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INSIDER TRADING: REGULATION, RISK REALLOCATION, AND WELFARE

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Abstract

I argue in this paper that the imposition of insider trading regulations on a securities market generates not only a reallocation of wealth from insiders to liquidity traders, but also a reallocation of risk from the former to the latter. I further argue that, although the wealth reallocation has no impact on social welfare, under plausible assumptions, the risk reallocation imposes a cost on society.

Key Words
Insider trading. Securities Regulation

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I- INTRODUCTION [1]

The bulk of the literature on insider trading has focussed on the impact of insider trading regulation (ITR) on market liquidity and informational efficiency; see, for example, Kyle (1985), Subrahmanyam (1991), and Fishman and Hagerty (1992). The relationship between ITR and social welfare, on the other hand, has received much less attention, although it has been addressed by Ausubel (1990), Leland (1992), and Estrada (1993a,b). In this paper, I attempt to analyze the welfare issue from a novel perspective.

Most discussions on ITR focus on the wealth reallocation generated by the imposition of this regulation. However, the *risk* reallocation forced by ITR, although critical to determine the impact of this regulation on social welfare, is usually ignored. In this paper, I basically make two points: First, that under plausible conditions, the risk reallocation forced by ITR imposes a cost on society. And, second, that this cost is increasing in the difference in risk aversion between insiders and liquidity traders, as long as the risk aversion of the latter is higher than that of the former. Therefore, the higher the risk aversion of liquidity traders, compared to that of insiders, the weaker the case for imposing ITR.

The rest of the paper is organized as follows. In part II, I introduce the model, which is a simplified version of the analytical framework in Estrada (1993b). In part III, I analyze the impact of the risk reallocation forced by the imposition of ITR on social welfare. And, finally, in part IV, I summarize the implications of the analysis.

II- THE MODEL

Consider a one-period economy where 0 denotes the present (the beginning of the period) and 1 denotes the future (the end of the period). Further, consider three types of traders interacting in a market for a risky asset: insiders (indexed by N), liquidity traders (indexed by Q), and a market maker. This interaction takes place either in an unregulated market (indexed

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[1] I would like to thank Ignacio Peña, Asani Sarkar, participants of the First Conference in Law and Economics (Universidad Carlos III, Madrid, Spain), and participants of the Gerzensee Conference on Regulation and Risk in the Financial Services Area (Gerzensee, Switzerland). The views expressed below and any errors that may remain are entirely my own.

by U) or in a regulated market (indexed by R); that is, a market under ITR.[2]

Let $\tilde{x}_{ij}$ be trader i's demand for the risky asset in the jth market. Further, let $\tilde{p}_{0j}$ be the price of this asset in the jth market at the beginning of the period, and $\tilde{p}_1$ its price at the end of the period. This terminal price is given by $\tilde{p}_1 = \bar{p}_1 + \tilde{\epsilon}$, where $\bar{p}_1$ is the expected (terminal) price of the risky asset given all publicly-available information, and $\tilde{\epsilon}$ is a random variable such that $\tilde{\epsilon} \sim N(0,\Sigma_\epsilon)$. Thus, the terminal price of the risky asset is determined by all publicly-available information and by a (normally-distributed) random shock. This random shock may be thought of as representing firm-specific events that affect the value of the firm that issues the risky asset under consideration; hence, $\tilde{\epsilon}$ represents inside information and is observed only by insiders.

Insiders, defined as those traders that (directly or indirectly) observe inside information, are assumed to trade for informational reasons. They costlessly observe all publicly-available information about the terminal price of the risky asset (summarized in the parameter $\bar{p}_1$) and a given realization of the variable $\tilde{\epsilon}$ (ϵ_1); their trading strategy is considered below. Unlike insiders, liquidity traders do not trade for informational reasons. They are assumed to demand a random quantity $\tilde{x}_Q$ of the risky asset, such that $\tilde{x}_Q \sim N(0,\Sigma_Q)$. This demand is assumed to be independent from the type of market (regulated or unregulated) in which liquidity traders trade, and to have no information content; that is, $Cov(\tilde{\epsilon},\tilde{x}_Q)=0$.

