INSIDER TRADING:
REGULATION, RISK REALLOCATION, AND WELFARE

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Abstract: I argue in this article that the imposition of insider trading regulation 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 show that this reallocation of risk (usually ignored in the literature), unlike the reallocation of wealth (usually addressed in the literature), has a critical impact on social welfare. I further show that, under some assumptions, this risk reallocation imposes a cost on society.

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I- INTRODUCTION

The bulk of the formal 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 far less attention; see, however, Ausubel (1990), Leland (1992), and Estrada (1994,1995). In this article, I perform a welfare analysis placing special emphasis on an issue largely ignored by previous analyses on the topic.

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 three points: First and foremost, that the risk reallocation forced by ITR has a critical impact on social welfare; second, that under some conditions the risk reallocation forced by ITR imposes a cost on society; and, third, 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.

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 (1995).[1] 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 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 *j*th market. Further, let $\tilde{p}_{0j}$ be the price of this asset in the *j*th 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 $\tilde{p}_1 = \bar{p}_1 + \tilde{\varepsilon}_1$, where $\bar{p}_1$ is the expected (terminal) price of the risky asset given all publicly-available information, and $\tilde{\varepsilon}$ is a random variable such that $\tilde{\varepsilon} \sim N(0, \sigma_\varepsilon^2)$. 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

[1] Readers interested in a more detailed analysis of the modelling technique and a more extensive introduction that, among other things, discusses how this type of welfare analysis fits in, and is different from previous work on insider trading are referred to Estrada (1995).

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

that affect the value of the firm that issues the risky asset under consideration; hence, 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 $\overline{p}_1$) and a given realization of the variable $\tilde{\varepsilon}$ (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 $\tilde{x}_Q \sim N(0, \sigma_Q^2)$. This demand is assumed to be independent from the type of market (regulated or unregulated) in which liquidity traders trade, and to have no informational content; that is, $Cov(\tilde{\varepsilon}, \tilde{x}_Q) = 0$.[3]

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 $(\tilde{w}_{ij}^1)$ given by

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

where w_i^0 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 *j*th market.

Insiders and liquidity traders are assumed to be risk averse and to have a negative exponential utility function (*V*); that is, $V_i(\tilde{w}_i^1) = 1 - EXP(-a_i w_i^1)$, *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 $(\tilde{\varepsilon})$, is given by

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

The market maker is assumed to be risk neutral and to set the price of the risky asset efficiently by taking into account all publicly-available information and the order flow.[4] Thus, his pricing function is given by

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[3] It could be assumed that liquidity traders trade different amounts depending on whether or not the market is regulated. However, since they are assumed to trade randomly (that is, their trading decision that does not arise from a utility-maximization model), the case for assuming differential trading is weak. An alternative approach, not pursued here, is that proposed by Spiegel and Subrahmanyam (1992) in which liquidity traders are replaced by hedgers; that is, by investors that strategically trade to hedge the endowment of an asset.

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

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

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

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

$$i)\quad x^*_{Nj} = \arg\max_{x_{Nj}} E\left[V_N\left(\tilde{w}^1_{Nj}\right)\middle| \tilde{\varepsilon} = \varepsilon_1\right] \qquad j = U, R$$

$$ii)\quad p^*_{0j} = E\left(\tilde{p}_1 \middle| \tilde{x}^*_{Nj} + x_Q\right), \qquad j = U, R$$

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 expected utility of insiders, conditional on their private information;[5] and, second, is efficient in the sense that it is equal to the expected (terminal) price of the risky asset, conditional on all the information available to the market maker.

When selecting their portfolio, insiders are assumed to behave strategically in the sense that 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 further assumed that insiders' demand for the risky asset is a linear function of their private information; that is, $\tilde{x}_{Nj} = \beta_j \tilde{\varepsilon}$, for a given parameter β_j. As will be seen below, this conjecture is confirmed in equilibrium.[6]

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

$$\alpha^*_U = \frac{\beta^*_U \sigma^2_\varepsilon}{\left(\beta^*_U\right)^2 \sigma^2_\varepsilon + \sigma^2_Q} \tag{4}$$

$$\beta^*_U = \frac{1}{2\alpha^*_U + a_N\left(\alpha^*_U\right)^2 \sigma^2_Q} \tag{5}$$

[5] Note that maximizing an insider's (conditional) expected utility is equivalent to maximizing an insider's (conditional) certainty equivalent of wealth $(CE_N | \tilde{\varepsilon})$, which is given by $CE_N \mid \tilde{\varepsilon} = E(\tilde{w}^1_N \mid \tilde{\varepsilon}) - (a_N/2)Var(\tilde{w}^1_N \mid \tilde{\varepsilon})$. This is due to the fact that $E[V_N(\tilde{w}^1_N \mid \tilde{\varepsilon})]$=1-EXP[-$a_i(CE_N | \tilde{\varepsilon})$]. Thus, for simplicity, in what follows insiders are assumed to maximize $(CE_N \mid \tilde{\varepsilon})$.

