Information Dissemination on Asset Markets with Endogenous and Exogenous Information: An Experimental Approach*

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Abstract

In this paper we study information revelation on asset markets with endogenous and exogenous information. Our results indicate that superior information can only be exploited in the beginning of trading. Information disseminates on the market and informational advantages are counter-balanced over time. This result holds true for both, exogenous and precise endogenous information. Vague endogenous information, however, has no impact on individual payoff. Furthermore, we find that excessive trading decreases individual earnings.

Keywords: Financial markets; Insider trading; Long-lived assets

JEL-Classification: C90; D40; G14

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1 Introduction

Empirical studies on the hypothesis of market efficiency (Fama, 1970, 1991) have long been of interest to researchers in economics and finance. However, despite the extensive academic literature, the process and the degree of information dissemination are still very much open to debate. Field data usually indicates that private or superior information is exploitable by market insiders (e. g., Jaffe, 1974; Lorie and Niederhoffer, 1968; Niederhoffer and Osborne, 1966; Phillips and Weiner, 1994; Scholes, 1972), violating the assumption of strong-form efficiency[1]. The significant dependencies between points of time and seasonal patterns (e. g., day of the week effects, the January effect or return reversals) question weak-form efficiency.

Experimental evidence on the efficiency of financial markets is mixed. Some studies[2] indicate that financial markets are informationally efficient according to the strong form (see, e. g., Copeland and Friedman, 1992; Friedman et al., 1984; Plott and Sunder, 1982), whereas others indicate that there are considerable pricing inefficiencies which are, at least partially, exploited by market insiders (e. g., Ackert and Church, 1998; Güth et al., 1997; Krahnen et al., 1999; Van Boening et al., 1993).

The efficiency of financial markets is also important from a legal point of view. Of all 103 countries that have stock markets 87 have laws that prohibit insider trading, however only 38 countries have actually enforced the law as evidenced by prosecutions (Bhattacharya and Daouk, 2002). This raises the question whether enforcement is really necessary. If markets were informationally efficient enforcement would become obsolete.

Previous experimental studies on the efficiency of financial markets primarily considered exogenous information, such as dividend distributions or financial statements, thereby neglecting that traders on real-world markets often do not only passively observe exogenous information, but generate themselves information, which may impact the behavior of other traders and thus also market prices and overall efficiency. On financial markets there is a huge amount of financial information available to investors, of which only a fraction is primary information. Most of the information is aggregated and interpreted information, combining different sources and involving a large number of agents, such as financial analysts and investment consultants, i. e. surveys, sentiment indices, and newsletter recommendations.

We contribute to extend literature by analyzing information revelation not only based on privately available exogenous information but also on endogenously generated information, which can be thought of as a (more or less) reliable signal of investor sentiment. We are using a factorial design to explore the interaction of differently informed market

participants within one market. More precisely, participants obtain two different types of information: exogenous and endogenous information. Participants are (i) either fully informed about the exogenous dividend distribution or remain completely uninformed, and (ii) either obtain a precise endogenous signal, a vague endogenous signal, or no endogenous signal about the other market participants' price predictions.

2 The experiment

2.1 Participants

Overall, 72 participants, all undergraduate students either at the University of Vienna or at the Vienna University of Economics and Business Administration, participated in six experimental asset markets. Participants earned on average € 15.25 ($SD = 11.77$). The time required to conduct the experiment was about 2 hours and 15 minutes. Twenty-one females and 51 males, aged 18 to 29 ($M = 21.51$, $SD = 2.33$), participated in the experiment. Fifty-nine participants were students of economics, the remaining 13 participants were enrolled in other social science disciplines.

