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**Working Paper**

## Do Insiders Contribute to Market Efficiency? Informational Efficiency and Liquidity of Experimental Call Markets with and without Insiders

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# Do Insiders Contribute to Market Efficiency?



## Informational Efficiency and Liquidity of Experimental Call Markets with and without Insiders

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### Abstract:

This paper reports the results of 13 experimental asset markets with 195 subjects that explore the effects of insider behavior on the price formation process and market liquidity. The experimental call markets use a more realistic design than related studies. We introduce infinitely-lived assets instead of periodical liquidation (so-called „reset“ markets) and provide full market transparency to the investors with an open orderbook.

Our main findings are that insider trading does not improve informational efficiency at all but depresses market liquidity of the assets significantly.

At a first glance, the observed spread widening as an impact of insider behavior leads to the conclusion that our call markets react „as if“ all subjects behave rationally like dealers in a market making environment. At a second glance, a first look into the individual data shows that only a smaller group of investors act as „endogenous“ market makers in the call market regime.

JEL Classification: D44, G12, G14

Key words: Market Microstructure, Experimental Asset Markets, Insider Behavior, Market Efficiency, Call Markets, Behavioral Finance

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# 1 Introduction

During the last decade there has been a growing interest in issues of market microstructure and behavioral finance. Among the still unresolved problems of an optimal design of stock exchanges the relation between market efficiency and the information aggregation process driven by the investors' behavior and market design is one of the most interesting topics.

Modern but traditional theory of financial markets is based on the assumption that the investors in the market are rational in two perspectives: An economic subject (homo oeconomicus) first makes decisions based on the axioms of von Neumann-Morgenstern expected utility theory and second she is able to forecast the future cash flows or market prices unbiasedly. While the strong version of this theoretical concept that all subjects behave in accordance with these basic assumptions is no longer valid in the opinion of most scholars, the „as if“ approach has become the prevailing concept in the scientific community and the textbooks on financial economics. The theoretical concept is based on the assumption that not all individual investors have to act fully rational, but it suffices if rational market results (prices and volumes) obtain: all market participants work together as if they were be rational agents.

Both theories, the stronger and the weaker version, suggest that the individual processes of perception and expectation formation and the market processes of information aggregation and price formation have not to be taken into consideration and modelled. In financial markets, the transformation from the microlevel to the macro- or marketlevel is done by definition. It still remains open, based on which assumptions and models an „invisible hand“ turns the individual decisions into the rational market result.

Despite of this, many crucial empirical phenomena like the equity premium puzzle or the predictability of future stock returns on the basis of past returns weaken the descriptive power of the neo-classical theory on financial markets. In addition, the existence of decision biases of well-trained subjects who are convinced of the Bernoulli-rationality give rise to doubt on the normative power as well.

Figure 1 summarizes the change in paradigms: the traditional view shifts to the market-microstructure and behavioral-finance paradigm.

Please insert figure 1 around here

One of the key factors in the international competition of stock exchanges is the design of the real or virtual market place with regard to the clients' needs. Basic elements are the trading rules and institutions (including the technical environment), the listed assets, and the settlement rules.

Based on the short discussion above, it is worthwhile to analyze the price impact of different trading mechanisms and the legal environment.

While the complexity of and the noise in existing financial markets impede the analysis of the information-aggregation and the price-formation process and reduce the validity of the results, the experimental method enables us to control for all major parameters, to vary the available information for the subjects, and to study potential learning behavior by means of identical replication of the markets. Furthermore, we can control the investors' behavior for the use of private and public information. Therefore, different results can be attributed to the design of the trading mechanisms and the informational environment.

In contrast, investigations of insider trading based on stock market data from existing exchanges are very difficult or even impossible because these studies mostly rely on assumptions about the amount of information and how information is processed for actual transactions.

Because of the fact that we model the (experimental) situation and not human behavior, we can precisely compare theoretical predictions and actual behavior in order to explain and to evaluate the observed differences in the light of future recommendations for the design of stock exchanges and the legal environment. Our experiments are designed in a manner that enhances the comparability of the results to those obtained from field studies in existing stock markets.

We contribute to the gap described by Noeth (1998, 182/3, transl.) that „experimental research has failed or evade to analyze the behavior of information monopolists or insider behavior in general, whose behavior is oftenly treated as rational.“

Our most important results can be summarized as follows. Insider trading does not improve informational efficiency at all but depresses market liquidity significantly.

At a first glance, the observed spread widening (or decrease of market liquidity) as an impact of insider behavior leads to the conclusion that our call markets react „as if“ all subjects behave rationally like dealers in a market making environment. At a second glance, a first look into the individual data shows that only a smaller group of investors act as „endogenous“ market makers in the call market regime.

