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Abstract: We investigate the formation of market prices in a new experimental setting involving multi-period call-auction asset markets with state-dependent fundamentals. We are particularly interested in two informational aspects: (1) the role of traders who are informed about the true state and/or (2) the impact of the provision of Bayesian updates of the assets' state-dependent fundamental values (BFVs) to all traders. We find that markets with asymmetrically informed traders exhibit smaller price deviations from fundamentals than markets without informed traders. The provision of BFVs has little to no effect. Behavior of informed and uninformed traders differs in early periods but converges over time. On average, uninformed traders offer lower (higher) limit prices and hold less (more) assets than informed traders in "good"-state ("bad"-state) markets. Informed traders earn superior profits. The precision of market price forecasts is impeded by the presence of insiders.

JEL classification: C92, D47, D53, D82, G14

Keywords: Experimental economics, asset markets, informational asymmetries

1. Introduction

Financial markets are characterized by pronounced informational asymmetries. This is particularly true in times of market uncertainty following economic turbulences or in the wake of stock market launches (IPOs). Although insider trading is prohibited by law in all prominent financial markets, insider information is often a prominent cause of informational asymmetries.[1] Given that the allocative efficiency of a market crucially depends upon the correct pricing of its assets, insider trading could theoretically be seen as a positive. The more information the market price reflects, the higher is the informational and thus also the allocative efficiency of a market. As insiders potentially bring critical information to the market, the proponents of insider trading presume potentially positive effects on market efficiency. Opponents of the regulation of insider trading, however, counter that the integrity of financial markets is at stake, when no barriers on insider trading are imposed.[2]

In this paper, we study asset-price formation and the consequences of insider trading in a new experimental setting involving multi-period assets in an environment with uncertainty about market fundamentals. Specifically, we consider the existence of two possible states of nature. We compare price formation in markets with and without insiders that have information about the true state. We investigate to what extent our financial markets are informationally efficient and how informational asymmetries (due to insider information) impact market-price formation. Such an investigation would hardly be possible (if not impossible) on real market grounds, due to the blurry nature of underlying securities' values and the uncontrollable and incalculable information distribution among market participants. In the experiment we can control the information available to market participants and the securities' fundamentals. Although the expectation formation of market participants remains difficult to grasp,[3] we can explicitly control the informational asymmetries between market participants, including the number of informed participants (henceforth also inside traders or insiders) relative to the uninformed (henceforth also outside traders or outsiders). We neither claim nor aim to resolve the debate between proponents and opponents of insider trading regulation but strive to fuel the discussion with the provision of new experimental evidence.

[1] Bris (2005) even finds, by using acquisition data from 52 countries between 1990 and 2000, that the introduction of laws that prohibit insider trading increases the occurrence and profitability of insider trading.

[2] In the ongoing debate, to date, neither efficiency nor fairness and equity arguments can mutually persuade the debating parties (Bainbridge, 1998; Fishman and Hagerty, 1992).

[3] How the available information disseminates through the market and is processed by the individual traders to build individual expectations remains a tremendous source of uncertainty. It resembles Keynes (1936) view of the stock market as a "beauty contest" in which traders are more concerned about the beliefs of others than about their own valuation based upon all available information. As good as the experimenters can control for the market parameters, as bad they can control the endogenous beliefs of participants about other participants' behavior (Noussair and Plott, 2008).

Since the seminal paper by Smith et al. (1988) (henceforth, SSW) countless studies have investigated common stock valuation in experimental asset markets with multi-period assets characterized by declining fundamental values (FVs). However, relatively few studies consider informational asymmetries. If (experimental) markets are efficient, the market value should equal the risk-adjusted present value of the rationally expected future financial benefits conditioned on all available information. Asset price changes should only occur when new information is brought into the market, which changes expectations about the income stream (Shiller, 2003). Deviations from fundamentals, if at all, should be only temporary until the risk-adjusted expectations converge. Such kind of markets would approximate what Fama (1970), the originator of the efficient-market hypothesis (EMH), called "efficient". However, SSW-type markets predominantly resist showing efficiency and persistently exhibit bubbles, which hardly can be explained by differences in preferences or risk aversion. The observed bubble-and-crash phenomenon is found to be strikingly robust to changes in the experimental environment.[4] The only factor that fairly reliably impairs this widely observed pattern is experience (in the sense of repetition). Dufwenberg et al. (2005) have shown that even a fraction of experienced subjects in an experimental market is sufficient to reduce the occurrence of bubbles. However, this seems to hold only if the market environment (initial endowments and dividend structure) remains unchanged during the trials (Hussam et al., 2008).

On the basis of Dufwenberg et al. (2005), Sutter et al. (2012) hypothesize that, in addition to experience, an asymmetric distribution of information about an asset's imminent future dividends among the participants might serve to reduce mispricing, i.e., the magnitude of bubbles. They conjecture that the main driver of this alleviating effect might be the common knowledge of the existence of better informed or experienced traders. Implementing a SSW framework, they find information asymmetries to significantly reduce the size of price bubbles, implying higher market efficiency. Moreover, they do not detect a significant difference in profits between traders with different information levels. However, in an earlier study, King (1991) finds no evidence for asymmetric distribution of information to eliminate price bubbles in a SSW environment. In his study informed traders, likewise, could not capitalize their informational advantage through higher profits; they were just able to recoup the costs for the acquisition of the private information.[5]

Another experimental literature strand studies asymmetric information using an approach different from SSW. It is based on one-period Arrow-Debreu assets with state-contingent and trader-type dependent dividends, and in the cases where insider information is investigated, asymmetric distributions of state information (e.g., Forsythe et al. (1982; 1984), Plott and Sunder (1982; 1988), Ang and Schwarz (1985), Camerer

[4] See, e.g., King et al. (1993), Porter and Smith (1994), or Palan (2013) for comprehensive and salient reviews of the experimental "bubble" literature. For an overview of bubble definitions see, e.g., Siegel (2003).

[5] Unlike the work of Sutter et al. (2012), which uses randomly assigned and free private information, King (1991) investigates costly private information that is auctioned off before the markets start.

and Weigelt (1991), Sunder (1992), Friedman (1993), Ackert et al. (1997), and Ackert and Church (1998)). The studies in this literature strand focus on the test of the "prior information equilibrium pricing prediction model" (PI) versus the "fully revealing rational-expectations equilibrium prediction model" (RE). Both prediction models will be explained in more detail in Section 3 below. In summary, this literature strand shows that markets are generally able to aggregate information quite successfully. PI predictions seem to be a good benchmark for trades in earlier repetitions of the market, whereas the RE predictions appear more accurate in later repetitions. Plott and Sunder (1988), for example, argue as follows: "Rational expectations can be seen either as a static theory of markets (e.g., in the efficient market literature in finance) or as an end-point of a dynamic path of adjustment." (p. 1104)

Our experiment is novel in that it combines both literature strands and introduces state-dependence in the SSW framework. In our new framework, insider information is defined as the knowledge of the state. The aim of our study is to analyze how informational aspects, including the existence of inside knowledge, influence price formation and market performance.

In our experiment, the dividend paid by an asset, in each of 15 periods, has four possible values and is the same for all traders. However, in each period, the dividend is stochastic and its distribution function depends upon one of two possible states of the world. In other words, the state determines the probabilities with which the respective dividends are drawn. The "state of the world" is determined at the beginning of the experiment and stays the same over all periods. Traders generally do not know the state but are informed that the probability of each state is 50 percent. This is the prior belief, which determines the ex-ante expected fundamental value of the assets. Based on the observed dividends during the experiment, this belief can be updated according to the method of Bayes, resulting in ex-post expected fundamental values (BFVs) of the assets. In some of the experimental markets informational asymmetry is established via a random assignment of cost-free information about the state to some inside traders.

In this framework, we investigate how information is processed and disseminated trough market prices. We are particularly interested in two informational aspects: (1) the role of traders who are informed about the true state (insiders), and/or (2) the impact of the provision of Bayesian updates of the assets' state-dependent fundamental value to all traders. We compare the outcomes in markets where two traders with insider information about the actual "state of the world" are present (and the presence is common knowledge) to the outcomes in markets without any insider information. Additionally, in half of the markets with insiders and half of the markets without insiders, we provide all traders in every period with updated BFVs. In all four resulting treatments, to scrutinize traders' ability to anticipate uncertain future outcomes, a key issue in financial markets, we elicit traders' expectations about the future market prices at the beginning of each period and provide monetary incentives for the accuracy of their predictions.

Our main results are surprising in that, in all treatments, we find bubbles to occur rarely, even though all traders are inexperienced and have never participated in a market experiment before. Markets with asymmetrically informed traders exhibit smaller price deviations from fundamentals, suggesting higher market efficiency. The provision of BFVs has little to no effect. Behavior of in- and outsiders differs in early periods but converges over the course of the markets. On average, we find outsider limit buy/sell prices to be lower (higher) in the "good" ("bad") state and outsiders to hold less (more) assets in "good"-state ("bad"-state) markets compared to insiders. Insiders manage to exploit their superior position and are able to earn higher profits. With regard to price expectations, we find forecasts and actual market prices to be highly correlated. Forecast precision, however, seems to be impeded by the presence of insiders, while the provision of BFVs seems to have no impact on the quality of the forecasts.

The remainder of this paper is structured as follows: Section 2 presents the experimental market design and describes the experimental procedures. Section 3 introduces two behavioral models and provides testable hypotheses. Section 4 reviews these hypotheses in the face of the experimental results. Section 5 gives a summary and concludes.

2. Laboratory Markets and Experimental Procedures

We conducted the computerized experiment in the Göttingen Laboratory of Behavioral Economics at the University of Göttingen, Germany, based on the z-tree software package (Fischbacher, 2007).

A total of 240 subjects participated in 40 markets with six traders, each. Participants were student volunteers recruited for a decision-making experiment via ORSEE (Greiner, 2004). All participants were Bachelor or Master Students in business administration or international economics at the University of Göttingen and thus had some background in economics.

Each subject assumed the role of a trader in an asset market. Six participants (henceforth traders) participated in a market lasting 15 periods. Each experiment session involved two or three independent markets. At no time, traders did know the identity of other traders in the market. A market lasted 15 periods and involved trading in call auctions (for buying and selling) in each period.

The experimental sessions were conducted in two parts. In the first part, risk preferences were elicited using lottery choices following Holt and Laury (2002) (see Appendix A for more details). Trading in the call-auction market took place in the second part. For both parts traders were given detailed written instructions. For the first part, written instructions were individually provided. For the second part, instructions were read aloud in a briefing room and supplemented by a presentation of screenshots which included all screens traders encountered during the experiment. Instructions and screenshots of the program are provided in the Appendix C. The whole process before the call-auction market started lasted on average about 45 minutes. During the entire session traders were not allowed to talk to each other.

2.1. Characteristics Common to All Sessions

At the beginning of each experimental market each trader is endowed with 10 assets and 10,000 ECU working capital. We have chosen to provide the same endowment to all traders to prevent trading merely due to the desire to realign portfolios. King et al. (1993) found no significant effect of equal endowments on bubble formation. Each trader's initial endowment in ECU is large enough to buy at least a quarter of the other traders' assets in a market at initial fundamental values. Short selling is not permitted. The initial working capital has to be repaid at the end of the market session. Traders' asset and working capital holdings are carried over from one period to the next.

Prior to the trading stage, at the beginning of each period, traders have to state their expectations about the prospective market prices of the present and all subsequent

trading periods. Thus, each trader has to state in each period $t \in (1, \dots, 15)$ a total of $(16 - t)$ forecasts. To create an incentive for participants to care about forecast precision, participants are rewarded (in ECU) for the accuracy of each forecast.[6] If the forecasted price is within a 10 percent, 10-20 percent or 20-30 percent range, a respective reward of 5 ECU, 2 ECU or 1 ECU is paid. For less accurate forecasts no reward is paid. Over the course of the 15 market periods, for any period t $(1 \leq t \leq 15)$ t predictions are requested and thus a reward may be obtained up to t times. In each period, after all traders have stated their predictions, trading commenced in a call-auction market, where traders also could use their rewards from the forecasts for asset trading.

Each of the 15 market periods on average lasted five minutes (including forecasts). In each period, assets with an initial lifetime of 15 periods can be traded. Each asset pays the same dividend to all its holders in a market. The dividend is randomly drawn after the trading at the end of each period. It can take a value of 10 ECU, 20 ECU, 40 ECU, or 80 ECU. The fundamental value of an asset is determined by the dividend stream that it generates to its holder. It corresponds to the sum of all expected future dividends. Consequently, the fundamental value declines to zero in the course of a market. After the final payment of the dividend in the last period, the asset becomes worthless.

Since our research focus lies in the propensity of markets to aggregate and disseminate information, we incorporate state-dependency of assets, as in Camerer and Weigelt (1991). Like in the SSW type markets, the dividend from holding an asset does not differ across traders. That means that markets have only one "type" of trader with regard to dividend value. However, the expected dividend depends upon the "state of the world", which is randomly drawn at the beginning of a market. There are two equally likely states. State 1 is called the "good" and State 2 the "bad" state. The set of possible dividend values is equal in both states of the world but dividend values occur with different probabilities. We have chosen probability distributions of the dividends in order to focus the subjects' attention on the two different expected values for the "good" and "bad" state and to determine two clearly distinguishable states of the world. Actual dividends originate from independent random draws out of the set $\{10, 20, 40, 80\}$ of possible dividends. The expected dividend per period in a given state is given by the probability weighted sum of the possible dividends. Table 1 provides the possible per period dividend values and the corresponding probabilities of occurrence under each of the two states. It also provides the expected per period dividend ED_S in each state $S \in (1, 2)$.

[6] We use incentivized belief elicitation because it can be expected that participants exert more effort to forecast correctly and that these forecasts are more accurate than non-incentivized, as was, for example, found by Gächter and Renner (2010).

Table 1: Possible Dividend Values and Probabilities

Possible Dividends	Probability in "Good" State ($S = 1$)	Probability in "Bad" State ($S = 2$)
10	0.1	0.4
20	0.2	0.3
40	0.3	0.2
80	0.4	0.1
ED_S	49	26

In the "good" state the probabilities of the higher dividends are larger than in the "bad" state, resulting in a higher expected dividend value per period and a higher FV in each period. The expected dividend per period is 49 in the "good" state and 26 in the "bad'" state. In the first period, with no information about the state at hand the expected dividend is 37.5. This value changes after each period's dividend draw according to Bayes' theorem, since the updated probability to be in one state or the other also changes according to this rule. For a given "state of the world", the FV is given by the product of the expected dividend per period and the number of remaining periods the dividend is paid. Formally, the FV in State S and period t is given by $(16 - t)ED_S$, assuming no discounting.

FVs in both states reduce after each period by the expected dividend per period. Given the ex-ante probabilities for the states and actual dividend draws Bayesian inference is possible due to the different drawing probabilities of the dividends in both states. The Bayesian fundamental value (BFV) in a given period is the probability-weighted mean of the FVs in the "good" and "bad" state in the respective period. The weights are given by the conditional probabilities based on Bayesian inference. The probabilities of dividends in both states of the world and the probabilities for both states are provided to all traders in the (read-aloud) experimental instructions and are thus considered as common knowledge. We additionally provided fundamental values for both states for participants to have common expectations about fundamentals (Cheung et al., 2014).

To have control over the drawn dividends and to render markets comparable, we follow the approach of Sutter et al. (2012). We randomly draw sequences of 15 realizations of the dividend (one for every period) with the respective probabilities in the "good" state and "mirror" this sequence for the realizations of the dividends in the "bad" state. This is easily feasible due to the symmetric framework. Among the randomly drawn sequences, we choose one that does not "fully" reveal the underlying state in early periods. This sequence (for the "good" state, or mirrored, for the "bad" state) is used for all markets.

Table 2: Sequence of Dividend Draws and Corresponding Fundamentals in the "Good" and "Bad" State

Period	"Good" State				"Bad" State				Cond. Prob.
	FV	D	AFV	BFV	FV	D	AFV	BFV	for the State
1	735	40	720	563	390	20	420	563	0.50
2	686	80	680	557	364	10	400	493	0.60
3	637	20	600	594	338	40	390	381	0.86
4	588	10	580	533	312	80	350	367	0.80
5	539	80	570	413	286	10	270	413	0.50
6	490	80	490	444	260	10	260	306	0.80
7	441	20	410	429	234	40	250	246	0.94
8	392	40	390	376	208	20	210	224	0.91
9	343	80	350	334	182	10	190	191	0.94
10	294	10	270	292	158	80	180	158	0.98
11	245	40	260	238	130	20	100	137	0.94
12	196	20	220	192	104	40	80	108	0.96
13	147	80	200	143	78	10	40	82	0.94
14	98	40	120	97	52	20	30	53	0.98
15	49	80	80	49	26	10	10	26	0.99

Notes: FV = Fundamental Values, D = Dividends, AFV = Actual Fundamental Values, BFV = Bayesian Fundamental Values.

In the experiment we have chosen the states in such a way that one half of the markets were in the "good" state and the other half in the "bad" state. Table 2 provides, for each state, the ex-ante expected FVs (if the state were known), the sequence of the actual dividend draws (Ds), the "ex-post" actual FVs (AFVs) and the (depending on the dividend draws) updated Bayesian FVs (BFVs). The last column of this table provides the conditional probabilities of the actually prevailing state at the beginning of the period.

The columns displaying the AFVs in Table 2 show that the selected sequences of dividends are not too optimistic or pessimistic with respect to the total value of dividends in comparison to the FVs. It can be thus assumed that both sequences properly represent the fundamentals of both states. As further can be seen, the dividends at the beginning correctly suggest the underlying state, then by period 5 reset state probabilities to 50:50, and subsequently again correctly suggest the underlying state. Toward the end, dividends reveal the state with almost certainty. This characteristic of the dividend stream has the desirable property to introduce initial uncertainty regarding the real state as it is surely frequently present on real markets.

Trading in the call market in each period lasts a maximum of 240 seconds. During the first 120 seconds traders have the opportunity to submit a purchase offer; in the second 120 seconds they have the opportunity to submit a sale offer. Each trader may determine one buy and one sell limit order per period to buy/sell a certain number of assets. A buy (sell) order consists of the maximum (minimum) price which a trader wants to pay (is willing to accept) per asset and the maximum number of assets the trader is willing to buy (sell) at that price. Traders are not obliged to submit buy and/or

sell orders. In the case of a "zero order" no assets are bought and/or sold at any market price; traders just keep their stock of assets. At no point of time, traders get to know the offers of others.

All bids and asks within a period are submitted simultaneously and are aggregated into market demand and supply. The call market features a market-clearing condition such that demand equals supply in each trading period. Markets are cleared at unitary prices for all transactions within each period so that the trading volumes are maximized.[7] Transactions only take place as long as there are dealers who want to sell at a lower or the same price than other dealers are willing to pay. The market price is determined by the average of the lowest limit buy price and the highest limit sale price for which a transaction takes place. No trader has to pay more for an asset than he/she offered and no trader has to sell for less than he/she asked. If the aggregated market price lies above the chosen sale price the trader is a seller and if the market price lies below the chosen buy price the trader is a buyer. If, depending on the submitted buy and sell orders, no transactions can take place, there is no market price. In this case we referred to the market price as zero.

Ties on the demand and/or selling side are handled using an order precedence rule consisting of the price, quantity and entering time. On the buy (sell) side higher (lower) buy (sell) prices, higher quantities, and an earlier submission time are favored.[8] Traders are instructed that they might not get all or part of their buy/sell order fulfilled even if they hand in an adequate price.

During the choice of buy and sell offers, traders have to make sure that these are permissible. Firstly, they can never sell more assets than they have at the beginning of the period in their own portfolio. Secondly, never buy more assets as permitted by the available sum of asset holdings of the other traders in their group. Thirdly, never buy more assets at a certain price than permitted by the available trading capital. Fourthly, the limit sell order price must exceed the limit buy order price by at least one ECU.

At the end of the trading state in each period all possible individual transactions are completed, the drawn dividend is announced, and the updated account of asset and trading capital holdings along with the dividend earnings for the current period are presented to the traders. Additionally the results for the accuracy of price forecasts along with the associated earnings are given for the current period. Furthermore, traders are provided with a complete history of relevant information concerning their portfolio (asset and cash holdings etc.) during both phases of the trading stage in each period.

[7] The call market institution has the advantage that it yields for each trader a unique trading price per period for all buy and sell orders. Furthermore, Liu (1992) found that call markets are more efficient than continuous double auction markets in settings were uninformed traders are present jointly with diversely informed insiders (Sunder, 1995).

[8] Index $= 100 \cdot R_{p_{D,S}} + 10R_{q_{D,S}} + E$, where $R_{p_{D,S}}$ is the price rank, decreasing with ascending (descending) buy (sell) price; $R_{q_{D,S}}$ is the quantity rank, decreasing in the buy (sell) quantity; and E is the entering order number. Lower rank numbers are favored and a lower index corresponds to a preferred offer.

The payout relevant profit (in ECU) to a subject is determined by the available trading capital at the end of the 15th period minus the initial working capital. It can be alternatively calculated as the sum of the period profits:

$$\begin{aligned}\text{Period profit} = {} & \text{Number of assets at end of the period} \times \text{dividend per asset} \\ & + \text{Proceeds from sold assets} \\ & - \text{Expenses for purchased assets} \\ & + \text{Remuneration of market-price forecast(s)}\end{aligned} \tag{1}$$

Following the method of induced value theory, we expect traders to exhibit a positive utility for money, i.e., to maximize their earnings. Demand for (Supply of) assets is hence induced by a preference for (higher) earnings (Smith, 1976).

All trading in the experiment was in terms of Experimental Currency Units (ECU). Earnings were converted into Euros at the end of the market, at a known rate of 0.003 €/ECU. Additionally, each trader was paid a show-up fee of 3 €. A session lasted on average about 2.5 hours. Traders' earnings averaged about 25 €[9].