2.2 Experimental design

In this study we are using the data from an experimental investigation of individual overconfidence conducted by Kirchler and Maciejovsky (2002). In contrast to their analysis we solely focus on information dissemination between heterogeneously informed traders. The experiment is conducted in a 2×3 factorial design. Two independent variables are introduced, (i) the dividend information provided as an exogenous factor (complete information about the dividend distribution, no information), and (ii) the endogenous signal subjects receive about the other market participants' price prediction as an endogenous factor (precise endogenous signal, vague endogenous signal, no endogenous signal). Both independent variables are between-subjects factors.

Participants are randomly assigned to the experimental conditions. (i) Half of the participants receive complete information about the dividend distribution (market insiders), whereas the other market participants get no information (market outsiders). (ii) Participants receive exactly one of three endogenous signals. In the experimental condition precise signal, subjects are informed about the exact average price prediction of all market participants; in the experimental condition vague signal, subjects are informed about current market mood on a seven-step scale ranging from very optimistic market mood to very pessimistic market mood with respect to one's own price prediction; and

in the experimental condition no endogenous signal, subjects are not informed about the predictions of the other market participants at all.

2.3 Experimental procedure

After receiving instructions about the experimental asset market (see Appendix), subjects participated in two trial periods of six minutes in order to become familiar with the selling and buying procedures on the market. After the trial periods, the asset market was opened. Overall, six market sessions were run with 12 participants each on a computerized asset market (z-Tree, Fischbacher (1999)). For a screenshot of the asset market see Figure 1.

[Figure 1 about here.]

Each market participant was entitled (i) to submit bids and asks, (ii) to accept standing bids and asks, whereas only better offers, i. e. higher bids and lower asks, respectively, were allowed, or (iii) to stay passive. Bids and asks were automatically ranked, indicating the most favorable offer. Participants were provided with information about trading history, as a chronological list of contracts, throughout the market periods.

The experiment was performed as a continuous anonymous double auction. Participants were endowed with 250 Experimental Guilders[3] plus five risky assets. Dividends were randomly determined according to p_d (see Table 1), and were paid out at the end of each period, using a common value design. In order to reveal possibly divergent dynamics in price and the intrinsic value of the asset, a monotonously falling expected value of the dividend was stipulated, implying consistently expected falling asset prices across trading periods.

[Table 1 about here.]

Participants were informed that the market would be open for at least 12 periods and at most 15 periods. The probability that the market ends after the 12th, 13th, and 14th period is 33 percent. Participants were also informed that at the end of the final market period the liquidation value of the asset is zero. Thus, the individual payoff y_i is denoted by

$$y_i = e_0 + \sum_{t=1}^{T} a_{t,i} v_t - \sum_{t=1}^{T} c_{t,i} + \sum_{t=1}^{T} r_{t,i} \tag{1}$$

with e_0 as the initial monetary endowment, T as the number of periods, $a_{t,i}$ as the number of person is asset holdings in period t, v_t as the dividend of the assets in period t, $c_{t,i}$ as

the costs of person i due to buying assets in period t and $r_{t,i}$ as person is revenue from selling assets in period t, whereby

$$c_{t,i} = \sum_{j=0}^{b_{t,i}} q_{t,i,j} \quad \text{and} \quad r_{t,i} = \sum_{j=0}^{f_{t,i}} s_{t,i,j} \tag{2}$$

with $q_{t,i,j}$ as person is buying prices in period t and $b_{t,i}$ as his / her number of assets bought in period t. The selling prices of person i in period t are denoted by $s_{t,i,j}$, whereas the number of assets sold by him/her in period t is denoted by $f_{t,i}$.

To ensure comparability between sessions, the last market period was randomly chosen once for all six sessions before the experiment was actually conducted. According to the random selection, it was determined that each session ends after the 13th period. Each period lasted for 180 seconds.

Before the market was opened subjects (i) either received information ($\delta_1 = 1$, $\delta_2 = 0$) about the distribution of dividends in the next market period or received no such information ($\delta_1 = 0$, $\delta_2 = 1$). Subjects (ii) had to predict the next average market price ($p_{t,i}$), and (iii) obtained one of three endogenous signals, a precise ($\delta_3 = 1$) a vague ($\delta_4 = 1$) and no signal ($\delta_3 = 0$, $\delta_4 = 0$).

