considered, in a different model, by Leland (1992).

18. These calculations are shown in part I of the appendix.

19. This table follows from Equations 9-11, 23-25, and the values reported in Table 1.

20. This table follows from Equations 26-30 and the values reported in Tables 1-2.

21. Fishman and Hagerty (1992) build a model in which, if insider trading is *allowed*, prices may become less efficient. In their model, this happens when insider trading deters a sufficiently large number of market analysts, who withdraw from the market thus ceasing to acquire (costly) information. However, Meulbroek (1992) and Cornell and Sirri (1992) present solid evidence establishing that insider trading corrects prices significantly and in the right direction.

22. This table follows from Equations 31-38 and the values reported in Tables 1-2.

23. This table follows from Equation 7 and the values reported in Tables 1-2.

24. $\Sigma_{i = N,T,Q,K} E(\tilde{w}_{iU}^{1}) = 8 > \Sigma_{i = N,T,Q,K} E(\tilde{w}_{iR}^{1}) = 7.9998878.$

25. $\Sigma_{i=N,T,Q,K} Var(\tilde{w}_{iR}^{1}) = .0006673 > \Sigma_{i=N,T,Q,K} Var(\tilde{w}_{iU}^{1}) = .0005531$, where $Var(w_{NR}^{1}) = Var(w_{KU}^{1}) = Var(w_{KR}^{1}) = 0$.

26. It may be argued that, besides forcing insiders out of the market, ITR may also encourage other investors to enter the market. However, the recent imposition of ITR in Japan and in the European Union does not seem to give empirical support to this claim.

27. I would like to thank Asani Sarkar for suggesting me this line of inquiry.

28. The range of variation of the parameters of the model in the sensitivity analysis is as follows: The variability of inside information (σ_{ε}^{2}) ranges from .002 to .024; the variability of outside information (σ_{η}^{2}) from .016 to .038; the variability of liquidity trading (σ_{Q}^{2}) from .002 to .024; and, finally, the risk aversion of insiders (a_N), outsiders (a_T), and liquidity traders (a_Q) from .5 to 8.

29. Note that no sensitivity analysis is performed with respect to changes in the risk aversion of liquidity traders. This is due to the fact that liquidity traders trade randomly, and, therefore, their attitude towards risk has no impact on a securities market.

30. Throughout this analysis, $E(V_{KU} - V_{KR}) = .00000102$.

31. For $a_N = .5$, $E(V_{NU} - V_{NR}) = .00069023$, whereas for $a_N = 8$, $E(V_{NU} - V_{NR}) = .00000001$.

32. For $a_N = .5$, $E(V_{TR} - V_{TU}) = .0000528$ and $E(V_{QR} - V_{QU}) = .0000757$, whereas for $a_N = 8$, $E(V_{TR} - V_{TU}) = .0000527$ and $E(V_{QR} - V_{QU}) = .0000756$.

33. For $a_N = .5$, $E(V_{NU} - V_{NR}) = .00013468$ and $E(V_{QR} - V_{QU}) = .0000757$, whereas for $a_T = 8$, $E(V_{TR} - V_{TU}) = .00013471$ and $E(V_{QR} - V_{QU}) = .0000766$.

34. For $a_T = .5$, $E(V_{TR} - V_{TU}) = .0002904$, whereas for $a_T \geq 7$, $E(V_{TR} - V_{TU}) = 0$.

35. For $.5 \leq a_Q \leq 8$, $E(V_{NU} - V_{NR}) = .00013467$ and $E(V_{TR} - V_{TU}) = .0000528$.

36. For $a_Q = .5$, $E(V_{QR} - V_{QU}) = .0003803$, whereas for $a_Q = 8$, $E(V_{QR} - V_{QU}) = 0$.

37. Some of the most notorious insiders have been arbitrageurs (like Ivan Boesky) or investment bankers (like Dennis Levine). It seems plausible to think that these traders, who repeatedly invest large sums of money in search for a quick profit, are inherently less risk averse than liquidity traders, who trade for liquidity reasons.

38. It is acknowledged that due to the (unfair?) lack of popularity of insider trading, there may be no government willing to eliminate ITR completely. An intermediate step in the process of deregulating insider trading could be to allow this practice and to impose a tax on insider trading profits. Estrada (1994b) analyzes this issue in detail, and shows that such a policy dominates ITR in the sense that it yields a higher level of social welfare. Estrada (1994c), in turn, analyzes another alternative policy, namely, one in which insider trading is allowed and a lump-sum tax on insiders is imposed.

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