

Hidden Liquidity: Some new light on dark trading

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Motivation: Transparency

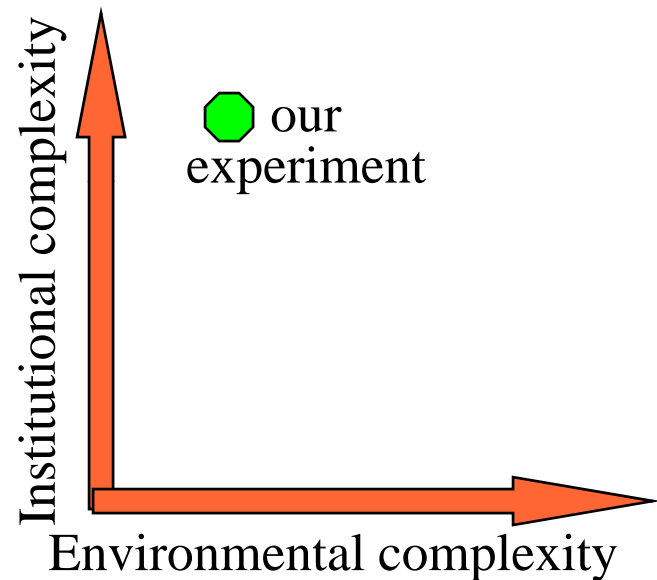
- ◆ Most equity markets around the world are organized as electronic limit order books.
- ◆ Over the past decade, many of them introduced rules that allow traders to hide some shares in the book.
 - Market participants do not observe the shares.
 - Non-displayed shares lose time priority to displayed shares.
- ◆ Advocates: Non-displayed orders enhance liquidity by protecting limit order traders from predation of opportunistic traders.
- ◆ Critics: Non-displayed shares create uncertainty about the state of liquidity in the market and harm the informational efficiency of prices.

Motivation – cont.

- ◆ We investigate three market structures:
 - Visible markets (all shares must be displayed).
 - Iceberg (or reserve) markets (a minimum number of shares must be displayed in each order).
 - Hidden markets (orders may be completely non-displayed).
- ◆ Closest theory:
 - Buti and Rindi (2008): only uninformed traders. Opacity leads to same or wider spread, but could also result in greater depth.
 - Moinas (2010): Informed traders can only supply liquidity, not demand it. Opacity leads to improved liquidity and welfare.
 - Our experiment features differentially informed traders who can pursue a wide range of strategies in a realistic market structure.
- ◆ Does the ability to hide liquidity affect trader behavior (and how)?
- ◆ Is market performance degraded when liquidity can be hidden?

Experiments versus Theory

- ◆ Theoretical modeling usually limits the complexity of the economic environment in order to allow solving the model.
- ◆ Imagine a two dimensional space:
 - Institutional complexity:
 - » e.g., trading mechanism.
 - Environmental complexity:
 - » e.g., state space of uncertainty.
- ◆ One advantage that experiments have over theory is that we do not need to use simplified preferences and action sets.
- ◆ Example: No satisfactory theory of trading in a double auction (e.g., electronic limit order book) with frictions exists. The double auction is the primary institution used for trading financial securities. Experiments can be useful in investigating the behavior of individuals in this complex setting.