3 Experimental results

In each of the 13 market periods an average of 44.9 contracts were concluded by the groups of 12 market participants (SD = 15.07, ranging from a minimum of 7 contracts to a maximum of 89 contracts). On average market prices were 79.94 Experimental Guilders (SD = 53.22). In Figure 2 and 3 the average trading prices with respect to exogenous and endogenous signals are displayed.

[Figure 2 about here.]

[Figure 3 about here.]

Interestingly, despite the fact that some participants remained completely uninformed about the exogenous dividend distribution and some additional endogenous signal, they were nevertheless engaged in considerable trading activity.

In the following we analyze (i) how individual traders form their predictions of actual average trading prices in each period, (ii) the change in average trading prices in subsequent periods, and (iii) whether market insiders can exploit their informational advantage.

OBSERVATION 1 *Individual predictions of average market prices are based on weighted updating of available information.*

Evidence for this observation is provided by the results of a panel regression with fixed effects (see Table 2).

[Table 2 about here.]

The predicted average market price is denoted by p_t, whereby t indicates the period. The observed average market price is denoted by m_t, and d_t is the actually observed dividend. Information available to market insiders allows them to derive the expected dividend $E(d_t)$.

Trader's own price expectations and actual average market prices in $t-1$ are significantly positively correlated with market price predictions in t indicating that individuals engage in a weighted updating of predictions conditional on available information, i. e. actual average market prices in $t-1$ and for market insiders expected dividends $E(d_t)$. Former dividends have no significant influence on the formation of market price predictions. Since the asset's true value depends only on the (discounted) sum of future dividends this is what we expect to be true for rational participants. With market outsiders not having information about the expected dividends these cannot have any significant influence on their price predictions as indicated by our regression results.

OBSERVATION 2 *Neither endogenous nor exogenous information improves the accuracy of market price predictions.*

Support for this observation is provided by an ANOVA with accuracy of market price predictions as dependent factor and endogenous (market mood signal) and exogenous information (dividend information) as independent factors. Individual accuracy A_i is measured by

$$A_i = 1 - \sqrt{\frac{1/T \sum_t^T (p_t - m_t)^2}{1/T \sum_t^T p_t^2}} \tag{3}$$

with $A_i \in [0,1]$ and $A_i = 1$ indicating perfect predictions. Despite the missing monetary incentives the average accuracy index of $A = 0.7052$ (SD = 0.1483) indicates a rather high accuracy level of the participants in predicting average market prices. Endogenous and exogenous information are not significantly contributing to the explanation of the variance of prediction accuracy ($F(5;66) = 0.495$, $p = 0.779$). Thus, our results show

that superior private information, both endogenous and exogenous, does not lead to an improvement of prediction accuracy.

OBSERVATION 3 *The change in average trading prices is driven only by time, the change in actual dividends, and the change in precise endogenous information. Exogenous information has no explanatory power.*

Evidence for this observation is provided by Table 3. Vague and precise endogenous information are denoted by $V_{t,i}$ and S_t, respectively. Only lagged changes in dividends (which is due to the experimental design, i. e. monotonously decreasing expected values of the dividends, see Table 1), changes in the precise endogenous signals, and time (which serves as a proxy for a decreasing sum of future dividends) are significantly contributing to the explanation of the changes in average market prices. Neither changes in relative market mood (vague signal) nor changes in exogenous market information (dividends) contribute to the explanation of the change in average trading prices.

[Table 3 about here.]