The timing of the model is as follows. At the beginning of the period, endowments are distributed, information and liquidity trading are realized, 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, when all uncertainty is resolved and the payoffs of the portfolios are realized, insiders and liquidity traders possess (random) terminal wealth ($\tilde{w}^1_{ij}$) given by:

$$\tilde{w}^1_{ij} = w^0_i + (\tilde{p}_1 - \tilde{p}_{0j})\tilde{x}_{ij}\ , \qquad i=N,Q, \quad j=U,R \tag{1}$$

where w^0_i is trader i's (certain) initial wealth, and $(\tilde{p}_1 - \tilde{p}_{0j})\tilde{x}_{ij}$ are trader i's trading profits in the jth market.

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[2] In what follows, subscripts i will be used to index traders (i=N,Q), and subscripts j to index markets (j=U,R).

Insiders and liquidity traders are assumed to be risk averse and to have a negative exponential utility function (V); that is, $V_i(\tilde{w}_i^1)=1\text{-EXP}(-a_i\tilde{w}_i^1)$, i=N,Q, where a_i ($a_i>0$) is the absolute risk aversion parameter. The expected value of V, conditional on an insider's private information set ($\tilde{\epsilon}$), is given by:

$$E\left[V_N(\tilde{w}_N^1)|\tilde{\epsilon}\right] = 1 - e^{-a_N\left[E\left(\tilde{w}_N^1|\tilde{\epsilon}\right) - \left(\frac{a_N}{2}\right)Var\left(\tilde{w}_N^1|\tilde{\epsilon}\right)\right]} \tag{2}$$

Thus, insiders are assumed to select, conditional on their private information, the demand for the risky asset that maximizes (2).

The market maker is assumed to be risk neutral and to set the price of the risky asset efficiently; that is, by taking into account all publicly-available information and the order flow.[3] Thus, his pricing function is given by:

$$\tilde{p}_{0j} = E(\tilde{p}_1|\tilde{x}_{Nj}+\tilde{x}_Q) = \bar{p}_1 + \alpha_j(\tilde{x}_{Nj}+\tilde{x}_Q) , \qquad j=U,R \tag{3}$$

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

Let an equilibrium be defined as a realization of the random variable $\tilde{p}_{0j}$ such that the following two conditions hold:

$$\begin{aligned} &i)\ \ x_{Nj}^{*} = \underset{x_{Nj}}{argmax}\ E\left[V_N(\tilde{w}_{Nj}^1)\,|\,\tilde{\epsilon}=\epsilon_1\right] , && j=U,R \\ &ii)\ \ p_{0j}^{*} = E\left(\tilde{p}_1|x_{Nj}^{*}+x_Q\right) , && j=U,R \end{aligned} \tag{4}$$

That is, an equilibrium is a (current) price of the risky asset that: first, arises from a demand for the risky asset that maximizes the utility of insiders, conditional on their private information;[4] and, second, is efficient in the sense that it is equal to the expected (terminal)

[3] Hence, the market maker is constrained to make zero profits and his welfare is not analyzed.

[4] As argued above, an insider's demand for the risky asset follows from the maximization of (2). Note, however, that maximizing this expression is equivalent to maximizing an insider's (conditional) certainty equivalent of wealth (CE_N | $\tilde{\epsilon}$), which is given by CE_N | $\tilde{\epsilon}=E(\tilde{w}_N^1$ | $\tilde{\epsilon})$-$(a_N/2)Var(\tilde{w}_N^1$ | $\tilde{\epsilon})$. Thus, for simplicity, in what follows, insiders are assumed to maximize CE_N | $\tilde{\epsilon}$.

price of the risky asset, conditional on all the information available to the market maker.

When selecting their portfolio, insiders behave strategically in the sense that their choice takes into account the impact of their demand on the price of the risky asset. That is, they solve their maximization problem by taking the market maker's pricing function (but not the price of the risky asset) as given. It is conjectured that insiders' demand for the risky asset is a linear function of their private information; that is, $x_{Nj}=\beta_j \tilde{\epsilon}$, for a given parameter β_j. As will be seen below, this conjecture is confirmed in equilibrium.[5]