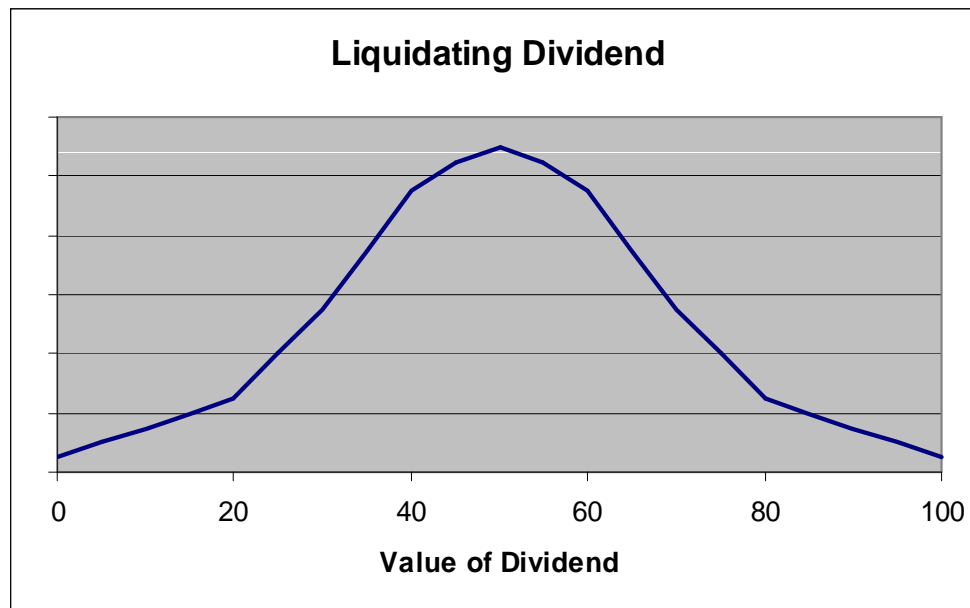


Experimental Subjects

- ◆ Carefully designing incentive schemes to motivate subjects.
 - e.g., in asset market experiments subjects are paid according to their trading profits.
 - Are sums of money used in experiments sufficient to motivate subjects?
- ◆ Students versus professionals.
 - While for some questions experiment with professionals are better, for many other questions using students is preferable.
 - Literature about differences between experts and novices: experts act according to “if-then” statements learned from experience.
 - Experimentalists are interested in subjects reacting to the environment they design, not to perceived similarities with other environments.

Experimental Design: Securities

- ◆ A security is a claim on a terminal dividend that is drawn from a bell-shaped distribution.



- ◆ Trading in each security lasts 180 seconds.
- ◆ Traders in a each session trade 24 different securities.

Experimental Design: Traders

- ◆ There are eight traders in each session:
 - Four informed traders.
 - Four liquidity traders.
- ◆ Two informed traders observe the sum of the true liquidating dividend plus a predetermined random number, while the other two observe the sum of the true liquidating dividend minus the same predetermined random number.
- ◆ This information structure was chosen because:
 - Each informed trader has imperfect information about the security's value (hence trading entails risk).
 - Informed traders in aggregate have full information (rational expectations equilibrium price would be equal to the true liquidating dividend).

Experimental Design: Traders – cont.

- ◆ Liquidity traders are assigned trading targets (in terms of shares) that they must achieve before the end of trading.
 - Two traders have a target of 30 shares each in one direction.
 - Two traders have a target of 40 shares each in the other direction.
- ◆ \$100 penalty is imposed for each unfulfilled share in a target.
 - Use of trading targets is meant to capture the notion that liquidity traders are transacting for exogenous reasons unrelated to information.
- ◆ Each trader alternated playing the roles of informed and liquidity traders.
 - Enables them to think about the strategic interaction from both perspectives.

Experimental Design: Manipulations

- ◆ Primary manipulation: Opacity regime (Visible, Iceberg, or Hidden markets).
- ◆ Within-Subjects design: each trader experiences every setting (to reduce error variance due to individual differences).

Experimental Design: The Market

Buy				Sell			
Price	All Disp	Your Disp	Your NDisp	Price	All Disp	Your Disp	Your NDisp
25	1	0	0	26	1	1	50
24	1	0	0	27	1	1	98
13	45	0	0	33	5	0	0
12	98	0	0	34	10	0	0
10	1	0	0	45	99	0	0
				50	10	0	0

Market	Price	N Disp	N NonDisp	OrderId
Iceberg	27	-1	-98	10000100
Iceberg	26	-1	-50	10000300

Market	Last Price	Volume	Bid	Ask
Iceberg	25	31	25	26

CURRENTLY TRADING SEC # 10		
YOUR ROLE: INFORMED TRADER		
Min Dividend	7	
Max Dividend	27	
Signal Range	[-10,10]	
	BUYS	SELLS
My # Shares	0	31
MY Ave Price	na	25
Cash Holdings	775	(\$)
Share Holdings	-31	Shares

Market Structure

You are currently trading in the **ICEBERG** market. You can submit orders with both displayed and nondisplayed shares. However, each order must have at least one displayed share.

