No. 2251

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FINANCIAL ECONOMICS

Centre for Economic Policy Research

ISSN 0265-8003

INSIDER TRADING, INVESTMENT AND LIQUIDITY: A WELFARE ANALYSIS

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Discussion Paper No. 2251
October 1999

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CEPR Discussion Paper No. 2251

October 1999

ABSTRACT

Insider trading, Investment and Liquidity: A Welfare Analysis*

We compare competitive equilibrium outcomes with and without trading by a privately informed ‘monopolistic' *insider*, in a model with real investment portfolio choices *ex ante* and noise trading generated by aggregate uncertainty regarding other agents' intertemporal consumption preferences. The *welfare implications* of insider trading for the *ex ante* expected utilities of outsiders are analysed. The role of interim information revelation due to insider trading, in improving the risk-sharing among outsiders with stochastic liquidity needs, is examined in detail.

JEL Classification: D52, D82, G14
Keywords: portfolio choice, incomplete markets, private information, rational expectations

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* We are grateful for financial support from Ente Einaudi, the Italian MURST and the International Centre for Economic Research (ICER), Torino. It is a pleasure to acknowledge the excellent research assistance of Giacomo Elena. Work on this Paper was begun while Bhattacharya was a Visiting Fellow at ICER during the summer of 1995. We wish to thank, without implicating in errors, Gabriella Chiesa and Jose Marin for advice and encouragement; participants at seminars at the Universities of Brescia, Roma ‘Tor Vergata’, Tilburg, Torino; and the CEPR Conference on ‘Information, Financial Intermediation and the Macroeconomy’, Alghero 1997, for their comments.

Submitted 1 July 1999

NON-TECHNICAL SUMMARY

Past academic research on the effects of trading by the privately informed insiders of a firm on its stock on the welfare of other shareholders of the firm, has focused mainly on the *trade-off*s arising from (a) the adverse selection losses to the non-insiders, versus (b) the possible benefits from the impact of insider trading on the interim stock price. The major benefit of more informative (regarding future returns) interim stock prices has mostly been modelled in terms of their impact on more allocationally efficient interim value-maximising real investment choices by the firm, as for example in the papers of Allen (1984), Leland (1992), Dow and Rahi (1996). In analysing the impact of interim insider trading on non-insiders' *ex ante* welfare, modelling *all* other traders explicitly (in terms of their preferences, endowments and *a priori* information) is also of consequence, and this has only been given its due importance very recently.

In this Paper, we advance the point of view that the private information of a firm's *insiders*, as opposed to that of privately informed outside shareholders, ought to be largely reflected in its interim choices such as on investment, *even without* the reflection of these insiders' information (regarding future returns) in the interim stock price, since the same insiders make these choices! Given this observation, can insider trading still possibly improve non-insiders' *ex ante* welfare?

We examine a scenario in which *aggregate* real investment choices must be made irrevocably at the *ex ante* stage, prior to the insiders' acquisition of information concerning the final returns on the risky investment at the interim stage. Non-insider agents are modelled as a continuum, its elements being subject to *interim liquidity shocks* that are statistically independent conditional on a random *aggregate liquidity shock*, which determines their preferences over consumption at the interim versus final stages. Even without insider trading, the presence of such an aggregate liquidity shock affects the equilibrium stock price at the interim stage which, together with the *ex ante* investment, across a risk-free short term and risky long-term technologies, determine the consumption levels of the non-insider agents at the interim and the final stages. Since agents' liquidity shocks are privately observed and uninsurable, in general the allocations resulting from such interim trading among them would *not* be *ex ante* (Pareto) optimal.

The presence of a privately-informed insider in the interim stock market, for the risky long-term investment, can alter the information (partitions) (regarding some combinations of the interim aggregate liquidity shock and the anticipated final return on the investment) that is conveyed (revealed) by the market-clearing interim stock prices. Such revelations, and their implications for stock price levels in different (aggregate) states, may directly impact on the consumption allocations of non-insiders and also on their *ex ante* investment choices across the two assets.

We show that the above-mentioned *direct effects of* insider trading *can on balance be beneficial* for the *ex ante* welfare (expected utilities) of non-insiders, despite the adverse selection losses suffered by them when the insider's information is not *fully* revealed in the interim stock price at which they trade, *provided that the insiders' equilibrium trades are small*, relative to the trades made by the others. This is the case if the random variations in the aggregate liquidity trading by non-insiders is small, relative to its average level. Given the average level and the variability of liquidity-seeking trades, insider trading is also more likely to benefit other shareholders when the risk of the *ex ante* anticipated returns on the long-term investment technology is small. When neither of the above conditions is satisfied, allowing interim trading by better-informed insiders would either decrease others' *ex ante* welfare or, especially if the asset returns are risky and only market orders are allowed, the insider would choose not to participate in the trading.

I. INTRODUCTION and SUMMARY

Models of trading with privately informed traders in financial markets, and the resulting implications for the informativeness of market prices regarding anticipated risky asset returns in a noisy Rational Expectations Equilibrium (REE), have constituted a major component of new advances in economic theory and finance for more than a quarter century. Major contributions to this literature include the papers of Lucas (1972), Grossman and Stiglitz (1980), and Kyle (1985). More recently, inspired in part by work on the welfare implications of incomplete markets beginning with Hart (1975), attention has turned to the impact of such privately informed trades and noisy REE on real variables in the economy, chief among which are (i) the level of privately chosen aggregate *investments* in risky technologies, and (ii) the levels of *welfare* of agents who are less well-informed a priori. Recent work emphasizing some of these issues includes the papers of Ausubel (1990), Dennert (1992), Dow and Rahi (1996), Leland (1992), Biais and Hillion (1994) and Repullo (1994). In some of these analyses, the informational monopoly power of the insider, and its strategic use, have been incorporated along the lines of Kyle (1985).

In much of the above-mentioned work on informed trading and its impact on real variables, it has been customary -- in order not to have unrealistic fully revealing REE and no insider trading profits -- to postulate some portion of the market demand for (or supply of) securities arising from unmodelled "noise traders", whose endowments and preferences for consumption are left unspecified. This makes it difficult to reach a *welfare judgement*, regarding for example the impact of allowing Insider trading by (informed) managers of a firm, even if its implications for some endogenous variables such as the informativeness of asset prices in a noisy REE -- and the level of aggregate real investment in risky technologies -- can be ascertained. Thus, an important issue in financial regulatory policy, regarding the desirability of trading by (ex post identifiable) informed Insiders of a traded firm, remains largely unresolved at the conceptual level.

Our major goal in this paper is to rectify this shortcoming, by modelling both noise traders and rational (a priori) uninformed traders together, as agents with well-specified endowments and preferences whose intertemporal consumption preferences, and hence *interim* trading strategies, are *ex ante* uncertain. This phenomenon is modelled as interim "shocks" to agents' preferences (or other incomes) affecting their (indirect) utility functions for consumption (withdrawal of savings) at one of two time points that follow the ex ante beginning, when real investment decisions -- the allocation of agents' endowments across risky and riskless technologies -- are made. Thus, our methodology "transplants" modelling techniques from the literature on banking models (Bryant, 1980) to the arena of privately informed insider trading, an innovation also found in the recent related work of Qi (1996).