2.2. Treatments

We conducted our experiment by using a 2 × 2 design. Firstly, the information structure of markets differed across sessions, i.e., the structure of informed and uninformed traders with respect to the true state of nature differed across markets. In the so called Nin(B)[10] sessions no participant was given a clue about the true state of nature and it was announced that no trader received information about the state. In the so called Tin(B) sessions two participants in a market are provided on the computer screen with information about the underlying "state of the world" at the beginning of the market. In these sessions it was publicly announced (common knowledge) that there will be two randomly chosen informed traders in each market and that their identity will remain secret to all other participants. The information given to the informed participants was identical and perfect in the sense that it would reveal the state of nature with certainty (this was also common knowledge). By virtue of the design of the markets, insiders and outsiders were the same traders throughout the entire markets. Secondly, we distinguish between sessions where participants were or were not provided with updated conditional probabilities for both states and the corresponding BFVs. The B after Nin and Tin indicates that in these markets all traders were provided with updated BFVs in each period.

[9] Despite of the compulsory repayment of the initial working capital, no participant actually faced a loss (earnings of zero). The minimum payout earned in the markets is 7.36 € (1453.5 ECU + 3 € show-up fee).
[10] When markets with or without insider information are considered together, regardless of the provision of BFVs, we refer to them simply as Tin(B) and Nin(B) markets.

Table 3: Markets and Information Levels

Treatment No.	Label	State	State Label	BFVs	Insiders (#)	Market No.
1	Nin	Good Bad	Nin+ Nin-	No	No	17, 19, 21, 23 18, 20, 22, 24
2	NinB	Good Bad	NinB+ NinB-	Yes	No	1, 3, 5, 7 2, 4, 6, 8
3	Tin	Good Bad	Tin+ Tin-	No	Two	25, 27, 29, 31 26, 28, 30, 32
4	TinB	Good Bad	TinB+ TinB-	Yes	Two	9, 11, 13, 15 10, 12, 14, 16
5	"SSW"	---	---	No	"Six"	33, 34, 35, 36, 37, 38, 39, 40

Note: Markets are numbered in the order how the observations were collected during the experimental sessions.

Thirdly, we conducted a control treatment in that we used the same set of possible dividends $\{10, 20, 40, 80\}$, which were, however, equally likely to occur (25 percent). There was no uncertainty about the state, such that traders were in a sense all "insiders". Table 3 displays a summary of the design parameters of each of our 40 asset markets. Specifically, it gives an overview over the underlying state, the provision of BFVs, and the presence of insiders in each market.

3. Informational Models and Hypotheses

3.1. Informational Models

Following the studies of, for example, Camerer and Weigelt (1991) and Plott and Sunder (1982; 1988), we test two different models: the prior information equilibrium (PI) model and the fully revealing rational-expectations equilibrium (RE) model. Both models assume traders to be risk-neutral and give different forecasts about trading behavior of differently informed traders. These models can be formalized quantitatively and tested against each other.

The PI-model states that traders use their prior dividend information to build expectations about the state but do not learn from price signals. They ignore the informational content of market prices (reflecting the aggregated information held by others) and speculation possibilities based on the actions of other traders (Palan, 2009). Traders only use Bayes' rule to update their expectations about the true state.

The RE-model additionally states that in equilibrium all traders behave as if they are aware of the entire information of all traders in the market. Thus even uninformed traders have the ability to supplement their prior ("private") information with private information of others via price signals from the market that entail (perfect) information of insiders.[11] They are aware of the relationship between the market price, the underlying state, and their gains from trade and utilize the market price and their "private" information in their demand decision (Tirole, 1982).

In our experiment we chose dividends, prior probabilities of dividends, and states in a manner that fundamentals and hence predictions of the PI- and RE-models clearly differ in both states. Table 4 shows the expected FVs per asset with respect to information, state, and informational model. Independent of the state, when there is no inside information in the market, the PI- and the RE-models both predict no trade, when traders have identical risk preferences. According to both models, all traders have the same expectations about the FVs, which equal the BFVs. There are no evident gains from and thus no incentives to trade. Traders with different risk preferences, however, will trade since the more risk-loving traders would attribute a higher value per asset than the more risk-averse traders leading to an asset flow from the latter to the former.

[11] The RE-model has a close connection to the efficient markets hypothesis. Bid/ask prices reflect diverse private information and thus induce trading actions identical to those if all traders had all market information (Harrison and Kreps, 1978).

Table 4: Expected FVs under PI and RE by Information and State

	No Information		Inside Information			
	"Good"	"Bad"	"Good"		"Bad"	
Period	PI = RE	PI = RE	PI	RE	PI	RE
1	563	563	**735** **[563]**	**735** **[563]**	390 [563]	390 [563]
2	557	493	686 [557]	686 [686]	364 [493]	**364** **[364]**
3	594	381	637 [594]	637 [637]	338 [381]	338 [388]
4	533	367	588 [533]	588 [588]	312 [367]	312 [312]
5	413	413	539 [413]	539 [539]	286 [413]	286 [286]
6	**444**	**306**	490 [444]	490 [490]	**260** **[306]**	260 [260]
7	429	246	441 [429]	441 [441]	234 [246]	234 [234]
8	376	224	392 [376]	392 [392]	208 [224]	208 [208]
9	334	191	343 [334]	343 [343]	182 [191]	182 [182]
10	292	158	294 [292]	294 [294]	156 [158]	156 [156]
11	238	137	245 [238]	245 [245]	130 [137]	130 [130]
12	192	108	196 [192]	196 [196]	104 [108]	104 [104]
13	143	82	147 [143]	147 [147]	78 [82]	78 [48]
14	97	53	98 [97]	98 [98]	52 [53]	52 [52]
15	49	26	49 [49]	49 [49]	26 [26]	26 [26]

Notes: Figures show for the case of insider information the known FVs for informed and expected FVs for [uninformed] traders. The bold figures identify the convergence period as defined in Section 4.1.

When insider information is present, both, the PI- and the RE-model, predict different expectations about fundamentals of in- and outsiders. For the RE-model this is only true for the first period. In addition to the differences in expectations, the occurrence of trade requires that outsiders do not behave rationally. Rational outsiders would not trade since they know that trading with insiders is only to their detriment. If trade occurs, the market price will approximately average the expected FVs under the assumption that in- and outsiders are strict payoff maximizers and place bid prices marginally below and ask prices marginally above their expected FVs.

Since in the first period the resulting market price is higher (lower) than the BFV of 563 in the "good" ("bad") state, outsiders update their prior information with this price

signal and are able to infer the correct state under the RE-model assumptions. Informed traders can thus take advantage of their superior position in the first period only. Under the PI-model, with traders that do not behave in a fully rational way, trade may virtually take place throughout all periods, assuming availability of assets on the supply side and sufficient trading capital on the demand side. Since market participants ignore the informational content of market prices, expectations about fundamentals only converge slowly to the true value, which leads to a more persistent superior position of insiders. According to both models, trading will result in asset allocations where insiders hold more (less) assets in the "good" ("bad") state than outsiders, as long as traders have identical risk preferences and behave not fully rational. Heterogeneous risk preferences may additionally induce trading and enforce or mitigate the predicted asset allocation pattern.

3.2. Hypotheses

To facilitate the illustration of the results in the following section our analysis focuses around six hypotheses.

Hypothesis 1: *Trading prices converge toward the actual FV under all treatment conditions but the convergence is faster in markets with insider information and markets where traders are provided with BFVs.*

In our markets, convergence toward fundamentals depends substantially on the accuracy of the probability assessment. This is a complex task, especially in an experimental situation, where time is limited. Markets aggregate information. However, it will take time for prices to track the FV.[12] Following Romer (1993), the dissemination of privately held information and/or expectations is likely to cause lagged price movements. Proponents of the "efficiency camp" of insider trading argue that convergence of market prices toward fundamentals is faster when inside information is present (Engelen and Liedekerke, 2007; Manne, 1984; McGee, 2008). Sutter et al. (2012) and Dufwenberg et al. (2005) provide experimental evidence that markets where some traders have an informational/experiential edge above others show a significantly better performance in terms of market efficiency. Since people are unlikely to carry out Bayesian inference by themselves (Camerer, 1999; Kahneman and Tversky, 1972; Rabin and Schrag, 1999), we expect markets where traders are provided with BFVs to converge faster toward fundamentals than markets that are not.

Hypothesis 2: *Bubbles occur but the introduction of asymmetrically informed traders or the provision with BFVs significantly reduces the occurrence and extent of bubbles.*

[12] Forsythe et al. (1984) argue that "investors bring only their private information to the market and only after traders have observed prices will they learn the information necessary to achieve the [fully revealing rational-expectations equilibrium]." (p. 973)

A vast literature shows that the bubble-and-crash phenomenon is strikingly robust in SSW markets (see footnote 4). Since the introduction of insider information is expected to enhance market performance in terms of the duration of equilibrium adjustment of market prices, we expect markets with asymmetrically informed traders to be less prone to bubble formation than markets with symmetrically informed traders, a result also observed by Sutter et al. (2012) and Dufwenberg et al. (2005). Similarly, given that markets that are provided with BFVs are expected to converge faster toward fundamentals than markets that are not, we also expect them to exhibit smaller bubbles.

Hypothesis 3: *In early periods, trading behavior of uninformed traders differs from that of informed traders but converges along with the market price toward that of informed traders. Uninformed traders learn to grasp the correct state and to trade accordingly.*

Informed traders condition their trading behavior on private information and uninformed traders adapt their trading behavior based on the belief that informed traders only trade if it is advantageous for them to do so, thereby revealing gradually the underlying state. In a fully revealing RE all private information held by informed traders is (sooner or later) revealed via the market price (King, 1991). To the same extent as information is revealed, we expect that an adaptation of the trading behavior of in- and outsiders takes place.

Hypothesis 4: *In the "good" state, we expect insiders to hold more assets than outsiders, and in the "bad" state, outsiders to hold more assets than insiders.*

Given the different information structures of in- and outsiders, we expect the two types to show a significantly different buying and selling behavior. In Table 4 above we calculate the FV expectations of in- and outsiders. Based on these calculations we derive that insiders buy/hold more assets in the "good" state and outsiders in the "bad" state, under both the PI- and RE-assumption. The predicted asymmetric asset distribution should at least hold true in earlier periods, since we expect outsiders to learn in the course of the market.

Hypothesis 5: *Informed traders have a trading advantage and earn superior profits.*

Given that, especially in the beginning of the markets, insiders are able to buy and sell their assets for advantageous prices they should benefit from their superior informational position.

Hypothesis 6: *Elicited price expectations and actual market prices are highly correlated. Thereby, we expect predictive power to be greater in markets with inside information, and in markets where traders are provided with BFVs.*

There is a certain circularity in the market-price development process since current prices depend on expectations about future prices; but both are simultaneously influenced by current price levels and trends (Ball and Holt, 1998). Self-fulfilling price expectations can render observed market prices independent of the asset's fundamentals, leading to bubbles, in which even rational traders get involved in the

expectation of even "greater fools".[13] Expectations should therefore provide crucial information about the market price development.

[13] Such bubbles are referred to as "rational growing bubbles" (Camerer, 1989) or simply "rational bubbles" (Diba and Grossman, 1988b). They "reflect a self-confirming belief that the stock price depends on a variable (or a combination of variables) that is intrinsically irrelevant" (Diba and Grossman, 1988a, p. 520). Porter and Smith (1995), however, find that "subjects report a tendency to think that if the market turns [when the bubble bursts] they will be able to sell ahead of the others, but then are "amazed" at the speed with which the crash occurs." (p. 513)

4. Experimental Results

4.1. Equilibrium Adjustment of Market Prices

Figure 1 illustrates the main findings of our experiment by showing the course of the average equilibrium market prices in our four treatments. Each curve in the four graphs represents four markets under equal conditions with respect to state, insider information, and the provision of BFVs. All four graphs show the tendency of convergence toward the correct state. Most intriguing, the ubiquitous tendency of earlier laboratory asset markets with well-defined declining fundamental value and inexperienced traders to exhibit a well-known bubble-and-crash pattern is not observed in this aggregated examination, independent of the provided information structure.

Strikingly, trade in both states starts, regardless of the presence of insiders and/or the provision of BFVs, on aggregate closer to fundamentals in the "bad" state, indicating risk aversion for the average trader.[14] Indeed, we find slight risk aversion for the average trader in our risk pretests and in the personal assessment of one's own attitude toward risk in the ex-post questionnaire (see Appendix A, Table A. 1 to Table A. 4). Given that average risk attitudes are very similar in all markets, we cannot find a significantly negative Spearman correlation between the average risk-aversion measure in a market and the 1st period market price.[15] However, when counting the number of risk-averse (not risk-neutral, or risk-loving) traders per market, we find a slightly significant Spearman correlation for Risk-Test 1 following Holt and Laury (2002) (ρ = -.3049, p-value = .0897, N = 32). Despite the substantial initial deviations from fundamentals (especially in the "good" state), we observe a clear tendency of convergence of aggregate market prices toward fundamentals of the actually underlying state around the fifth period. Intuitively, convergence starts in either state somewhere between the two fundamentals. This implies that we should observe convergence from below in the "good" state and convergence from above in the "bad" state. In the following we explore Hypothesis 1.

While markets on aggregate show a clear convergence pattern, individual markets show substantial diversity. Some markets perform much better than others in terms of convergence toward the FV of the underlying state. Ten out of 32 markets even never converge to it.[16] We consider market prices as "converged" if they approach the respective FV as close as $\pm 20\%$ and stay in this range until the end of the market or no more trading takes place. For the very last periods, our definition of convergence

[14] Since dividend draws can be considered as lotteries, trading prices below (above) fundamentals indicate risk aversion (loving) of the average market participant. Hence, the ratio of the realized price and the fundamental value can serve as a proxy for average risk attitude in a market (Chen et al., 2004).

[15] The algebraic signs point in the intuitive direction that higher risk aversion in a market leads to a lower starting price. Only for "Risk-Test 2b" the sign is counterintuitive.

[16] Markets 4, 6, 9, 10, 15, 21, 26, 28, 30, 32 never converged toward the FV of the actual underlying state using the applied convergence measure.

requires at least two consecutive periods without trading, when market prices previously have deviated out of the range.[17] Figure 2 shows the course of individual market prices for all markets in the four treatments. As seen, market prices initially fluctuate more erratically, but converge in most cases, sooner or later, toward the genuine state. Table 5 presents the average convergence period by treatment and the individual market convergence periods for the markets that have converged.

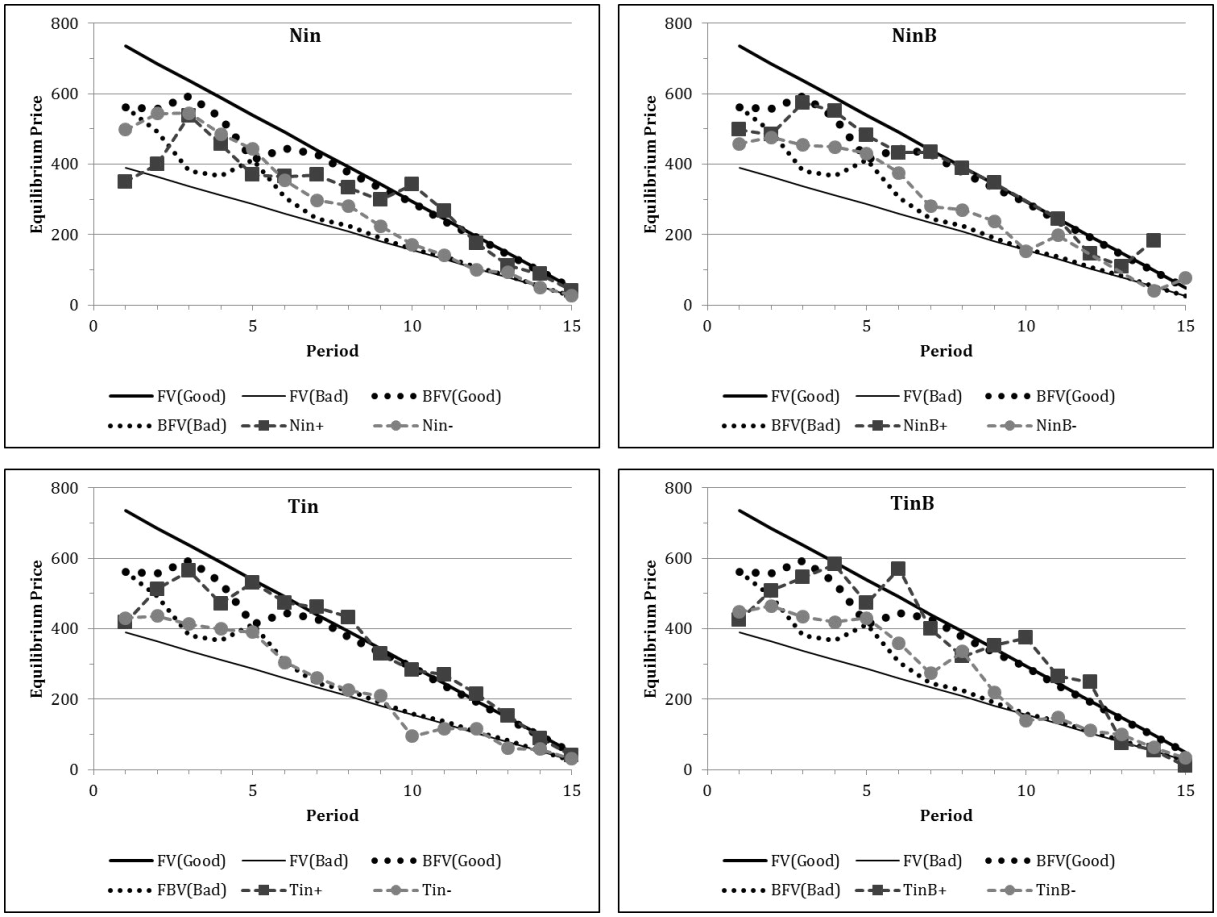
To test for general convergence, we count for each treatment the number of markets that have converged. Applying one-sided binomial tests to the number of converged versus the number of non-converged markets, we find a significant tendency of convergence only for Nin, where seven out of eight markets converge (p-value = .0039). The hypothesis of general convergence is neither confirmed for NinB nor for Tin or TinB markets, when analyzed separately.

When pooling the Nin and NinB markets, we observe 13 of 16 markets to converge, which yields statistical significance for general convergence (p-value = .0106, one-sided binomial test). Pooling Tin and TinB markets, we observe only 9 out of 16 markets to converge, implying no statistical significance. This indicates that the presence of insiders does not enhance but rather defer market convergence. On the other hand, confidence intervals for the absolute deviations from fundamentals are for the majority of periods narrower for Tin(B) than for Nin(B) markets. Although not statistically significant, this suggests that the above result lack of convergence in Tin(B) markets is driven by the small number of independent markets.

Result 1: *Using our simple counting measure, we only observe a general convergence toward fundamentals in Nin(B) markets. Our test for general convergence indicates that the presence of insiders defers convergence. This result, however, might be an artifact produced by the relatively small sample size. The provision of BFVs has no effect on convergence.*

[17] This "rule" has been relaxed/adjusted in some markets, where the measure in the last five periods trespassed the range in only one period, but was adhered to before, so that the assumption of convergence seems prudent. This "correction" has the aim to obtain a more "organic" and adequate measure of convergence. When no trading occurs, no pair of traders is willing to trade away from fundamentals, indicating that all traders are aware of the actual FV and that it is common knowledge (as defined by Aumann (1976)). There is no opportunity to "fool" another trader.

Figure 1: Average Market Prices



The trajectory of average market prices exhibits clear differences in comparison to most of earlier experiments using the SSW framework. Even in Nin markets the price course resembles that of markets with experienced traders or markets with a composition of traders with mixed information or experience levels (see, for example, Dufwenberg et al. (2005), Haruvy et al. (2007), Hussam et al. (2008), and Sutter et al. (2012)). Additionally, convergence, as we have defined it, occurs on average later than predicted by the PI- and RE-models,[18] except for NinB+ and Tin-. We thus conclude that neither the PI- nor the RE-model provide indeed good approximations of asset markets in our symmetric and asymmetric information settings. This finding stands in contrast to the previously mentioned literature on markets involving one-period assets and asymmetric information.

[18] Both, the PI- and RE-models, predict convergence to occur (as we define it) in the sixth period in both states, when no insiders are present. The PI-model predicts convergence in the first and in the sixth period and the RE-model predicts convergence in the first and in the second period, in the "good" and "bad" state, respectively, when insiders are present.

