Experimental Studies on the Value of Information in Financial Markets with Heterogeneously Informed Agents

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Abstract

Today information is generally considered the most valuable good in modern economies. Especially in financial markets information is often viewed as the only ingredient to achieve above-average returns. However, empirical, theoretical and experimental work shows that the answer is not that simple. At the University of Innsbruck a team of scientist has developed an experimental setting as well as theoretical models and an agent-based simulation to analyse how valuable forecasting ability is in financial markets.

JEL-Classification: C91, D82, D83, G14

Keywords: Value of information, financial markets, trading strategies, experimental economics, heterogeneous agents, asymmetric information

Research question and relevance for real-world problems

"We live in an information society" is one of the most often heard sentences today. Education, knowledge and information are considered the most important ingredients to success in business. While we agree with this notion for most situations, we think it does not hold for financial markets.

For many years Burton Malkiel (2003a, 2003b) has criticised the underperformance of professional investment funds compared to the index: on average about 70 percent of actively managed stock market funds were outperformed by the market over a ten-year period, for bonds the number is even higher at 90 percent.

How can it be, that highly paid and professionally trained specialists are not able to be better than the market? We think that our study can give an answer to this question and advice investors how to improve their results: by processing less information.

Why? Because, if the random walk hypothesis holds (and most scientists agree it does), a trader who does not gather any information but trades randomly in time can expect to earn the market return. There is no reason to assume any systematic over- or underperformance, if she really chooses her shares randomly, e.g. by throwing a dart arrow at a quotations list.

Of course we are aware, that this is a provocative finding, therefore we tried to keep our experiment very close to reality to make it clear to many people, that it is not some kind of 'esoteric' scientific finding, but a problem relevant to real-world investors all over the world.

Our market with heterogeneous agents

In our market several traders with different forecasting abilities have to trade shares of a virtual company. They can also choose to invest in a risk-free bond. The market was conducted as a continuous double-auction over 30 periods. One period in the experiment was equal to one month in real markets, so we adjusted several parameters like the risk-free interest rate, the dividends,… to monthly data. Each trader was provided with 40 shares (each worth $40 at the start of the experiment) and $1.600 in cash at the start of the experiment. Depending on their expectations about the future development of the share price they could then freely sell or buy shares by placing limit orders or accept open bids and asks from other traders.

The most critical part about our market is the information structure: To value the shares agents get information about future dividends. One agent (I1) can only predict this period's dividend correctly. I2 knows the dividends of this and of the next period; I3 knows the actual and the next two dividends, etc. until the ‘insider’ I9 who knows the actual dividend and who is able to predict the next eight dividends. We therefore have heterogeneously informed agents which are to a different degree able to predict future cash flows of a company (which is exactly what most analysts try to do, namely calculating the present value of a company by discounting future cash flows).

We have a multi-period model. This means, that traders got new information during the experiment at the start of each new period. At the end of each period the actual dividend was paid out and disappeared from the screen. In turn time t moved one period forward and the dividend of former t+1 was now the actual dividend, while former t+2 was the new t+1, etc. In this way there were 30 periods of trading in the market.

Example of the movement of dividends in two subsequent periods:[1]

	t	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8
Dividends shown in period X	20	22	26	23	25	22	18	19	21
Dividends shown in period X+1	22	26	23	25	22	18	19	21	24

For the experiment we conducted seven markets with nine traders each. The experiments took place in the computer laboratories at the University of Innsbruck in June and July 2004 with Austrian business students. At the start of the experiment each trader was assigned a different information level which was kept constant for the whole experiment. Each trader knew his own endowment and the general distribution of information levels.

Experimental Results

The main focus of our experiments is the relationship between the information level of the agents and their relative performance in the market. The graph below shows the median (solid line) and average (dotted line) of the relative net returns in our seven experimental sessions (dots).

[1] E.g.: In period X trader with information level I3 knew the dividends of the actual and the next 2 periods, namely 20, 22, 26. In period (X+1) he saw the dividends 22, 26, 23 for this and the following 2 periods, etc.

We see that information does not display the strictly positive effect on returns that is often assumed. Instead we find that traders with information level I5, who are able to predict the actual and four future dividends correctly, do worst in the market.