Our second methodological observation is to note that, when *privately* observed (conditional on some aggregate shock) and not-separately-insured shocks to agents' intertemporal consumption preferences are postulated -- as a convenient modelling device to capture "noise trading" without abandoning welfare analysis -- we are in a context of incomplete markets (Hart, 1975), even in the *absence* of privately informed insiders who acquire interim information about future risky asset returns, indeed even with riskless investment technologies. Thus, traded outcomes with endogenous real investment choices, even in a one-commodity (at each time-point) model, may be *constrained* Pareto-inferior to what could be attained by a planner in terms of agents' *ex ante* expected utilities, even if she has no information on agents' private liquidity shocks; see Bhattacharya and Gale (1987). Hence, to characterise fully the *incremental* impact of privately informed (on asset returns) trading in these models, one may consider scenarios in which (owing to the nature of the preference shocks of non-insiders) traded outcomes are ex ante Pareto inefficient in the absence of the possibility of interim trading based on insider information. Thus, the details of our modelling differ from the usual negative exponential utility and Normal returns and information distributions-based modelling of Grossman-Stiglitz, Dennert, Leland, Repullo, Dow and Rahi etc., who all work with a setup in which the interim traded outcomes are always ex-ante Pareto efficient in the absence of private information on asset returns.[1]

The recent literature on insider trading, as well as some earlier work of Allen (1984), makes it clear that the greater interim informativeness of asset market prices brought about by informed trading may benefit other investors' welfare, if real investment-level choices are sufficiently flexible (with low liquidation costs) at the *interim stage* when the insider acquires her information. Thus, for example, the average level of such interim investment may be higher with than without insider trading (Leland, 1992), since the lower conditional variance of future asset returns with insider trading, in a noisy REE, causes rational outsiders to augment their demand schedules for risky investments. Similarly, as Diamond and Verrecchia (1982) and more recently Holmstrom and Tirole (1993) have pointed out, interim share prices that reflect a greater degree of (otherwise unverifiable) payoff-relevant information regarding future returns, may be useful to construct precise performance measures for *incentive schemes for firms' managers*, vis-à-vis their ex ante effort and project selection choices. In this paper, we *deemphasize* these interim investment effects[2], focusing instead on (a) inflexible *ex ante*

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[1] The reason is, of course, the wealth-invariant demand for the risky asset implied by (intertemporally additively separable) exponential utility preferences.

[2] Our modelling choice of deemphasizing interim investment choices is justified in an environment in which the time lag between the insiders' information arrival and subsequent public knowledge thereof (e.g. , for accounting

(aggregate) choices across risky long-term, versus riskless short-term, real technologies for investment, and (b) interim traded prices for early liquidation by a *stochastic* proportion of non-insiders, which are further affected by the presence of insider trading.

The interim consumption and portfolio allocations of non-insiders are clearly affected by a greater informativeness of interim asset prices brought about by insider trading. The insider, in turn, is a strategic player, with "market power" arising *only* from her information, who takes others' portfolio choices into account in deciding on her trading strategy, given her private information at the interim stage. Together, these choices- along with the *aggregate liquidity shocks* for outsiders- determine the informativeness of interim asset prices regarding their ultimate returns. We study these effects of insider trading on interim asset prices, on the outsiders' ex ante optimal allocations of their savings across a riskless and a risky long-term assets, and finally on the outsiders' ex ante expected utility levels with and without insider trading at the interim stage, before risky returns are realized.

We compare agents' ex ante and interim optimal choices, given aggregate resource constraints and/or budget constraints at traded equilibrium prices, as well as their welfare levels across three scenarios: (A) optimising choices by a welfare-maximising planner, (B) interim trading among (early- and late-dying) outsider agents only, and (C) interim trading with possible participation by the informed insider. These comparisons are carried out numerically, for reasons of tractability in the face of possibly binding interim resource constraints, i.e., "corner solutions", which in turn affect the agents' ex ante optimal choices. We find that the non-insider agents' ex ante welfare is always the highest in scenario (A), strictly, which is not surprising since our planner is endowed with the same interim

earnings or tender offers) is short, and/or the nature of interim information makes it costless to disclose ex post, partly to serve as the basis for managerial incentive schemes.

information as the insider, and she can thus adjust early- and late-dying agents' optimal consumption levels to the realised (interim information on the) return on the long-term technology, which is in general desirable. Our results on comparing agents' choices and welfare levels and also interim equilibrium asset prices, across the scenarios (B) and (C), generates more subtle and perhaps surprising conclusions.

We find that often the outsider agents' ex ante expected utility levels are higher in scenario (C), in which the informed insider may take part in the interim asset trading, as compared to scenario (B) in which the uninformed outsiders carry out such trading among themselves. This outcome is more likely to arise when the lowest possible return on the risky technology rises (as well as the highest), and also as the proportion of agents requiring early consumption increases – provided it is not so large as to make trading by the insider unprofitable for her [3]. This result - of outsider agents being ex ante better off with the insider trading - becomes less likely as the range of possible variation in the proportion of early-dying agents in the economy becomes higher, the reason being that then the insider is thereby able to carry out sales of higher quantities of the long-term asset when its anticipated future return is low [4].

The adverse selection losses incurred by uninformed agents to the insider may be exceeded for their ex ante expected utility by the main beneficial impact of insider trading, which arises as follows. Since the insider does not sell [5] the long-term asset when its anticipated return is high, if in addition the aggregate liquidity shock is low, the selling price on the long-

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[3] This occurs when a small proportion of late-dier agents requires a high risk premium in interim asset prices to compensate for the adverse selection losses to the insider.

[4] She may still obtain a profitable price whenever the uninformed outsiders are "confused" between the states of nature in which (i) the aggregate liquidity shock is low but the insider is selling the long-term asset, and (ii) the aggregate liquidity shock is high but the insider is not selling, because she expects high returns on the long-term asset.

[5] Our insider is endowed with the risky asset, and can only sell it because any borrowing would reveal her identity.

term asset fully reflects its high return, which enhances the consumption level of early diers, modulo the purchasing power of late-dier agents. This impact of insider trading on outsider agents' consumption profiles is the dominant factor behind the possibility of outsiders' ex ante welfare improving with insider trading -- even without any interim flexibility in aggregate real investment, unlike in Allen (1984), Leland (1992) and Dow and Rahi (1996), for example. It is more difficult to discern the impact, in a definite direction, of insider trading on the outsiders' ex ante (privately) optimal asset allocation choices, for example to align these more closely to the ex ante optimal choices in scenario (A), than to those in trading scenario (B). The latter possibility is always logically present in an incomplete-markets setting (Hart,1975) with the uninsured private liquidity shocks, in which interim traded allocations are generally allocationally ex ante inefficient even with a riskless long-term (as well as a short-term) asset (see Bhattacharya and Gale,1987) -- but this ex ante indirect effect does not appear to be playing a major role in our scenario (C).