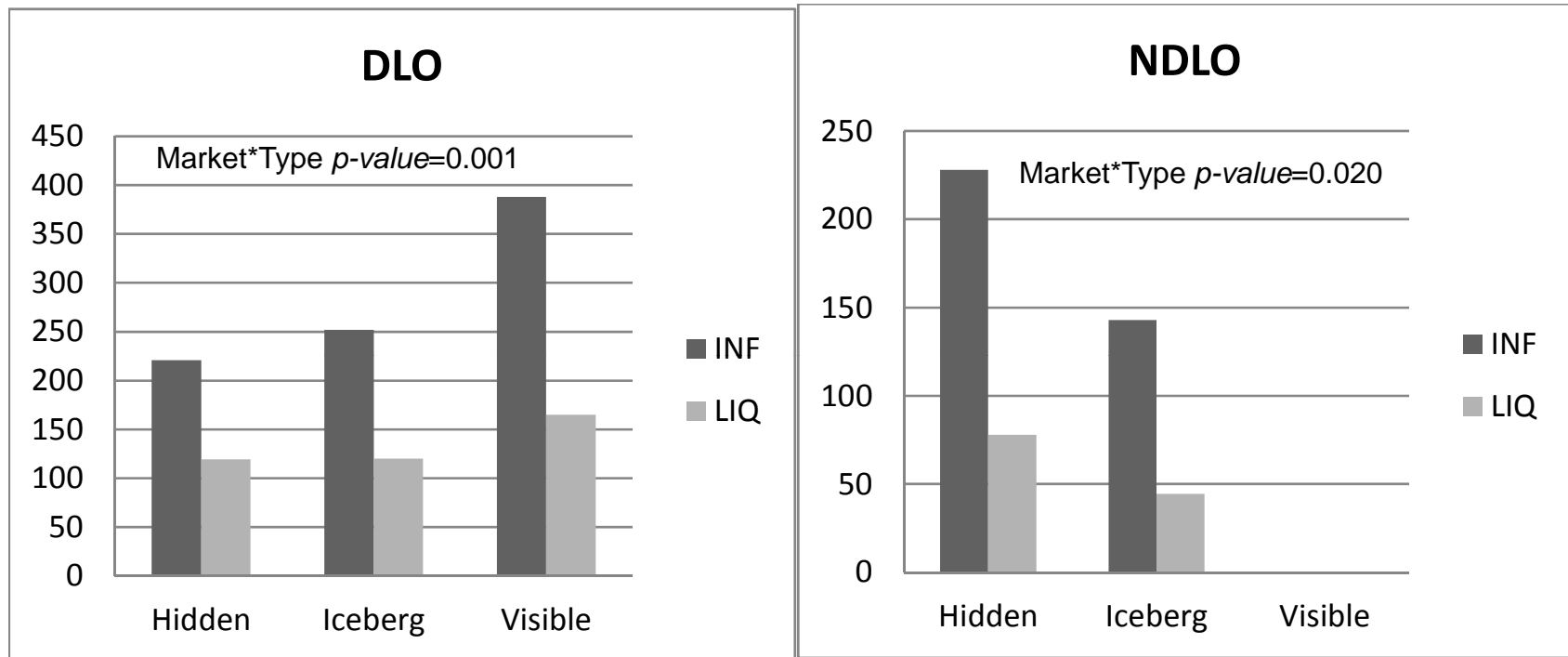
Time Remaining:

9

seconds

You sold @ 25

Limit Orders



- DLO (NDLO) are shares in displayed (non-displayed) limit orders.
- ◆ Both trader types submit non-displayed shares.
- ◆ The informed traders' submission patterns are more sensitive to changes in the transparency of the market.
 - Total number of shares in limit orders is similar across opacity regimes.