Market efficiency is measured as common in empirical capital markets research by the deviation of the market prices from the fundamental value as the usual benchmark and by the (endogenous) bid-ask spread which is known from dealer markets.

The paper is organized as follows. We proceed with a short introduction to previous research and the measurement of efficiency in the context of our work (section 2). Section 3 outlines the experimental design and procedures and section 4 specifies the hypotheses we will test. The experimental data and results are presented and analyzed in section 5. The final section summarizes our results and provides suggestions for further research.

## **2 Previous Research and Measurement**

### **Quality of Information Aggregation**

Friedman (1993) uses the root mean squared error (RMSE) as a measure of price efficiency in his experimental study on different trading institutions. As the definition below shows, the measure is based on the difference between the relevant fundamental or „true“ asset value and the transaction price, weighted by the number of market prices in a given time period.

$$RMSE_t = \sqrt{\frac{1}{c_t} \sum_{i=1}^{c_t} (p_{i,t} - v_t)^2}$$

with  $p_{i,t}$  =  $i$ -th market clearing price in period  $t$

$v_t$  = fundamental asset value in period  $t$

$c_t$  = number of clearing prices in period  $t$

If one uses RMSE as a measure of the quality of information aggregation the market is the more efficient the lower the value of RMSE is. Schiereck (1997) replicates this measure for his experimental analysis of call markets.

Theissen (1997) uses a non-squared measure of price efficiency which is based on the absolute deviation between price and value, divided by the fundamental asset value. The mean relative error (MRE) is defined as

$$MRE = \frac{1}{n} \sum_{t=1}^n \frac{|p_t - v_t|}{v_t}$$

with  $p_t$  = market clearing price in period  $t$

$v_t$  = fundamental value in period  $t$

$n$  = number of periods

The division by the fundamental value can be interpreted as a standardization procedure: the measure makes experiments series with different asset value levels comparable.

Friedman's RMSE gives more weight to larger deviations than the MRE. On principle, RMSE should also be standardized.

In our analyses, the standardized RMSE leads to the same results as MRE, since only one market clearing price is determined in each period (cf. Friedman 1993). However, medians are used in place of the arithmetic means (see section 5.1 below).

## Liquidity

Probably based on the general assumptions by Mendelson (1982), Friedman (1993) defines his measure of liquidity (operational efficiency) of an asset market. He calculates the difference between the best rejected (extramarginal) bid and ask prices. This concept considers that an additional buy order reaching the market will be executed at exactly that price on which the best rejected sell order is limited on (rejected ask) and vice versa. Friedman (1993, 423) confirms: „This provides an implicit measure of transactions costs that is valid across institutions.“

This implicit bid-ask spread is quite similar to the market spread in dealer markets if one assumes that call market participants are allowed to act as a dealer, submitting orders both with bids and asks. Higher values of the spread correspond to lower liquidity or operational efficiency of a market. A standardization procedure similar to the price-efficiency measures is useful and medians are used again to reduce the weight of outliers. Our liquidity measure is defined as follows:

$$ARS = \Delta(RS_t) \quad \text{with } RS_t = \frac{Ask_t^{rej} - Bid_t^{rej}}{v_t}; \quad t = 1, \dots, 16$$

## 3 Design and Procedures

### 3.1 Market Institution and Trading Mechanism

The basic trading mechanism that we used is a call market where a clearinghouse matches buy and sell orders once in every trading period. After the orders are collected a computer aggregates them and fixes the market clearing price so that the transaction volume is maximized. Thus, the call market institution provides a uniform price to all market participants. In terms of auction theory our market institution is a sealed bid multiple unit double auction.

If the clearinghouse procedure resulted in an interval of possible prices the midpoint was chosen. If the calculated price did not clear the market completely, rationing took place under the following rules: Sell (buy) orders with lower (higher) price limits were executed with first



priority. In the case of equal limits the orders were rationed proportionally to their order size. Orders limited to the clearing price were rationed in the same manner.

Traders were allowed to submit buy and/or sell orders. The only restrictions were the budget constraint and a short-selling restriction (see section 3.3 for details). The minimum tick size was set to 1 and the price could only take on integer values. Market orders (orders without any limit price) were not allowed. Such buy (sell) orders can be mimicked by setting the price limit sufficiently high (low). There are no transaction costs.

Subjects were provided with a fully transparent but anonymized ex-post orderbook (cf. Oehler/Unser 1998) and an individual message about the order execution at the end of every trading period.

We conducted 13 experimental sessions with groups of 15 subjects. Each session consists of 16 trading periods. In each experimental call market only one type of asset was traded. The aspects of limited information processing and bounded rationality in a market design with two or more asset types is discussed separately (cf. Oehler/Unser 1998).