Our paper is set out as follows. In the next section, we describe the main features of our model, and solution methods for it. Numerical comparisons of investment choices, asset prices and welfare are made in Section III. In Section IV we conclude.

II. ALTERNATIVE ALLOCATIONAL MECHANISMS

There are three time points t=0,1,2. All agents are born at t=0 and supply inelastically savings/endowments of unity in aggregate. There is a continuum of agents with aggregate Lebesgue measure of unity, and in addition possibly an Insider of strictly positive measure. These endowments can be invested either in a *risky* two-period technology paying off at t=2, or in a riskless storage technology paying off at t=1 and, if reinvested at t=1, at t=2. Holdings of the two period risky technology can, however, be traded in a *secondary market* at t=1, with selling by agents who wish to consume early. The storage technology has unit gross returns, and the risky technology with constant returns to scale has final payoffs per unit investment of $\tilde{\theta}$ distributed as:

$$\tilde{\theta} = \begin{cases} \theta_L \text{ with probability } \pi. \\ \theta_H \text{ with probability } (1-\pi) \end{cases} \quad \textbf{(1)}$$

as viewed from the ex ante time point t=0, where $\theta_H > 1 > \theta_L$. It is assumed that π is common knowledge among all the agents, and that

$$\pi\theta_L + (1-\pi)\theta_H > 1. \quad \textbf{(2)}$$

For convenience, we sometimes denote $\{\pi,(1-\pi)\}$ as $\{\pi_L, \pi_H\}$.

The non-insider agents' intertemporal preferences for consumption, at t=1 and/or t=2, can be described as follows. There are two *aggregate states* l and h, and associated conditional probabilities $0<\alpha_l <\alpha_h <1$, such that conditional on the aggregate state l(h), *each* agents' utility for consumptions at t=1 and/or t=2 is an independently identically distributed random variable

$$U(C_1,C_2) = \begin{cases} U(C_1) \text{ with probability } \{[\alpha_l] \text{ or } [\alpha_h]\} \\ U(C_2) \text{ with probability } \{[1-\alpha_l] \text{ or } [1-\alpha_h]\} \end{cases} \quad \textbf{(3)}$$

These aggregate "liquidity states" l and h, are assumed to arise with ex ante probabilities q and (1-q), sometimes denoted $\{q_l, q_h\}$. We assume that $\{q, \alpha_l, \alpha_h\}$ are common knowledge, but that each uninformed agent *only* knows her own realized $U(C_1,C_2)$, but *not* the aggregate state l(h). These randomized preferences, coupled with their aggregate variability, have effects on prices that are akin to those arising from "noise traders" in REE models.[6] [7]

Agents make per capita *real investment choices* across the two available investment technologies, in proportions K and (1-K) respectively, initially at t=0. Further investment in or liquidation of the risky technology at the interim date t=1 is assumed to be *infeasible*. However, individual agents who wish to consume at t=1, and those who wish to postpone their consumption until t=2, can anticipate trading their long-term investment in the risky technology at equilibrium prices $P(K, \theta_j, \alpha_i)$, $j \in \{L,H\}$, $i \in \{l,h\}$, per unit investment. Here, $P(K, \theta_j, \alpha_i)$ is the Rational Expectation Equilibrium price mapping from the underlying aggregate state (including the equilibrium investment choice K at t=0) which must be measurable with respect to the information possessed by the collection of trading agents, possibly, including the informed insider when she participates.

The insider is assumed to have an exogenously given ex ante endowment of the risky technology only at t=0, from which she may choose to (partially) sell and reinvest in the riskless short-term technology at t=1, for consumption at t=2. The interim and final payoffs and consumption allocations, arising from a rationally anticipated $P(K, \theta_j, \alpha_i)$ mapping, are taken into account by the atomistic outsiders in their optimal, and identical, ex ante choices K and (1-K) to respectively invest in the short –term riskless and risky long-term asset.

A. Ex Ante Optimal Allocations

The central planner, endowed with interim information about the risky asset payoff, chooses $C_{t,ij}$ and K to maximise:

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[6] In recent papers, e.g., Diamond and Verrecchia (1981) or Dow and Rahi (1996), noise trading has been modelled explicitly via endowment shocks (with Normal distributions) to agents having negative exponential utilities for consumption at one future time-point.

$$\sum_{i=l,h} \sum_{j=L,H} q_i \pi_j \left[\alpha_i U(C_{1ij}) + (1-\alpha_i) U(C_{2ij})\right] \qquad \textbf{(4)}$$

subject to the resource constraints that, for each $i,j \in \{l,h\}\times\{L,H\}$:

$$\alpha_i C_{1,ij} \leq K \qquad \textbf{(5a)}$$

$$(1-\alpha_i) C_{2,ij} = [\theta_j (1-K) + K - \alpha_i C_{1,ij}] \qquad \textbf{(5b)}$$

B. ***Traded Equilibria Without Inside Information***

If at t=0 agents choose (per capita) investments of K and (1-K) in the storage and risky two-period technologies, respectively, then those who wish to consume at t=1 *ex post* obtain :

$$C_{1ij} = \left[(1-K) P_{ij} + K\right] \qquad \textbf{(6a)}$$

whereas those who wish to consume late at t=2 obtain the consumption level:

$$C_{2ij} = \left[(K - P_{ij} X_{ij}(P_{ij})) + \theta_j (1 - K + X_{ij}(P_{ij}))\right] \qquad \textbf{(6b)}$$

where the subscripts {i,j} refer to the aggregate states of liquidity l (h) and risky asset return L (H), respectively and $X_{ij}(P_{ij})$ is the per capita trade of "late diers" buying the long-term asset, at t=1, from the "early diers". In an equilibrium without inside information about $\tilde{\theta}$, $\{P_{ij}, X_{ij}\}$ can only depend on the liquidity state i. Furthermore, in equilibrium we must have market clearing:

$$(1-\alpha_i) X(P_i) = \alpha_i (1-K) \qquad \textbf{(7a)}$$

and since the "late diers" wishing to consume (only) at t=2 have, in the aggregate, no agents to borrow from[8], we must also have:

$$K - P_i X(P_i) \geq 0. \qquad \textbf{(7b)}$$

[7] In Bhattacharya and Gale (1987) it is shown that, even when $\{\alpha,\theta\}$ are deterministic, interim traded allocations at t=1 are ex-ante Pareto inefficient unless U(C)=log(C).
[8] In other words, the equilibrium borrowing rate at t=1 must be such that no late-dier outsider wishes to borrow.