[6] The plausibility of linear strategies has been strengthened by work by Bhattacharya and Spiegel (1991). They analyze linear and nonlinear strategies and show that, if informed traders had to choose between them, they would choose the former over the latter.

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

$$\tilde{w}_{NU}^{1} = w_N^0 + \left(\tilde{\varepsilon} - \alpha_U \tilde{x}_{NU} - \alpha_U \tilde{x}_Q\right)\tilde{x}_{NU}\ . \tag{6}$$

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

$$CE_{NU}\left|\tilde{\varepsilon} = w_N^0 + \left(\varepsilon_1 - \alpha_U x_{NU}\right)x_{NU} - \left(\frac{a_N}{2}\right)\left(\alpha_U^2 x_{NU}^2 \sigma_Q^2\right)\right.. \tag{7}$$

Maximizing (7) with respect to x_{NU} and solving for this variable yields the optimal value of $\beta_U\,(\beta_U^*)$, 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 $\alpha_U\,(\alpha_U^*)$, yields (4).[7] ■

Recall that, by definition, 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, β_R=0), the regulated market would be infinitely liquid.[8] 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; this parameter may be thought of as determining the maximum amount of insider trading in which insiders can engage without being detected. Thus, in the regulated market, the following theorem holds:

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

$$\alpha_R^* = \frac{\beta_{\min}\sigma_\varepsilon^2}{\beta_{\min}\sigma_\varepsilon^2 + \sigma_Q^2} \tag{8}$$

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

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 $\alpha_R\,(\alpha_R^*)$, yields (8). ■

Although the equilibrium in the regulated market is simple, the equilibrium in the unregulated market is more complicated and 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

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[7] A more detailed proof of a similar but more complicated theorem can be found in Estrada (1995).

[8] It follows from (8)-(9) below that if β_R=0 then α_R=0. Since market liquidity (L_j) is usually defined as $L_j=1/\alpha_j$, then the claim follows.

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

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

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

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

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

Let social welfare in the *j*th 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 *j*th market. Further, let trader *i*'s (unconditional) certainty equivalent of wealth in the *j*th 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,[9] 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.

III- REGULATION, RISK REALLOCATION, AND WELFARE

Having set up the analytical framework, I turn to analyze the impact of the wealth and 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, $a_Q \geq a_N$.[10] Two base cases are considered below: 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; therefore, SW_U-SW_R>0 indicates that ITR is harmful, whereas SW_U-SW_R<0 indicates that ITR is beneficial.

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

[10] Some of the most notorious insiders have been arbitrageurs (like Ivan Boesky) or investment bankers (like Dennis Levine). It seems plausible to hypothesize 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. Readers that find this assumption implausible should pay special attention to the caveat that immediately follows Result 2 below.

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 ($\sigma_\varepsilon^2, \sigma_Q^2, w_i^0$, and a_i) need to be assumed. The volatility of securities prices (σ_ε^2=.04) and the variability of liquidity trading (σ_Q^2=.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 ($\sigma_\varepsilon^2, \sigma_Q^2, w_i^0$, 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.[11]

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 issue and the model becomes significantly simpler.[12] Figure 1 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 (SW_U-SW_R=0). 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.[13]

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[11] Recall that the reason for not modelling a fully-effective regulation (β_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 β_R=β_{min}=.005. From a qualitative point of view, the results of the analysis are independent from this particular choice of β_R.

[12] 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 $\alpha_U^* = .5(\sigma_\varepsilon^2 / \sigma_Q^2)^{1/2}$, and $\beta_U^* = .5(\sigma_\varepsilon^2 / \sigma_Q^2)^{1/2}$.

[13] 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 (1994).