The market designs of the 13 experimental sessions differ only in the existence of insiders. Design I (6 groups) represents a call market without insiders, design II implements two insiders among the 15 subjects. Trading is anonymous in both designs, i.e. the identity of each trader who submitted an order is never revealed. In design II the traders know that there are insiders in the market, but they could only identify them by their order behavior.

In design II two insiders were implemented instead of one. This concept was based on the assumption that the two insiders were forced by the situation to realize their informational advantage (see below, section 3.2) quickly because they have no opportunity to communicate or cooperate among each other (cf. Noeth/Weber 1996).

Both designs were conducted as multi-stage markets, i.e. every subject holds his portfolio and cash from period to period. In contrast to this more realistic market environment, many comparable experiments in financial markets research use so-called „reset“ markets, i.e. at the end of each trading period the portfolio and cash is returned to the experimenter and all participants start the next period with the same new endowment (cf. Krahen/Weber 1999, Noeth/Weber 1999, Theissen 1997).

Some researchers argue that the advantage of the reset market design consists of the subjects' ability to act every time at both sides of the market because they have no restriction on cash and assets (cf. Theissen 1997). In addition to the problem that such designs are very unrealistic the reset design ignores the intertemporal characteristic of expectation formation. Moreover, the assumption of statistically independent periods does not hold true (with all consequences for the test statistics, cf. Friedman 1993), since either the information structure is modelled multiperiodically or no one can assume seriously that a subject's memory is really „formatted“ at the start of every new trading period. As a result, the expectation formation process in reset markets is virtually less complex. In fact, reset markets need the same number of experimental sessions and subjects as designs with infinitely-lived assets.

### **3.2 Information Structure and Determination of the Asset Value**

Financial market experiments usually incorporate information asymmetries. The standard procedure to introduce this is to define a small number of states of nature that determine the asset's payoff to traders. Subjects were then provided with different access to the relevant information about the actual state or future states, respectively. In microstructure literature asymmetric information is commonly introduced by a procedure that provides single (or a group of) traders with superior information (cf. Plott/Sunder 1982, Glosten/Milgrom 1985, Kyle 1985, Admati/Pfleiderer 1988).

In our markets traders were provided with the same information about the asset value first. Two traders were then randomly chosen as insiders. The two insiders in design II got insight in the future of the determination process of the asset value (see below). The asset value  $v_t$  of period  $t$  is determined by a binomial tree defined by the following five parameters:

- asset value  $v_1$  of the first period
- probability  $p$  of an upward step in the next period
- probability  $q = 1 - p$  of a downward step in the next period
- extent  $u$  of an upward step
- extent  $d$  of a downward step.

The binomial process our subjects provided with is described in the table below.

Parameters	Values
$v_1$	1,000
$p$	0.6
$q$	0.4
$u$	1.2
$d$	0.8

Every trader receives this table and the expected value  $E_t(v_{t+1}) = p \cdot u \cdot v_t + q \cdot d \cdot v_t$ . The up and down step is determined randomly. Figure 2 reveals the whole tree and all the data the participants could calculate on their own.

Please insert figure 2 around here

The use of the fundamental asset value is twofold.

First, the portfolio of each investor at the end of the last trading period is valued at the asset value in this period. The payment of the subjects is based on this valuation procedure.

Second,  $E_t(v_{t+1}) = p \cdot u \cdot v_t + q \cdot d \cdot v_t$  is the only information given to all investors. All subjects were provided with this expected value at the beginning of each new trading period. Thus, the whole tree but not the exact branch is revealed to the participants (see figure 2). The behavior of a rational investor has to be determined by  $E_t(v_T)$  of the asset value  $v_T$  of the last trading period.

The superior information of the insiders (design II) consists of a time lag of the non-insiders. Insiders receive the expected value of the fundamental asset value one period in advance, i.e. they get the  $E_t(v_{t+2})$  at the beginning of each period. Consequently, insiders can make a better assessment of  $v_T$  and the volatility.

### **3.3 Subjects, Endowment, and Experimental Procedures**

The experiments were conducted with undergraduate students of the University of Hagen, Department of Finance and Banking in the winter term 1998/99. In contrast to undergraduates of other German universities these students normally do their studies parallel to a fulltime job, mainly in the banking and insurance industry, and invest more money in the stock market (cf. Oehler 1995). All participants have basic knowledge on financial markets from their studies and/or practice and participated for the first time and only once.

Subjects received a set of written instructions three weeks before the experiments started. All questions were answered in this pre-period and some tests were done.

Subjects were endowed with 50 asset units and 35,000 currency units (cu). Shortselling and borrowing was allowed up to the initial endowment.