The structure of the model is such that the market maker selects the parameter that determines the liquidity of the market (α_j), and insiders select the parameter that determines their demand (β_j). Note that, in equilibrium, the value of these parameters will depend on whether or not the market is regulated. Thus, in the unregulated market, 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:*

$$\alpha_U^* = \frac{\beta_U^* \Sigma_\epsilon}{(\beta_U^*)^2 \Sigma_\epsilon + \Sigma_Q} \tag{4}$$

$$\beta_U^* = \frac{1}{2\alpha_U^* + a_N (\alpha_U^*)^2 \Sigma_Q} \tag{5}$$

Proof: A representative insider's terminal wealth can be written as:

$$\tilde{w}_{NU}^1 = w_N^0 + (\tilde{\epsilon} - \alpha_U \tilde{x}_{NU} - \alpha_U \tilde{x}_Q)\, \tilde{x}_{NU} \tag{6}$$

Taking the expected value and the variance of (6), both conditional on the insider's private information, and replacing them into the expression for the insider's (conditional) certainty equivalent of wealth yields:

[5] The plausibility of linear 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.

$$CE_{NU}|\tilde{\epsilon} = w_N^0 + (\epsilon_1 - \alpha_U x_{NU})x_{NU} - \left(\frac{a_N}{2}\right)\left(\alpha_U^2 x_{NU}^2 \Sigma_Q\right) \tag{7}$$

Maximizing (7) with respect to x_{NU} and solving for the insider's optimal demand for the risky asset yields the optimal value of β_U (β_U^*), which is given by (5). Substituting the insider's optimal demand for the risky asset into (3), and applying the projection theorem to solve for the optimal value of α_U (α_U^*), yields (4). ■

Recall that, for the purposes of the analysis, a regulated market is one in which insider trading is prohibited. If ITR were assumed to be fully effective thus fully preventing insider trading (that is, $\beta_R=0$), the regulated market would be infinitely liquid.[6] In order to avoid this extreme result, it is assumed that ITR reduces insider trading to a minimum level, without eliminating it completely. This minimum level of insider trading is determined by the parameter $\beta_R=\beta_{min}$, which is exogenous to the model.[7] Thus, in the 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:*

$$\alpha_R^* = \frac{\beta_{min}\Sigma_\epsilon}{\beta_{min}^2\Sigma_\epsilon + \Sigma_Q} \tag{8}$$

$$\beta_R = \beta_{min} \tag{9}$$

Proof: The parameter that determines the insider's minimum demand for the risky asset is determined exogenously and given by (9). Substituting the insider's minimum demand for the risky asset into (3), and applying the projection theorem to solve for the optimal value of α_R (α_R^*), yields (8). ■

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[6] This follows from the fact that, as shown below by (8), $\beta_R=0$ implies $\alpha_R=0$. Since market liquidity (L_j) is usually defined as $L_j=1/\alpha_j$, then the claim follows.

[7] This parameter may be thought of as determining the maximum amount of insider trading in which insiders can engage without being detected.

Although the equilibrium in the regulated market is simple, the complexity of the equilibrium in the unregulated market precludes a tractable analysis in closed form. Therefore, the impact of ITR on social welfare is evaluated below using numerical analysis. The welfare analysis is performed in terms of a representative trader of each type, and is performed *ex-ante*; that is, before the realization of the random variables. Thus, an insider's (unconditional) expected terminal utility in the unregulated market and that in the regulated market are given, respectively, by:

$$E\left[V_N\left(\tilde{w}_{NU}^1\right)\right] = 1-e^{-a_N\left\{w_N^0+(1-\alpha_U\beta_U)\beta_U\Sigma_\epsilon-\left(\frac{a_N}{2}\right)\left[2(1-\alpha_U\beta_U)^2\beta_U^2(\Sigma_\epsilon)^2+(\alpha_U\beta_U)^2\Sigma_\epsilon\Sigma_Q\right]\right\}} \tag{10}$$

$$E\left[V_N\left(\tilde{w}_{NR}^1\right)\right] = 1-e^{-a_N\left\{w_N^0+(1-\alpha_R\beta_R)\beta_R\Sigma_\epsilon-\left(\frac{a_N}{2}\right)\left[2(1-\alpha_R\beta_R)^2\beta_R^2(\Sigma_\epsilon)^2+(\alpha_R\beta_R)^2\Sigma_\epsilon\Sigma_Q\right]\right\}} \tag{11}$$