Equations (7a) and (7b) together imply the aggregate liquidity constraint on market-clearing prices $\{ P_i \}$:

$$P_i\, \alpha_i\, (1\text{-}K) \leq (1\text{-}\alpha_i)\, K \qquad \textbf{(8)}$$

In their ex ante choice of K, agents maximise their ex ante expected utility

$$\underset{\{K,X_i\}}{\text{Max}} \sum_{i=l.h} \sum_{j=L,H} q_i \pi_j \left[\alpha_i U(C_{1i}) + (1-\alpha_i) U(C_{2ij})\right] \qquad \textbf{(9)}$$

whereas at t=1, given P_i (which in equilibrium will reveal state l or h to traders without private information about $\tilde{\theta}$), the "late diers" choose X_i to

$$\underset{X_i}{\text{Max}} \left[\sum_{j=L,H} \pi_j\, U\left(C_{2ij}\right) \middle| P_i\right] \qquad \textbf{(10)}$$

leading to a uniquely maximal X_i (P_i) which, in interim equilibrium (7a), must satisfy (7b), given the ex ante optimal K choice which *anticipates* this equilibrium (and optimal) evolution $\{X_i, P_i\}$ at time t=1. The equilibrium prices $P_i(K)$ are to be found among the positive real roots of a non-linear equation in P_i[9], unless the no-borrowing constraint (7b) binds in which case $P_i = \dfrac{(1-\alpha_i)K}{\alpha_i (1-K)}$, from equation (8) .

The program **MATHEMATICA®** is used to compute the solution to the first-order condition relative to K and X_i, the market clearing conditions (7a) and the no-borrowing conditions (7b). The resulting computed *ex ante* optimal K^* (liquid asset investment) choices at t=0, as well as our agents' *ex ante* expected utility, which depend on the parameters $\{\alpha_l,\alpha_h,\theta_L,\theta_H,q,\pi\}$ of the model, are numerically tabulated in Section III below. These solutions are then compared to those arising in a scenario in which an additional agent, the

[9] The non-linear equation is quadratic with logarithmic utility and of degree 4 when $U(C)=-1/(2C^2)$. Three out of the four roots can be dismissed (two are complex; one exceeds the value of θ_j.

insider, with perfect information about the realised value of θ at t=1, participates strategically in the trading (anticipating the trading by the uninformed) at the interim stage, as well as with the allocations that are ex ante optimal, as described in the subsection above.

C. *Noisy REE with Insider Trading and Market Orders*

We now postulate that, in addition to the agents we have already modelled, there is an insider endowed at t=0 with $n \geq [\alpha_h - \alpha_l]$ units of the risky, and illiquid, technology only, which she may sell at time t=1 and invest in the riskless storage technology. This insider only wishes to consume at time t=2, and she knows *perfectly* at t=1 if the return on the risky technology at t=2 would be θ_H or θ_L. Only for simplicity in computing her expected utility and thus her decision to participate in any selling at t=1 or not, we assume that the insider is *risk-neutral*.

The imperfectly informed outsider late diers' trades are assumed to depend on the partitions of the aggregate state space, $\{\alpha_l, \alpha_h\} \times \{\theta_L, \theta_H\}$, that are revealed to them by the equilibrium prices with the insider trading. The outsider agents take the market-clearing REE prices in these partitions as given parametrically, and the late diers submit demand functions {X(P)} with domain restricted to these prices only; the early-diers supply their long-lived asset inelastically. The insider chooses her trading rule strategically to take the outsiders' behaviour into account. However, we assume that the insider can condition its trade only on its realized information about $\tilde{\theta}$ (θ_L or θ_H), but *not* on the aggregate liquidity shock among non-insiders, i.e., α_l or α_h. Since it is in the interest of insiders to "mask" their private information about $\tilde{\theta}$, such strategic trading by insiders will (be shown to) result in a noisy REE in which the following three partitions of the aggregate state space are revealed by equilibrium prices:

$$\text{a:} \quad \{h,L\} \qquad \textbf{(11a)}$$

$$\text{b:} \quad [\{l,L\}, \{h,H\}] \qquad \textbf{(11b)}$$

$$\text{c:} \quad \{l,H\} \qquad \textbf{(11c)}$$

with the associated (weakly increasing) set of interim prices $\{P_a,P_b,P_c\}$ respectively. In such an equilibrium, the insider sells a quantity Q>0 of the risky asset in states {h,L} and {l,L}, and does not trade otherwise. In particular, we rule out any borrowing at t=1 by the insider from "late dier" outsiders, who are identical and know that "early diers" have no wish to borrow for the future.

The insider's choice of Q is made subject to the knowledge that late-dier outsiders would choose their net purchases (per capita) of the risky asset X_{ij}, in aggregate state {i,j}, to maximize their conditional expected utility:

$$\underset{X_{ij}}{\text{Max}} \sum_{j\varepsilon\{L,H\}} \left[\hat{\hat{\pi}}_{ij} \text{Log}\left[\left(K - P_{ij}X_{ij}\right) + \theta_j\left(1 - K + X_{ij}\right)\right]P_{ij}\right] \qquad \textbf{(12a)}$$

where P_{ij} is the noisy REE equilibrium price at t=1 in state {i,j} per unit of the risky technology, $\hat{\pi}_{ij}$ is the outsiders' revised beliefs about $\tilde{\theta}$, and X_{ij} must satisfy:

$$X_{ij} = X_{kl}\ ,\ i \neq k \text{ and/or } j \neq l, \text{ if } P_{ij} = P_{kl} \qquad \textbf{(12b)}$$

The outsiders' trades at t=1 must also satisfy a no-borrowing constraint:

$$P_{ij}X_{ij} \leq K\ \forall_{ij} \qquad \textbf{(12c)}$$

Equivalently, the REE must meet the aggregate liquidity constraint:

$$P_{ij}\ \alpha_i\ (1\text{-}K) \leq (1\text{-}\alpha_i)\ K \qquad \textbf{(13)}$$

The revised beliefs $\{\hat{\pi}_{ij}\}$ of outsiders depend, of course, on the partitions of the aggregate state space generated by the trading of (themselves and) the insider. Finally, the outsiders' ex ante optimal choice of investment pattern, K, is made to maximise in equation

(9) as above, taking into account the $\{X_{ij},P_{ij}\}$ configurations in interim equilibrium at t=1 for each K choice ex ante. Finally, in examining the existence of any equilibrium with Q>0 (in states {l,L} and {h,L}) trades by the insider, we must compare her expected utility in such an equilibrium versus one in which -- as in Section II.b above -- it desists from trading, and thus one obtains an equilibrium in which prices are P_1 in states [{l,L} and {l,H}] and $P_h \leq P_l$ in states[{h,L} and {h,H}].