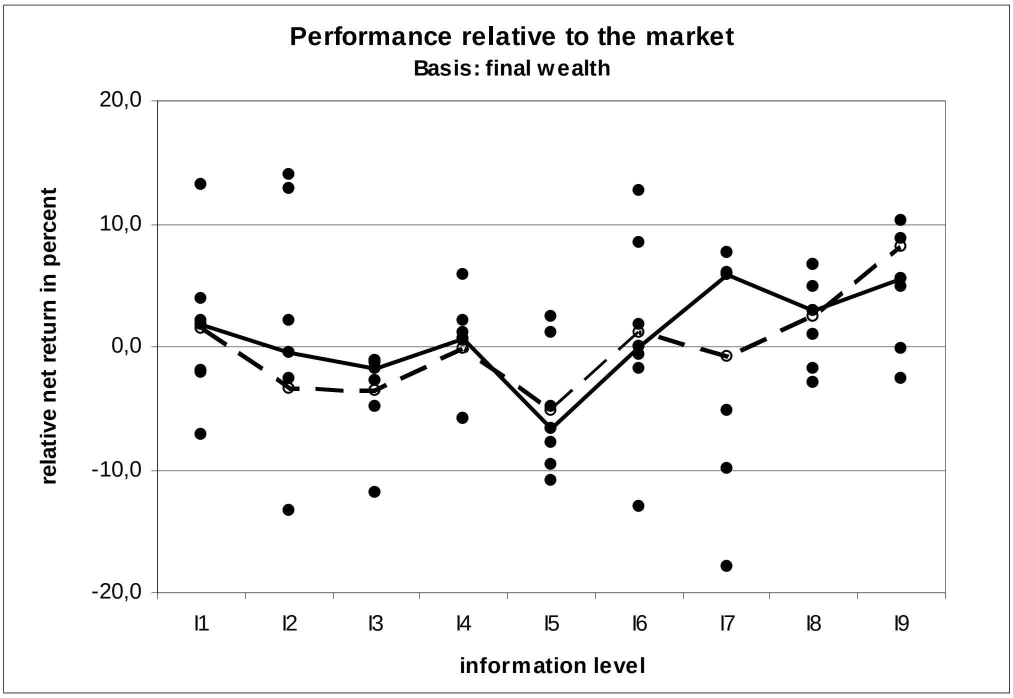


Figure 1: Relative net return in percent per information level

This result is not due to inefficient prices. In our analysis of single subject behaviour we found that fundamental information was processed correctly in about 70% of all transactions. Furthermore we see from the movement of prices (grey line) and dividends (black line), that information was mainly processed and reflected in prices. As traders have forecasting abilities prices lead dividends with a lag of five periods.

For all markets with exception of market 2 the correlation of prices and dividends [lag=5] is significant at a 1% level (Spearman-Rho: $p<0.01$).