As mentioned above investors were rewarded for their participation in dependence of their success which was measured by their final holdings in assets and cash. The value of the end-of-last-period portfolio was transformed into Deutsche Mark by a known divisor and paid out. The average payoff for a three hours experiment was DM 37.82, individual payoffs ranged from DM 0.00 to DM 60.03.

## **4 Hypotheses**

Based on both theoretical and empirical (experimental) literature (for an overview see Schnitzlein 1996) we derive the working hypothesis that information aggregation is improved by insider trading. So, insider markets have a higher informational efficiency (see above, section 2):

Hypothesis 1: Insiders contribute to market efficiency by improving the informational efficiency.

Additionally, considering the growing body of theoretical and experimental literature in the field of market microstructure (cf. Glosten 1989, Pagano/Röell 1996, Schnitzlein 1996), we expect that insiders lead to a reduction of market liquidity because of the adverse selection costs the non-insiders are afraid of. This leads to our second working hypothesis.

Hypothesis 2: The existence of insiders in a market reduces the market liquidity, i.e. widens the bid-ask spread.

## 5 Results

### 5.1 Aggregation of Information

The described information structure and the payment system based on it imply an investment behavior that is oriented on the binomial tree. Every realization means an adjustment onto the fundamental asset value that is decisive for the later payoff. The price mechanism has to aggregate the public and the private information (expectations of all subjects and insiders) contained in the realizations of the tree.

Please insert table 1.1 around here

According to this, the RMSE (see section 2) is used in a standardized form with medians as a measure of the quality of aggregation. Table 1.1 shows the results on average for all experimental sessions. The fact that the deviation of informational efficiency in both designs is about 30% leads to the conclusion that the first hypothesis cannot be supported. Insiders do not improve informational efficiency and there is no higher quality in the aggregation function of the market. The detailed data for every single session (see table 1.2) and the additional statistical test (Wilcoxon rank sum test) confirm this consideration.

Please insert table 1.2 around here

At a first glance, the results can be interpreted in that way that either the insiders did not succeed in obtaining the relevant market volume with their orders (problem of market power)

or the non-insiders were not able to „read“ the informational advantage in the clearing prices and/or the orders itself (problem of „communication“ or detection via prices).

At a second glance, an additional descriptive analysis of individual investment behavior (see figure 3) shows that insiders generate a significantly higher profit of about 10% (statistically significant at the 5%-level) with a lower payoff dispersion at the same time (see Krahnert/Weber 1999 for similar results).

Please insert figure 3 around here

To classify our results according to the literature we compare our data in table 1.1 with such from other experimental financial markets. The study by Noeth and Weber (1996, see also Noeth 1998) uses a comparable design, on principle, but they do their analyses with a reset market design (see above, section 3.1) and employ the (1–RMSE) measure.

The data of Noeth/Weber in their design „s0“ (without insiders) shows a deviation from full efficiency in a range between 38% and 60.5% (dependent on the special sub-designs) while our data in table 1.1 amount to 27.8%.

The design with two insiders in the Noeth/Weber study (design „s2“) improves the efficiency to a range between 30% and 9%, but their results are statistically not significant. Our insider design leads to a similar efficiency at 30.8%.

To get a better impression of the investor behavior in our markets figure 4 illustrates the information structure, the derived expected fundamental asset values during the trading periods used for the payment and the market clearing prices of each period.

Please insert figure 4 around here

The market prices documented in figure 4 show a more myopic behavior. Investors „anchor“ their clearing prices around the public signal  $E_t(v_{t+1})$  which were given at the beginning of each period. The expectation formation of the subjects is not clearly affected by the fundamental value in the last period  $E_t(v_T)$ .

Overall, these findings suggest a deeper analysis on the individual level which constitutes the special advantage of experimental markets. We hope to contribute to the result by Krahen/Weber (1999, 19) who remark „...we do not find a clear difference in behavior between informed and uninformed traders, however, informed traders earn more than uninformed ones“.

## 5.2 Liquidity

A market is considered to be liquid when a listed asset can be bought or sold rapidly and at a price close to the equilibrium value. Accordingly, we have defined in section 2 the liquidity measure ARS for our call markets with discrete points in time where the market price is calculated.

Table 2.1 shows the results for ARS on average, table 2.2 documents the same for each datapoint (experiment).

Please insert table 2.1 and 2.2 around here

The data show that our second hypothesis cannot be rejected, i.e. liquidity decreases in design II (with insiders) in comparison with design I. The difference between the two market designs is significant at the 10%-level (Wilcoxon rank sum test; 6.88%).

