# Information Dissemination on Asset Markets with Endogenous and Exogenous Information: An Experimental Approach[a]

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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; Experimental economics

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 (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).

While previous experimental studies on the efficiency of financial markets primarily considered exogenous information, such as dividend distributions or financial statements, 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.

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.

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).

## 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 (forthcoming). In contrast to their analysis we solely focus on information dissemination between heterogeneously informed traders. The experiment is conducted in a $2 \times 3$ 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[3] about the experimental asset market, 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

3 The instructions are available from the authors upon request.

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 |

was opened. Overall, six market sessions were run with 12 participants each on a computerized asset market (z-Tree, Fischbacher (1999)).

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[4] 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.

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 $i$´s 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 $i$´s revenue from selling assets in period $t$, whereby

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

4 One-hundred Experimental Guilders are €0.73.

with $q_{t,i,j}$ as person $i$´s 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). The average market price was 79.94 Experimental Guilders (SD = 53.22).

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).

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

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

| Dependent Variable: $p_t$ | | | | |
|---|---|---|---|---|
| Method: GLS - Cross Section Weights | | | | |
| 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 |

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)

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

Dependent Variable: $\Delta m_t$
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 |
| $\Delta d_{t-1}$ | 0.208166 | 0.029956 | 6.949 | 0.0000 |
| $\Delta S_t$ | 0.061966 | 0.014248 | 4.349 | 0.0000 |
| $\Delta V_t$ | 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 |

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.

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.

Observation 5 Excessive trading harms 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.

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[\| Z \|> z] |
|---|---|---|---|---|
| constant | 34.317895 | 15.765411 | 2.177 | 0.0295 |
| $\delta_1$ | 104.128041 | 20.876137 | 4.988 | 0.0000 |
| $\delta_4$ | 4.022581 | 10.617422 | 0.379 | 0.7048 |
| $\delta_3$ | 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 | | |

## 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 harms 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.

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