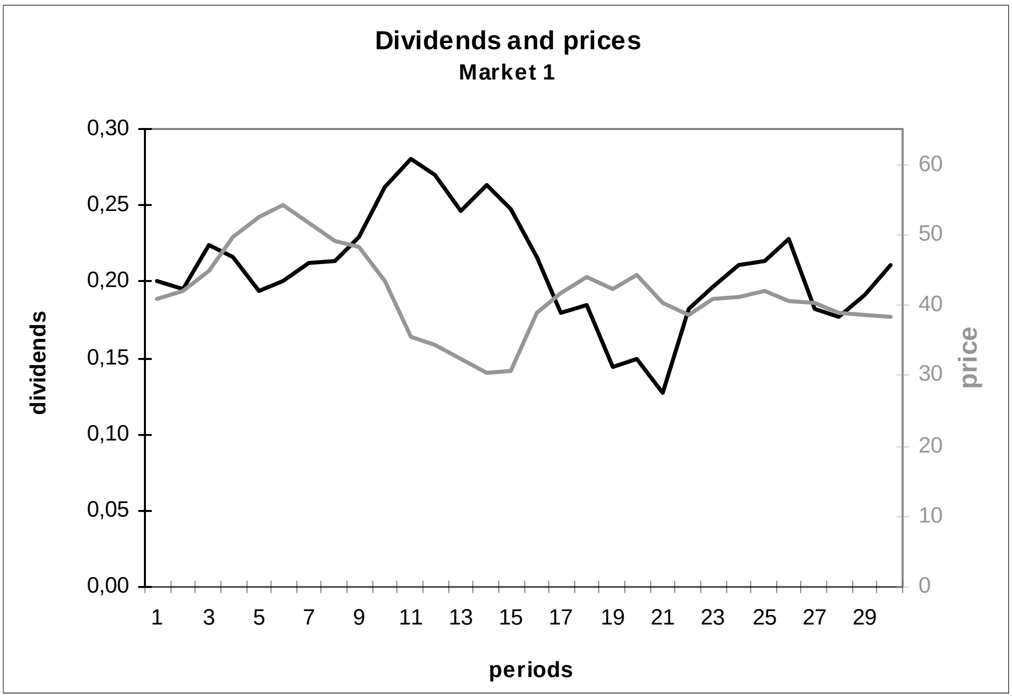


Figure 2: Dividends and mean prices per period of market 1

With our data we can show, that actively acting traders with average information levels will underperform the market, as they buy too late (and therefore too expensive) when prices are rising and vice versa. This is not due to stupidity or errors in information processing, but it is inherent to the market. These results are very similar to our theoretical predictions, stating that the average informed are the ones that are losing most due to a high covariance in prediction errors with the others. The worst informed traders are somewhat protected by their small amount of information they process, making them, compared to average or best informed, basically random traders. So they are more independent than the average informed, because they have a smaller covariance in prediction errors. In a market where the random walk hypothesis holds, this means, that they can expect the average market return.

Properties of the market

We tested whether our market displays some of the properties of real stock markets, know as stylized facts. First we looked at the distribution of log returns. In most capital markets this distribution displays excess kurtosis, what is known as “fat tails and steep peak”.

We also found excess kurtosis in our experimental markets with values ranging from 5.47 to 34.46 and non-gausseanity in log returns in all markets according to the Kolmogorov-Smirnov test statistics (p<0.001).

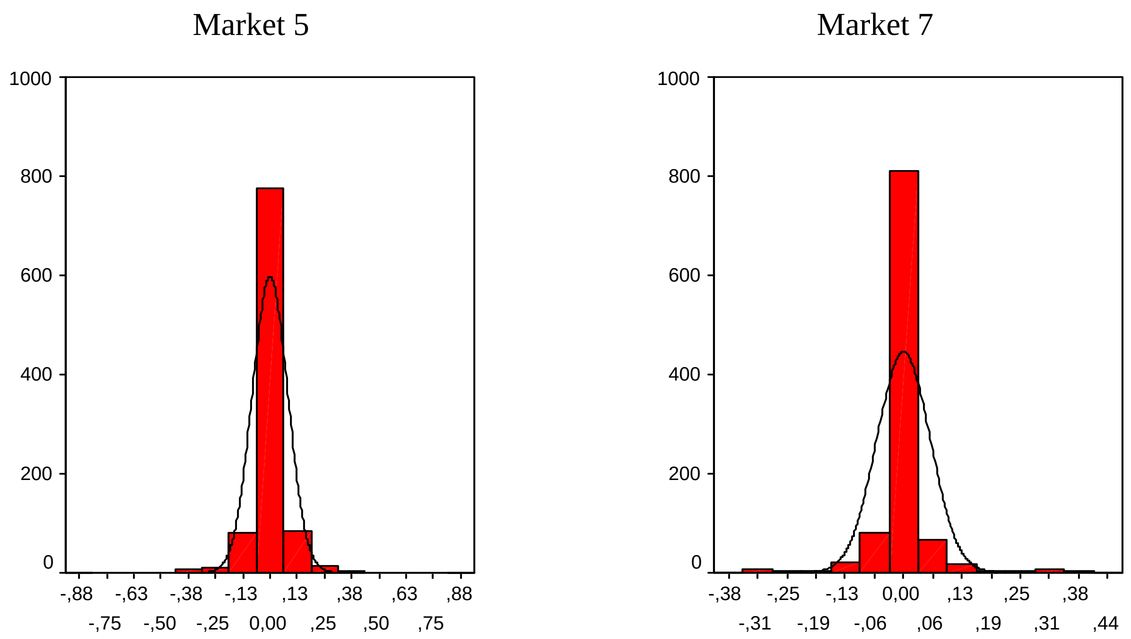
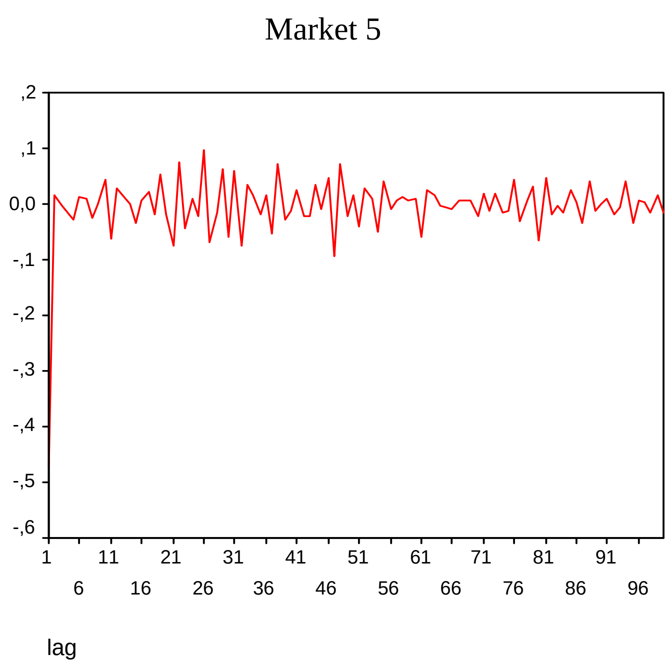