Our 6.1% spread in design I can be qualified by other experimental studies. Schiereck (1997) reaches about 9% to 10% and Theissen (1999) documents 2%, but with a „reset“-market design.

An alternative way for the standardization of the relative spreads which is discussed by Rubio and Tapia (1996) is the midquote. Our results with both measures are quite similar.

In the perspective of the modern capital market theory the results of the spread widening can be explained with the „as if“ approach. The investors behave in the aggregate as if they were rational dealers (market makers) who are afraid of adverse selection costs, i.e they avoid to contract with an informed investor.

On a descriptive level, this explanation is not really satisfactory because in a call or clearinghouse market an „invisible hand“ is necessary that coordinates the individual orders to a wider spread.

Hence, an analysis on an individual level is helpful and experiments are cutted out for such a procedure. Findings of a first analysis on the individual behavior indicate that in every trading period about 20% to 25% of the investors behave like a dealer, i.e. quote bid and ask. The spread of such implicit or „endogenous“ market makers increases by about 24% on average from design I to design II.

## **6 Summary and Conclusion**

Using a design that incorporates asymmetric information, we find that the call market institution with insider trading yields similar informational efficiency but lower operational efficiency (liquidity) than a clearing house without any informed investors.

Interestingly, „the market“ as a whole successfully acts against informed participants with a significant spread widening. Analyses on the micro level indicate that this behavior of the aggregate is caused by a group of investors who exhibit the trading pattern of (implicit) dealers.

But this is only the first step of an fruitful analysis of individual investor behavior in markets. Further results are expected in the study of behavioral patterns and their differences between insiders and uninformed subjects, e.g. a contribution to the question why insiders generated more profit. Accordingly, the relative success of individual trading strategies should be analyzed.

Moreover, the results from call markets should to be contrasted with such from similar designs from continuous auction and (exogenous) dealer markets to clarify whether a market institution (trading system) dominates another with regard to criteria like informational efficiency (quality of information aggregation) or liquidity.

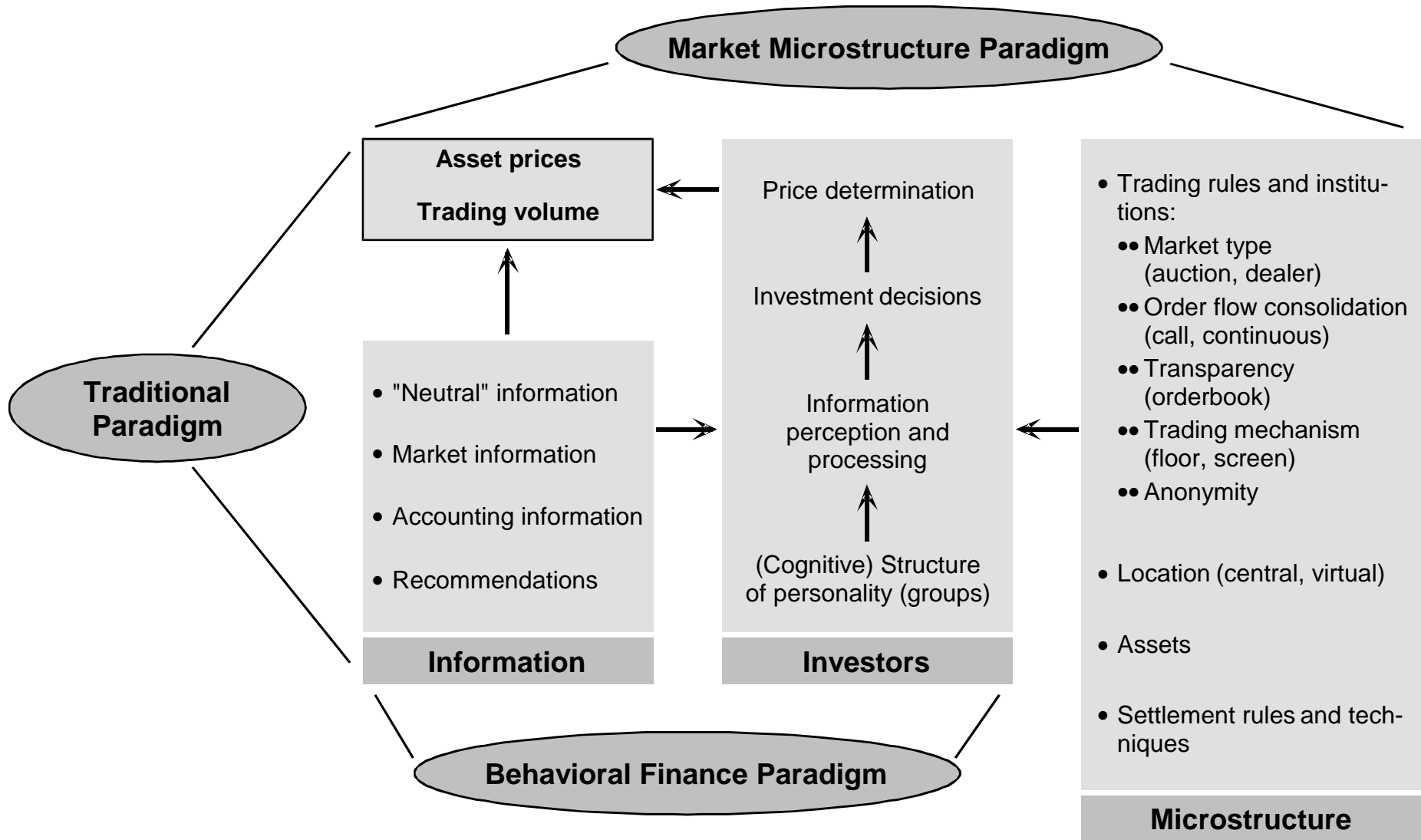
We end with the ritual cry for further work to finally answer the question, whether insiders enforce or depress market efficiency and whether one market institution is more robust against insider trading than another.