OBSERVATION 4 *Informational advantages do not lead to a higher total payoff. Thus, information disseminates on the market.*

Evidence for this observation is provided by the results of an ANOVA with total payoff as dependent factor and endogenous and exogenous information as independent factors. Our results neither show a significant main effect for endogenous and exogenous information nor an interaction effect ($F(5; 66) = 1.048$, $p = 0.397$). In addition, the results of a panel regression (see Table 4) with individual profits due to trading as dependent variable and the different information conditions as independent variables indicate that (i) market insiders can exploit their superior information, however, only in the beginning of trading. The informational advantage is counter-balanced over time. The same holds (ii) for traders who obtain precise endogenous information. Conversely, we find no significant influence of obtaining only vague information about the price predictions of other market participants on individual earnings due to trading.

[Table 4 about here.]

OBSERVATION 5 *Excessive trading lowers individual earnings, i. e. individual trading volume is negatively correlated with earnings.*

This observation is supported by Table 4. Our findings indicate that the higher the individual trading volume the lower the earnings on the market. This result corresponds to the findings of Barber and Odean (2000), who analyzed investment behavior of 66,465 households with accounts at a large discount broker in the period from 1991 to 1996. The authors found that high turnover households underperformed the low turnover households.

4 Discussion

In this paper we study information revelation on an experimental asset market with endogenous and exogenous information. Endogenous information is captured by distributing individual price predictions among traders on the market, whereby each trader either obtains a precise, a vague, or no endogenous signal about the price predictions of the other market participants. Exogenous information is captured by providing market insiders with exact information about the dividend distribution.

Our results indicate that individual predictions of average market prices are based on weighted updating of available information. However, neither endogenous nor exogenous information improves the accuracy of market price predictions. The change in average trading prices is driven only by time, the change in actual dividends, and the change in precise endogenous information. Exogenous information has no explanatory power. Further, informational advantages do not lead to a higher total payoff. Superior information can only be exploited in the beginning of trading. Information disseminates on the market and informational advantages are counter-balanced over time. This result holds true for both, exogenous and precise endogenous information. Vague endogenous information, however, has no impact on individual payoff. Last, individual trading volume is negatively correlated with earnings, i. e. excessive trading reduces payoff.

Generally our results support the hypothesis of market efficiency; private information cannot persistently be exploited by traders. Both, endogenous and exogenous information are revealed on the market. More precisely, exogenous dividend information and precise endogenous information do not lead to significantly higher total payoffs.

Appendix: Instructions

Thank you for participating in our experiment. The experiment will last for about 2 hours and 15 minutes. You will trade assets on a market, whereby your payoff depends on your decisions.

In the following the trading mechanism is explained in detail. You will learn how to place buying and selling offers, and how to accept offers by other market participants. After reading the instructions there will be time to ask questions. Afterwards there will be a short test to check whether you understood the trading rules. The experiment will not begin until all participants have correctly answered all questions in the test. Then you will participate on a trial market with two periods: You will have the opportunity to try out the buying and selling procedures without affecting your payoffs. The two trial periods will last for 6 minutes each. After the trial market the real asset market will be opened.

Let us now explain how the asset market works. Generally, there are two possibilities to buy assets and also two possibilities to sell assets.

Let us start with the buying of assets: You can buy assets in 2 ways: You can either (i) submit a bid to the market, or you can (ii) accept a standing ask by another market participant.

(i) If you want to submit a bid, you have to type your maximal buying price in the input box "your bid", and press the button "bid" (ii) If you want to accept a standing ask by another market participant, you have to press the button "buy". Standing asks for the assets are ranked according to prices and are listed in columns. Of course, the best offer for you, and all other potential buyers, is the lowest ask. The lowest ask is listed at the bottom of the column.

Let us now explain the selling of assets: You can sell assets in 2 ways: You can either (i) submit an ask to the market, or you can (ii) accept a standing bid by the other market participants.

(i) If you want to submit an ask, you have to type your minimal selling price in the input box "your ask", and press the button "ask". (ii) If you want to accept a standing bid by another market participant, you have to press the button "sell". Standing bids for the assets are ranked according to prices and are listed in columns. Of course, the best offer for you, and all other potential sellers, is the highest bid. The highest bid is listed at the bottom of the column.