Submission Rates

Type	Market	DSR	NDSR	SR
INF	Hidden	0.455	0.427	0.882
INF	Iceberg	0.544	0.340	0.884
INF	Visible	0.848	0.000	0.848
LIQ	Hidden	0.480	0.319	0.799
LIQ	Iceberg	0.577	0.237	0.814
LIQ	Visible	0.810	0.000	0.810

DSR
Market *p-value*<0.0001
NDSR
3-Mkt Market *p-value*<0.0001
2-Mkt Market *p-value*=0.021
2-Mkt Type *p-value*=0.001
SR
Type *p-value*=0.003

- SR=number of shares in limit orders divided by the total number of shares submitted (in both limit and marketable orders).
- SR=DSR+NDSR (displayed vs. non-displayed components).
- ◆ Submission rates are similar across the opacity regimes.
- ◆ Hiding trading intentions when supplying liquidity appears to be more attractive to the informed traders than it is to the liquidity traders.

Taking Rates

- ◆ Limit Order Book: There is a tradeoff between aggressively pursuing a trade by opting for an immediate execution at a worse price or waiting for the execution of a limit order at a better price.

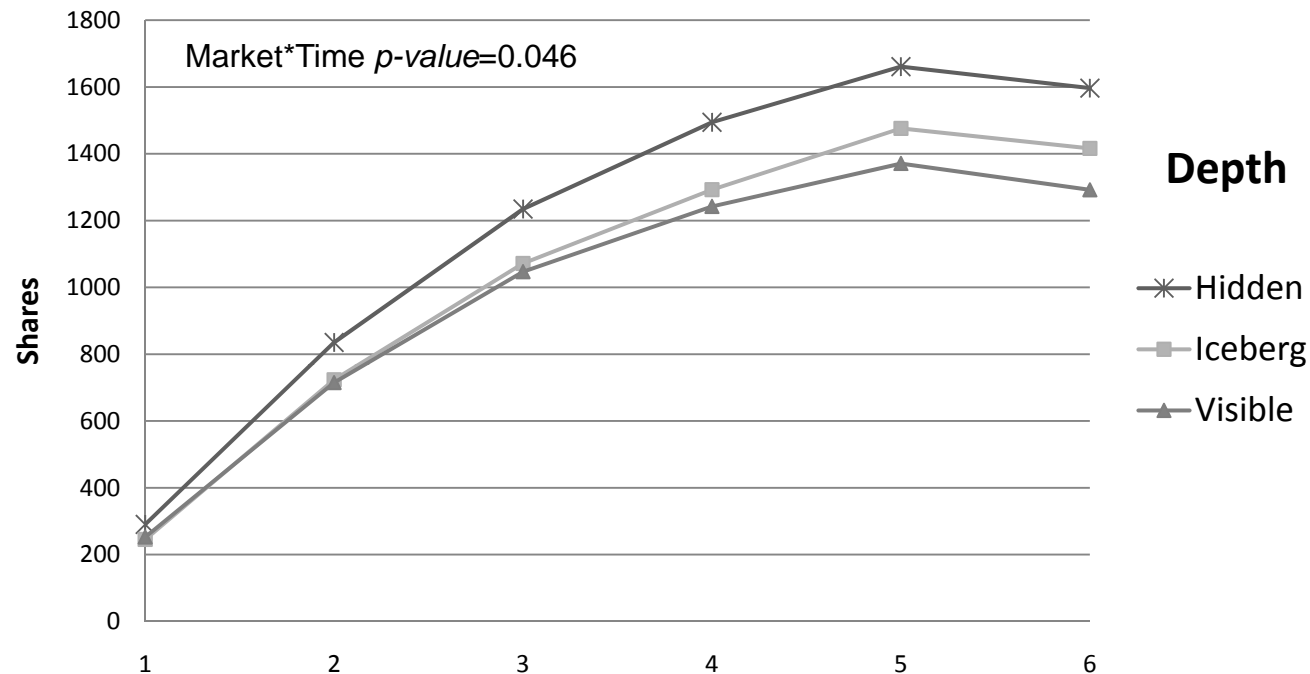
Type	Market	TR
INF	Hidden	0.434
INF	Iceberg	0.478
INF	Visible	0.496
LIQ	Hidden	0.571
LIQ	Iceberg	0.518
LIQ	Visible	0.505

Market*Type
p-value=
0.041

- TR=number of shares a trader executes using marketable orders divided by the total number of shares he or she trades.