We are now in a position to describe fully the noisy REE in our setting with a strategic insider at the interim stage:

PROPOSITION. If condition (16) below is satisfied, then there exists a noisy REE in which the insider sells Q>0 in states {l,L} and {h,L} where Q satisfies

$$(1\text{-}K)\alpha_h = (1\text{-}\alpha_h)X(P_b) \qquad \textbf{(14a)}$$

$$(1\text{-}K)\alpha_l + Q = (1\text{-}\alpha_l)X(P_b) \qquad \textbf{(14b)}$$

where $X(P_b)$ is the late diers' per capita demand for trade in the risky technology in states [(l,L) and (h,H)] given equilibrium price P_b therein, chosen to maximize in (12a) given their revised beliefs:

(i) $$\left(\hat{\pi}_H \middle| P_b\right) = \frac{q_h \pi_H}{\left(q_h \pi_H + q_l \pi_L\right)} \qquad \textbf{(14c)}$$

with the complementary conditional probability $\hat{\pi}_L = 1 - \hat{\pi}_H$. In the other states, equilibrium prices and beliefs satisfy:

(ii) in state {h,L} price P_a with $\left(\hat{\pi}_H \middle| P_a\right)$=0, and

$$(1\text{-}\alpha_h)\ X\ (P_a) = (1\text{-}K)\alpha_h + Q \qquad \textbf{(14d)}$$

where $X(P_a)$ maximizes in (12a) given P_a and $\left(\hat{\pi}_{H/L} \middle| P_a\right)$;

(iii) in state {l,H} price P_c with $\left(\hat{\pi}_H \middle| P_c\right)$ = 1, and

$$(1-\alpha_l)\ X(P_c) = (1-K)\alpha_l \qquad \textbf{(14e)}$$

where $X(P_c)$ maximizes in (12a) given P_c and $\left(\hat{\pi}_{H/L} \middle| P_C\right)$.

The demands of outsiders must further satisfy the conditions:

$$X(P_a) = \frac{K}{P_a} \text{ if } P_a < \theta_L \qquad \textbf{(15a)}$$

$$X(P_a) \in \left[0, \frac{K}{P_a}\right] \text{ otherwise} \qquad \textbf{(15b)}$$

and, similarly,

$$X(P_c) = \frac{K}{P_c} \text{ if } P_c < \theta_H \qquad \textbf{(15c)}$$

$$X(P_c) \in \left[0, \frac{K}{P_a}\right] \text{ if } P_c = \theta_H \qquad \textbf{(15d)}$$

Together, the outsiders' ex ante optimal investment choice K and the interim equilibrium prices must satisfy the aggregate liquidity costraint (13). Finally, in order to satisfy the condition for profitability of this insider trading strategy we must have that, in equilibrium, given the ex ante optimal choice of K by non-insiders,

$$q_l(P_b-\theta_L) + q_h(P_a-\theta_L) \geq 0. \qquad \textbf{(16)}$$

Remark: violation of equation (16) is possible since $P_a<\theta_L$ is feasible.

III. NUMERICAL RESULTS ON INVESTMENTS, PRICES, AND WELFARE.

The complexity of the above set of models, in particular the possibility of "corner solutions" vis-à-vis interim $\{X_{ij}\}$ trades at t=1 over a (possibly proper) *subset* of the parameter space, appears to rule out a fully analytic solution procedure for our programs of finding the equilibrium $\{P_{ij}(K)\}$ functions and the ex ante optimal K^* choices as delineated above. Hence, even for our agents with *additively separable* (over time) *power utilities*, we have to resort to numerical simulations[10] -- of equations of the type embodied in the Proposition above -- in order to compare equilibrium outcomes across alternative informational "regimes". In particular, the scenarios to be compared are those of:

(A) *First Best, or Unconstrained Optimal Outcomes;*

(B) *Uninformative Equilibria*, with no-one having (revised) information about θ at t=1;

(C) *Insider Trading Equilibria*, with trading by insiders affecting prices, and hence outsiders' information about realised θ.

In Tables I through IV below, we compare the equilibrium outcomes in these different regimes, focusing in particular on the non-insider agents' ex ante optimal liquid asset investment (K) choices, and their equilibrium ex ante expected utilities[11]. We seek to understand under what circumstances one would expect to see one trading regime (no insider) do better than another (insider trading) for ex ante welfare, in order in particular to establish guidelines for desirable regulatory restrictions on insider trading (which is ex-post identifiable and punishable with non-zero probability).

We have done our numerical simulations using the following sets of parameter values:

(i) $\{q,\pi\} = \{½ , ½\}$;

(ii) $\{\alpha_l, \alpha_h\} = \{.1, .15\}$, $\{.9, .95\}$,$\{.48, .53\}$, $\{.45, .55\}$, $\{.4,.6\}$;

[10] The MATHEMATICA programs are available from the authors upon request.

[11] Qi (1996) works with risk-neutral outsider agents, hence his model does not capture the impact of insider trading on risk-sharing among (late- and early-dier) outsider agents that our calibrations do.

(iii) $\{\theta_L\}\in\{.75, .8, .85, .9, .95\}$ with $\{\theta_H\}\in\{1.25, 1.3, 1.35, 1.4, 1.45, 1.5\}$.

For most of our simulations, we have worked with $U(C)=-C^{-2}$, with a relative risk aversion coefficient of 3, though other U(C) were tried as well. We have taken n=1, i.e., an insider with at least equal shareholdings as that of non-insiders. However, it is the equilibrium extent of selling of the long-term risky technology in some states of nature at t=1 by the insider (Q>0) that impact on interim prices, and Q is bounded above by the difference in the aggregate trades among type II (late dier) and type I (early dier) outsiders across the states {l,L} and {h,H}, a difference which the insider "masks" via her trading.

From the comparisons in Table I, we see that (1) the first-best solution (A) always dominates the uninformed only trading (B) and insider trading (C) scenarios in ex ante welfare, (2) that for $\{\alpha_h - \alpha_l\}$ =.05, the outsiders' welfare is higher with insider trading (C) than without in 23 of the 30 cells of the matrix in the $\{\theta_L,\theta_H\}$ space [12], and (3) this outcome arises only in 10 cells when $\{\alpha_h - \alpha_l\}$ =.1 and in only 4 cells if $\{\alpha_h - \alpha_l\}$ =.2. Note also that insider trading is more likely to improve outsiders' welfare when θ_L is high (above .85), and the degree to which it does so is greater when θ_H goes up. However, as the gap $\{\alpha_h - \alpha_l\}$ widens -- allowing the amount of equilibrium insider trading (selling) Q to increase -- insider trading equilibria (C) become more likely worse for outsiders than traded equilibria (B) without such trading.

In Table II, we look at outsiders' ex ante investment (K) choices, across scenarios (A), (B) and (C) – focusing on the case $\{\alpha_l, \alpha_h\}=\{.48, .53\}$. No clear pattern of comparison

[12] When both $[\theta_L, \theta_H]$ are high the individual borrowing (12c) and the aggregate liquidity (13) constraints are violated in state $[\alpha_l, \theta_H]$ in the insider trading case. We therefore compute the solution imposing $P_c = (1-\alpha_l)K/[\alpha_l * (1-K)]$. The resulting equilibrium values are reported in the tables, under the heading (C2). When the aggregate liquidity constraint starts binding in states $[\alpha_l, \theta_H]$ and $[\alpha_l, \theta_H]$ as well, we further impose $P_b = (1-\alpha_h)K/[\alpha_h (1-K)]$ and report solutions under the heading (C3).

emerges, except to note that K(B)>K(C)>K(A) when $\{\theta_L,\theta_H\}$ are low, whereas K(A)>K(B)>K(C) or K(A)>K(C)>K(B) when $\{\theta_L,\theta_H\}$ are high. Hence, there appears to be <u>no</u> discernible pattern of investment choice with insider trading, K(C), being closer to the ex ante optimal choice K(A) than is K(B), the ex ante choice in the interim traded equilibrium without the insider.