Figure 2: Individual Market Prices

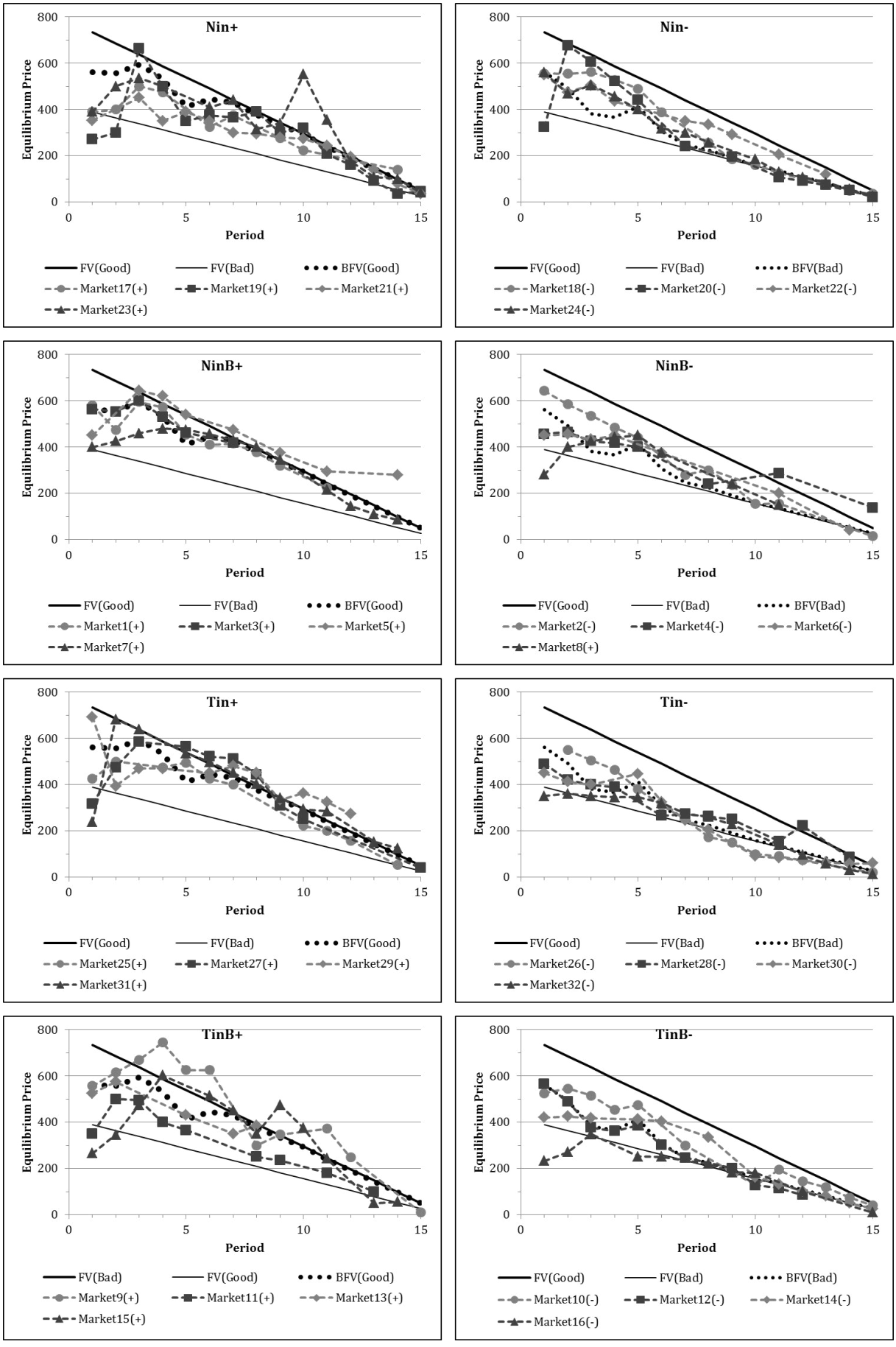


Table 5: Periods of Convergence

State Label	Average Period of Convergence	Individual Markets Convergence Periods	Market No.
NinB+	5.3	3, 2, 2, 14	1, 3, 5, 7
NinB-	10.0	10, --, --, 10	2, 4, 6, 8
TinB+	11.0	--, 14, 8,--	9, 11, 13, 15
TinB-	6.0	--, 6, 9, 3	10, 12, 14, 16
Nin+	13.3	11, 15, --, 14	17, 19, 21, 23
Nin-	9.5	9, 6, 14, 9	18, 20, 22, 24
Tin+	7.3	11, 3, 13, 2	25, 27, 29, 31
Tin-	--	--, --, --, --	26, 28, 30, 32

Notes: Markets that did not converge are denoted by "--". Averages are computed using converged markets only.

4.2. Over- and Undervaluation of Market Prices

This chapter focuses on Hypothesis 2. As mentioned earlier, bubbles didn't occur in aggregated form. However, some markets exhibited patterns that, though smaller than in many previous experiments, could be considered as price bubbles. To gauge the severity of market-price deviations from fundamentals, i.e., differences in market performance, we employ two deviation measures,[19] both developed by Stöckl et al. (2010).

The applied average bias measure for a market calculates the relative deviation (RD) as the average difference between the market price (P_t) and the fundamental value (FV_t) normalized by the average fundamental value ($\overline{FV}$). It measures the average relative distance between the market price and the fundamental value. A value of ±0.1 indicates that the assets are on average overvalued (undervalued) by 10% relative to the average fundamental value.

$$RD = \frac{1}{15}\sum_{t=1}^{15}\left(\frac{P_t - FV_t}{\overline{FV}}\right) \qquad (2)$$

The applied average dispersion measure for a market calculates the relative absolute deviation (RAD) as the average absolute difference between the market price (P_t) and the fundamental value (FV_t) normalized by the average fundamental value ($\overline{FV}$). It measures the average absolute distance between the period market price and the

[19] Given the high correlation of these deviation measures with other calculated "bubble" measures, we restrain our analysis with the focus on these potentially most reliable measures, RD and RAD. These measures are robust to variations in the number of market periods, the determination of the FV and dividend distribution/variation.

fundamental value. A value of 0.1 indicates that the assets price differs on average by 10% from the average fundamental value.

$$RAD = \frac{1}{15}\sum_{t=1}^{15}\left(\frac{|P_t - FV_t|}{\overline{FV}}\right) \tag{3}$$

Both measures are used to get a first impression of differences in price deviations from fundamentals between treatments. We conduct two-sided Mann-Whitney U tests with the null hypothesis of no difference for both deviation measures. Table 6 displays the results. RDs are not significantly different when compared by treatment, due to the fact that negative deviations in the "good" and positive deviations in the "bad" state cancel each other out. The comparison of RADs shows that the provision of BFVs is only conducive to market performance when no insiders are present. The presence of insiders enhances performance compared to the situation without insiders, however, only when no BFVs are given. The performance of markets where insiders are present and BFVs are given together is indistinguishable to markets where only one of these features is at work.[20] [21]

To check the robustness of the results above and for a deeper understanding of potential factors that influence price formation and thus over- or undervaluation of equilibrium markets prices, we conduct panel-regressions with markets as cross sections ($m = 1, \ldots, 32$). The dependent variable is derived from the above mentioned RD measure (Stöckl et al., 2010), denoted in percent. It is defined as:

$$RD_{mt} = \frac{P_{mt} - FV_t}{\overline{FV}}, \tag{4}$$

where RD_{mt} measures the difference between the market price of period t (P_t) and the respective fundamental value (FV_t), normalized by the average fundamental value ($\overline{FV}$) (Stöckl et al., 2010). The index m denotes the market.

[20] We also calculated the normalized absolute price deviation measure $ND = \frac{\sum_{t=1}^{15}|P_t - FV_t|}{60}$, which was introduced by King et al. (1993) and van Boening et al. (1993). ND sums up the deviations of the market prices from the FVs and normalizes this sum by the total number of assets outstanding in a market. Given that this measure yields qualitatively the same results as RAD, we refrain from a detailed presentation of the figures for this measure.

[21] Given the structure of our markets, it could be interesting to replace FV by BFV in both deviation measures. Since the results remain qualitatively very similar, we refrain from the presentation of these results.

Table 6: Relative and Absolute Deviation Measures from Fundamentals

Comparison by		Nin	NinB	p-value	Tin	TinB	p-value
Bayes[a]	RD	0.058	0.074	.8336	0.015	0.018	.9164
	RAD	0.291	0.195	**.0357**	0.176	0.200	.5286
		Nin	Tin	p-value	NinB	TinB	p-value
Insider[a]	RD	0.058	0.015	.8747	0.074	0.018	.5286
	RAD	0.291	0.176	**.0033**	0.195	0.200	.7527

Comparison by		Nin+	Nin-	p-value	NinB+	NinB-	p-value
State[b]	RD	-0.202	0.319	**.0209**	-0.095	0.243	**.0209**
	RAD	0.242	0.339	**.0209**	0.124	0.265	**.0433**
		Tin+	Tin-	p-value	TinB+	TinB-	p-value
State[b]	RD	-0.097	0.128	**.0209**	-0.113	0.148	**.0433**
	RAD	0.149	0.203	.1489	0.185	0.214	.7728
		Nin+	NinB+	p-value	Nin-	NinB-	p-value
Bayes[b]	RD	-0.202	-0.095	**.0833**	0.319	0.243	.2482
	RAD	0.242	0.124	**.0209**	0.339	0.265	.2482
		Tin+	TinB+	p-value	Tin-	TinB-	p-value
Bayes[b]	RD	-0.097	-0.113	.7728	0.128	0.148	.5637
	RAD	0.149	0.185	.3865	0.203	0.214	.7728
		Nin+	Tin+	p-value	Nin-	Tin-	p-value
Insider[b]	RD	-0.202	-0.097	**.0591**	0.319	0.128	**.0209**
	RAD	0.242	0.149	**.0209**	0.339	0.203	**.0209**
		NinB+	TinB+	p-value	NinB-	TinB-	p-value
Insider[b]	RD	-0.095	-0.113	.7728	0.243	0.148	.3865
	RAD	0.124	0.185	.2482	0.265	0.214	.3865

Notes: Mann-Whitney U test, two-sided: [a] N = 16 (8/8), [b] N = 8 (4/4).

We control for treatment effects by using dummy variables for different treatment features (considering Nin+ as the control group) and their interactions. In particular, we control for the "state of the world" ($State$, which is equal to one in the "bad" state and zero otherwise), for the provision of BFVs ($Bayes$, which is one when BFVs are given and zero otherwise), and for the presence of insiders ($Insiders$, which is equal to one, when insiders are present, and zero otherwise). Additionally, we control for autocorrelation by inclusion of the dependent variable with a lag of one period ($L.\ RD$), for a time trend within markets by inclusion of a period variable ($Period$), and for the trading volume ($Volume$). Furthermore we included the drawn dividend in the prior period ($L.\ Dividend$) and the number of risk-averse traders within a market ($\#\ Risk\ Averse$) as explanatory variables. The results are shown in Table 7.

Since both regression models shown in Table 7 display qualitatively the same results, we focus our analysis on Model 2. The model shows that price deviations are strongly path-dependent; a price deviation in the previous round ($L.\ RD$) has a significantly positive effect on the current price deviation. Price deviations decrease over time as participants

gain trading experience. $Period$ has a significantly negative effect on price deviation. The last dividend ($L.\ Dividend$) has a significantly positive (euphoriant price boosting) effect, the higher the dividend in the previous period the larger the price deviation in the current period. Trading activity as measured by $Volume$ has no significant effect, just as the number of risk-averse traders within a market ($\#\ Risk\ Averse$).

Turning to the effects of treatment features, we see that "bad"-state markets exhibit significantly larger price deviations then "good"-state markets, a non-surprising finding, consistent with the prior nonparametric analysis. The provision of BFVs has no effect in both states, when the utilized control variables are considered. This contradicts the nonparametric result. We do not expect that this lack of difference is caused by the fact that traders were actually able to calculate BFVs in the setting where they were not provided. But traders seem to be intuitively able to anticipate approximated BFVs. The presence of insiders is only significant, i.e., exerting a negative (price deviation decreasing) effect in "bad"-state markets,[22] a finding that requires further analysis for a proper understanding.

We are able to calculate the treatment effects (coefficients), given that treatments are comprised of combinations of several features. These coefficients are presented in Table 8 in descending order in terms of the coefficient size. The calculated coefficients are equal to the ones that result out of a regression with treatments as dummy variables and Nin+ as baseline.

Using these coefficients we are able to disentangle differences between treatments by conducting meaningful comparisons which consist of three comparisons for each treatment: (1) a comparison with the counterpart in the "bad"/"good" state, (2) a comparison with the counterpart where BFVs are/are not provided, and (3) a comparison with the counterpart where insiders are/are not present, respectively. We conduct Wald tests to test for the equality of estimated coefficients for these comparisons. The results can be retraced via Table 9, where all possible comparisons are shown and significant differences are highlighted as bold figures.

Our finding that "bad" state markets exhibit significantly larger price deviations then "good"-state markets is confirmed with the exception of Tin markets, where deviations in the "bad" state are larger, however, statistically insignificant. The result that the provision of BFVs has no effect is unambiguously confirmed. Moreover, as already seen, the presence of insiders significantly reduces price deviations in "bad"-state markets, leading to an improved market performance.

[22] This outcome is, as explained later, driven by the fact that Nin+ and Tin+ markets are not statistically different. For NinB+ and TinB+ markets the presence of insiders is beneficial.

Table 7: Regressions for RDs of Market Prices from Fundamentals

Dependent Variable: RD_{mt}	Model 1	Model 2
Constant (Nin+)	6.30	-3.53
	(5.01)	(10.12)
$L.RD_{mt}$	0.56***	0.57***
	(0.05)	(0.04)
Period	-1.15***	-1.20***
	(0.41)	(0.57)
Volume	0.13	0.10
	(0.27)	(0.26)
State (Nin-)	22.30***	25.38***
	(7.03)	(8.22)
Bayes (NinB+)	-4.75	-2.68
	(4.08)	(4.87)
Insiders (Tin+)	4.43	4.66
	(4.87)	(5.10)
State×Bayes	6.56	3.12
	(6.54)	(9.12)
State×Insiders	-16.39**	-17.29*
	(7.93)	(10.09)
Bayes×Insiders	8.63	6.42
	(6.53)	(7.60)
State×Bayes×Insiders	-8.06	-3.05
	(9.41)	(12.98)
L. Dividend		0.12***
		(0.04)
# Risk Averse		0.92
		(1.68)
R^2	.7478	.7534
N	247	247

Notes: Prais-Winsten panel-regressions with heteroskedastic panels corrected standard errors and panel-specific autocorrelation (AR1) (Beck and Katz, 1995). 32 markets as cross sections with a maximum of 15 observations over time (unbalanced). Only periods where trade took place are considered. Standard errors are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 8: Treatment Effects on RDs of Market Prices from FVs in Model 2

Treatment	Effect of…	Coefficient	p-value
NinB-	*S+B+SB*	25.82	**.000**
Nin-	*S*	25.38	**.002**
TinB-	*S+B+I+SB+SI+BI+SBI*	16.56	**.000**
Tin-	*S+I+SI*	12.75	**.004**
TinB+	*B+I+BI*	8.40	**.062**
Tin+	*I*	4.66	.361
Nin+	---	-3.53	.727
NinB+	*B*	-2.68	.582

Notes: *S* = State ("Bad"), *B* = BFVs (provided), *I* = Insiders (present).

Table 9: Wald Test for Differences of Treatment Coefficients in Model 2

	NinB+	NinB-	TinB+	TinB-	Nin+	Nin-	Tin+	Tin-
NinB+	---	**.000**	**.018**	**.000**	.582	**.000**	.103	**.002**
NinB-		---	**.001**	**.032**	**.000**	.942	**.000**	**.003**
TinB+			---	**.077**	**.062**	**.027**	.469	.364
TinB-				---	**.000**	.175	**.016**	.379
Nin+					---	**.002**	.361	**.004**
Nin-						---	**.005**	**.087**
Tin+							---	.134
Tin-								---

Notes: p-values of Wald tests for the simple linear hypothesis of equality of estimated parameters are shown. Nin+ is the reference category. Bold figures show significant differences at the 10 % level.

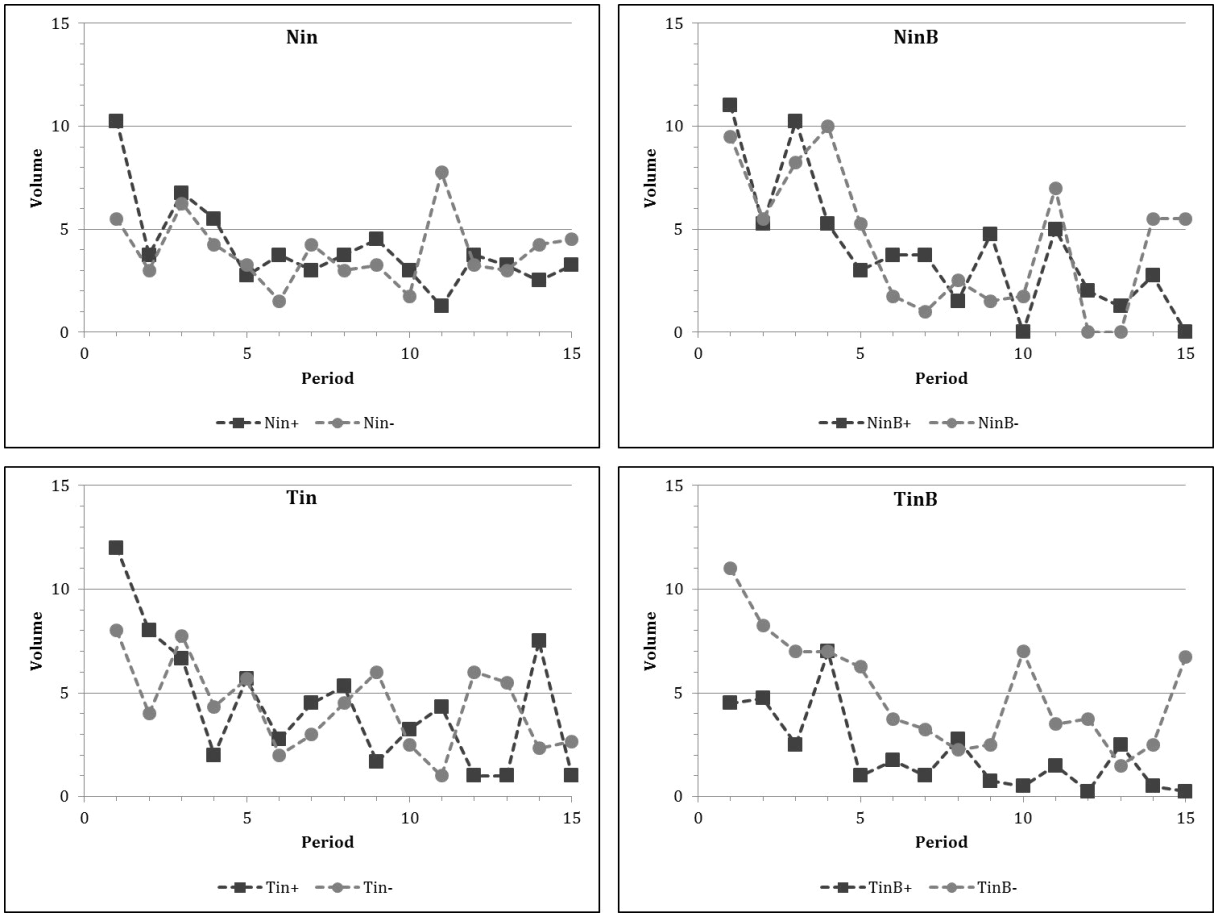
Furthermore, the presence of insiders leads to an increase of the deviation measure in the "good" state, which, given that "good"-state markets tend to trade below fundamentals, leads to an improvement in market performance, i.e., deviations from FVs are smaller in absolute terms, when insiders are present; however, the difference between Nin+ and Tin+ is not significant. Thus, these findings confirm and broaden the prior findings of the nonparametric analysis.[23]

Result 2: *Bubbles occur but are infrequent. The nonparametric analysis indicates that the introduction of insiders reduces bubbles, measured by RD and RAD, however, only when BFVs are not provided. The provision with BFVs significantly reduces deviations, however, only when no insiders are present. The performance of markets where insiders are present and BFVs are given together is not distinguishable from markets where only one of these ingredients is at work. The panel analysis refines and demerges the previous results and indicates that the introduction of insiders improves market performance (measured by* RD_{mt}*) and that the provision of BFVs has no effect on market performance.*

For the sake of completeness, Figure 3 presents the course of the average trading volumes conditioned on information and the provision of BFVs. Each curve represents the average over four markets, in the "good" or "bad" state, respectively. The trading volume shows a tendency to decline on average with market duration. Trading volumes do not to differ significantly between different treatment conditions.

[23] The replacement of FV by BFV in the RD measure of the regressions yields qualitatively very similar results, we thus refrain from the presentation.

Figure 3: Average Trading Volume



4.3. Comparison of Insider and Outsider Behavior

Following the investigation of overall trading patterns, we now turn to the analysis of the trading behavior of in-and outsiders and explore Hypotheses 3 to 5. Figure 4 shows the course of average limit buy and sell order prices in the TinB and Tin markets.[24] As can be seen, in- and outsider limit bids and limit asks differ but not substantially. Limit buy and sell order prices only differ clearly in the first period(s) of the TinB- and Tin+ markets. In these cases both prices are lower for insiders in the TinB- markets (in the case of limit sell order prices "irrationally" low) and higher in the Tin+ markets, respectively. Furthermore, the following general patterns are visible. Firstly, both trader types, on average, want to pay less when buying and ask higher prices when selling assets compared to the actual FV in the TinB+ and Tin+ markets. Secondly, both trader types, on average, want to pay approximately the FV to buy assets but ask more than the actual FV to sell assets in the TinB- and Tin- markets.

Result 3: *Trading behavior of uninformed traders at the beginning differs from that of informed traders but converges with the market price during the market toward that of informed traders. Uninformed traders are able to grasp the correct state and to trade accordingly to it.*

We continue our analysis with nonparametric statistical tests on first-period bid and ask behavior of in- and outsiders, measured by the limit buy/sell order prices and quantities. First-period behavior of outsiders does not differ between the two states (using two-sided U tests), whether BFVs are provided or not. In other words, the starting positions of outsider bid and ask prices and quantities are the same in the "good" and "bad" state. First-period behavior of insiders, on the contrary, differs significantly between the two states, with higher bid/ask prices in the "good" state, and also larger bid/ask quantities, when BFVs are not provided (see Table A. 5 in Appendix A).

Comparing first-period behavior between in- and outsiders, we find outsider limit buy/sell order prices to be higher in TinB- markets and insider limit buy order prices and sale quantities to be higher in the Tin+ markets (using two-sided U tests). The differences in buy/sell order prices and quantities in TinB+ and Tin- markets are insignificant (see also Table A. 5 in Appendix A).

To identify overall differences in the buying and selling behavior of in-and outsiders, we conduct panel-regressions with traders as cross sections ($i = 1, \ldots, 192$). The dependent variable used is again derived from the RD measure (Stöckl et al., 2010), denoted in percent, and is defined as:

$$RD_{it}^{D,S} = \frac{p_{it}^{D,S} - FV_t}{\overline{FV}}, \tag{5}$$

[24] Figures A. 1 and A. 2 in Appendix A additionally exhibit the average limit buy and sell prices of the Nin(B) and Tin(B) markets, whereby for the latter prices are averaged over both in- and outsiders.

