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Testing market regulations in experimental asset markets – The case of margin purchases☆

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ABSTRACT

Margin requirements regulate the risks of leveraged positions in financial markets. Violated margin requirements trigger margin calls leading to automated liquidation of open margin positions. Due to a lack of active margin regulation, however, empirical studies are not able to capture the effect of margin regulation on asset market performance. Instead, we conduct an experimental finance study to understand how margin regulations, and in particular margin purchases, influence market performance. Our experimental results indicate that permitting margin purchases inflates market prices; in fact, active margin trading positively correlates with market prices. In a robustness check, we also permit short sales which curb though not eliminate the effects from margin purchases.

1. Introduction: leverage in financial asset markets

"I guarantee you that if you want to get rid of the bubble, whatever it is, that [raising margin requirements] will do it. My concern is that I am not sure what else it will do."

Alan Greenspan, Sept. 24, 1996, Fed Policy Meeting

The financial turmoil around 2008 has reconfirmed that a significant risk in financial markets lies in the bursting of speculative bubbles with tremendous effects on the global financial and economic system. Political regulators attempt to control price bubbles; but only in the aftermath of the bursting of the bubble, measures are taken to facilitate a soft-landing

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(e.g. short-sale constraints). However, regulation is double-edged as decision errors may lead from bad to worse outcomes. Regulators can only have a positive impact on the life-cycle of a bubble if they know how institutional changes affect financial market outcomes. Comparative-statics studies of margin regulations are necessary to endow the political decision-maker with relevant information on the regulatory impacts on speculative bubbles. Our paper contributes empirical data on the use of leverage in asset markets to the scientific knowledge-accumulation.

Margin accounts allow traders to use leverage in their portfolio decisions. In the U.S., Regulation T gives the Federal Reserve Bank (Fed) the authority to set margin requirements. These requirements limit margin debt by establishing the minimum levels of equity to be provided by traders. Margin calls upon violation of the requirements can lead to automatic liquidation of positions unless traders provide collateral in the short term. Until 1974 the Fed made use of an active margin policy and changed the requirements 21 times. After that, the margin requirements have been unchanged for margin loans, and also margin requirements for short sales have generally remained the same but were suspended only temporarily amid the recent short-sale bans. Hence, empirical evidence on the effect of margin regulations, and in particular margin purchasing, are missing.

An active margin policy as a control for price bubbles has been debated for long even before the Fed took office.[1] The empirical evidence from naturally occurring markets about the impact of margin regulations is rare and mixed, and so are the opinions about the effects of intervention by the policymaker. While some studies claim that margin requirements indeed have an impact on prices, volatility and liquidity (Eckardt and Rogoff, 1976; Grube et al., 1979; Luckett, 1982; Hardouvelis and Peristiani, 1992; Seguin, 1990; Lee and Yoo, 1991; Shiller, 2000a; Kofman and Moser, 2001), others see no impact (Cohen, 1966; Largay III and West, 1973; Kupiec, 1989; Sentana and Wadhwani, 1992). Not knowing the reasons for the adjustment of margin requirements during those times, it is debatable whether changing the margin requirements was effective or even necessary. Thus, the studies highlight the difficulties inherent in formulating a real-world margin regulation since the fear of regulatory intervention is that it may cause harmful unintended consequences. Using a heterogeneous agent model, Fostel and Geanakoplos (2008) show that the ability to leverage purchases inflates prices because the 'natural buyer' has access to more capital. Thus, Geanakoplos (2010) mentioned the margin requirements and the money supply among the core competences of the regulator to control speculative bubbles.

We provide experimental evidence of the effect of margin purchases on asset price bubbles, or more precisely on "overpricing" in asset markets (see, e.g., Janssen et al., 2019). In the remainder of the paper, we refer to "overpricing", rather than bubbles, and to specific measures that describe fundamentally unjustified positive price deviations, as the definition of a "bubble" is still controversially discussed and empirical detection of price bubbles, even ex-post, is challenging as the exact fundamental value is unknown in archival data (e.g. Brunnermeier, 2009).