Note that you can engage simultaneously in buying and selling activities. However, you cannot buy more assets than your cash holdings allow, and you cannot sell more assets than you own. If you have submitted a bid to the market, then your available money for further activities is reduced by this amount. On the other hand, if you have placed an ask to the market, then your available asset holdings are reduced by this one offer. That is, we do not grant any credit, nor do we allow for short selling.

Only improving offers, i. e. higher bids and lower asks, are allowed in the market.

During a trading period you can buy assets, sell assets, or be passive. You can engage in all three possibilities at all times. In fact, you can submit buying offers and selling offers, and accept standing offers by other market participants simultaneously.

You are also informed about the remaining trading time, the current period number, and about the previous trades, and their trading prices. All trades are chronologically listed in the column "previous trades".

You will now have the opportunity to try out the buying and selling procedures without affecting your payoffs. The trial market consists of two periods, each lasting for 6 minutes.

[Trial market]

Now the "real" market will be opened. Each trading period lasts for 180 seconds. You will be endowed with 250 Experimental Guilders, whereby 100 Experimental Guilders equal € 0.73, and with five assets. The minimum number of trading periods is 12 and the maximum number of trading periods is 15. The probability that the market ends after the 12th, 13th, and 14th period is 33 percent. At the end of the final market period the liquidation value of the asset is zero. Dividends are randomly determined according to a pre-specified distribution, and are paid out at the end of each period. Note that not all participants necessarily receive the *same* information. It might be that some participants obtain different, i. e. more or less, information.

Notes

1 The efficient market hypothesis has historically been subdivided into three categories, each dealing with a different type of information: Weak form tests investigate whether all information based on historical prices is fully reflected in market prices; semi-strong form tests are tests based on publicly available information; and strong form tests investigate whether all information, public or private, is fully reflected in market prices.