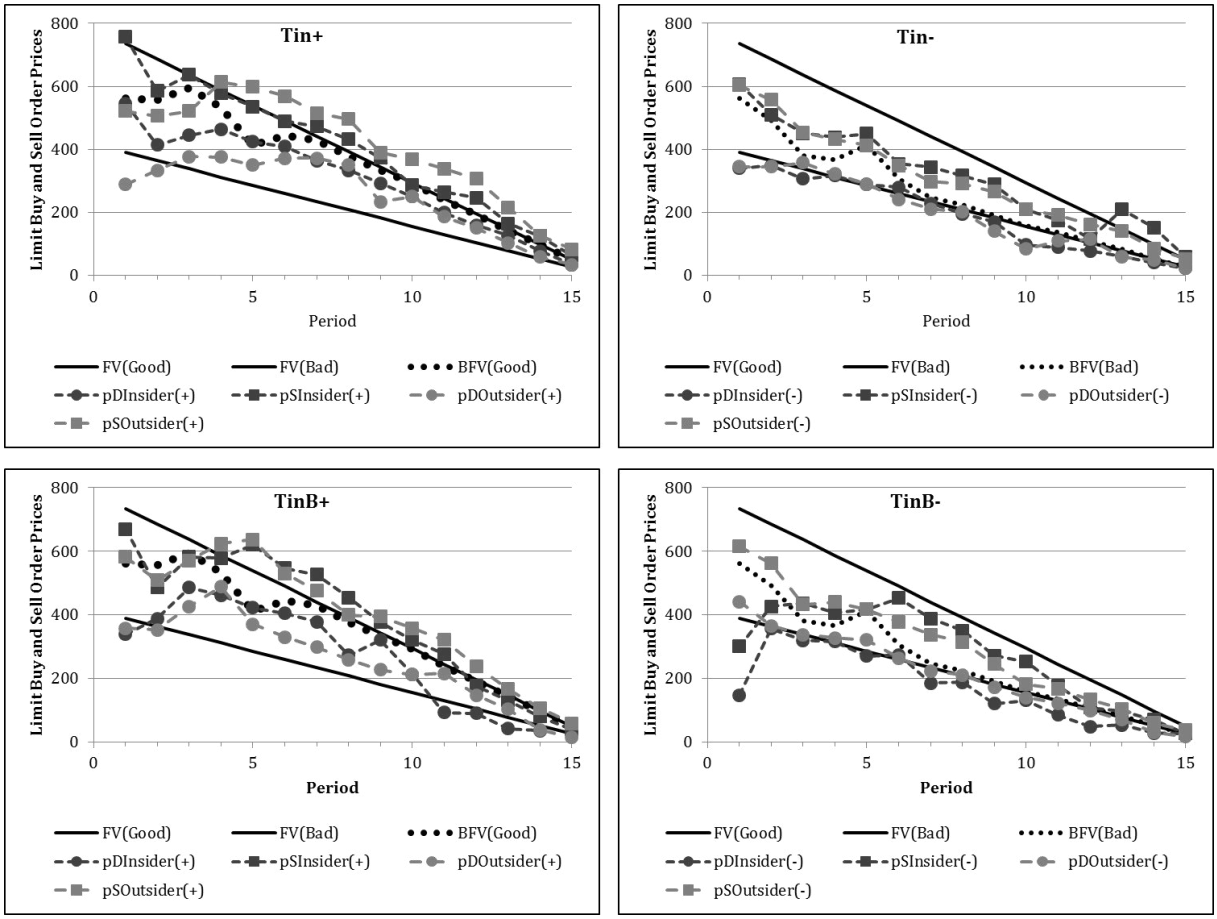
where $RD_{it}^{D,S}$ measures the difference between the individual limit buy/sell order prices of period t ($p_{it}^{D,S}$) and the respective fundamental value (FV_t), normalized by the average fundamental value ($\overline{FV}$).

We control for trader type effects by using dummy variables for the trader types under all treatment conditions (resulting in $Nin + Outsider$ as the reference type). Additionally, we control for autocorrelation by inclusion of the dependent variable with a lag of one period ($L.\ RD$), for a time trend within markets by inclusion of a period variable ($Period$), for the bid/ask quantity ($Order\ Quantity$), for the amount of assets held in the portfolio ($Asset\ Holdings$), and for the trading activity in the previous period ($L.\ Bought\ Assets$, $L.\ Sold\ Assets$). Furthermore, we include the drawn dividend of the prior period ($L.\ Dividend$), a variable that measures the individually perceived understanding of the market ($Market\ Understanding$, elicited in the ex-post questionnaire, ranging from 0 to 10), a variable that measures individual risk aversion ($Risk\ Aversion$) (elicited following the approach of Holt and Laury (2002), ranging from -3 to 5), and $Gender$ (with women as reference category) as explanatory variables. The results are shown in Table 10. Given the similar results for each of both dependent variables, we focus our analysis respectively on the augmented Models 4 and 6.

The regression results for Model 4 show that bid price deviations (measured by $RD_{it}^{p^D}$) are path-dependent; $L.RD$ has a significantly positive effect. Traders bid relatively more eagerly in later periods; $Period$ has a significantly positive effect on bid prices. Traders are cautious when buying, the higher the bid quantity, the lower the bidding price; $Order\ Quantity$ (q_{it}^{D}) has a significantly negative effect. Current asset holdings (in the portfolio) and the quantity of sold assets in the prior period do not have an influence; $Asset\ Holdings$ and $L.\ Sold\ Assets$ are insignificant. Previous buying success, however, reduces bid prices; $L.\ Bought\ Assets$ has a significantly negative effect. The dividend drawn in the previous period has a slight price boosting effect, the higher the dividend in the previous period the larger the bid price in the current period; $L.Dividend$ is significantly positive. Individual $Market\ Understanding$ and $Risk\ Aversion$ have significantly negative effects on bid prices. Male traders bid higher prices compared to women; $Gender$ is significantly positive.

Comparing the bid prices of in- and outsiders, we see that on average insiders bid higher prices in the Tin+ and TinB+ markets and lower prices in the Tin- and TinB- markets. All differences are significant, except for TinB- (see Table 11).

Figure 4: Insider and Outsider Limit Buy Order and Limit Sell Order Prices



The regression results for Model 6 show that ask prices (measured by $RD_t^{p^S}$) are strongly path-dependent (more path-dependent than bid prices); $L.\,RD$ has a significantly positive effect. Traders are satisfied with lower ask prices in later periods; $Period$ has a significantly negative effect. Traders seem not to be as cautious with regard to their portfolio when selling; $Order\ Quantity$ (q_{it}^S) and current $Asset\ Holdings$ do not to have a significant effect. On the other hand, previous buying success reduces ask prices, $L.\ Bought\ Assets$ is significantly negative, and previous sale success increases ask prices, $L.\ Sold\ Assets$ is significantly positive. The dividend drawn in the previous period again has a slight price boosting effect on the ask price in the current period; $L.\ Dividend$ is significantly positive. Individual $Market\ Understanding$, $Risk\ Aversion$, and $Gender$ have no significant effects on ask prices.

Looking at the comparison of ask prices between in- and outsiders we see that on average insiders ask higher prices in the Tin+, TinB+, and TinB- markets and lower prices in the Tin- markets. However, the differences are only significant for Tin+ and Tin- markets (see Table 11).

Table 10: Regressions for RDs of Limit Buy and Sell Prices from Fundamentals

Dependent Variable:	Model 3 $RD_{it}^{p^D}$	Model 4 $RD_{it}^{p^D}$	Model 5 $RD_{it}^{p^S}$	Model 6 $RD_{it}^{p^S}$
Constant (Nin+ Outsider)	-18.53***	-5.78	7.47**	23.40***
	(6.23)	(10.14)	(3.06)	(7.64)
L. $RD_{it}^{p^{D,S}}$	0.32***	0.31***	0.56***	0.56***
	(0.06)	(0.06)	(0.03)	(0.03)
Period	0.65*	0.62*	-0.72***	-0.72***
	(0.34)	(0.33)	(0.24)	(0.24)
Order Quantity (q_{it}^D, q_{it}^S)	-0.63***	-0.73***	-0.12	-0.11
	(0.12)	(0.13)	(0.23)	(0.22)
Asset Holdings	-0.14	-0.25	-0.12	0.01
	(0.18)	(0.17)	(0.23)	(0.20)
L. Bought Assets	-2.17***	-2.17***	-1.20***	-1.08***
	(0.36)	(0.36)	(0.39)	(0.38)
L. Sold Assets	-0.13	-0.18	2.36***	2.55***
	(0.46)	(0.45)	(0.46)	(0.46)
Nin- Outsider	41.83***	43.75***	25.94***	26.12***
	(7.08)	(7.18)	(4.52)	(4.31)
NinB+ Outsider	9.68**	10.12**	-0.17	0.09
	(3.90)	(4.05)	(2.76)	(3.09)
NinB- Outsider	37.68***	38.47***	25.18***	24.84***
	(6.84)	(6.94)	(4.42)	(4.55)
Tin+ Insider	4.63	10.77**	1.61	5.04
	(4.59)	(5.13)	(2.77)	(3.21)
Tin+ Outsider	3.29	1.14	-0.49	-3.38
	(3.91)	(4.13)	(2.93)	(3.21)
Tin- Insider	14.36***	13.15***	5.77	0.82
	(4.68)	(4.89)	(4.39)	(4.82)
Tin- Outsider	20.65***	21.88***	9.63***	9.25***
	(5.06)	(5.40)	(3.42)	(3.59)
TinB+ Insider	9.31*	10.35**	1.46	0.66
	(4.91)	(5.13)	(2.82)	(3.06)
TinB+ Outsider	0.53	-2.92	0.33	-1.83
	(4.04)	(4.83)	(2.85)	(2.86)
TinB- Insider	24.66***	22.87***	17.44***	15.62***
	(7.95)	(8.16)	(4.48)	(4.81)
TinB- Outsider	26.44***	25.60***	10.91**	9.62*
	(5.79)	(5.80)	(5.31)	(5.40)
L. Dividend		0.05*		0.07**
		(0.03)		(0.03)
Market Understanding		-2.98**		-3.69
		(1.29)		(1.13)
Risk Aversion		-1.57***		-0.34
		(0.51)		(0.53)
Gender (Male)		8.16***		0.05
		(2.45)		(1.99)
R^2	.3961	.4131	.6099	.6170
N	1597	1597	1742	1742

Notes: Prais-Winsten panel-regressions with heteroskedastic panels corrected standard errors and panel-specific autocorrelation (AR1) (Beck and Katz, 1995). 192 traders as cross sections with a maximum of 15 observations over time (unbalanced).). Only cases where buy/sell offers were made are considered. Standard errors are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 11: Wald Tests for Differences of Treatment Coefficients in Models 4 & 6

Treatment (State Label)	Insider vs. Outsider $\bar{p}^D$ (4)	$\bar{p}^S$ (6)
Tin+	**.0291 (>)**	**.0280 (>)**
Tin-	**.0459 (<)**	**.0704 (<)**
TinB+	**.0080 (>)**	.4158
TinB-	.7135	.3083

Notes: p-values of Wald tests for the simple linear hypothesis of equality of estimated parameters are shown.

Aggregating the results for limit bid/ask prices, we conclude that, particularly in the beginning of the markets, insiders are the traders which tend to buy assets in the "good" state, when assets are relatively cheaply sold by outsiders and sell assets in the "bad" state, when they are relatively expensively bought by outsiders. Given this conclusion it is not surprising that asset holdings of in- and outsiders indeed differ significantly between "good"-state and "bad"-state markets, at least in the beginning of the markets, as it is theoretically predicted by both informational models (PI and RE).

In the "good"-state markets, insiders are those traders that hold on average more assets during the entire markets and significantly more during the first six periods. In the "bad"-state markets outsiders are those traders that hold on average more assets during the entire markets and significantly more during periods 3 to 13. All differences are significant at the 5-10% level, using the Wilcoxon matched pairs signed-rank test, $N = 16$ (8/8). Insiders are thus capable of using their superior informational position and buy relatively underpriced assets in the "good" state and sell relatively overpriced assets in the "bad" state. However, it should be noted that asset stocks of in- and outsiders align during the course of the markets in both states.

Result 4: *Insiders are those traders that hold more assets in the "good"-state markets and outsiders are those traders that hold more assets in the "bad"-state markets.*

Furthermore a concentration of assets at single players over the course of the markets is evident. Over all markets the trader with the largest asset portfolio in one market holds on average 27.2 assets (with a standard deviation of 6.298) at the end of period 15. Concentration, however, is not automatically equated with a more remunerative trading strategy of the "hoarding" traders. Although, in eleven markets those traders which held the largest asset stock also earned the highest net-profit (total profit minus prediction earnings), a significant correlation cannot be detected between the asset stock of a trader at the end of a market and her/his net-profit. The Spearman's rank correlation coefficient is $\rho = .0263$ (p-value = .7174).

Although the behavior of in- and outsiders converges, insiders are able to benefit from their superior informational position. Insiders on average earn higher total profits in Tin+, Tin-, TinB+, and TinB- markets, though the difference to outsiders is only significant for Tin+ (see Table A. 6 in Appendix A). Aggregated over all treatments with informational asymmetry, insiders earn significantly higher total profits (6346 ECU vs. 5565 ECU, two-sided t-test, p-value = .0793, N = 96, 32/64).

Result 5: *Informed traders have a trading advantage that is revealed in superior profits. Summarized our data definitively indicates that traders in Tin(B) markets didn't incur what Camerer et al. (1989) call the "curse of knowledge".*

Our markets are not strong-form efficient, following the definition of Fama (1970), because insiders are able to earn "abnormal returns" from trading on the basis of their private (insider) information. This result supports the findings of Jaffe (1974).

4.4. Beliefs and Market Prices

Since optimal trading actions depend on beliefs about other players' decisions, which again depend on the beliefs of actions of others etc. (Palfrey and Wang, 2009),[25] we examine if stated beliefs on the market price are informative about the actual market price. We investigate to what extent elicited price expectations and actual market prices are correlated. Furthermore, we are interested in how expectations change if the available information and distribution of information changes.

We are aware that belief elicitation can alter decisions in the experiment. Gächter and Renner (2010) for example have shown that incentivized belief elicitation about contributions of others leads to higher contributions in a public-good experiment. However, the experimental asset markets investigated by Haruvy et al. (2007), who elicited beliefs about market prices in the same way as we do, closely resemble markets of previous studies without belief elicitation. Thus, we do not expect a large manipulation.

In the beginning of each period, participants were required to state their expectations about the prospective market prices of the present and all subsequent trading periods. In the following we denote the elicited beliefs in the form: B_t^f, where t denotes the period of elicitation, i.e., the period in which traders were asked to submit their price beliefs and f denotes the period forecasted, i.e., the period for which the price beliefs are stated.

[25] "In a world of uncertainty "fundamentals" get replaced by expectations about fundamentals" (Sunder, 1995, p. 468).

Figure 5 shows the average predicted price levels by treatment. Each bar in all eight graphs represents the average of four markets, i.e., 24 traders.[26] As can be seen, traders' expectations about the price trajectory contain the belief of declining prices as theoretically prescribed by fundamentals. This indicates that fundamentals are clearly interpreted as the expected value of the future dividend stream, as emphasized in the experimental instructions. In contrast to Lei et al. (2001), in our framework, a common dividend, and common knowledge thereof, seems to be sufficient to induce initial common expectations that are consistent with fundamentals. In contrast, traders in Haruvy et al. (2007) anticipated a flat price trajectory at the beginning, followed by an increasing trajectory in the middle, and a declining trajectory toward the end of the first round of their experiment. Our findings resemble their markets with most experienced traders.[27]

Individual beliefs for the first period (B_1^1) start under almost all conditions around the BFV in the 1st period, which is 563. A t-test for the null hypothesis of no difference shows only for Tin a significant difference, where the average is 465.7 (p-value = .0036, N = 48), compared to 547.4, 528.6, and 552.9 for NinB, TinB, and Nin respectively. Price assessments do not differ significantly by state within equal treatment conditions.

Within the insider treatments with and without the provision of BFVs we find that insider B_1^1 are respectively significantly higher for the "good" state compared to the "bad" state (two-sided U tests, N = 16: 587.9 vs. 296.6, p-value = .0098; 596.5 vs. 488.8, p-value = .0712). Outsider beliefs on the other hand are, as we would expect, not significantly different between both states (two-sided U tests, N = 32: 548.2 vs. 595.4, p-value = .4677; 431.4 vs. 423.1, p-value = .7773), though clearly different with and without the provision of BFVs.

Applying our convergence measure defined in Section 4.1 on the average last belief for each period ($\bar{B}_t^t$), we find that beliefs converge more slowly toward fundamentals than market prices. We find 21 out of 32 markets not to converge, compared to ten markets for prices. Convergence time is slower for all treatments, though the difference is only significant for Tin (two-sided Wilcoxon signed-rank test, p-value = .0487). This result is consistent with the findings of Haruvy et al. (2007) when traders had some experience. Comparing the RD and RAD measures for last beliefs (B_t^t) and market prices, we find that RD shows only a significant difference between beliefs and market prices in NinB, where it is larger for prices, while the RAD measure is significantly larger for beliefs in NinB, TinB, and Tin markets (two-sided Wilcoxon signed-rank test, respective p-values: .0687, .0251, and .0357). It seems that positive and negative deviations cancel out each other in RD for both, beliefs and prices, but that deviations are absolutely larger for beliefs as revealed by RAD. Markets seem to exert a kind of synergy effect on traders' beliefs that help prices to converge faster to the rational expectations equilibrium than beliefs. To further test whether better market-price predictions in a market, measured

[26] Figure A. 3 in Appendix A illustrates the associated between-subject standard deviations of the market-price predictions.

[27] Participants in Haruvy et al. (2007) played four markets, consisting of 15 periods each, in a row.

by the average total prediction earnings in a market, lead to lower price deviations from fundamentals, measured by RD and RAD, we use a Spearman correlation test. We find a negative, however insignificant relation for RD (ρ = -.1850, p-value = .3108), but a significantly negative correlation for RAD (ρ = -.3082, p-value = .0862). Better predictions thus seem to lower price deviations.

Since the most important characteristic of forecasts or predictions is their correctness, we now turn to the ability of forecasts to make inferences about future prices. To estimate the informational content contained in predictions of traders, we first estimate if and how the price level and the average belief about the market price are "correlated", using the following model:

$$P_{mt} = \alpha + \beta \bar{B}^t_{mt} + \gamma X + \epsilon_t, \tag{6}$$

where P_t is the market price in period t, $\bar{B}^t_t$ is the average stated belief for the market price of period t in period t. X is a vector of further explanatory variables, containing treatment dummies, a period variable ($Period$), and the drawn dividend in the prior period ($L.\ Dividend$). If short-term expectations of market prices are unbiased, then $\alpha = 0, \beta = 1$, and $\gamma = 0$ are the expected coefficients.

Furthermore, to test the correctness of average trader beliefs concerning the anticipation of the market price, we estimate the following model:

$$\frac{\bar{B}^t_{mt} - P_{mt}}{P_{mt}} = \alpha + \beta \left(\frac{\bar{B}^{t-1}_{mt-1} - P_{mt-1}}{P_{mt-1}} \right) + \gamma X + \epsilon_t, \tag{7}$$

where $(\bar{B}^t_t - P_t)/P_t$ denotes the deviation of the average belief in a market from the market price, relative to the market price. $(\bar{B}^{t-1}_{t-1} - P_{t-1})/P_{t-1}$ is simply the one-period lag of the dependent variable and X is defined as above. If short-term expectations are unbiased, i.e., correct, then $\alpha = 0, \beta = 0$, and $\gamma = 0$ are the expected coefficients.

The regression results of both models are shown in Models 7 and 8 in Table 12. As can be seen from Model 7 price expectations and actual market prices are strongly "correlated" with a highly significant coefficient of 0.9, which is however significantly different from one ($\beta \neq 1$, p-value = .0011). Model 8 shows that the forecast quality, i.e., the relative deviation of beliefs from market prices, is not auto-correlated since β is not statistically different from zero. Moreover, as it seems, the presence of insiders rather impedes forecast precision than enhances it. The three largest negative coefficients of treatment dummies, which hint on an underestimation of market prices, are all attributed to treatments where insiders were present (TinB+, Tin+, and Tin-).

This finding seems to be driven by the outsiders in the Tin(B) markets and is supported by the following: On aggregate over all treatments with informational asymmetry, we find a significant difference in prediction earnings between in- and outsiders (144.9 ECU

vs. 115.3 ECU, two-sided t-test, p-value = .0735, N = 96, 32/64).[28] Prediction earnings of outsiders in the Nin(B) markets are, however, not significantly different from earnings of insiders in the Tin(B) markets; but they are also significantly larger than prediction earnings of outsiders in the Tin(B) markets (137.0 ECU vs. 115.3 ECU, two-sided t-test, p-value = .0562, N = 160, 96/64). The presence of insiders thus seems to psychologically impede the prediction ability of outsiders in the Tin(B) markets. This finding is consistent with Lovaglia et al. (1998), who found that a randomly assigned lower status impedes performance in a test of mental ability.

Given that the maximum possible amount for prediction earnings is 600 ECU, if all predictions lie in a range of $\pm$10% of the market price, prediction earnings of both trader types are quite bad and close to another, with a mean of 125.2 ECU, a standard deviation of 76.3 ECU, and a minimum and maximum of 0 ECU and 396 ECU over all 192 traders, respectively. Nevertheless, although the difference in prediction earnings between in- and outsiders is not large, it indicates that the trading advantage of insiders is at least partially conveyed in a better ability to anticipate market prices.

Result 6: *Elicited price expectations and actual market prices are highly correlated. However, forecast quality (precision of beliefs) seems rather to be impeded by the presence of insiders. The provision of BFVs seems to have no impact on forecast quality.*

To test whether better predictors also earn higher total trading profits (total profits corrected for prediction earnings) we use a Spearman correlation test. Over all 196 traders we find a highly significant connection between individual prediction quality and trading profits (ρ = .2717, p-value = .0001). As we would expect, better predictors have more success in the market.

Additionally, we found men to make significantly higher earnings for predictions compared to women (139.5 vs. 118.5, two-sided t-test, p-value = .0432, N = 192, 113/79) and higher total trading profits, though here the difference is not significant (5800 vs. 5559, two-sided t-test, p-value = .4362, N = 192, 113/79). Alike, master students make significantly higher earnings for predictions compared to Bachelor students (151.4 vs. 124.9, two-sided t-test, p-value = .0319, N = 181, 42/139) and also earn higher total trading profits (6372 vs. 5430, two-sided t-test, p-value = .0106, N = 181, 42/139).

[28] When Tin+, Tin-, TinB+, and TinB- markets are considered separately (see Table A. 6 in Appendix A), we find insiders to be slightly better predictors and earn on average higher prediction earnings, however, the difference to outsiders is not significant.