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Figure 1: Paradigms in financial market research



**Figure 2: Generating the fundamental asset value with a binomial tree**

Parameters	
$v_1$	1,000
$p$	0.60
$q (=1-p)$	0.40
$u$	1.20
$d$	0.80

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	[P17]	prob.(*)
																	18,488	0.0%
																15,407	12,326	0.3%
														10,699	10,271	8,217	5,478	1.5%
												7,430	5,944	7,133	5,706	6,848	5,478	4.7%
										5,160	4,128	4,953	3,963	4,755	3,804	4,565	3,652	10.1%
							2,986	3,583	4,300	3,440	2,752	3,302	2,642	3,170	2,536	3,043	2,435	16.2%
					2,074	1,659	1,991	2,389	2,867	2,293	2,752	2,202	2,642	2,113	2,536	2,029	1,623	19.8%
				1,728	1,382	1,106	1,327	1,593	1,911	1,529	1,835	1,468	1,761	1,409	1,691	1,353	1,082	18.9%
		1,200	1,440	1,152	922	1,106	1,327	1,593	1,911	1,529	1,835	1,468	1,174	1,409	1,691	1,353	1,082	18.9%
	1,000	800	960	768	922	1,106	1,327	1,593	1,911	1,529	1,835	1,468	1,174	1,409	1,691	1,353	1,082	14.2%
			640	614	614	737	885	849	849	815	815	652	783	939	751	902	721	14.2%
				512	492	492	590	708	566	544	544	652	522	626	501	601	481	8.4%
					410	393	393	472	566	453	453	435	522	417	501	401	321	3.9%
						328	262	315	377	302	302	290	348	278	334	267	214	1.4%
							210	252	302	201	242	290	232	278	223	178	142	0.4%
								168	201	161	193	155	186	148	119	95	63	0.0%
									134	107	129	103	82	99	79	63	35	0.0%
											86	69	55	44	42	28	0.0%	0.0%

(\*) probability of this fundamental asset value in period 17, calculated in period 1

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	[P17]
<b>fundamental asset values</b>	1,000	1,200	1,440	1,728	1,382	1,106	1,327	1,593	1,911	1,529	1,835	1,468	1,174	1,409	1,691	1,353	1,623
<b>delivered expected fund. values <math>E_t(v_{t+1})</math></b>	1,040	1,248	1,498	1,797	1,438	1,150	1,380	1,656	1,987	1,590	1,908	1,526	1,221	1,465	1,758	1,407	
<b>expected asset values for the payoff <math>E_t(v_T)</math></b>	1,873	2,161	2,494	2,877	2,213	1,703	1,964	2,267	2,615	2,012	2,321	1,786	1,374	1,585	1,829	1,407	

**Table 1.1: Results on Information aggregation – Overview**

The table shows the results of the RMSE measure on informational efficiency for both designs:

I = without insiders

II = with 2 insiders

The highest quality of informational efficiency is reached when the measure's value amounts to 0%.

We use medians instead of means in the averaging procedure to give not too much weight to outliers (cf. Noeth 1998). Additionally, the Wilcoxon rank sum test uses this measure. Results calculated with the mean are quite similar.