A liquidity trader's (unconditional) expected terminal utility in the unregulated market and that in the regulated market, on the other hand, are given, respectively, by:

$$E\left[V_Q\left(\tilde{w}_{QU}^1\right)\right] = 1-e^{-a_Q\left\{w_Q^0-\alpha_U\Sigma_Q-\left(\frac{a_Q}{2}\right)\left[(1-\alpha_U\beta_U)^2\Sigma_\epsilon\Sigma_Q+2\alpha_U^2(\Sigma_Q)^2\right]\right\}} \tag{12}$$

$$E\left[V_Q\left(\tilde{w}_{QR}^1\right)\right] = 1-e^{-a_Q\left\{w_Q^0-\alpha_R\Sigma_Q-\left(\frac{a_Q}{2}\right)\left[(1-\alpha_R\beta_R)^2\Sigma_\epsilon\Sigma_Q+2\alpha_R^2(\Sigma_Q)^2\right]\right\}} \tag{13}$$

Let social welfare in the jth market (SW_j) be defined as the joint expected utility of insiders and liquidity traders in that market; that is, $SW_j=E(V_{Nj}+V_{Qj})$, where $E(V_{ij})$ is trader i's expected utility in the jth market. Further, let trader i's (unconditional) certainty equivalent of wealth in the jth market (CE_{ij}) be defined as $CE_{ij}=E(\tilde{w}_{ij}^1)-(a_i/2)Var(\tilde{w}_{ij}^1)$. Thus, since $E(V_{ij})$ and CE_{ij} move in the same direction,[8] it is simpler to define social welfare as $SW_j=CE_{Nj}+CE_{Qj}$. Therefore, only the certainty equivalents of the utility functions (10)-(13) will be used in the welfare analysis.

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[8] Note that $E[V_i(\tilde{w}_{ij}^1)]=1\text{-EXP}[-a_i(CE_{ij})]$.

III- REGULATION, RISK REALLOCATION, AND WELFARE

Having set up the analytical framework, I turn to analyze the impact of the risk reallocation forced by the imposition of ITR on social welfare. Throughout the analysis, liquidity traders are assumed to be at least as risk averse as insiders; that is, $a_Q \geq a_N$.[9] I consider below two base cases: one in which insiders and liquidity traders are risk neutral, and another in which both are risk averse. Beginning from each base case, a sensitivity analysis is performed in which the risk aversion of one type of traders is varied while that of the other type of traders remains fixed. Throughout the analysis, the impact of ITR on social welfare is measured by SW_U-SW_R; hence, SW_U-$SW_R>0$ indicates that ITR is harmful, whereas SW_U-$SW_R<0$ indicates that ITR is beneficial.

As argued above, the complexity of the equilibrium in the unregulated market precludes a tractable analysis in closed form. In order to find a numerical solution for the equilibrium in each market, particular values for the parameters of the model (Σ_ϵ, Σ_Q, w_i^0 and a_i) need to be assumed. The volatility of securities prices ($\Sigma_\epsilon=.04$) and the variability of liquidity trading ($\Sigma_Q=.01$) are taken from Leland (1992) and reflect average market data. The initial wealth of insiders and liquidity traders ($w_N^0=w_Q^0=1$) is normalized without loss of generality. Finally, the risk aversion of insiders and liquidity traders depends on the case under consideration and is specified below. Once the values of Σ_ϵ, Σ_Q, w_i^0, and a_i are replaced into the systems (4)-(5) and (8)-(9), the model yields the equilibrium values of α_U, β_U, and α_R, with β_R being exogenously determined.[10]

1.- Base case 1: Risk Neutrality ($a_N=a_Q=0$)

Under the assumption that insiders and liquidity traders are risk neutral, risk is not an

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[9] Some of the most notorious insiders have been arbitrageurs (like Ivan Boesky) or investment bankers (like Dennis Levine). It seems plausible to assume 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.

[10] Recall that the reason for not modelling a fully-effective regulation ($\beta_R=0$) is that of preventing the regulated market from becoming infinitely liquid. Note that any arbitrarily-small value of β_R would fit that purpose. Throughout the analysis, it is assumed that $\beta_R=\beta_{min}=.005$. From a qualitative point of view, the results of the analysis are independent from this particular choice of β_R.