Figure 5: Average Predicted Market Prices

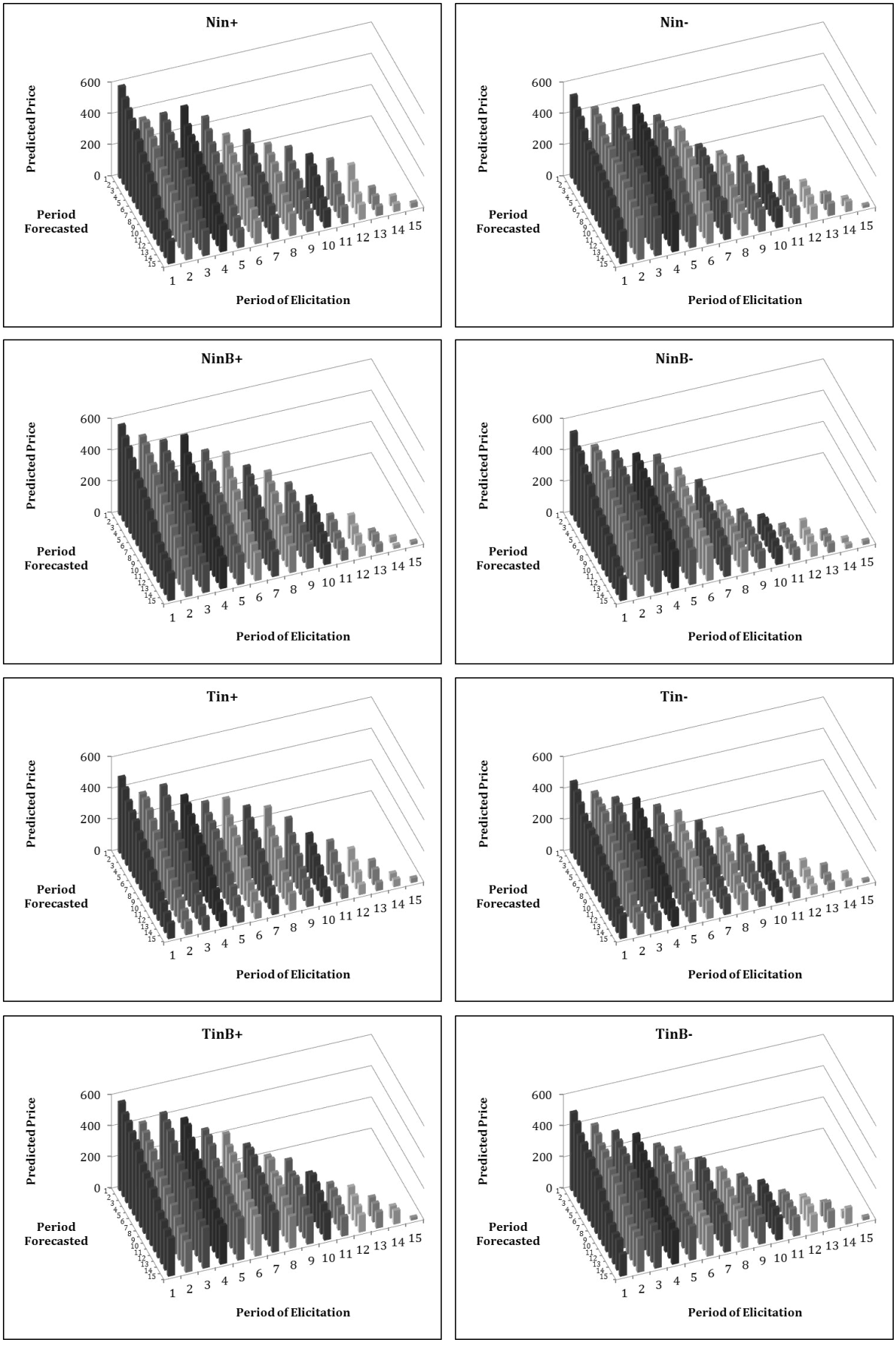


Table 12: Belief Regressions

Dependent Variable	Model 7 P_{mt}	Model 8 $(\bar{B}^t_{mt} - P_{mt})/\ P_{mt}$
Constant (Nin+)	21.59	3.08
	(15.35)	(5.60)
$\bar{B}^t_{mt}$	0.90***	
	(0.03)	
$(\bar{B}^{t-1}_{mt-1} - P_{mt-1})/P_{mt-1}$		-0.02
		(0.05)
Period		0.56
		(0.36)
L. Dividend	0.29**	-0.04
	(0.13)	(0.04)
NinB+	52.77***	-3.82
	(17.91)	(4.76)
NinB-	47.04**	-9.22*
	(19.04)	(5.12)
TinB+	40.51**	-12.88**
	(19.45)	(5.53)
TinB-	3.21	-2.09
	(13.43)	(5.13)
Nin-	12.47	-9.65*
	(17.45)	(5.21)
Tin+	71.08***	-22.26***
	(18.89)	(5.56)
Tin-	-7.62	-10.34*
	(13.08)	(6.12)
R^2	.8746	.1450
N	315	247

Notes: Prais-Winsten panel-regression with heteroskedastic panels corrected standard errors and panel-specific autocorrelation (AR1) (Beck and Katz, 1995). 32 markets as cross sections with a maximum of 15 observations over time (unbalanced). Only periods where trade took place are considered. Standard errors are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

5. Conclusion

Our study investigates price formation in a multi-period asset market with uncertainty about market fundamentals. This novel framework combines the SSW environment with a "state-environment" investigated by, for example, Camerer and Weigelt (1991). It represents a "more realistic" market, although we are aware that real-life markets are not only characterized by uncertainty but also by ambiguity. In this newly designed uncertain SSW environment, we investigate whether (1) the existence of traders who are informed about the true state and/or (2) the provision of Bayesian updates of the assets' state-dependent fundamental values lead to better market performance.

Our results differ from earlier studies in that we hardly find any bubbles under all treatment conditions, even though all subjects were inexperienced. Out of 32 markets only four reveal a bubble pattern. Our explanation is that possibly the two possible states exert a psychologically restraining effect on market prices and force participants to more carefully reflect on their trading decisions.

We find markets with asymmetrically informed traders to exhibit smaller price deviations from fundamentals, implying higher market efficiency. This result is consistent with the findings of Sutter et al. (2012), and is most likely attributed to the fact that uninformed traders act in a more prudent way to bypass exploitation, when they are aware of the fact that some traders have an advantage (of whatever kind).

The provision of BFVs has seemingly little to no effect. The mere assistance in the assessment of the state seems not to be sufficient to improve market performance.

Concerning the trading behavior of in- and outsiders, we find that it differs at the beginning but converges during the course of the markets, indicating that that state information is revealed over time. In accordance with the predictions of the PI- and RE-models, we further find outsider limit buy/sell prices on average to be lower (higher) in the "good" ("bad") state compared to the limit buy/sell prices of insiders. As a result, outsiders on average hold less (more) assets in "good"-state ("bad"-state) markets. Thus, informed traders are able to earn superior profits. Depending on the state, they buy cheaply from or sell expensively to outsiders and thus capitalize their superior position.

With regard to elicited price expectations, we find forecasts and actual market prices to be highly correlated. The precision of forecasts, however, seems to be impeded by the presence of insiders, while the provision of BFVs seems to have no impact on forecast quality.

We observe that the presence of insiders increases market efficiency. However, we have to be very cautious with this interpretation. We are not inclined to state that informational asymmetries are per se beneficial for market performance. In our experiment, the existence of insiders increases the information in the market. Increasing the level of information even more, we have conducted an additional experiment, in

which we employed a standard SSW framework with a single state. Dividends again could take values of 10 ECU, 20 ECU, 40 ECU, or 80 ECU, however, with equal and fix probabilities of 25 percent, respectively. Traders did not face any uncertainty about the state, and were in a sense all insiders. These markets, again, hardly showed any bubbles.[29] Additionally they exhibited with -0.078 a smaller average RD than all our other treatments with two possible states (accounted for the state) and with 0.180 also the smallest average RAD. This seems plausible if we consider these markets as pure insider markets, since there are no traders with uncertainty about the state.[30]

We may conclude that increased information in a market tends to lead to more market efficiency. However, we have to be aware of the fact that informational asymmetries in markets are not beneficial in all aspects. The higher market efficiency in our markets, where insiders were present and could trade on their information, is based on the expense of outsiders. Given the differences in the trading behavior, particularly in the beginning of the markets, insiders on average manage to shift their asset holdings to the detriment of outsiders. In addition, the presence of insiders seems to confuse outsiders given their significantly inferior market price forecast capability. Taken together, it is likely that deprived market participants in such trading environments would lose faith and trust in the securities' markets and possibly withdraw all or part of their capital, rendering the market less liquid.

Hence, to maintain the confidence in the fairness of financial markets, we rather support the position of proponents of insider trading regulation, requesting traders and other market agents possessing material nonpublic information to make reasonable efforts to achieve public dissemination of the relevant information on the broadest possible basis (CFA Institute Code of Ethics & Standards of Professional Conduct, CFA Institute, 2010). We advocate all types of rules which are targeted towards faster and broader dissemination of information.

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[29] The general lack of bubbles might, besides the general difference of the structure of fundamentals, might be caused by the relatively small number of traders in our markets. This might decrease the incentives to speculate, in particular in combination with the call-auction trading mechanism, which tends to lead to a lower trading volume than continuous double-auction markets. Sutter et al. (2012) and Dufwenberg et al. (2005) observed bubbles with the same number of traders per market, however, by using double auctions; van Boening et al. (1993) and Haruvy et al. (2007) observed bubbles by using call auctions.

[30] Figure B. 1 in Appendix B shows the trajectory of individual market prices and Figure B. 2 the trajectory of the average price in this experiment.

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Appendix A

Additional Tables and Figures

Attitudes Toward Risk

Table A. 1: Risk-Test 1

Decision #	Lottery A	Lottery B	Expected Payoff Difference	Risk Attitude (# safe choices)
1	1/10 of 50 , 9/10 of 40	1/10 of 96 , 9/10 of 2	29.6	-3
2	2/10 of 50 , 8/10 of 40	2/10 of 96 , 8/10 of 2	21.2	-2
3	3/10 of 50 , 7/10 of 40	3/10 of 96 , 7/10 of 2	12.8	-1
4	4/10 of 50 , 6/10 of 40	4/10 of 96 , 6/10 of 2	4.4	0
5	5/10 of 50 , 5/10 of 40	5/10 of 96 , 5/10 of 2	-4.0	1
6	6/10 of 50 , 4/10 of 40	6/10 of 96 , 4/10 of 2	-12.4	2
7	7/10 of 50 , 3/10 of 40	7/10 of 96 , 3/10 of 2	-20.8	3
8	8/10 of 50 , 2/10 of 40	8/10 of 96 , 2/10 of 2	-29.2	4
9	9/10 of 50 , 1/10 of 40	9/10 of 96 , 1/10 of 2	-37.6	5
10	1 of 50 , 0 of 40	1 of 96 , 0 of 2	-46.0	5

Notes: All payoffs are in ECUs. Lottery A is considered as the "safe" choice and Lottery B as the "risky" choice. -5 = extremely risk-loving, -4 = highly risk-loving, -3 = very risk-loving, -2 = risk-loving, -1 = slightly risk-loving, 0 = risk-neutral, 1 = slightly risk-averse, 2 risk-averse, 3 = very risk-averse, 4 = highly risk-averse, 5 = stay in bed.
Market/subject mean = 1.750, market maximum (minimum) = 3.000 (0.500), subject maximum (minimum) = 5 (-3). Spearman's rank correlation coefficient between the average risk attitude in one market and the market price in the 1st period: -0.0979, p-value = 0.5942 (negative relationship expected).

Table A. 2: Risk-Test 2a

Decision No.	Lottery A	Safe Payoff	Expected Payoff Difference	Risk Attitude (# safe choices)
1	**Lottery A:** 4/10 of 80 , 3/10 of 40 , 2/10 of 20 , 1/10 of 10.	20	29	-5
2		25	24	-4
3		30	19	-3
4		35	14	-2
5		40	9	-1
6		45	4	0
7		50	-1	1
8		55	-6	2
9		60	-11	3
10		65	-16	4

Notes: All payoffs are in ECUs. -5 = extremely risk-loving, -4 = highly risk-loving, -3 = very risk-loving, -2 = risk-loving, -1 = slightly risk-loving, 0 = risk-neutral, 1 = slightly risk-averse, 2 risk-averse, 3 = very risk-averse, 4 = highly risk-averse, 5 = stay in bed.
Market/subject mean = -0.813, market maximum (minimum) = 0.167 (-2.167), subject maximum (minimum) = 4 (-5). Spearman's rank correlation coefficient between the average risk attitude in one market and the market price in the 1st period: -0.0369, p-value = 0.8412 (negative relationship expected).

Table A. 3: Risk-Test 2b

Decision #	Lottery A	Safe Payoff	Expected Payoff Difference	Risk Attitude (# safe choices)
1	**Lottery A:** 1/10 of 80 , 2/10 of 40 , 3/10 of 20 , 4/10 of 10.	5	21	-4
2		10	16	-3
3		15	11	-2
4		20	6	-1
5		25	1	0
6		30	-4	1
7		35	-9	2
8		40	-14	3
9		45	-19	4
10		50	-24	5

Notes: All payoffs are in ECUs. -5 = extremely risk-loving, -4 = highly risk-loving, -3 = very risk-loving, -2 = risk-loving, -1 = slightly risk-loving, 0 = risk-neutral, 1 = slightly risk-averse, 2 risk-averse, 3 = very risk-averse, 4 = highly risk-averse, 5 = stay in bed. Market/subject mean = 0.427, market maximum (minimum) = 1.500 (-1.167), subject maximum (minimum) = 5 (-4). Spearman's rank correlation coefficient between the average risk attitude in one market and the market price in the 1st period: 0.1205, p-value = 0.5111 (negative relationship expected).

Table A. 4: Ex-post Questionnaire Question - Attitude toward Risk

Question: Are you generally willing to take risks, or do you try to avoid risks?

Highly risk-averse (0)	----	---	--	-	(5)	+	++	+++	++++	Highly risk-loving (10)

Notes: Market/subject mean = 4.646, market maximum (minimum) = 6.667 (2.667), subject maximum (minimum) = 10 (0). Spearman's rank correlation coefficient between the average risk attitude in one market and the market price in the 1st period: 0.0956, p-value = 0.6029 (positive relationship expected).

Trading Behavior of Insiders and Outsiders

Table A. 5: First Period Comparisons of Insiders and Outsiders

	Insider w/ Bayes (1st Per.)			Insider w/o Bayes (1st Per.)		
	+	-	p-value[a]	+	-	p-value[a]
p^D	338.9	147.4	**.0397**	524.3	340.0	**.0235**
p^S	609.8	301.0	**.0541**	761.0	607.5	**.0279**
q^D	12.6	13.5	.7116	12.4	5.3	**.0262**
q^S	4.4	6.2	.2245	8.6	4.4	**.0626**
	Outsider w/ Bayes (1st Per.)			Outsider w/o Bayes (1st Per.)		
	+	-	p-value[b]	+	-	p-value[b]
p^D	361.6	446.4	.1257	290.7	355.7	.3250
p^S	581.8	609.5	.6807	517.1	602.8	.6921
q^D	10.7	10.6	.9293	13.3	8.8	.4297
q^S	5.0	6.6	.2744	6.1	5.6	.6287
	w/ Bayes+ (1st Per.)			w/ Bayes- (1st Per.)		
	Insider	Outsider	p-value[c]	Insider	Outsider	p-value[c]
p^D	338.9	361.6	.6968	147.4	446.4	**.0013**
p^S	609.8	581.8	.6100	301.0	609.5	**.0386**
q^D	12.6	10.7	.7947	13.5	10.6	.8083
q^S	4.4	5.0	.6733	6.2	6.6	.9159
	w/o Bayes+ (1st Per.)			w/o Bayes- (1st Per.)		
	Insider	Outsider	p-value[c]	Insider	Outsider	p-value[c]
p^D	524.3	290.7	**.0180**	340.0	355.7	.7830
p^S	761.0	517.1	.1896	607.5	602.8	.3560
q^D	12.4	13.3	.5238	5.3	8.8	.4484
q^S	8.6	6.1	**.0871**	4.4	5.6	.4296

Notes: Mann-Whitney U test, two-sided: [a] $N = 16$ (8/8), [b] $N = 32$ (16/16), [c] $N = 24$ (8/16).

Table A. 6: Profit and Prediction Earnings of Insiders and Outsiders

	Insider+			Insider-		
	w/ Bayes	w/o Bayes	p-value	w/ Bayes	w/o Bayes	p-value
Profit[a]	7568	8962	**.0929**	4369	4483	.6744
Pred. Earnings[a]	133.1	172.9	**.0460**	137.3	136.3	.4005
	Outsider+			Outsider-		
	w/ Bayes	w/o Bayes	p-value	w/ Bayes	w/o Bayes	p-value
Profit[b]	7183	6527	.2582	4315	4235	.6242
Pred. Earnings[b]	100.3	121.5	.4397	131.3	108.2	.5216
	w/ Bayes+			w/ Bayes-		
	Insider	Outsider	p-value	Insider	Outsider	p-value
Profit[c]	7568	7183	.3913	4369	4315	.9025
Pred. Earnings[c]	133.1	100.3	.3272	137.3	131.3	.8303
	w/o Bayes+			w/o Bayes-		
	Insider	Outsider	p-value	Insider	Outsider	p-value
Profit[c]	8962	6527	**.0059**	4483	4235	.3913
Pred. Earnings[c]	172.9	121.5	.1500	136.3	108.2	.2439

Notes: Mann-Whitney U test, two-sided: [a] N =16 (8/8), [b] N = 32 (16/16), [c] N = 24 (8/16).