In Table III, we look at interim prices -- in the two partitions $\{\alpha_l, \alpha_h\}$ for trading scenario (B) and in the three partitions $\{[(\alpha_l ,\theta_H], [\alpha_l ,\theta_L) \cup (\alpha_l ,\theta_H)], [\alpha_h ,\theta_L]\}$ in scenario (C) -- for different values of $\{\theta_L,\theta_H\}$. Note that in the partition $[\alpha_l ,\theta_H]$ the equilibrium with insider trading (often) has the interim long-term asset price equalling θ_H, which leads to consumption gains for early diers, that are beneficial in terms of the ex ante welfare of outsider agents. For $\theta_L \in \{.8,.85\}$ and θ_H not so high late diers' expected utility falls (slightly) but early-diers' increases by more, leading to an increase in ex ante welfare relative to (B). For both $[\theta_L ,\theta_H]$ large, the aggregate liquidity constraint binds and price is accordingly lower than θ_H in state $[\alpha_l ,\theta_H]$, which increases the return obtained by the late diers on the long-term technology. The rise in ex ante welfare is now associated to an increase in both early and late diers' expected utility.

Finally, in Table IV, we present some welfare comparisons for lower and higher <u>average</u> levels of α, i.e., $\{\alpha_l, \alpha_h\} = \{.1, .15\}$ and $\{.9, .95\}$. In the former case, the insider trading solution (C) is welfare superior to the traded solution (B) without the insider only when $\theta_L \geq .9$, as compared to $\theta_L \geq .8$ when $\{\alpha_l, \alpha_h\} = \{.48, .53\}$ - but the insider chooses not to trade when $\theta_L = .95$ and $\theta_H \geq 1.4$, so that insider trading effectively aids outsiders' welfare in only 9 of the 30 cells. The reasons for this are that (i) with lower α, fewer early-diers gain from the price improvement in the $\{\alpha_l, \theta_H\}$ state brought about by insider trading, and (ii) with high $\{\theta_L, \theta_H\}$ the insider's losses in the state $\{\alpha_h, \theta_L\}$ overwhelm her gains in $\{\alpha_l, \theta_L\}$. With $\{\alpha_l, \alpha_h\} = \{.9, .95\}$, the insider chooses not to trade whenever $\theta_L \geq .9$ and $\theta_H \geq 1.35$, or $\theta_L = .95$, so trading scenario (C) improves outsiders' welfare - as compared to scenario (B) – only in 5 of the 30 $\{\theta_L, \theta_H\}$ cells.[13]

IV. CONCLUDING REMARKS

We have shown, with an intertemporal model of individual as well as aggregate liquidity shocks to uninformed agents, that interim trading by informed insiders can improve outsiders' ex ante welfare, even when aggregate investment choices can not (technologically) respond to any partial information revelation brought about by such insider trading via prices. The rationale behind our finding is the beneficial impact of insider trading on outsiders' selling prices and consumption in some states, which more than compensates for their adverse selection losses in other states of nature. We find these results to be particularly interesting because the impact of insider trading on equilibrium interim real investment choices by a firm, an "alternative channel " for its beneficial effect, is artificial at best -- is it not the same insiders who are supposed to be choosing the firm's investments in the first place [14],with their interim private information?

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[13] We have carried out comparisons analogous to those in Table I for U(C)=log (C), with relative risk-aversion of unity, and $U(C)=-C^{-4}$, with relative risk-aversion of five. When $\{\alpha_l, \alpha_h\} = \{.4, .6\}$, insider trading improves in 3 cells in the former case and in 4 cells in the latter, while the insider does not trade in 8 and 5 cells respectively.

[14] This is assuming the presence of adequate incentive schemes for the insider that are contingent on their firm's realised ex post total return, when the insider is (a manager) tempted by shirking or private benefits.

This beneficial impact of insider trading on outsiders' ex ante welfare, which we have documented, is particularly likely to arise when (1) the insider's (equilibrium) trades are small, relative to outsiders' liquidity-based trades, and (2) the riskiness (lower bound) of return on the investment technology, about which the insider is privately informed at the interim date is also not too high (low). Otherwise, as conventionally thought, insider trading is harmful to the outsiders' (ex ante) welfare.

Table I
Ex Ante Optimal Expected Utilities of Non-Insider

$\alpha_l = 0.48$, $\alpha_h = 0.53$

(A)First Best

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.5	-0.497939	-0.489502	-0.477079	-0.46507
1.3	-0.498621	-0.493293	-0.482096	-0.469815	-0.45792
1.35	-0.495351	-0.487462	-0.475247	-0.463101	-0.451316
1.4	-0.491052	-0.481171	-0.468892	-0.456876	-0.445198
1.45	-0.486223	-0.475106	-0.462978	-0.451089	-0.439513
1.5	-0.481159	-0.469443	-0.457461	-0.445693	-0.434229

(B) Without Insider Trading

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.5	-0.498982	-0.494808	-0.484431	-0.470024
1.3	-0.499319	-0.496688	-0.490697	-0.478592	-0.464251
1.35	-0.497705	-0.493809	-0.486493	-0.473364	-0.459077
1.4	-0.495582	-0.490697	-0.482415	-0.468667	-0.454418
1.45	-0.493197	-0.487538	-0.478552	-0.464429	-0.450206
1.5	-0.490697	-0.484431	-0.474934	-0.460591	-0.446384

(C1)With Insider Submitting Market Orders

In the shaded area it does not pay the insider to trade. In the shaded area the aggregate liquidity constraint binds in state lH. Equilibrium values for these areas coincide with those in (C2) or (C3) below and are marked with *. Cells are marked with when (C)>(B).

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.499945	-0.499217	-0.494371	**-0.481685**	**-0.467365**
1.3	-0.499554	-0.496632	-0.489255	**-0.474859**	**-0.460698**
1.35	-0.497814	-0.493145	-0.483884	**-0.468648**	**-0.454602**
1.4	-0.495311	-0.489255	-0.478584	**-0.462965**	**-0.449379**
1.45	-0.492389	-0.485228	**-0.473497**	**-0.457738**	**-0.44432**
1.5	-0.489255	-0.481213	**-0.468683**	**-0.45291**	**-0.439639**

(C2) and Liquidity Constraint Imposed in State lH
In the shaded area the aggregate liquidity constraint binds in states lL and hH.

θ_H / θ_L	**0.85**	**0.9**	**0.95**
1.25		**-0.481943**	**-0.468649**
1.3		**-0.475446**	**-0.462724**
1.35		**-0.469637**	**-0.457438**
1.4		**-0.464409**	**-0.452692**
1.45	-0.473491*	**-0.459675**	**-0.448406**
1.5	-0.468716*	**-0.455368**	**-0.444516**

(C3) and Liq. Constraint Imposed in lH, lL and hH.