2 For a detailed survey of experimental results see Sunder (1995).

3 One-hundred Experimental Guilders are € 0.73.

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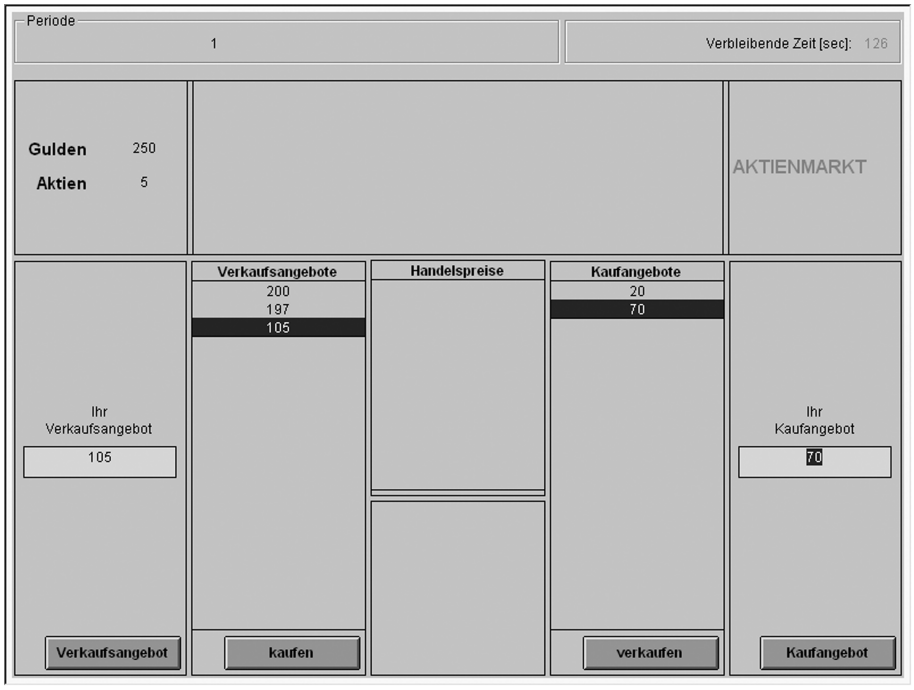
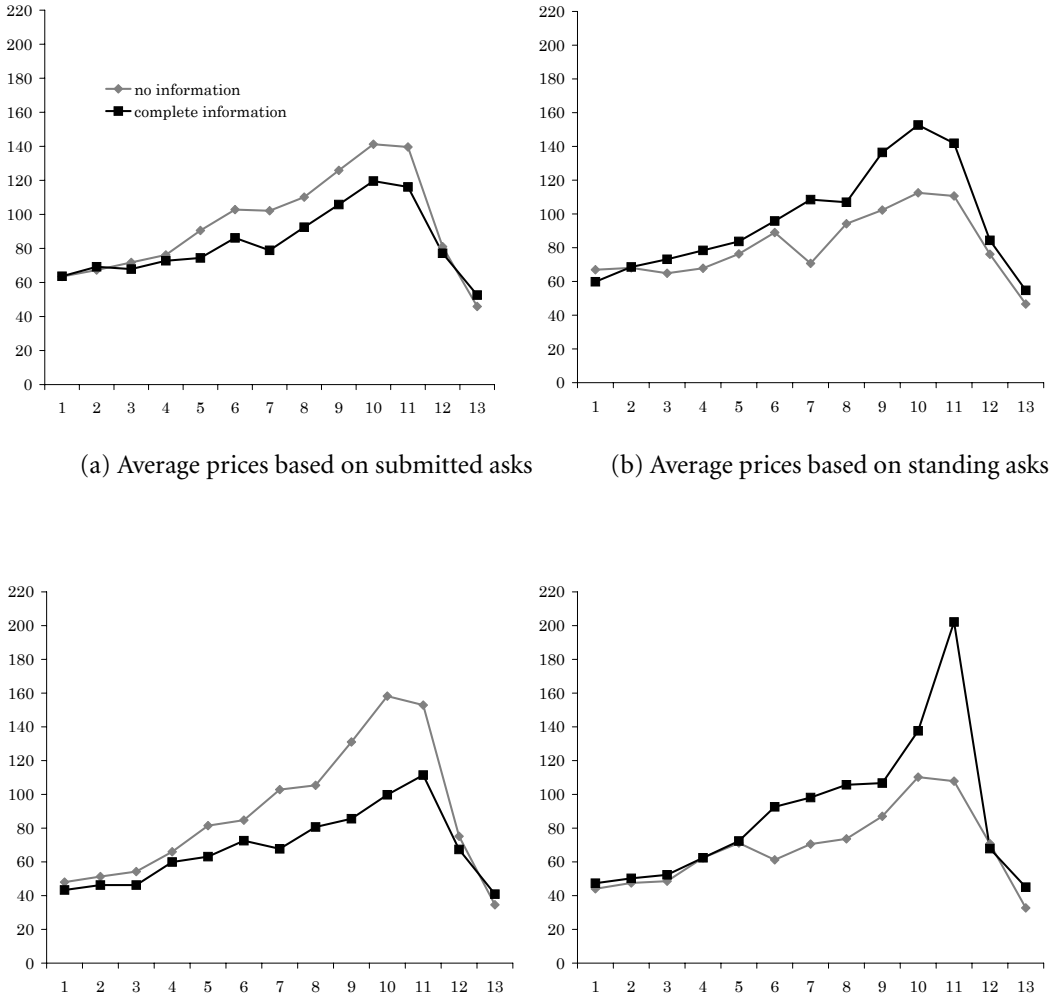