Limit Buy and Sell Prices

Figure A. 1: Average Limit Buy Order Prices

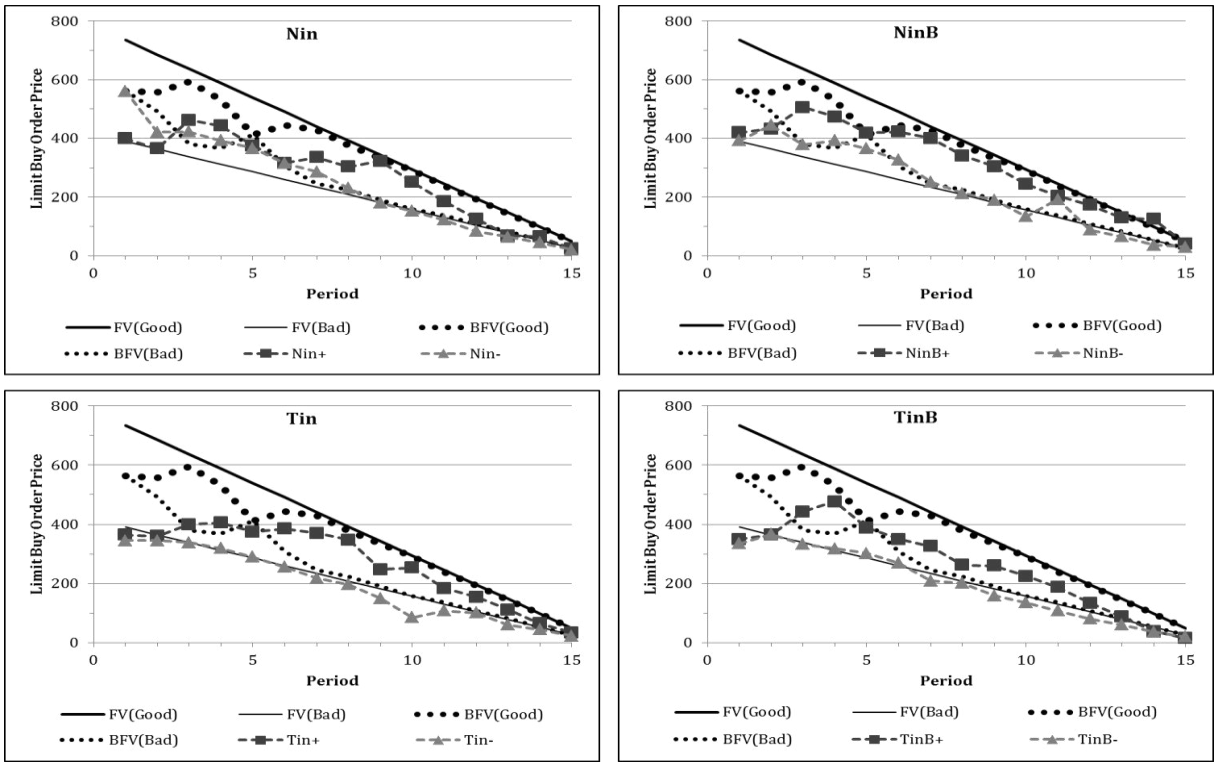
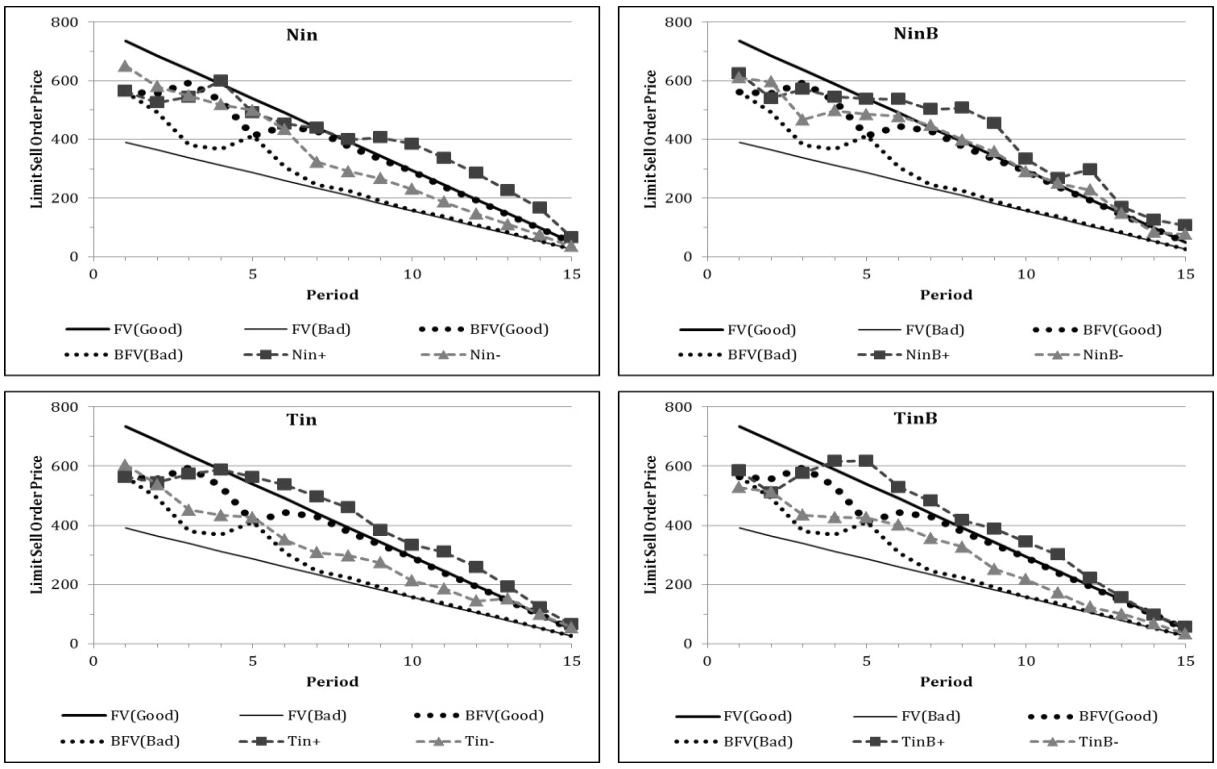
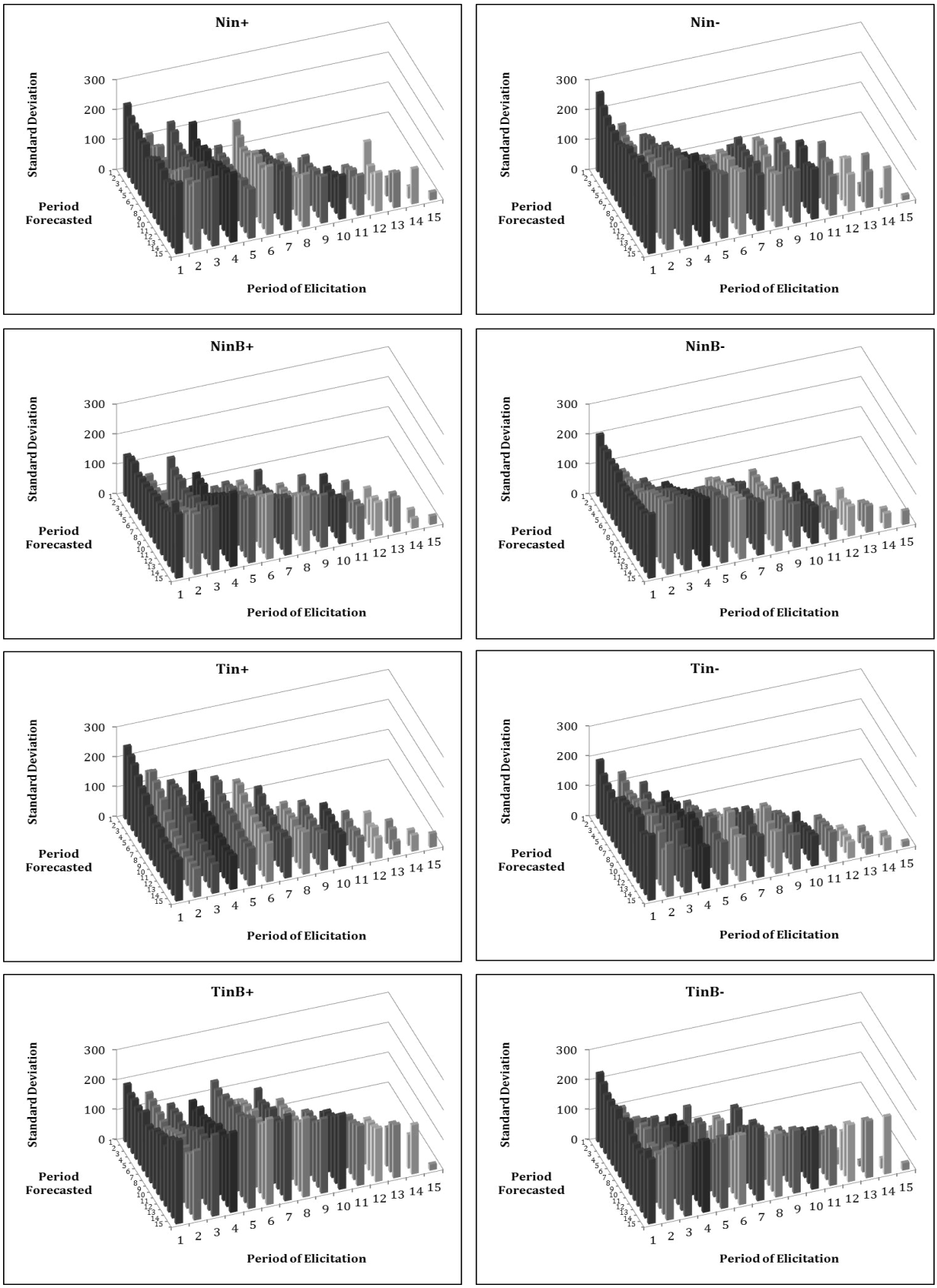


Figure A. 2: Average Limit Sell Order Prices



Beliefs

Figure A. 3: Standard Deviations of Predicted Market Prices



Appendix B

Results of Additional Experiments with Known Fundamentals (SSW Framework)

Figure B. 1: Individual Market Prices in the SSW Framework

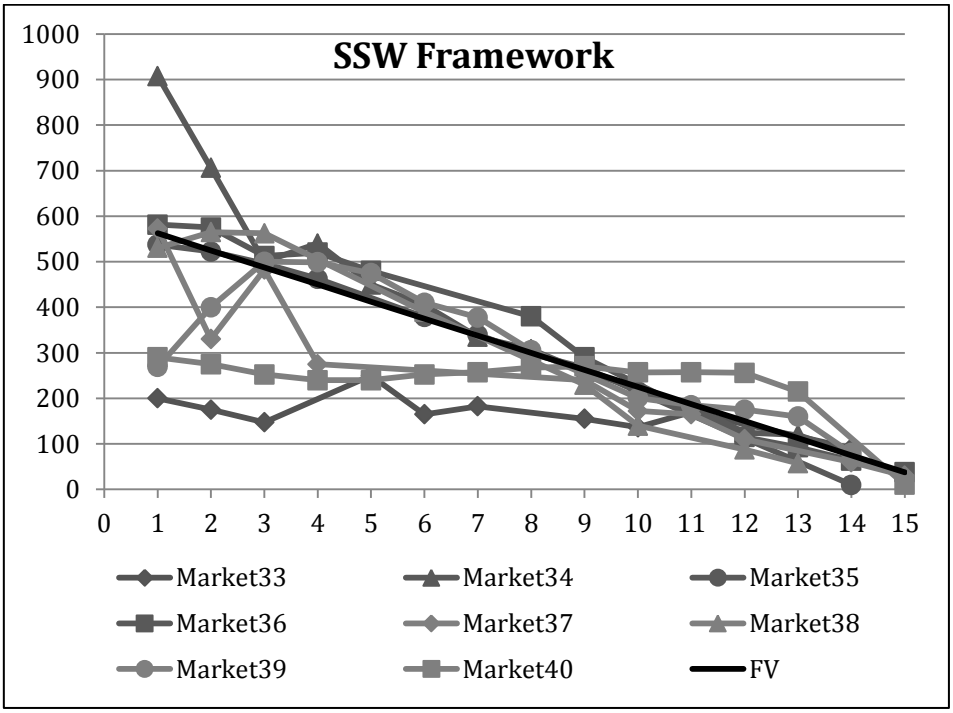
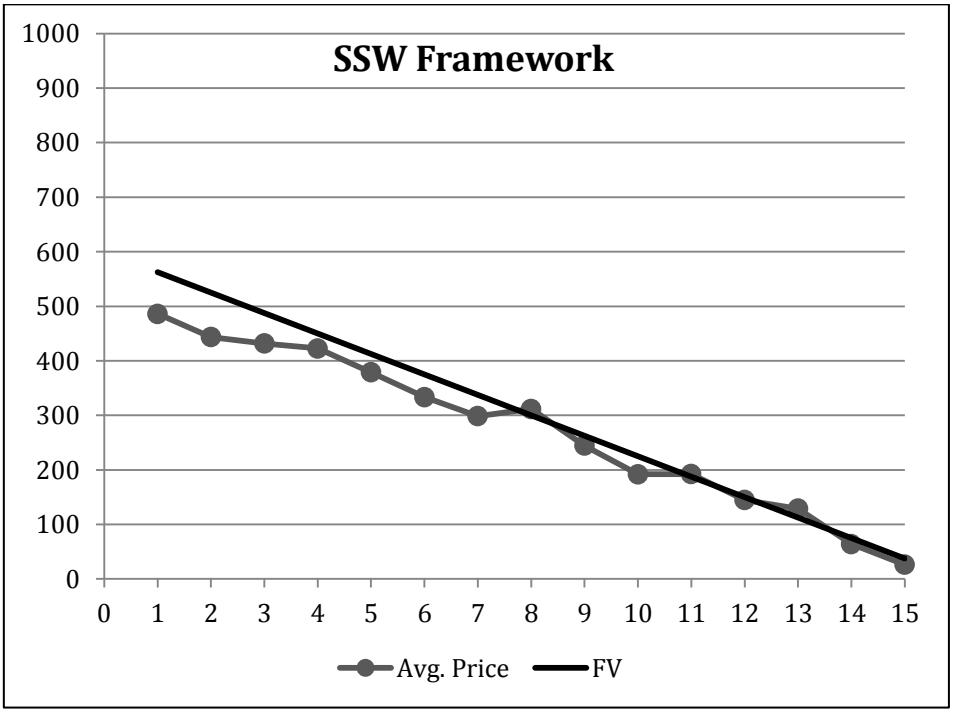


Figure B. 2: Average Market Price in the SSW Framework



Appendix C

EXPERIMENTAL INSTRUCTIONS (RISK TESTS)

Welcome! You participate in an experiment that consists of two parts. In Part I of the experiment, you first take part in a decision experiment in which you can earn money. How much you earn depends, in Part I, only on your personal decisions. In Part II, your earnings will also depend on the choices of others. Each participant makes its decisions in isolation from the others on her/his computer. We ask you not to talk to other participants.

PART I

Part I of the experiment consists of three tasks. In Task 1 you have to make 10 decisions, first. In each you must choose between two options, lottery X or lottery Y. Each lottery involves two payments, for which there are different probabilities of occurrence, in each case. The payoffs are given in a fictitious currency ECU (experimental currency units). At the end of Part I, the computer will select among your 10 decisions randomly one, for which you are paid according to your selected option. The resulting ECUs are converted according to a fixed exchange rate in €.

In Task 2A and 2B, you have to make 10 decisions each, choosing between a lottery and a safe payment (in ECU). At the end of Part I, the computer will select from among these choices randomly one, each, for which you are paid in € according to your selected option, taking into account the exchange rate.

AVAILABLE INFORMATION

A calculator is available at the right side of each decision screen which you can open via a small calculator icon. Once you have made your decisions in all three tasks, you will receive your results on the screen including your payment in € for Part I of the experiment.

PAYMENT

Your proceeds (in ECU) from the three tasks of Part I are converted into €, whereat each ECU is worth €0.005. You will also receive a compensation for your appearance. The payout is conducted individually and anonymously at the end of the experiment.

In order to start the experiment, you need to click on the <Next> button. After completion of Part I, we ask you to stay at your place in the cabin and wait for further instructions for Part II of the experiment.

EXPERIMENTAL INSTRUCTIONS (TINB)

In Part II, the main part of the experiment, you will participate in a market experiment in which you can still earn money. How much you earn depends, in this part, on your decisions and, unlike Part I, also on the decisions of other participants. Each participant makes its decisions in isolation from the others on her/his computer. We ask you not to talk to other participants.

PART II

You now participate in a market which runs 15 trading periods. At the beginning you will be randomly matched with five other persons to build a group of six, in which you remain throughout the 15 trading periods. You will not know the identity of your group members at any time, though.

In this part, you assume the role of a trader on a stock market, for assets of a single type. On this market, you have the opportunity to submit a buy and / or a sell offer in each of the 15 trading periods. However, you are not obliged to.

At the beginning of the 15 periods, each group member is endowed with 10 assets and an initial trading capital of 10,000 ECU. This initial trading capital has to be repaid at the end of the experiment in full, again!

THE VALUE OF AN ASSET

Each asset has a lifespan of 15 trading periods. The so-called fundamental value of an asset is determined in each of the 15 periods as the sum of the, for all assets identical, dividends to be accrued in the future. After the last dividend payment at the end of the last period the asset is worthless. The dividend for an asset is randomly determined in each period by the computer and can take a value of 10 ECU, 20 ECU, 40 ECU or 80 ECU.

There are two possible "states" with respect to the asset, State 1 ("good" state) and State 2 ("bad" state). Each state has the same probability of 50%. Given these probabilities, the computer randomly selects one of the two states before the first trading period. This state (State 1 or State 2) withstands for the total market duration of 15 trading periods.

Two randomly selected participants per group of six participants, whose identity remains secret, will be informed at the beginning of the market which state has actually been chosen and applies to all participants during the entire duration of the market. The other participants receive no information about the actually chosen state. The randomly drawn state determines the probabilities with which each of the possible values of the dividends of 10 GE, 20 GE, 40 GE or 80 GE are drawn. These probabilities and the expected dividend of one asset are presented in Table 1 for the two states.

Since, in the two states, the probabilities of the possible dividend values and thus the expected dividend per period of an asset are different, also the fundamentals of an asset will develop in different ways over the course of the market. Table 2 shows the computation of the fundamental values in the periods 1 to 15 for the two possible states.

Table 1

	State 1 ("good") [50%]	**State 2 ("bad") [50%]**
Possible Dividends [Probabilities]	10 ECU [10%] 20 ECU [20%] 40 ECU [30%] 80 ECU [40%]	10 ECU [40%] 20 ECU [30%] 40 ECU [20%] 80 ECU [10%]
Expected Dividend of an Asset per Period	49 ECU	26 ECU

Table 2

Fundamental Values (in ECU)					
Period	**State 1 ("good") [50%]**	Cond. Prob. for State 1	**State 2 ("bad") [50%]**	Cond. Prob. for State 1	**Expected Value according to Bayes**
1	735 (=15×49)	0.5	390 (=15×26)	0.5	562.5 (=0.5×735+0.5×390)
2	686 (=14×49)	$p_{1,2}$	364 (=14×26)	$p_{2,2}$	$p_{1,2}$×686+$p_{2,2}$×364
3	637 (=13×49)	$p_{1,3}$	338 (=13×26)	$p_{2,3}$	$p_{1,3}$×637+$p_{2,3}$×338
4	588 (=12×49)	$p_{1,4}$	312 (=12×26)	$p_{2,4}$	$p_{1,4}$×588+$p_{2,4}$×312
5	539 (=11×49)	$p_{1,5}$	286 (=11×26)	$p_{2,5}$	$p_{1,5}$×539+$p_{2,5}$×286
6	490 (=10×49)	$p_{1,6}$	260 (=10×26)	$p_{2,6}$	$p_{1,6}$×490+$p_{2,6}$×260
7	441 (=9×49)	$p_{1,7}$	234 (=9×26)	$p_{2,7}$	$p_{1,7}$×441+$p_{2,7}$×234
8	392 (=8×49)	$p_{1,8}$	208 (=8×26)	$p_{2,8}$	$p_{1,8}$×392+$p_{2,8}$×208
9	343 (=7×49)	$p_{1,9}$	182 (=7×26)	$p_{2,9}$	$p_{1,9}$×343+$p_{2,8}$×182
10	294 (=6×49)	$p_{1,10}$	156 (=6×26)	$p_{2,10}$	$p_{1,10}$×294+$p_{2,10}$×156
11	245 (=5×49)	$p_{1,11}$	130 (=5×26)	$p_{2,11}$	$p_{1,11}$×245+$p_{2,11}$×130
12	196 (=4×49)	$p_{1,12}$	104 (=4×26)	$p_{2,12}$	$p_{1,12}$×196+$p_{2,12}$×104
13	147 (=3×49)	$p_{1,13}$	78 (=3×26)	$p_{2,13}$	$p_{1,13}$×147+$p_{2,13}$×78
14	98 (=2×49)	$p_{1,14}$	52 (=2×26)	$p_{2,14}$	$p_{1,14}$×98+$p_{2,14}$×52
15	49 (=1×49)	$p_{1,15}$	26 (=1×26)	$p_{2,15}$	$p_{1,15}$×49+$p_{2,15}$×26

Since, in the game, you are not necessarily informed about which state has actually been drawn, you may only know the initial probability of 50% for each state, you are provided at the beginning of each period with recalculated probabilities for the two states according to the so-called Bayesian method. These so-called conditional probabilities for the states take into account the, up to that time, randomly drawn dividends. Because the conditional probabilities cannot be specified in advance, they are denoted in Table 2 with $p_{i,j}$. Thereby, $i \in \{1,\ 2\}$ denotes the state and $j \in \{2, \dots, 15\}$ denotes the period. In addition to the recalculated conditional probabilities you are provided, at the beginning of each period, with a fundamental value which is adapted to these conditional probabilities (fundamental value according to Bayes) on your screen.

DECISIONS

Before you can submit your buy and sell offers for the assets in each trading period, you are asked to forecast the resulting asset price in the market for all future periods. This market price is determined and announced to you at the end of each period. In particular, you enter in each period $t \in \{1, \dots, 15\}$ a total of $(16 - t)$ forecasts for the future periods. Because you can rethink your forecasts in each period, you have to submit for each period t a total of t forecasts in the course of the market. Depending on the forecast accuracy of your forecasts you receive a payment (in ECU) after each period which was predicted. Table 3 gives an overview of the payments depending on the quality of forecasts. These payments can be received for each period t a maximum of t times. With the <Tabulator> button you can switch the entry fields for your decisions. All entries are completed by clicking on the <Submit Forecasts!> button.

Table 3

Accuracy of the Forecast	Payment for each Correct Forecast
Within ± 10% of the actual market price	5 ECU
Within ± 10-20% of the actual market price	2 ECU
Within ± 20-30% of the actual market price	1 ECU

Trading in each period takes place as follows. Each trading period lasts a maximum of 240 seconds. In the first 120 seconds, you first have the opportunity to submit an offer to buy by entering a "limit buy price" and the corresponding "limit buy quantity" in the appropriate fields on the screen.

The limit buy price is the price you are willing to pay at most per asset. This means you buy at this or any lower price which is established on the market. Please enter in addition to your limit buy price your corresponding limit purchase quantity of assets you want to buy at a price lower than or equal to your limit buy price. If only a smaller amount of assets is available on the market for you, you get this smaller amount. In extreme cases, it is also possible that you get no assets. If you do not want to buy at any price but want just to keep your asset inventory, leave the entry fields empty.

Please confirm your entries by clicking on the button <Confirm Buying Decision!>. Subsequently you switch to the screen for the submission of your selling offer.

In the second 120 seconds you have then the opportunity to submit an offer to sell, by entering a "limit sell price" and the corresponding "limit sell quantity" in the appropriate fields on the screen.

The limit sell price is the price you want to have at least per asset. This means you sell at this or any higher price which is established on the market. Please enter in addition to your limit sell price your corresponding limit sell quantity of assets you want to sell at a price higher than or equal to your limit sell price. If there is only a lower demand for your assets on the market, you sell this smaller amount. In extreme cases, it is also possible that you sell no assets. If you do not want to sell at any price but want just to keep your asset inventory, leave the entry fields empty.

Please confirm your entries by clicking on the button <Confirm Selling Decision!>. When all participants have completed their decision to sell, the experiment continues. All buy and all sell offers aggregated, respectively. Out of this, the market price and the corresponding trading volume (the total quantity traded) are determined. All individual transactions that are possible under these conditions are conducted. If no transactions can take place, there is no market price. In this case, we denote the market price with 0.

Transactions take place as long as there are dealers who want to sell at a lower or the same price than dealers are willing to pay. For the determination of the market price and trading volume all bids are aggregated, from the highest to the lowest bid, into a falling demand curve in price, and all selling offers are aggregated, from the lowest to the highest selling offer, into an increasing supply curve in price. The intersection of these two curves determines the (maximum possible) trading volume. The market price is determined as the average of the smallest limit buy price and the highest limit sell price for which a transaction just comes about.

Please note that your inventory of assets and trading capital changes through trade after each period. The selling of assets reduces the asset and increases the trading capital inventory. The buying of assets increases the asset and reduces the trading capital inventory. In addition, the dividend income, of the assets held by you at the end of each period, increases the trading capital.

When choosing your buying and selling offers, you must ensure that they are permissible. If you trade, you firstly can never sell more assets than you have in your own asset inventory in this period, secondly never buy more assets, as is permitted by the available sum of the asset holdings of the other market participants in your group and thirdly never buy more assets at a certain price, as is permitted by your trading capital in this period. Fourthly, you must note that your limit sell price, at which you wish to sell assets, must be higher than your limit buy price, at which you wish to buy assets. Possible prices that may be entered are all integer numbers between 1 and 1500, as long as none of the rules above is violated. If you make an entry that violates these rules, this will be automatically indicated on the screen and you have to revise your input. However in this case, you also have the opportunity to continue without entering an offer by leaving the entry fields empty.

Should you have not verified your buying and/or selling decision during the respective 120 seconds, the (possibly) until then entered decisions are not taken into account, i.e., you would not buy or sell anything in the respective decision stage!

AVAILABLE INFORMATION

A calculator is available at the right side of each decision screen, which you can open via a small calculator icon. Additionally, you are provided in each period, in all decision stages, with all relevant information via a summary table on the screen. Just click on the button <Show Results of Previous Periods> which is located in the middle at the bottom of the screen. To return from this summary screen back into the respective decision stage, you have to click on the button <Back to…>, respectively. Furthermore, an overview of the results of the just completed period is displayed after each period on the screen.