Market design	RMSE – Median %
I	27.8
II	30.8

Standardized

**Table 1.2: Results on Information aggregation – Details**

The table shows the results of the RMSE measure on informational efficiency for both designs:

I = without insiders

II = with 2 insiders

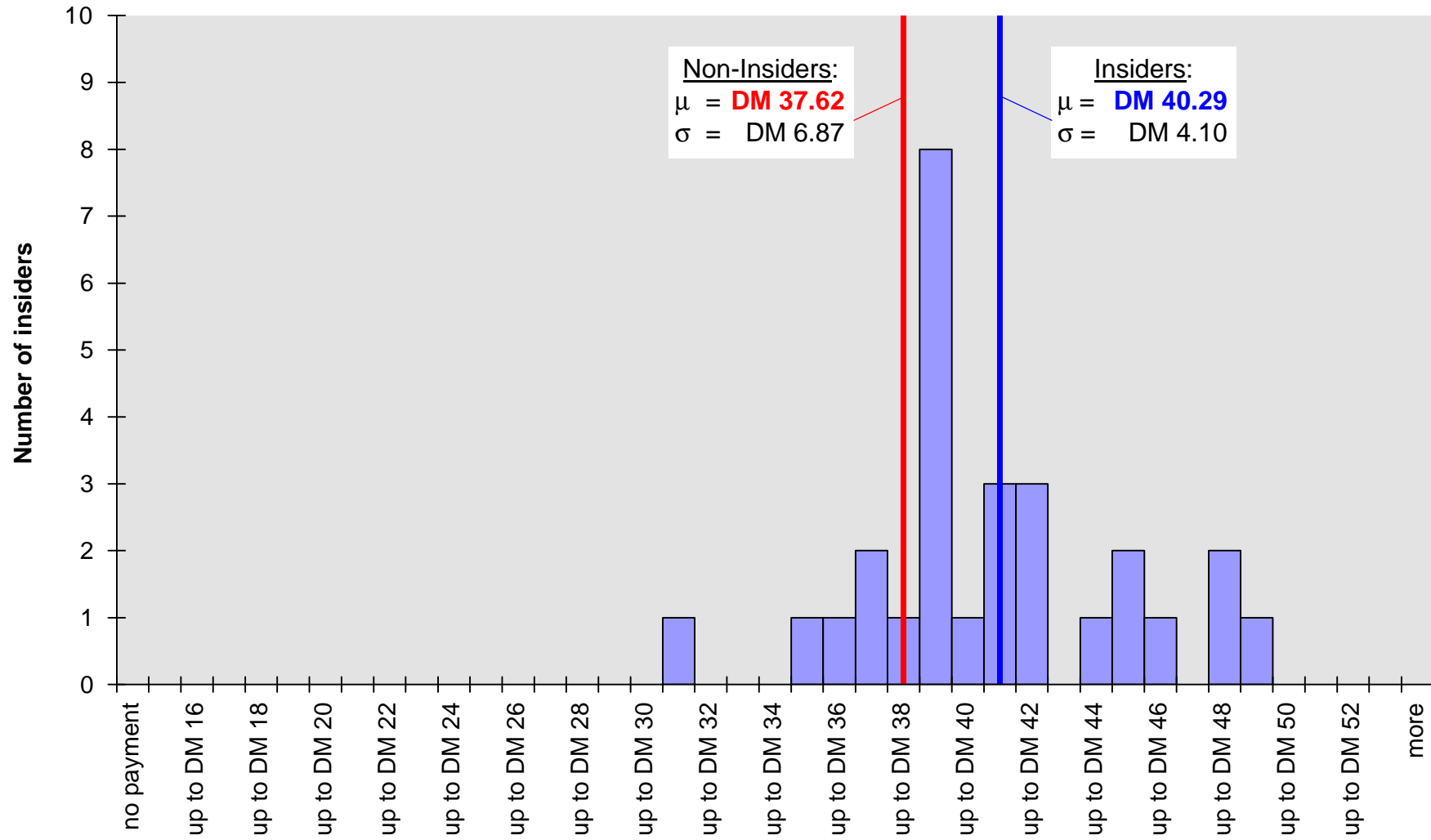
The highest quality of informational efficiency is reached when the measure's value amounts to 0%.

As supplement to table 1.1, table 1.2 shows the results for each experiment (datapoint).