Figure 1: Screenshot of the asset market



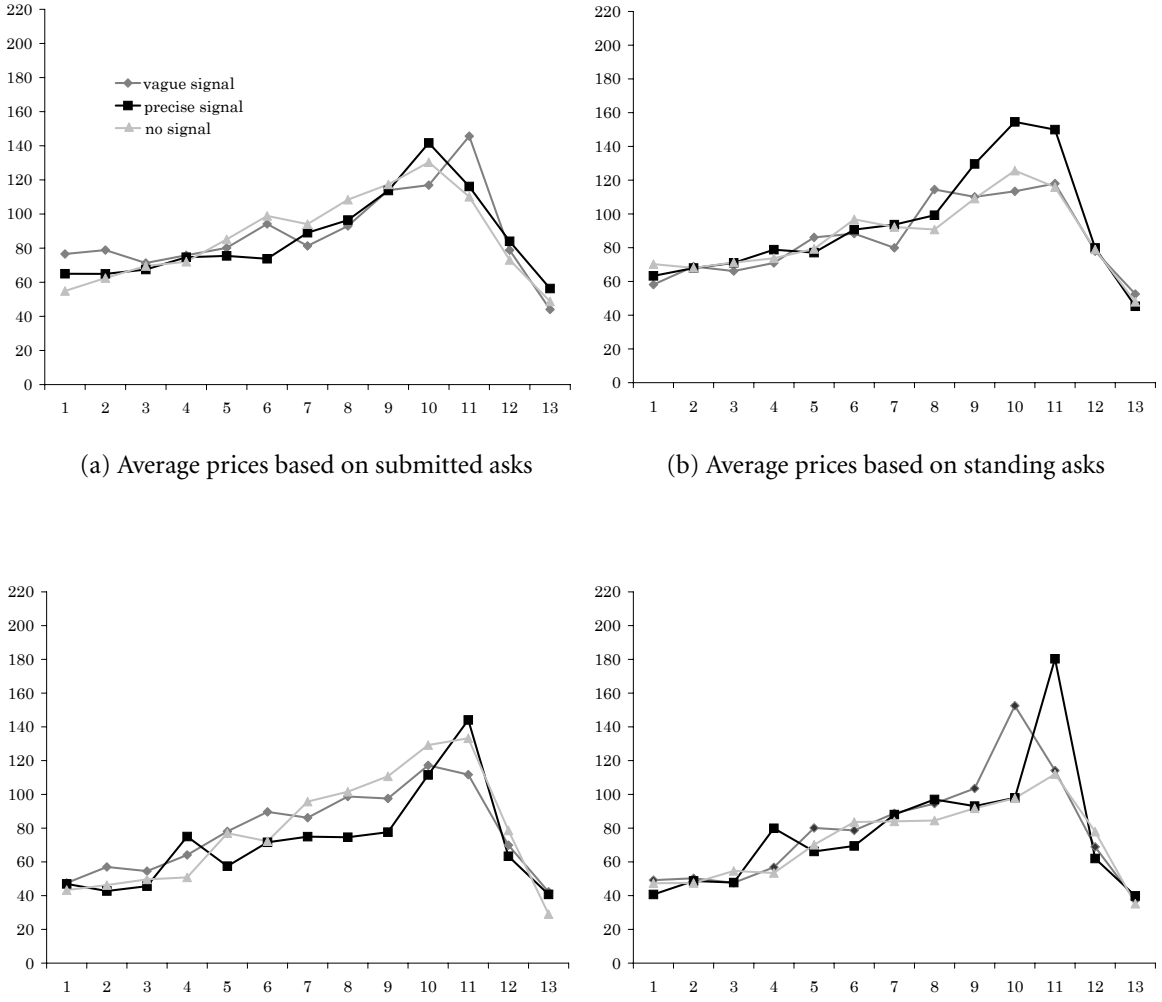
(a) Average prices based on submitted asks

(b) Average prices based on standing asks

(c) Average prices based on submitted bids

(d) Average prices based on standing bids

Figure 2: Average trading prices with respect to the exogenous signal across the 13 trading periods