FIGURE 1

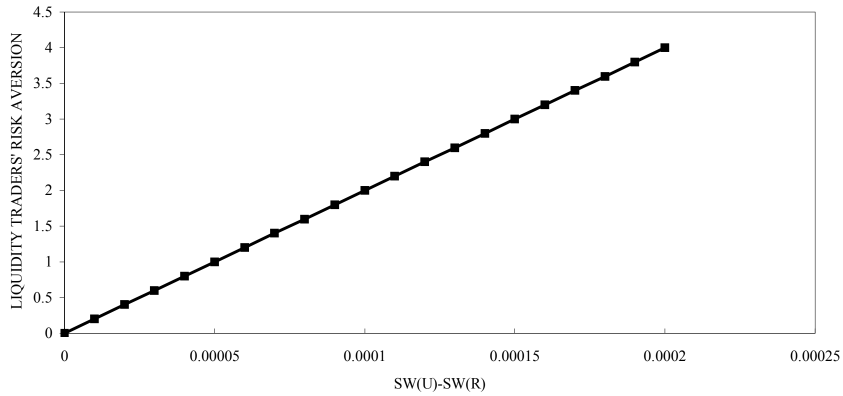

Figure 1 also shows that, as liquidity traders become more risk averse (while insiders remain risk neutral), the social cost of ITR increases. In order to rationalize this result, it is important to notice that ITR not only prevents insiders from trading; it also prevents them from bearing risk. Thus, 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, the higher the cost of the risk reallocation forced by ITR, and, therefore, the higher the cost of imposing this regulation. Thus, the results of this section can be summarized as follows:

Proposition 1: *If all traders are risk neutral, ITR forces a reallocation of wealth that has no impact on social welfare. However, if insiders are risk neutral and liquidity traders are risk averse, ITR also forces a reallocation of risk whose social 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

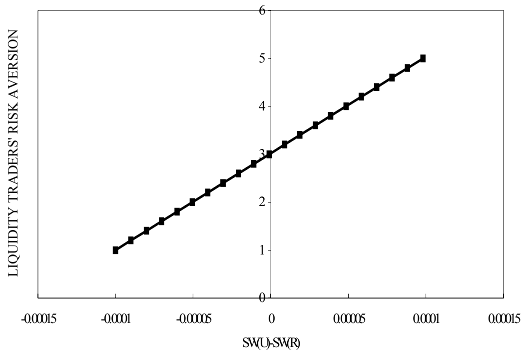

FIGURE 3

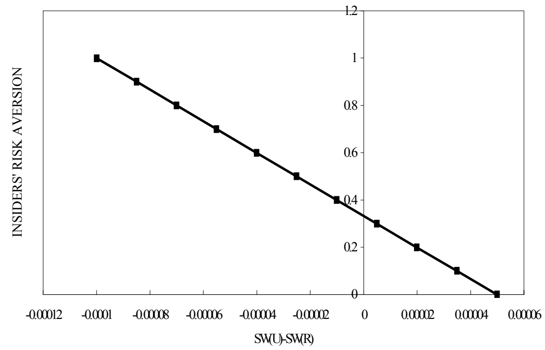

Figure 2 depicts the relationship between the impact of ITR on social welfare and the risk aversion of liquidity traders, beginning from a situation in which insiders and liquidity traders are equally risk averse (a_N=a_Q=1). This figure shows that, as the risk aversion of liquidity traders increases (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 exactly 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 (that is, 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. Thus, the results of this section can thus be summarized as follows:

Proposition: *If all traders are risk averse, ITR forces a reallocation of wealth that has no impact on social welfare. It also forces a reallocation of risk whose social 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.*[14]

A final caveat is in order. It is important to understand that the assumption that liquidity traders are more risk averse than insiders, however arbitrary, does not affect the *issue* addressed in this article; it merely affects the *result* about the desirability of ITR. In other words, results 1 and 2 above argue that the more risk averse liquidity traders are believed to be (compared to insiders), the weaker the case for

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

imposing ITR. Thus, a straightforward extension of this result suggests that, the more risk averse insiders are believed to be (compared to liquidity traders), the stronger the case for imposing ITR. It should therefore be clear that the assumption $a_Q \geq a_N$ does not affect the main *issue* discussed in the article, namely, the relevance of the impact of the risk reallocation generated by the imposition of ITR on social welfare.

IV- CONCLUSIONS

I have argued in this article 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, unlike the wealth reallocation, the risk reallocation does have an impact on social welfare. In particular, if liquidity traders are more risk averse than insiders, the risk reallocation is costly, and its cost is increasing in the difference in risk aversion between insiders and liquidity traders. 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.

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