- ◆ When their informational advantage can be maintained for a longer period of time because the market is more opaque, informed traders are less aggressive.
- ◆ As transparency increases, liquidity traders get more confident in their ability to “read” the market and they become less aggressive.

Liquidity: Depth

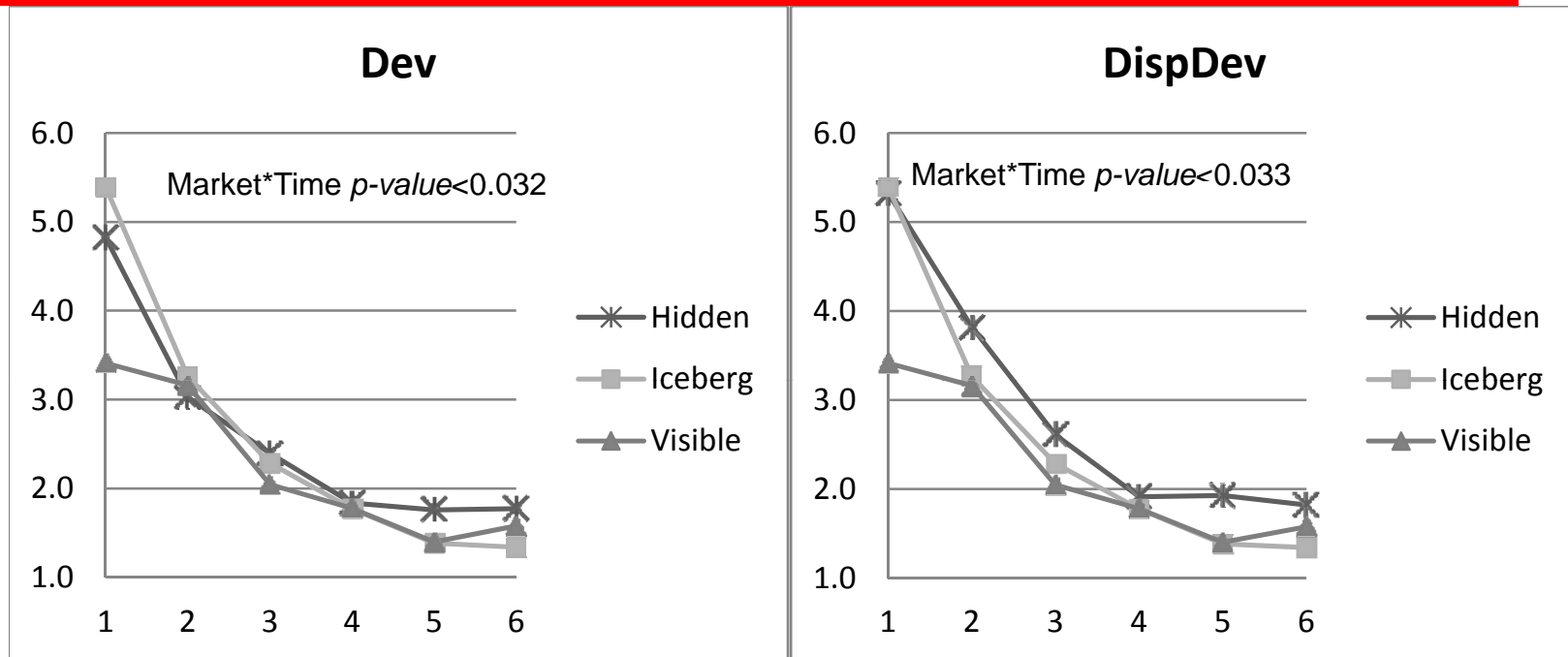


- Evolution of book depth over time (all orders up to 20 price levels from the best bid and ask prices; 6 time intervals).
- ◆ Total depth is higher in markets that allow the submission of non-displayed orders.
 - ◆ Consistent with Moinas (2010) and Buti and Rindi (2008).

Spreads and Volume

- ◆ “True” time-weighted average spreads are similar across the three opacity regimes (3.7 Hidden, 3.6 Iceberg, 3.5 Visible).
- ◆ Consistent with the finding that the cost of trading (effective and quoted spreads) is similar across the three opacity regimes, the quantity of trading (i.e., volume) is also not statistically different among them.
 - Key: Traders adapt strategies.