PAYMENT

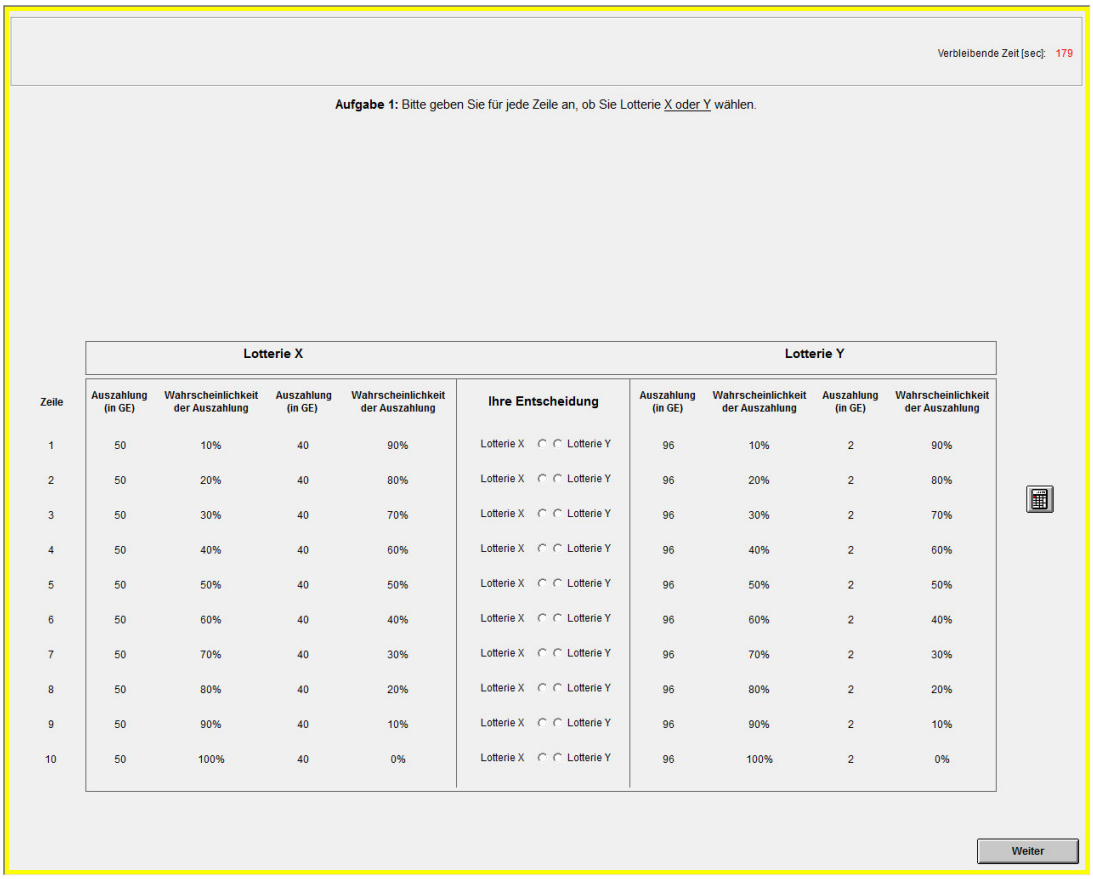
Your relevant income for the payout (in ECU) in Part II of the experiment is determined by your trading capital at the end of the last period minus the initial trading capital. The relevant income for the payout is calculated alternatively as the sum of your individual period profits. The period profit is calculated as follows:

Period profit	=	Your asset holdings at the end of the period × Dividend per Asset in this period (= dividend income)
	+	Proceeds from the disposal of assets in this period
	–	Expenditures for purchased assets in this period
	+	Remuneration for the forecast(s) of the market price in this period

Your relevant income for the payout (in ECU) from Part II is converted into €, whereat each ECU is worth €0.003. In addition, you will receive your payout from Part I and a show-up fee of €3. If your trading capital at the end of the last period of part II is not sufficient for the repayment of the initial trading capital, your relevant income for the payout in Part II is negative. This negative payment is deducted from your payout from Part I and your show-up fee. However, you cannot suffer a real loss, i.e., your minimum payout is zero. The payout is conducted individually and anonymously at the end of the experiment.

We ask you now to go to the computer with your participation number. There you have to click on <Continue>. You then will be given on your screen a number of questions regarding these instructions. If you have any questions please address yourself to the experimenter. Only when all participants have correctly answered all questions, the experiment starts.

Screenshots

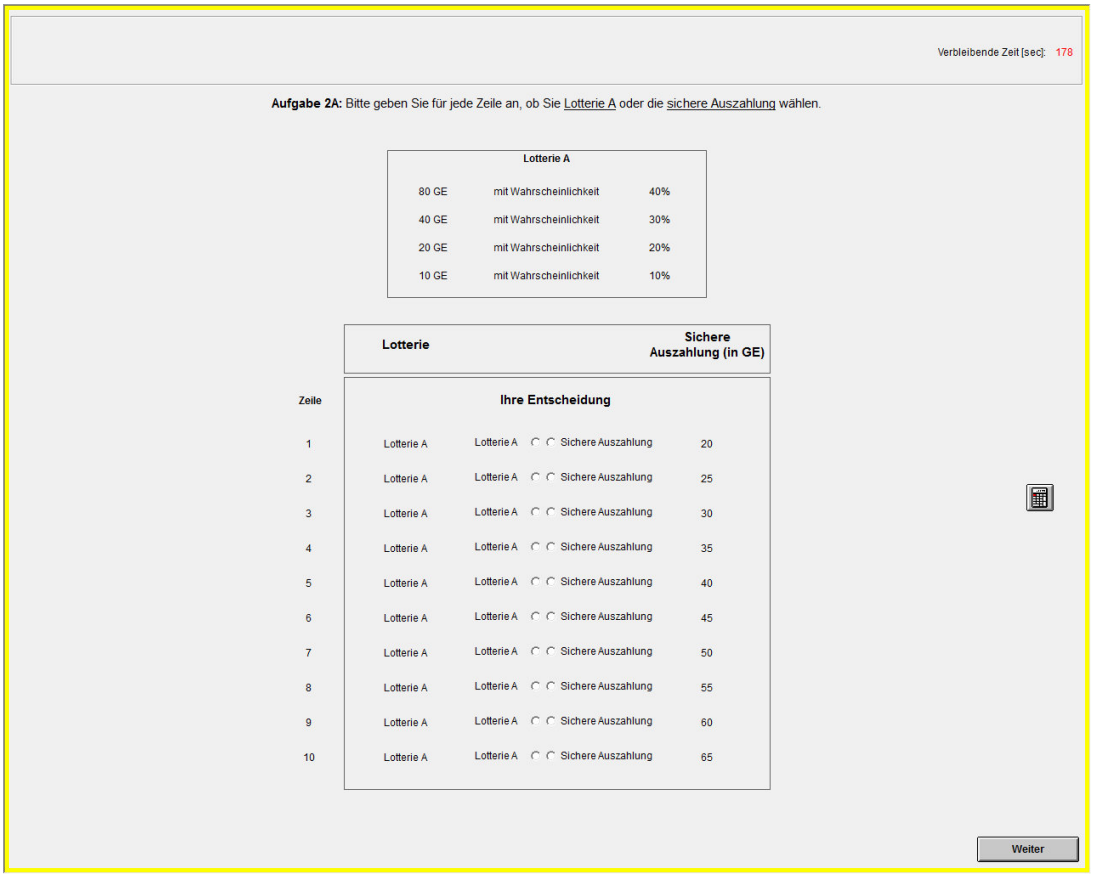


Verbleibende Zeit [sec]: 179

Aufgabe 1: Bitte geben Sie für jede Zeile an, ob Sie Lotterie X oder Y wählen.

	Lotterie X					Lotterie Y			
Zeile	Auszahlung (in GE)	Wahrscheinlichkeit der Auszahlung	Auszahlung (in GE)	Wahrscheinlichkeit der Auszahlung	Ihre Entscheidung	Auszahlung (in GE)	Wahrscheinlichkeit der Auszahlung	Auszahlung (in GE)	Wahrscheinlichkeit der Auszahlung
1	50	10%	40	90%	Lotterie X ○ ○ Lotterie Y	96	10%	2	90%
2	50	20%	40	80%	Lotterie X ○ ○ Lotterie Y	96	20%	2	80%
3	50	30%	40	70%	Lotterie X ○ ○ Lotterie Y	96	30%	2	70%
4	50	40%	40	60%	Lotterie X ○ ○ Lotterie Y	96	40%	2	60%
5	50	50%	40	50%	Lotterie X ○ ○ Lotterie Y	96	50%	2	50%
6	50	60%	40	40%	Lotterie X ○ ○ Lotterie Y	96	60%	2	40%
7	50	70%	40	30%	Lotterie X ○ ○ Lotterie Y	96	70%	2	30%
8	50	80%	40	20%	Lotterie X ○ ○ Lotterie Y	96	80%	2	20%
9	50	90%	40	10%	Lotterie X ○ ○ Lotterie Y	96	90%	2	10%
10	50	100%	40	0%	Lotterie X ○ ○ Lotterie Y	96	100%	2	0%

Weiter



Verbleibende Zeit [sec]: 178

Aufgabe 2A: Bitte geben Sie für jede Zeile an, ob Sie Lotterie A oder die sichere Auszahlung wählen.

Lotterie A		
80 GE	mit Wahrscheinlichkeit	40%
40 GE	mit Wahrscheinlichkeit	30%
20 GE	mit Wahrscheinlichkeit	20%
10 GE	mit Wahrscheinlichkeit	10%

	Lotterie		Sichere Auszahlung (in GE)
Zeile	Ihre Entscheidung		
1	Lotterie A	Lotterie A ○ ○ Sichere Auszahlung	20
2	Lotterie A	Lotterie A ○ ○ Sichere Auszahlung	25
3	Lotterie A	Lotterie A ○ ○ Sichere Auszahlung	30
4	Lotterie A	Lotterie A ○ ○ Sichere Auszahlung	35
5	Lotterie A	Lotterie A ○ ○ Sichere Auszahlung	40
6	Lotterie A	Lotterie A ○ ○ Sichere Auszahlung	45
7	Lotterie A	Lotterie A ○ ○ Sichere Auszahlung	50
8	Lotterie A	Lotterie A ○ ○ Sichere Auszahlung	55
9	Lotterie A	Lotterie A ○ ○ Sichere Auszahlung	60
10	Lotterie A	Lotterie A ○ ○ Sichere Auszahlung	65

Weiter

Verbleibende Zeit [sec]: 180

Aufgabe 2B: Bitte geben Sie für jede Zeile an, ob Sie Lotterie B oder die sichere Auszahlung wählen.

Lotterie B

80 GE	mit Wahrscheinlichkeit	10%
40 GE	mit Wahrscheinlichkeit	20%
20 GE	mit Wahrscheinlichkeit	30%
10 GE	mit Wahrscheinlichkeit	40%

Zeile	Lotterie	Ihre Entscheidung		Sichere Auszahlung (in GE)
1	Lotterie B	Lotterie B	○ ○ Sichere Auszahlung	5
2	Lotterie B	Lotterie B	○ ○ Sichere Auszahlung	10
3	Lotterie B	Lotterie B	○ ○ Sichere Auszahlung	15
4	Lotterie B	Lotterie B	○ ○ Sichere Auszahlung	20
5	Lotterie B	Lotterie B	○ ○ Sichere Auszahlung	25
6	Lotterie B	Lotterie B	○ ○ Sichere Auszahlung	30
7	Lotterie B	Lotterie B	○ ○ Sichere Auszahlung	35
8	Lotterie B	Lotterie B	○ ○ Sichere Auszahlung	40
9	Lotterie B	Lotterie B	○ ○ Sichere Auszahlung	45
10	Lotterie B	Lotterie B	○ ○ Sichere Auszahlung	50

Weiter

Verbleibende Zeit [sec]: 10

Ergebnisse für Teil I

Ergebnis aus Aufgabe 1:

Die zufällig für die Auszahlung ausgewählte Zeile	1
Die von Ihnen gewählte Alternative in dieser Zeile	X
Ihr Erlös in GE aus Aufgabe 1	40

Ergebnis aus Aufgabe 2A:

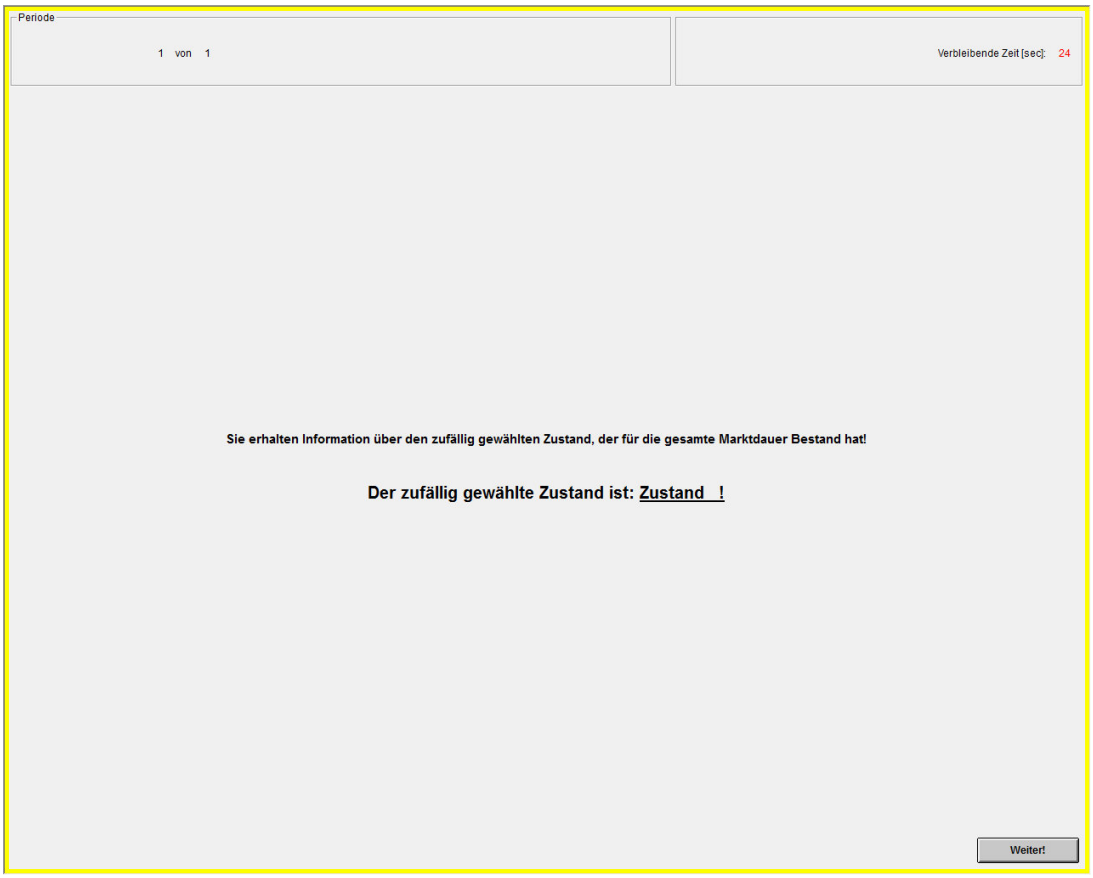
Die zufällig für die Auszahlung ausgewählte Zeile	5
Die von Ihnen gewählte Alternative in dieser Zeile	Lotterie A
Ihr Erlös in GE aus Aufgabe 2A	40

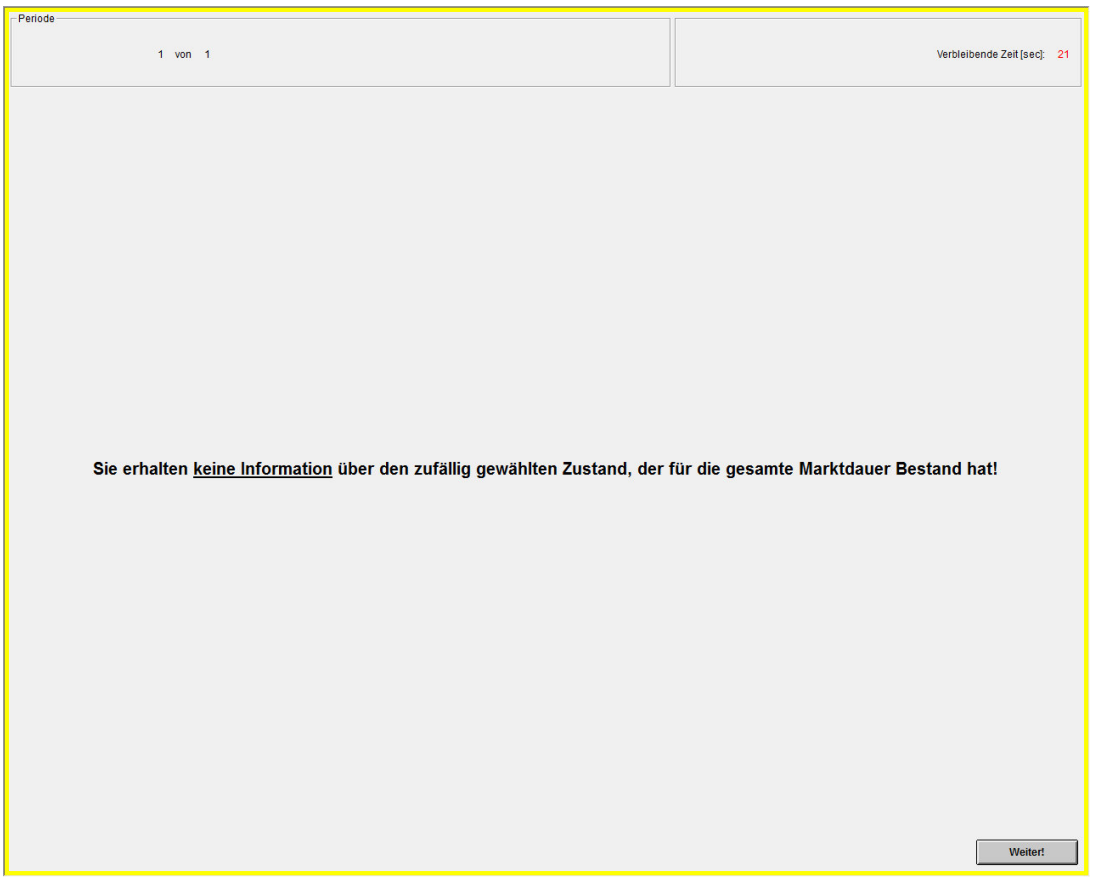
Ergebnis aus Aufgabe 2B:

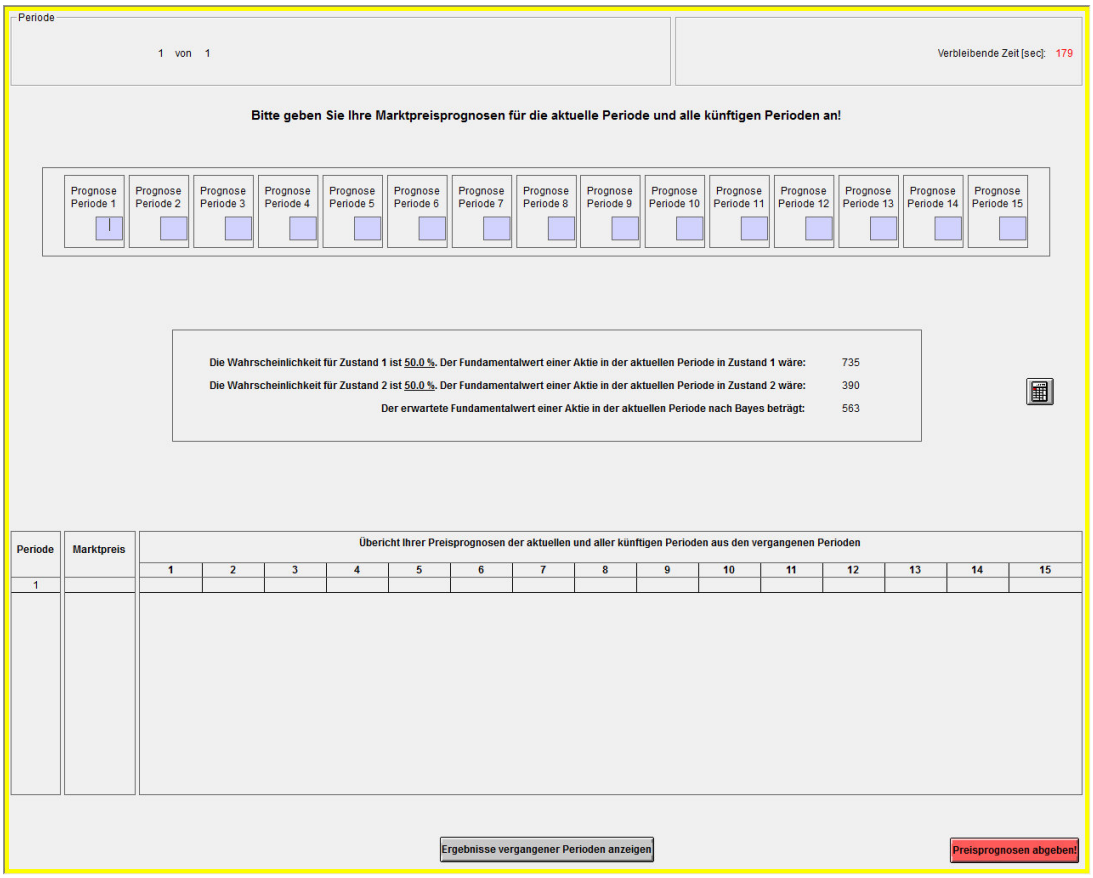
Die zufällig für die Auszahlung ausgewählte Zeile	2
Die von Ihnen gewählte Alternative in dieser Zeile	Sichere Auszahlung
Ihr Erlös in GE aus Aufgabe 2B	10