θ_H / θ_L	**0.9**	**0.95**
1.25	**-0.48182***	**-0.46739***
1.3	**-0.47523***	**-0.46094***
1.35	**-0.46933***	**-0.45517***
1.4	**-0.46403***	**-0.44999***
1.45	**-0.45926***	**-0.44533***
1.5	**-0.45494***	**-0.44112***

<u>Table I (continues)</u> **Ex Ante Optimal Expected Utilities of Non-Insider**

$\alpha_l = 0.45$, $\alpha_h = 0.55$

<u>(A) First Best</u>

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.5	-0.497939	-0.489559	-0.477782	-0.46636
1.3	-0.498621	-0.493293	-0.48241	-0.470768	-0.459455
1.35	-0.495351	-0.487462	-0.47579	-0.464277	-0.45307
1.4	-0.491052	-0.481248	-0.469641	-0.458252	-0.447146
1.45	-0.486223	-0.475378	-0.463912	-0.452643	-0.441635
1.5	-0.481159	-0.469891	-0.458562	-0.447407	-0.436494

<u>(B) Without Insider Trading</u>

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.5	-0.49898	-0.494794	-0.484391	-0.470851*
1.3	-0.499317	-0.49668	-0.49067	-0.478643	-0.465204*
1.35	-0.497699	-0.493792	-0.486453	-0.473484	-0.460122*
1.4	-0.49557	-0.49067	-0.482359	-0.46883	-0.455527*
1.45	-0.493179	-0.487501	-0.478481	-0.464613	-0.451353*
1.5	-0.49067	-0.484383	-0.474847	-0.46078	-0.44755*

<u>(C) With Insider Submitting Market Orders</u>

In the area it does not pay the insider to trade. In the area the aggregate liquidity constraint binds in state lH. Equilibrium values for these areas coincide with those in (B) above or in (C3)below, and are marked with *.Cells are marked with when (C)>(B).

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.499772	-0.499713	-0.495645	-0.483396	**-0.468507**
1.3	-0.499931	-0.497637	-0.490946	-0.476624	**-0.461967**
1.35	-0.498632	-0.494538	-0.485874	-0.470464	**-0.455985**
1.4	-0.496483	-0.490946	-0.480794	-0.464829	**-0.450661**
1.45	-0.493847	-0.487153	-0.475874	**-0.459651**	**-0.445666**
1.5	-0.490946	-0.483322	-0.471186	**-0.454872**	**-0.441046**

<u>(C3) and Liquidity Constraints imposed in states lH, hH and lL.[15]</u>

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25					**-0.469328**
1.3					**-0.462382**
1.35					**-0.456155**
1.4					**-0.45055**
1.45				-0.45967*	**-0.445488**
1.5				-0.45499*	**-0.440899**

[15] When the liquidity constraint is imposed in state lH only, it is violated in the other states.

Table I(continues)

Ex Ante Optimal Expected Utilities of Non-Insider

$\alpha_l = 0.4$, $\alpha_h = 0.6$

(A) First Best

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.5	-0.497939	-0.489866	-0.479649	-0.469658
1.3	-0.498621	-0.493293	-0.483381	-0.473281	-0.463389
1.35	-0.495351	-0.487486	-0.477357	-0.46737	-0.457571
1.4	-0.491052	-0.481749	-0.471746	-0.461866	-0.452155
1.45	-0.486223	-0.476387	-0.466504	-0.456726	-0.447101
1.5	-0.481178	-0.471363	-0.461595	-0.451915	-0.442372

(B) Without Insider Trading

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.5	-0.49901	-0.494948	-0.485	-0.473394*
1.3	-0.499338	-0.496779	-0.490943	-0.479651	-0.468185*
1.35	-0.497768	-0.493976	-0.48684	-0.474815	-0.463463*
1.4	-0.495702	-0.490943	-0.482853	-0.47042	-0.45916*
1.45	-0.49338	-0.48786	-0.479068	-0.466407	-0.455219*
1.5	-0.490943	-0.484825	-0.475517	-0.462728	-0.451597*

(C) With Insider Submitting Market Orders

In the shaded area ▨ it does not pay the insider to trade. Equilibrium values for this area coincide with those in (B) above, and are marked with *. The aggregate liquidity constraint never binds in state lH.
Cells are marked with ▭ when (C)>(B).

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.499007	-0.500455	-0.498212	-0.487293	**-0.471477**
1.3	-0.500398	-0.499562	-0.494519	-0.480712	**-0.465296**
1.35	-0.500118	-0.497387	-0.490182	-0.474719	**-0.459634**
1.4	-0.498806	-0.494519	-0.485649	-0.469237	**-0.454139**
1.45	-0.496856	-0.491297	-0.481145	-0.464201	**-0.449322**
1.5	-0.494519	-0.487923	-0.47678	-0.459555	**-0.444871**

Table II

Ex Ante Investment Choices

α_l = 0.48, α_h = 0.53

(A) First Best

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	1.	0.8341	0.5842	0.5712	0.5592
1.3	0.8892	0.7264	0.5885	0.5751	0.5628
1.35	0.8115	0.653	0.5927	0.5789	0.5662
1.4	0.755	0.6113	0.5967	0.5826	0.5696
1.45	0.713	0.6155	0.6005	0.5862	0.5728
1.5	0.6811	0.6194	0.6042	0.5896	0.5783

(B) Without Insider Trading

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	1.	0.9181	0.7857	0.5425	0.5193
1.3	0.9453	0.8649	0.7375	0.5283	0.5177
1.35	0.9069	0.8286	0.7063	0.5273	0.5164
1.4	0.879	0.8031	0.6857	0.5267	0.5156
1.45	0.8583	0.7847	0.672	0.5262	0.515
1.5	0.8425	0.7712	0.663	0.5259	0.5146

(C1) With Insider Submitting Market Orders

In the shaded area it does not pay the insider to trade. In the shaded area the aggregate liquidity constraint binds in state lH. Equilibrium values for these areas coincide with those in (C2) or (C3) below, and are marked with *. Cells are marked with when (C)>(B).

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	1.011	0.9056	0.7336	**0.5228**	**0.5153**
1.3	0.9388	0.8348	0.6666	**0.5198**	**0.5133**
1.35	0.888	0.7856	0.6217	**0.5173**	**0.5116**
1.4	0.8505	0.7499	0.5906	**0.5151**	**0.5062**
1.45	0.822	0.7235	**0.5688**	**0.5132**	**0.5042**
1.5	0.8	0.7036	**0.5533**	**0.5115**	**0.5026**

(C2) and Liquidity Constraint Imposed in State lH

In the shaded area the aggregate liquidity constraint binds in states lL and hH.

θ_H / θ_L	**0.85**	**0.9**	**0.95**
1.25		**0.5217**	**0.4782**
1.3		**0.5208**	**0.4759**
1.35		**0.5206**	**0.4743**
1.4		**0.5207**	**0.4733**
1.45	0.5715*	**0.5213**	**0.4728**
1.5	0.5736*	**0.5222**	**0.4727**

(C3) and Liq. Constraint Imposed in lH, lL and hH.