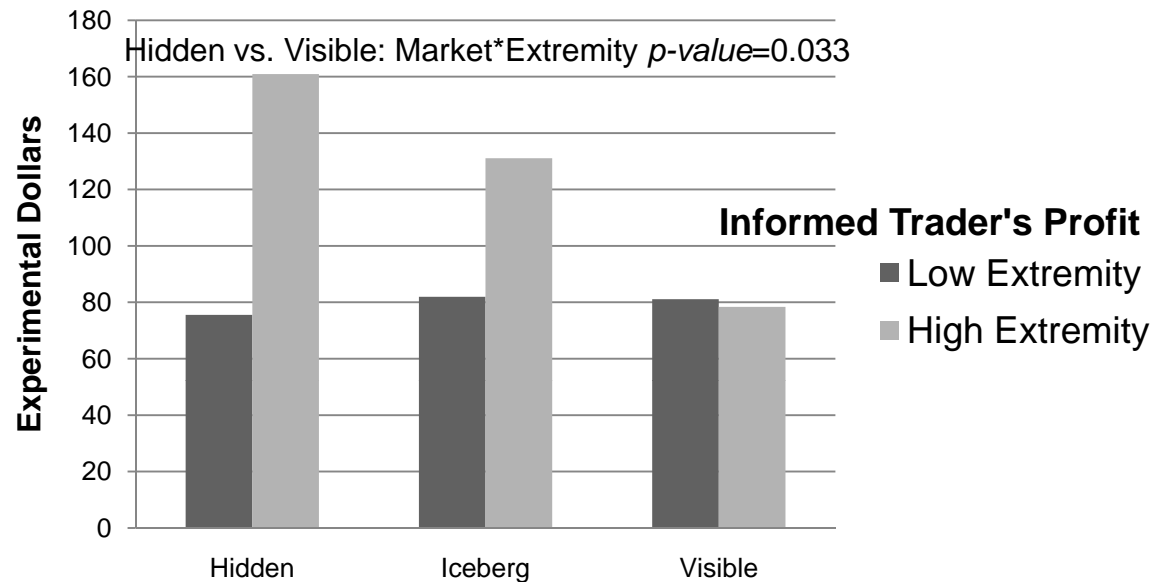
Informational Efficiency



- Dev (DispDev): absolute value of the difference between the liquidating dividend and the “true” (displayed) quote midpoint each time a trade occurs.
- ◆ There is a difference at the beginning (Visible is best), but pricing errors very quickly become similar in the three opacity regimes.

Profits

- ◆ Extremity is a measure of the value of the informed traders' private information.



- ◆ Trading in our markets is a zero-sum game: informed traders profit at the expense of liquidity traders.
- ◆ When the informed trader's advantage is small, market structure has no impact on their profits.
- ◆ A high degree of opacity could be advantageous to the informed traders (and harmful to the liquidity traders) when the extent of adverse selection in the market is high.

Trader Perception

- ◆ How fair was the market? (scale of 1 to 10)
 - Hidden: 3.54; Iceberg: 4.92; Visible: 6.30 (*p-value* < 0.0001)
- ◆ Which market setting did you prefer as an informed trader?
 - 41.7% participants preferred Hidden, 27% Visible, 16.7% Iceberg, 14.6% no preference.
- ◆ Which market setting did you prefer as a liquidity trader?
 - 77.1% participants preferred Visible, 4.2% Hidden, 3.1% Iceberg, 15.6% no preference.
- ◆ These results contrast with Moinas (2010)'s theoretical prediction that the expected utility of the uninformed traders in the more opaque market is greater than in the fully transparent market.

Conclusions

- ◆ Traders value the ability to hide shares and their trading behavior differs across the three opacity regimes.
- ◆ As a result of these optimized strategies, many attributes of the market equilibrium are unchanged across the opacity regimes.
- ◆ Results on profits, perceived fairness, and market preference suggest that while market outcomes are ultimately largely similar, the path to equilibrium in more opaque markets could potentially increase the actual and perceived value of private information at the expense of the liquidity traders.
- ◆ Results in the experiment are somewhat different from predictions of theoretical models in which strategies are restricted.