We contribute to the discussion on the price effects of margin purchasing by firstly introducing margin trading requirements along with margin calls and forced asset sales to the standard experimental asset-market model with salient rewards by Smith et al. (1988). We know only one other experimental market study that includes margin calls and forced asset sales (Selten et al., 2018). However, the focus of that paper is not on leverage but on the effect of uncertainty on stock returns in a production economy. We make use of the experimental method as it allows us to isolate and manipulate the ability to leverage, without resorting to complex and imperfect econometric techniques to filter out the effects of other variables (Bloomfield and Anderson, 2010). In our experimental setup, we first compare a market condition with and without margin purchasing opportunity. In the latter, traders have the opportunity to borrow money to purchase shares of assets, whereas their assets serve as collateral. Amid share-price appreciations the higher asset-value allows traders to purchase even more assets on margin due to inflated collateral. However, a drop in prices depreciates the asset-value such that until margin requirements are violated. Over-indebted traders face a margin call. If they cannot provide additional collateral, they have to liquidate their assets until they meet the margin requirements. Our results indicate inflated prices along with higher volatility and a wider bid-ask-spread when margin purchasing is permitted. Furthermore, the results suggest that active margin purchasing has a reinforcing effect on the magnitude of overpricing. In our second experimental condition, we additionally allow for short sales. Again, we find significantly higher overpricing in markets with margin purchasing in comparison to markets without margin purchasing even if short selling is permitted, i.e. short selling in our setting is not able to compensate the power of margin purchasing. In this way, we provide data that support the quoted statement of Alan Greenspan.

As far as we know, we are first to introduce margin purchasing requirements – using margin loans to trade shares which serve as collateral for the loan – in asset market design of Smith et al. (1988). Experimental studies that come close to our study consider markets in which traders start with extra cash at the start of the market which the traders have to pay back at the end of the market like in Ackert et al. (2006) or Haruvy and Noussair (2006) using double auctions or more recently Duchêne et al. (2019) using call markets. However, the amount borrowed remains fixed throughout the market.

[1] Fisher (1933) and Snyder (1930) reported on the importance of unregulated margin debt in generating price bubbles when analysing the Great Crash of 1929. The ability to leverage purchases increased demand, inflated asset prices, and increased equity market-value, which raised the debt-capacity of margin purchasers. The upward-price spiral was fueled by an expansion of debt through margin purchases. From the end of 1924, until the market crashed, brokers' loans rose four and one-half times (by $6.5 billion). After the price peak, a debt spiral started. Investors lost trust and started to sell assets. Excess supply led to declining prices and depreciation of collateral. Triggered margin calls led to forced asset sales pushing supply even further. An increase in defaults on debt, and short sales exacerbated supply and, finally, traders sold assets at fire-sale prices. It only took six weeks to extinguish half of the total of brokers' loans. Finally, in 1934, the U.S. Congress established federal margin authority to prevent unjustifiable increases or decreases in stock demand. Since then margin requirements limit leveraged trades on both sides, long and short, of the stock market in an attempt to prevent dramatic price fluctuations.

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Eventually, trading had finished when traders realised being bankrupt, which does not affect the market anymore. Instead, in our setup, the credit line is fixed exogenously but depends on the market value of shares; the higher the share price, the higher the credit line and vice versa. In our design, the inflow of additional cash is endogenously determined through margin purchases as our debt capacity depends on the value of assets, i.e. on the current market prices. As the ability to borrow money increases with collateral, the liquidity argument does not hold in our markets. However, liquidity seems to dry out rapidly after the bubble crashes as margin calls and resulting forced asset sales end in a lower value of collateral triggering even more margin calls.

Further on, we consider short selling as a robustness check for the effect of margin purchasing on market performance. In contrast to other experiments, we do not limit the size of short positions (Haruvy and Noussair, 2006; Ackert et al., 2006; Duchêne et al., 2019), but allow the short sale capacity to fluctuate with market prices analogous to our margin purchasing implementation in real world markets.