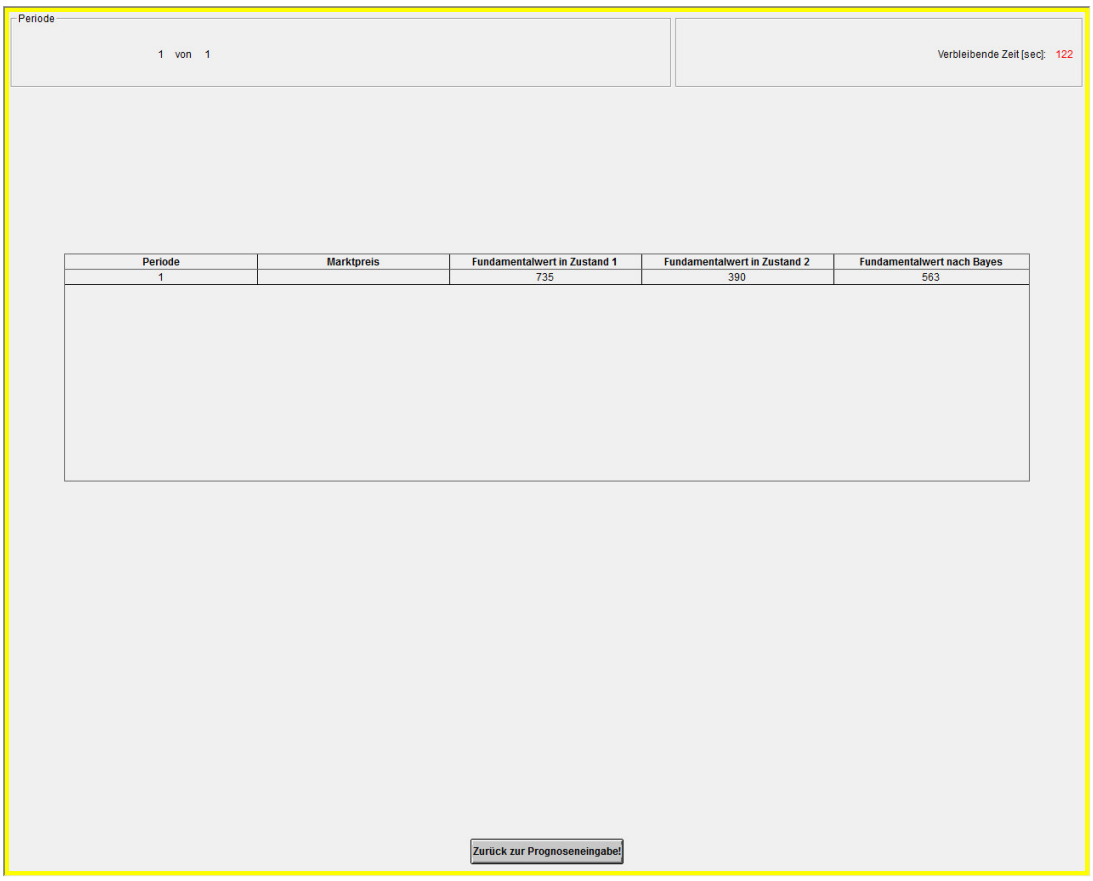
Ihre Auszahlung in Euro aus Ihren Entscheidungen in Teil I 0.45

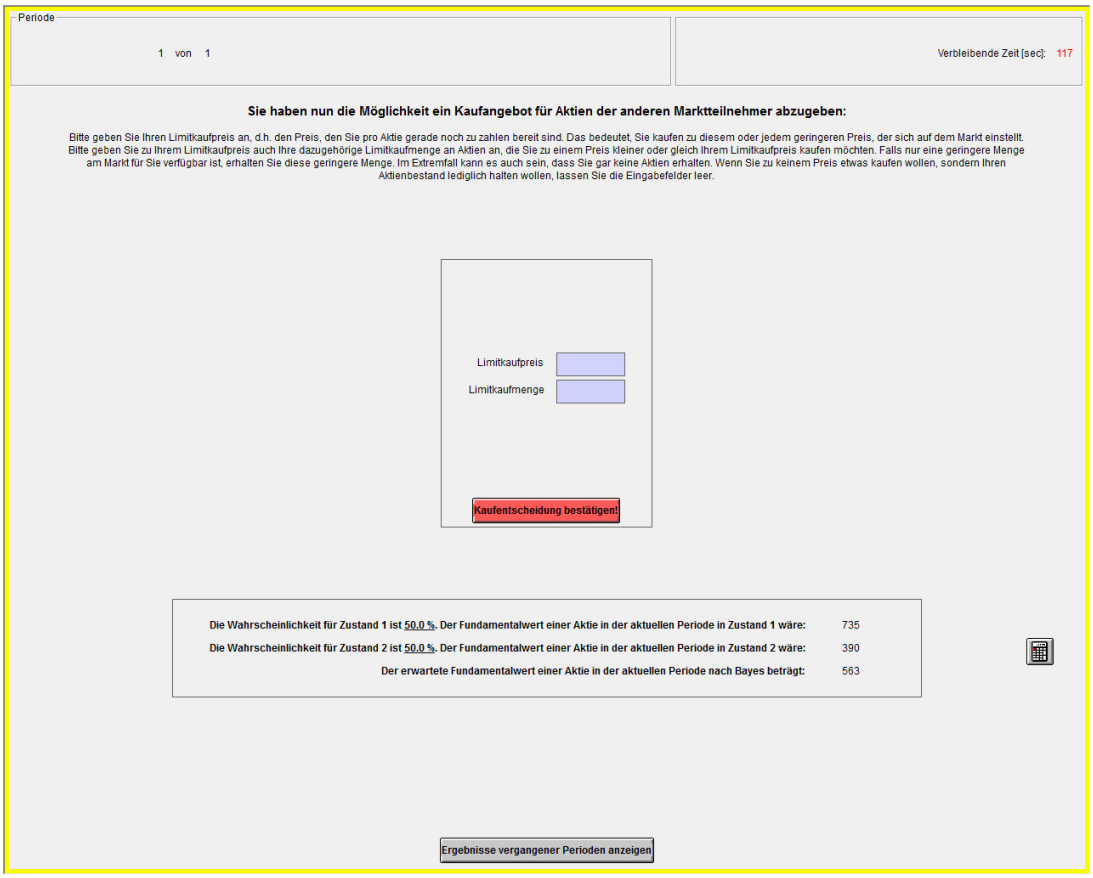
Weiter

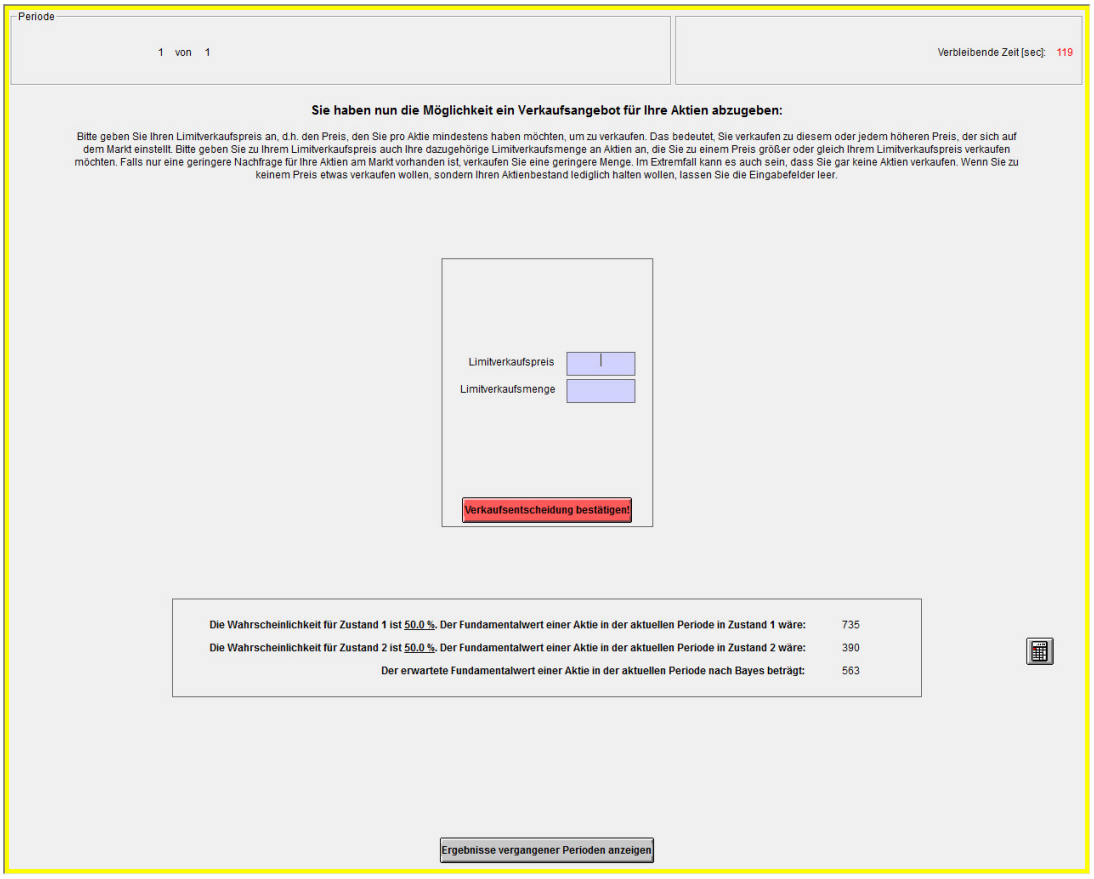

Periode
1 von 1
Verbleibende Zeit [sec]: 24
Sie erhalten Information über den zufällig gewählten Zustand, der für die gesamte Marktdauer Bestand hat!
Der zufällig gewählte Zustand ist: Zustand !
Weiter!

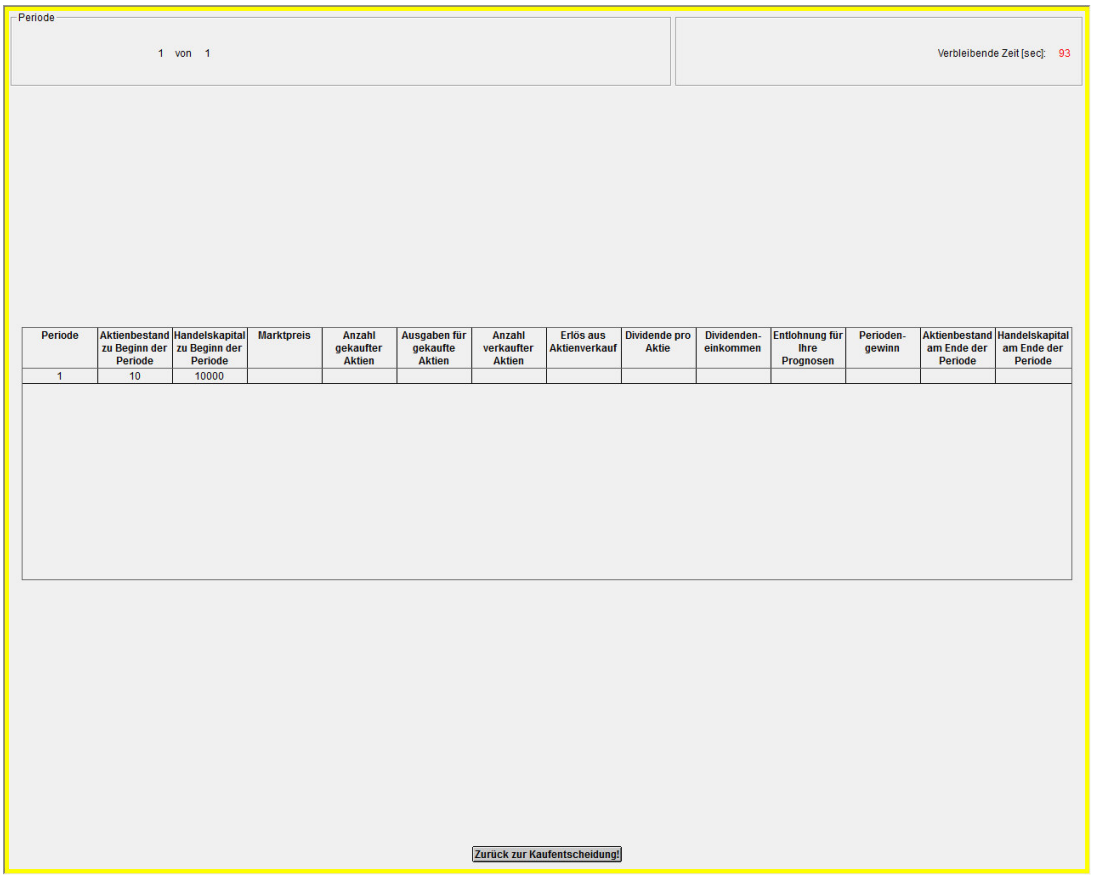

Periode
1 von 1
Verbleibende Zeit [sec]: 21
Sie erhalten keine Information über den zufällig gewählten Zustand, der für die gesamte Marktdauer Bestand hat!
Weiter!

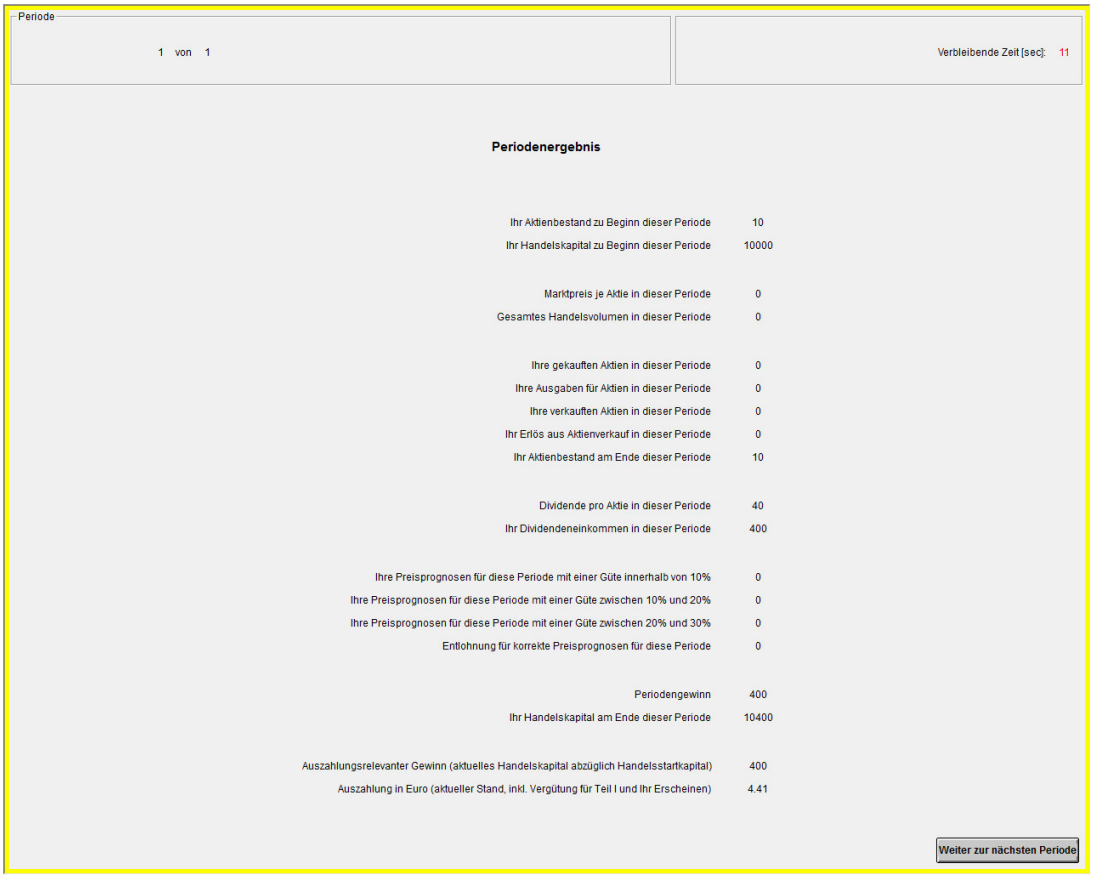

Periode
1 von 1
Verbleibende Zeit [sec]: 179
Bitte geben Sie Ihre Marktpreisprognosen für die aktuelle Periode und alle künftigen Perioden an!
Prognose Periode 1
Prognose Periode 2
Prognose Periode 3
Prognose Periode 4
Prognose Periode 5
Prognose Periode 6
Prognose Periode 7
Prognose Periode 8
Prognose Periode 9
Prognose Periode 10
Prognose Periode 11
Prognose Periode 12
Prognose Periode 13
Prognose Periode 14
Prognose Periode 15
Die Wahrscheinlichkeit für Zustand 1 ist 50.0 %. Der Fundamentalwert einer Aktie in der aktuellen Periode in Zustand 1 wäre: 735
Die Wahrscheinlichkeit für Zustand 2 ist 50.0 %. Der Fundamentalwert einer Aktie in der aktuellen Periode in Zustand 2 wäre: 390
Der erwartete Fundamentalwert einer Aktie in der aktuellen Periode nach Bayes beträgt: 563
Periode
Marktpreis
Übericht Ihrer Preisprognosen der aktuellen und aller künftigen Perioden aus den vergangenen Perioden
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1
Ergebnisse vergangener Perioden anzeigen
Preisprognosen abgeben!


Periode
1 von 1
Verbleibende Zeit [sec]: 122
Periode
Marktpreis
Fundamentalwert in Zustand 1
Fundamentalwert in Zustand 2
Fundamentalwert nach Bayes
1
735
390
563
Zurück zur Prognoseneingabe!


Periode
1 von 1
Verbleibende Zeit [sec]: 117
Sie haben nun die Möglichkeit ein Kaufangebot für Aktien der anderen Marktteilnehmer abzugeben:
Bitte geben Sie Ihren Limitkaufpreis an, d.h. den Preis, den Sie pro Aktie gerade noch zu zahlen bereit sind. Das bedeutet, Sie kaufen zu diesem oder jedem geringeren Preis, der sich auf dem Markt einstellt. Bitte geben Sie zu Ihrem Limitkaufpreis auch Ihre dazugehörige Limitkaufmenge an Aktien an, die Sie zu einem Preis kleiner oder gleich Ihrem Limitkaufpreis kaufen möchten. Falls nur eine geringere Menge am Markt für Sie verfügbar ist, erhalten Sie diese geringere Menge. Im Extremfall kann es auch sein, dass Sie gar keine Aktien erhalten. Wenn Sie zu keinem Preis etwas kaufen wollen, sondern Ihren Aktienbestand lediglich halten wollen, lassen Sie die Eingabefelder leer.
Limitkaufpreis
Limitkaufmenge
Kaufentscheidung bestätigen!
Die Wahrscheinlichkeit für Zustand 1 ist 50.0 %. Der Fundamentalwert einer Aktie in der aktuellen Periode in Zustand 1 wäre: 735
Die Wahrscheinlichkeit für Zustand 2 ist 50.0 %. Der Fundamentalwert einer Aktie in der aktuellen Periode in Zustand 2 wäre: 390
Der erwartete Fundamentalwert einer Aktie in der aktuellen Periode nach Bayes beträgt: 563
Ergebnisse vergangener Perioden anzeigen


Periode
1 von 1
Verbleibende Zeit [sec]: 119
Sie haben nun die Möglichkeit ein Verkaufsangebot für Ihre Aktien abzugeben:
Bitte geben Sie Ihren Limitverkaufspreis an, d.h. den Preis, den Sie pro Aktie mindestens haben möchten, um zu verkaufen. Das bedeutet, Sie verkaufen zu diesem oder jedem höheren Preis, der sich auf dem Markt einstellt. Bitte geben Sie zu Ihrem Limitverkaufspreis auch Ihre dazugehörige Limitverkaufsmenge an Aktien an, die Sie zu einem Preis größer oder gleich Ihrem Limitverkaufspreis verkaufen möchten. Falls nur eine geringere Nachfrage für Ihre Aktien am Markt vorhanden ist, verkaufen Sie eine geringere Menge. Im Extremfall kann es auch sein, dass Sie gar keine Aktien verkaufen. Wenn Sie zu keinem Preis etwas verkaufen wollen, sondern Ihren Aktienbestand lediglich halten wollen, lassen Sie die Eingabefelder leer.
Limitverkaufspreis
Limitverkaufsmenge
Verkaufsentscheidung bestätigen!
Die Wahrscheinlichkeit für Zustand 1 ist 50.0 %. Der Fundamentalwert einer Aktie in der aktuellen Periode in Zustand 1 wäre: 735
Die Wahrscheinlichkeit für Zustand 2 ist 50.0 %. Der Fundamentalwert einer Aktie in der aktuellen Periode in Zustand 2 wäre: 390
Der erwartete Fundamentalwert einer Aktie in der aktuellen Periode nach Bayes beträgt: 563
Ergebnisse vergangener Perioden anzeigen


Periode
1 von 1
Verbleibende Zeit [sec]: 93
Periode
Aktienbestand zu Beginn der Periode
Handelskapital zu Beginn der Periode
Marktpreis
Anzahl gekaufter Aktien
Ausgaben für gekaufte Aktien
Anzahl verkaufter Aktien
Erlös aus Aktienverkauf
Dividende pro Aktie
Dividenden-einkommen
Entlohnung für Ihre Prognosen
Perioden-gewinn
Aktienbestand am Ende der Periode
Handelskapital am Ende der Periode
1
10
10000
Zurück zur Kaufentscheidung!


Periode
1 von 1
Verbleibende Zeit [sec]: 11
Periodenergebnis
Ihr Aktienbestand zu Beginn dieser Periode 10
Ihr Handelskapital zu Beginn dieser Periode 10000
Marktpreis je Aktie in dieser Periode 0
Gesamtes Handelsvolumen in dieser Periode 0
Ihre gekauften Aktien in dieser Periode 0
Ihre Ausgaben für Aktien in dieser Periode 0
Ihre verkauften Aktien in dieser Periode 0
Ihr Erlös aus Aktienverkauf in dieser Periode 0
Ihr Aktienbestand am Ende dieser Periode 10
Dividende pro Aktie in dieser Periode 40
Ihr Dividendeneinkommen in dieser Periode 400
Ihre Preisprognosen für diese Periode mit einer Güte innerhalb von 10% 0
Ihre Preisprognosen für diese Periode mit einer Güte zwischen 10% und 20% 0
Ihre Preisprognosen für diese Periode mit einer Güte zwischen 20% und 30% 0
Entlohnung für korrekte Preisprognosen für diese Periode 0
Periodengewinn 400
Ihr Handelskapital am Ende dieser Periode 10400
Auszahlungsrelevanter Gewinn (aktuelles Handelskapital abzüglich Handelsstartkapital) 400
Auszahlung in Euro (aktueller Stand, inkl. Vergütung für Teil I und Ihr Erscheinen) 4.41
Weiter zur nächsten Periode