issue and the model becomes significantly simpler.[11] Figure 1 depicts the relationship between the impact of ITR (measured by SW_U-SW_R) and the risk aversion of liquidity traders. This figure shows that, when both insiders and liquidity traders are risk neutral (the origin of Figure 1), the level of social welfare attained in the unregulated market is the same as that attained in the regulated market; that is, ITR has no impact on social welfare. This result follows from the fact that the expected profits gained by liquidity traders due to the imposition of ITR are exactly offset by the expected profits lost by insiders due to the imposition of this regulation. Hence, ITR forces a redistribution of *wealth* that does not affect social welfare.[12]

FIGURE 1

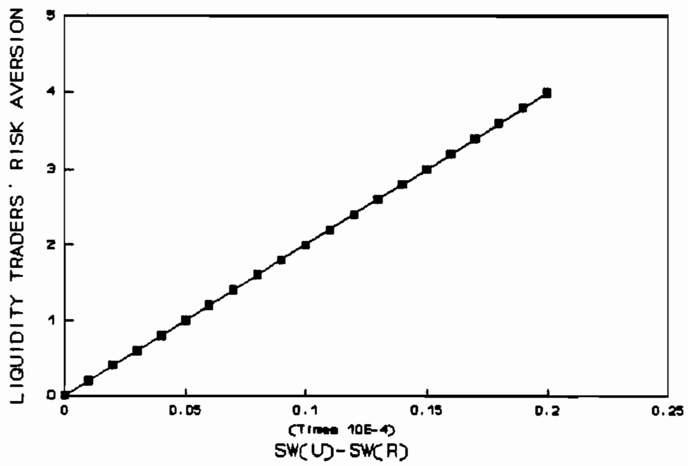

Figure 1 also shows that, as liquidity traders become more risk averse (while insiders remain risk neutral), the social cost of ITR increases. In order to rationalize this result, it is important to notice that ITR not only prevents insiders from trading; it also prevents them from bearing risk. Thus, the imposition of this regulation forces a reallocation of risk from traders that can bear risk at no cost (insiders) to traders that bear it at a higher cost (liquidity traders). As a consequence, the higher the risk aversion of liquidity traders, compared to that of insiders,

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[11] In fact, under risk neutrality, it is possible to find a simple closed-form solution for the equilibrium in each market. In particular, in the unregulated market, this solution is given by $\alpha_U^* = .5(\Sigma_\epsilon/\Sigma_Q)^{1/2}$, and $\beta_U^* = (\Sigma_Q/\Sigma_\epsilon)^{1/2}$.

[12] The impact of ITR on a securities market and on social welfare under the assumption of risk neutral traders is analyzed in detail in Estrada (1993a).

the higher the cost of the risk reallocation forced by ITR, and, therefore, the higher the cost of imposing this regulation. The results of this section are summarized in the following proposition:

Proposition 1: *When all traders are risk neutral, ITR forces a reallocation of wealth that has no impact on social welfare. However, when insiders are risk neutral and liquidity traders are risk averse, ITR also forces a reallocation of risk whose cost is increasing in the risk aversion of liquidity traders.*

2.- Base Case 2: Risk Aversion ($a_N=a_Q=1$)

The assumption of risk neutrality, though mathematically convenient, is empirically implausible, especially when applied to liquidity traders. Consider then a case in which both insiders and liquidity traders are risk averse. In particular, let the coefficient of risk aversion of both traders be $a_N=a_Q=1$. Beginning from this initial situation, the differential risk aversion between insiders and liquidity traders (satisfying the restriction $a_Q \geq a_N$) may be given by the fact that the risk aversion of liquidity traders is higher than $a_Q=1$, or that the risk aversion of insiders is lower than $a_N=1$. These two possibilities are considered in Figures 2 and 3, respectively.