θ_H / θ_L	**0.9**	**0.95**
1.25	**0.5265***	**0.5205***
1.3	**0.527***	**0.5209***
1.35	**0.5275***	**0.5212***
1.4	**0.5279***	**0.5216***
1.45	**0.5283***	**0.5219***
1.5	**0.5287***	**0.5222***

Table III

Interim Equilibrium Prices

α_l = 0.48, α_h = 0.53

(B) Without Insider Trading

Equilibrium price when $\alpha_i = 0.48$.

$\varepsilon\theta_H / \theta_L$	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	1.	1.001	1.002	1.003	1.044
1.3	1.001	1.002	1.003	1.007	1.051
1.35	1.002	1.003	1.004	1.011	1.057
1.4	1.004	1.004	1.005	1.014	1.061
1.45	1.005	1.005	1.006	1.015	1.064
1.5	1.006	1.006	1.006	1.017	1.065

Equilibrium price when $\alpha_i = 0.53$.

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	1.	0.9988	0.9976	0.997	0.9579
1.3	0.9987	0.9976	0.9967	0.9933	0.9517
1.35	0.9976	0.9965	0.9958	0.9894	0.9471
1.4	0.9964	0.9956	0.9951	0.9867	0.9438
1.45	0.9954	0.9947	0.9944	0.9849	0.9415
1.5	0.9944	0.9939	0.9939	0.9839	0.94

Table III

Interim Equilibrium Prices

In the shaded area ▨ it does not pay the insider to trade. In the shaded area ▧ the aggregate liquidity constraint binds in state lH. Equilibrium values for these areas coincide with those in (C2/C3) on the right , and are marked with *. Cells are marked with ▭ when (C)>(B).

(C1) With Insider Submitting Market Orders — (C2/C3) and Liq. Constraints Imposed

Price when $\alpha_i = 0.48$ and $\theta_j = \theta_H$

θ_H / θ_L	0.75	0.8	0.85	0.9	0.95
1.25	1.25	1.25	1.25	1.25	1.25
1.3	1.3	1.3	1.3	1.3	1.3
1.35	1.35	1.35	1.35	1.35	1.35
1.4	1.4	1.4	1.4	1.4	1.4
1.45	1.45	1.45	1.45	1.45	1.45
1.5	1.5	1.5	1.5	1.5	1.5

θ_H / θ_L	0.85	0.9	0.95
1.25		1.205*	1.176*
1.3		1.207*	1.178*
1.35		1.209*	1.179*
1.4		1.211*	1.181*
1.45	1.445*	1.213*	1.182*
1.5	1.457*	1.215*	1.184*

Price when $\alpha_i = 0.53$ and $\theta_j = \theta_L$

θ_H / θ_L	0.75	0.8	0.85	0.9	0.95
1.25	0.75	0.8	0.85	0.9	0.9426
1.3	0.75	0.8	0.85	0.9	0.9352
1.35	0.75	0.8	0.85	0.9	0.9288
1.4	0.75	0.8	0.85	0.9	0.95
1.45	0.75	0.8	0.85	0.9	0.95
1.5	0.75	0.8	0.85	0.9	0.95

θ_H / θ_L	0.85	0.9	0.95
1.25		0.9*	0.95*
1.3		0.9*	0.95*
1.35		0.9*	0.95*
1.4		0.9*	0.95*
1.45	0.85*	0.9*	0.95*
1.5	0.85*	0.9*	0.95*

Price when $\alpha_i = 0.48$ and $\theta_j = \theta_L$ and when $\alpha_i = 0.53$ and $\theta_j = \theta_L$

θ_H / θ_L	0.75	0.8	0.85	0.9	0.95
1.25	1.00	0.995	0.9862	0.971	0.943
1.3	0.99	0.987	0.9792	0.960	0.935
1.35	0.99	0.979	0.9731	0.950	0.929
1.4	0.987	0.972	0.9679	0.942	0.91
1.45	0.97	0.966	0.9633	0.935	0.902
1.5	0.96	0.961	0.9593	0.929	0.896

θ_H / θ_L	0.85	0.9	0.95
1.25		0.9861*	0.963*
1.3		0.9881*	0.964*
1.35		0.99*	0.965*
1.4		0.9917*	0.967*
1.45	0.9639*	0.9933*	0.968*
1.5	0.9641*	0.9948*	0.97*

Table IV

Ex Ante Optimal Expected Utilities of Non-Insider

In the shaded area it does not pay the insider to trade., and equilibrium values are identified with *. Cells are marked with a box when (C)>(B).

α_l = 0.1, α_h = 0.15 (B) Without Insider Trading

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.5	-0.498198	-0.490806	-0.472434	-0.445991
1.3	-0.498794	-0.494136	-0.483527	-0.462049	-0.435614
1.35	-0.495935	-0.489038	-0.476085	-0.452728	-0.426346
1.4	-0.492177	-0.483527	-0.468866	-0.444369	-0.41803*
1.45	-0.487955	-0.477935	-0.462028	-0.436843	-0.410539*
1.5	-0.483527	-0.472434	-0.455625	-0.43004	-0.403765*

(C) With Insider Submitting Market Orders

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.499967	-0.498549	-0.491278	-0.472414	-0.445112
1.3	-0.499094	-0.494612	-0.483866	-0.461618	-0.434383
1.35	-0.496384	-0.489489	-0.476197	-0.451917	-0.424767
1.4	-0.492657	-0.483866	-0.468707	-0.443192	**-0.416111**
1.45	-0.488389	-0.478109	-0.46158	-0.435314	**-0.40829**
1.5	-0.483866	-0.472414	-0.454885	-0.428173	**-0.401198**

α_l = 0.9, α_h = 0.95 (B) Without Insider Trading

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.5	-0.499862	-0.499297	-0.497967	-0.496592*
1.3	-0.499908	-0.499552	-0.498736	-0.497263	-0.495917*
1.35	-0.49969	-0.499161	-0.498159	-0.496621*	-0.495298*
1.4	-0.499402	-0.498736	-0.497595	-0.49603*	-0.494727*
1.45	-0.499078	-0.498303	-0.497057	-0.495484*	-0.494195*
1.5	-0.498736	-0.497874	-0.496548	-0.494978*	-0.4937*

(B) With Insider Submitting Market Orders

θ_H / θ_L	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
1.25	-0.499902	-0.500511	-0.500359	-0.498027	**-0.495894**
1.3	-0.500445	-0.500543	-0.499501	-0.49692	**-0.49492**
1.35	-0.500582	-0.500222	-0.498361	**-0.495917**	**-0.494005**
1.4	-0.500448	-0.499676	-0.497295	**-0.494994**	**-0.493142**
1.45	-0.500128	-0.498977	-0.496294	**-0.494119**	**-0.492324**
1.5	-0.499676	-0.498015	-0.495349	**-0.493285**	**-0.491386**

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