(a) Average prices based on submitted asks

(b) Average prices based on standing asks

(c) Average prices based on submitted bids

(d) Average prices based on standing bids

Figure 3: Average trading prices with respect to the endogenous signal across the 13 trading periods

Table 1: Dividend payments in Experimental Guilders

Periods	Dividends	Probability p_d	Expected value
1-3	0, 11, 27, 45, 59	.20	28.40
4-6	0, 19, 35, 53	.25	27.75
7-9	0, 13, 21, 33, 49	.20	23.20
10-12	0, 11, 29, 43	.25	20.75
13	0, 7, 19, 27, 39	.20	18.40

Table 2: Panel regression with fixed effects on the prediction of the average market price in period t

Dependent Variable: p_t				
Method: GLS				
White Heteroskedasticity-Consistent Standard Errors and Covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
d_{t-1}	0.006499	0.006381	1.01849	0.3088
p_{t-1}	0.273829	0.029660	9.23225	0.0000
m_{t-1}	0.662130	0.026772	24.73185	0.0000
$E(d_t, \delta_1)$	0.217424	0.086777	2.50555	0.0124
$E(d_t, \delta_2)$	−0.099708	0.086056	−1.15864	0.2470
R^2	0.946109	S.D. dependent var		84.52092
Adjusted R^2	0.940905	S.E. of regression		20.54665
F-statistic	3454.125	Prob(F-statistic)		0.000000

Note: The predicted average market price in period t is denote by p_t, d is the actually observed dividend, m is the average market price, $E(d_t, \delta_i)$ is the expected dividend for insiders (δ_1) and outsiders (δ_2).

Table 3: Panel regression with common effects on the change in average trading prices from period $t-1$ to t

Dependent Variable: Δm_t				
Method: GLS				
White Heteroskedasticity-Consistent Standard Errors and Covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
constant	31.152956	2.722094	11.444	0.0000
t	−4.098647	0.316625	−12.945	0.0000
Δd_{t-1}	0.208166	0.029956	6.949	0.0000
ΔS_t	0.061966	0.014248	4.349	0.0000
ΔV_t	0.028442	0.024541	1.159	0.2465
$\Delta E(d_t)$	−0.378078	0.623233	−0.607	0.5441
R^2	0.22763	S.D. dependent var		30.60984
Adjusted R^2	0.22272	S.E. of regression		26.98663
F-statistic	46.33	Prob(F-statistic)		0.00000

Note: The change in average market prices in period t is denote by Δm_t, Δd is the change in observed dividends, ΔS is the change in precise endogenous information, ΔV is the change in vague endogenous information and $E(d)$ is the expected dividend.

Table 4: Panel regression with common effects on individual profits with respect to endogenous and exogenous information

Dependent Variable: $y_t - a_{t-1}d_t$				
Method: MLE by iterated GLS				
White Heteroskedasticity-Consistent Standard Errors and Covariance				
Variable	Coefficient	Std. Error	b/Std. Error	$P[\mid Z \mid > z]$
constant	34.317895	15.765411	2.177	0.0295
δ_1	104.128041	20.876137	4.988	0.0000
δ_4	4.022581	10.617422	0.379	0.7048
δ_3	69.180837	25.029040	2.764	0.0057
$\Delta a_t d_t$	0.662607	0.069915	9.477	0.0000
# contracts	−2.501762	0.810568	−3.086	0.0020
t	−4.339173	1.678685	−2.585	0.0097
$\delta_1 t$	−9.940478	2.608736	−3.810	0.0001
$\delta_3 t$	−5.990418	3.072935	−1.949	0.0512
R^2	0.858747	Adjusted R^2	0.840810	
Log-likelihood function	-6283.4766			

Note: The individual profits in period t are denoted by y and income from asset holdings is captured by ad, δ_1 is a dummy for insiders, δ_3 is a dummy for precise, and δ_4 a dummy for vague signals. The number of contracts is denoted by # contracts.