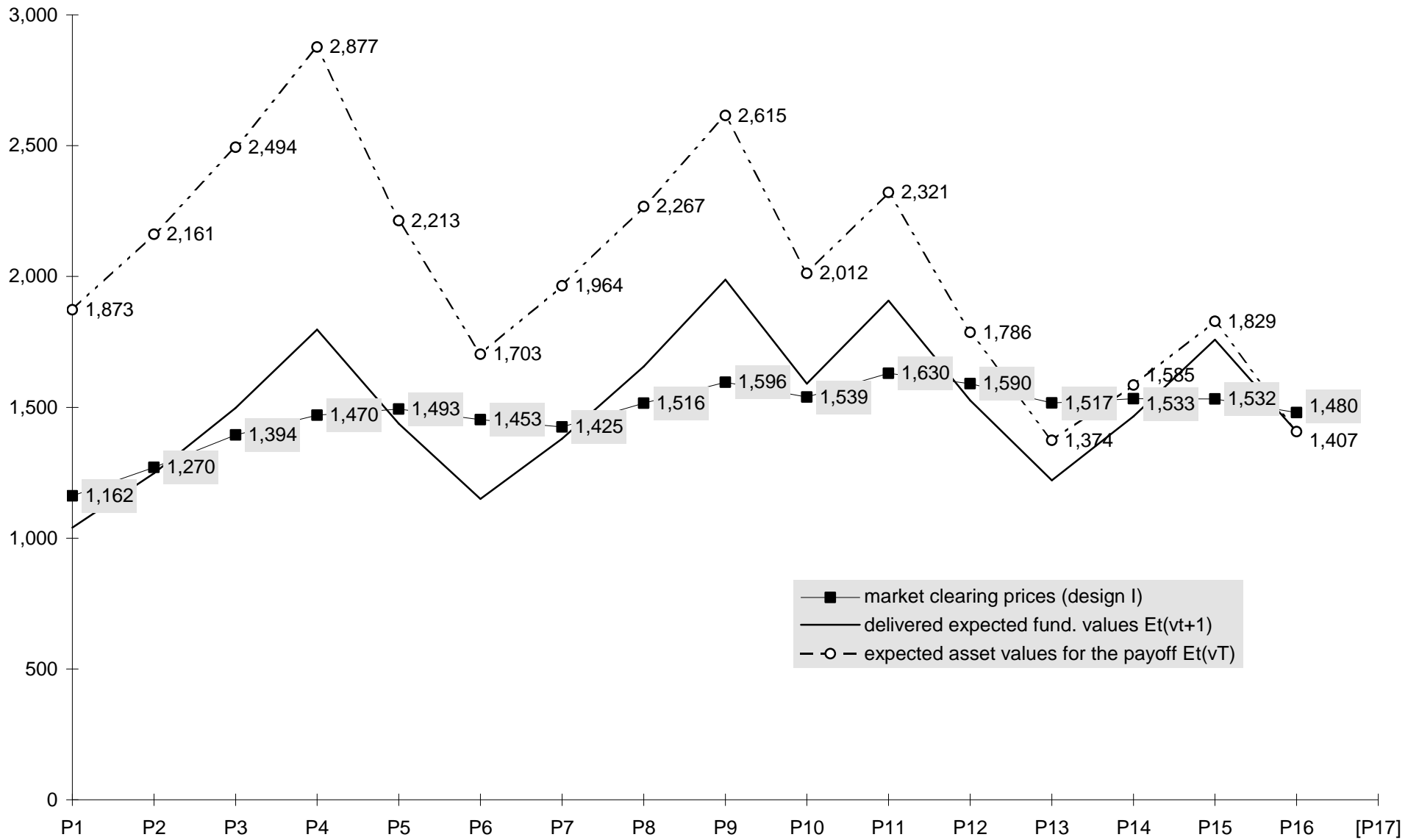
Market design	RMSE – Median % –datapoints (experiments)						
	1	2	3	4	5	6	7
I	24.4	24.2	26.0	33.3	30.9	29.6	—
II	23.7	20.8	36.5	28.0	34.9	30.8	34.6

Standardized

Figure 3: Earnings of Insiders and Non-Insiders



**Figure 4: Market prices, delivered expected fundamental values and expected asset values for the payoff**



**Table 2.1: Results on liquidity – Overview**

The table shows the results of the (implicit) bid-ask spread as the liquidity measure for both designs (averaged relative spread standardized with the fundamental value):

I = without insiders

II = with 2 insiders

We use medians instead of means in the averaging procedure to give not too much weight to outliers (cf. Noeth 1998). Additionally, the Wilcoxon rank sum test uses this measure. Results calculated with the mean are quite similar.

Market design	ARS – Median %
I	6.1
II	10.2

Standardized

**Table 2.2: Results on liquidity – Details**

The table shows the results of the (implicit) bid-ask spread as the liquidity measure for both designs (averaged relative spread standardized with the fundamental value):

I = without insiders

II = with 2 insiders

As supplement to table 2.1, table 2.2 shows the results for each experiment (datapoint).

Market design	ARS – Median % – datapoints (experiments)						
	1	2	3	4	5	6	7
I	5.0	6.7	7.0	5.6	9.6	5.5	—
II	12.4	10.2	11.0	7.5	4.0	6.1	12.0

Standardized