Figure 3: Distribution of log returns of market 5 and market 7

Next we looked at the autocorrelation of log returns. Here we found that the autocorrelation function of price increments is rapidly moving to zero for mainly all markets as is the fact in real financial markets.



Market 1

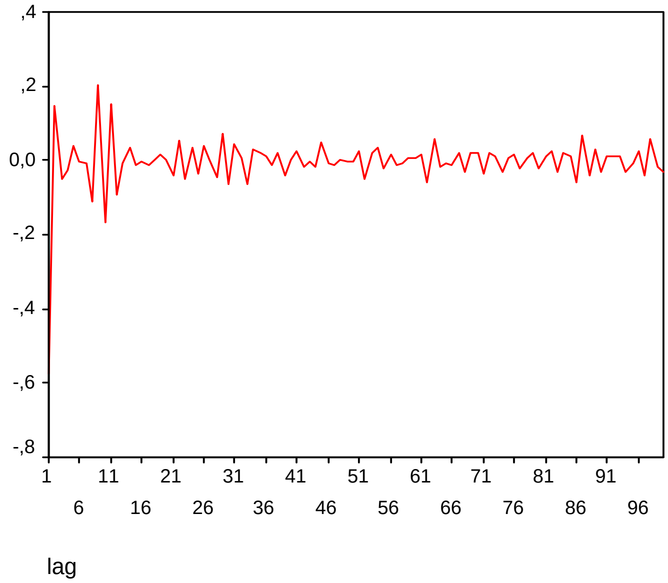


Figure 4: Autocorrelation of log return increments of market 5 and market 1

Concerning volatility clustering we can see similar patterns as in real world markets, because turbulent phases and silent phases are alternating.

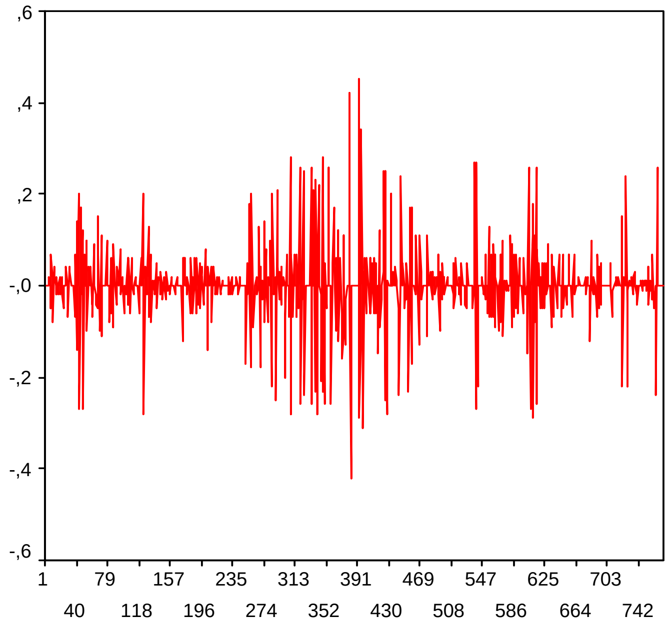


Figure 5: Volatility clustering of log returns of market 6

We found that our markets show similar behaviour to real markets in several very important aspects, namely volatility clustering, excess kurtosis, and the autocorrelation behaviour. This increases our confidence, that the one feature not observable in real markets – the relation between information level and return – looks similar as well.

Concluding remarks

In this study the relationship between information level and return in a market was explored. We understand financial markets as a game, where heterogeneous agents interact. In their attempts to outsmart each other only the best informed are able to gain above average returns. Average informed traders who rely on their information can be exploited by their better informed opponents, while less informed are hardly exploitable because they are trading on basis of few information and are therefore close to random traders. So it may be better for agents who are not insiders to stop gathering and processing information.

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