FIGURE 2

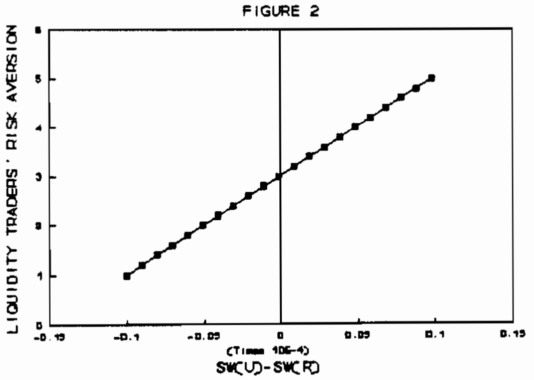

FIGURE 3

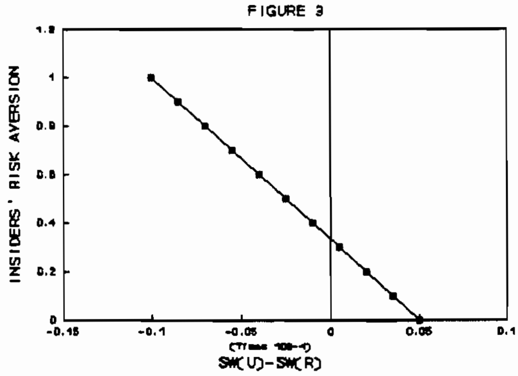

Figure 2 depicts the relationship between the impact of ITR on social welfare and the risk aversion of liquidity traders, beginning from a situation in which insiders and liquidity traders are equally risk averse ($a_N=a_Q=1$). This figure shows that, as the risk aversion of liquidity traders increases (and that of insiders remains fixed at $a_N=1$), the benefit of ITR decreases, and, beyond a point, the cost of ITR increases. This result is explained as follows. The expected profits gained by liquidity traders are offset by the expected profits lost by insiders; hence, the *wealth* reallocation generated by ITR has no impact on social welfare. However, the *risk* reallocation forced by this regulation is costly for it reallocates risk from traders that can bear risk at a low cost (insiders) to traders that bear it at a higher cost (liquidity traders). As a consequence, the higher the risk aversion of liquidity traders, compared to that of insiders (the larger a_Q-a_N), the higher the cost of the risk reallocation forced by the imposition of ITR.

Figure 3, on the other hand, depicts the relationship between the impact of ITR on social welfare and the risk aversion of insiders, beginning from a case in which insiders and liquidity traders are equally risk averse ($a_N=a_Q=1$). This figure shows that, as the risk aversion of insiders decreases (and that of liquidity traders remains fixed at $a_Q=1$), the benefit of ITR decreases, and, beyond a point, the cost of ITR increases; this result also follows from the risk-reallocation argument explained above. The results of this section are summarized in the following proposition:

Proposition 2: *When all traders are risk averse, ITR forces a reallocation of risk whose cost is increasing in the difference in risk aversion between insiders and liquidity traders, as long as the risk aversion of the latter is higher than that of the former.*[13]

IV- CONCLUSIONS

I have argued in this paper that ITR forces not only a reallocation of wealth from insiders to liquidity traders, but also a reallocation of risk from the former to the latter. I have shown that, although the wealth reallocation does not have an impact on welfare, under the plausible assumption that liquidity traders are more risk averse than insiders, the risk reallocation is costly. I have further shown that this cost is increasing in the difference in risk aversion between insiders and liquidity traders, as long as the risk aversion of the latter is higher than that of the former. Therefore, the policy implication of the analysis is clear: The more risk averse liquidity traders are believed to be compared to insiders, the weaker the case for imposing ITR.

[13] Propositions 1 and 2 can be jointly taken as saying that (SW_U-SW_R) is an increasing function of (a_Q-a_N).

REFERENCES

Ausubel, Lawrence (1990). "Insider Trading in a Rational Expectations Economy." American Economic Review, 80, 1022.

Bhattacharya, Utpal, and Matthew Spiegel (1991). "Insiders, Outsiders, and Market Breakdowns." Review of Financial Studies, 4, 255.

Estrada, Javier (1993a). "Insider Trading: Regulation, Securities Markets and Welfare Under Risk Neutrality." Ph.D. dissertation, chapter 1. Department of Economics, University of Illinois at Urbana-Champaign.

Estrada, Javier (1993b). "Insider Trading: Regulation, Securities Markets and Welfare Under Risk Aversion." Ph.D. dissertation, chapter 2. Department of Economics, University of Illinois at Urbana-Champaign.

Fishman, Michael, and Kathleen Hagerty (1992). "Insider Trading and the Efficiency of Stock Prices." Rand Journal of Economics, 23, 106.

Kyle, Albert (1985). "Continuous Auctions and Insider Trading." Econometrica, 53, 1315.

Leland, Hayne (1992). "Insider Trading: Should It Be Prohibited?" Journal of Political Economy, 100, 859.

Subrahmanyam, Avanidhar (1991). "Risk Aversion, Market Liquidity, and Price Efficiency." Review of Financial Studies, 4, 417.