Our contribution adds to the recent experimental studies on financial regulation policies. Fischbacher et al. (2013) consider monetary policy regimes in experimental asset markets. Armantier et al. (2013) experimentally tested "Reference Price Auction" mechanisms to remove toxic assets from portfolios of financially stressed banks (TARP auctions). Keser et al. (2017) implemented a game-theoretic model on the interaction between issuers and credit-rating agencies. Also, Weber et al. (2019) use the laboratory as a test-bed to analyse credit default swap regulation. In another paper, we also test different forms of IPO mechanisms (Füllbrunn et al., 2019).

We proceed as follows. In Section 2, we consider our first experiment in which we consider the difference between asset market performance in markets with and without the ability to buy on margin. In Section 3, we consider our second experiment in which we additionally allow for short selling in both settings. We conclude in Section 4.

2. Margin purchasing in experimental asset markets

2.1. Experimental implementation

We make use of the asset market design of Smith et al. (1988), which is known to produce speculative price bubbles in the laboratory (Palan, 2013; Janssen et al., 2019); the appendix provides detailed instructions.[2] Nine subjects, endowed with shares and cash (see Appendix B.3), trade 18 shares of a fictitious company during a sequence of 15 double-auction trading periods, each lasting three minutes. At the end of every period, each share pays a dividend that is 0, 8, 28, or 60 cash units (Taler) with equal probability. Since the expected per-period dividend equals 24 Taler, the fundamental value in period t equals $24 \times (16 - t)$, and declines from 360 in period 1 to 24 in period 15. After the last dividend payment in period 15, the shares become worthless and the cash holdings-the endowment plus gains from trade plus dividends-are paid out at an exchange rate of one cent to one Taler. The instructions include a table which explains the dividend process, including the sum of the expected dividend payments ($t \times 24$) and the range of the sum of dividend payments ($\{t \times 0, t \times 60\}$).

We implemented an empirically relevant trading facility, where traders submit limit and market orders to an order-driven continuous electronic market featuring an open order book. We thus deviate to some extent from the usual double auction implementation to allow for margin calls and also for cancellation of orders.[3] When a trader wants to sell a share, she submits an offer to sell at a minimum price. A trade occurs immediately if her submitted sell price undercuts the highest standing buy price (a market order); the price then equals the highest standing buy price, which is instantaneously removed from the order book. Otherwise, the limit order is listed in the open book of sale orders (where lower orders are listed before higher ones).[4] When a subject wants to buy a share, she submits an offer to buy for a maximum price. A trade occurs immediately if the submitted buy price exceeds the lowest standing sell price (market order); the price equals the lowest listed sell price. Otherwise, the limit order is listed in the open order book of purchase orders (in decreasing order).[5] Subjects were also able to cancel their standing limit orders.

To evaluate the impact of margin purchases on asset market prices, we compare the control treatment without margin trading opportunities (C) to a setting in which margin purchasing is permitted (Buy on Margin – B). Traders execute margin purchases when they purchase shares on loan (negative cash balance), which is collateralized by the shares (collateral = shares × current market price). The debt capacity depends on the value of collateral, i.e. traders can take up debt as long as the debt to collateral ratio is below 50% (= maintenance margin). On the one hand, a price increase enhances the

[2] The chosen asset market design has been implemented in several studies (Palan, 2013; Powell, 2016, e.g.) and some concerns have been raised (e.g., Kirchler et al., 2012). However, the Smith et al. (1988) asset market design still serves as the main work horse most prominently shown in recent studies like e.g. (Charness and Neugebauer, 2019; Carlé et al., 2019; Kocher et al., 2018; Füllbrunn et al., 2019). Using a different asset market design based on a flat fundamental value (dividend payments and interest balance out) introduced by Holt et al. (2017) and Weitzel et al. (2020) consider experiments with students and financial professionals and shows that market institutions comparisons like permitting short selling yield qualitatively similar results as the Smith et al. (1988) asset market design.

[3] See for example http://http://www.nasdaqtrader.com/Trader.aspx?id=Workstation. However, we do not use a market maker. Usually, asset market experiments are double auctions without the possibility to cancel the order.

[4] For example, subject A submits a sell order at 220 and subject B has the highest standing buy order at 300. Then, subject A sells to subject B at a price of 300.

[5] For example, subject B submits a buy order at 300 and subject A has the lowest standing sell order at 220. Then subject A sells to subject B at a price of 220.

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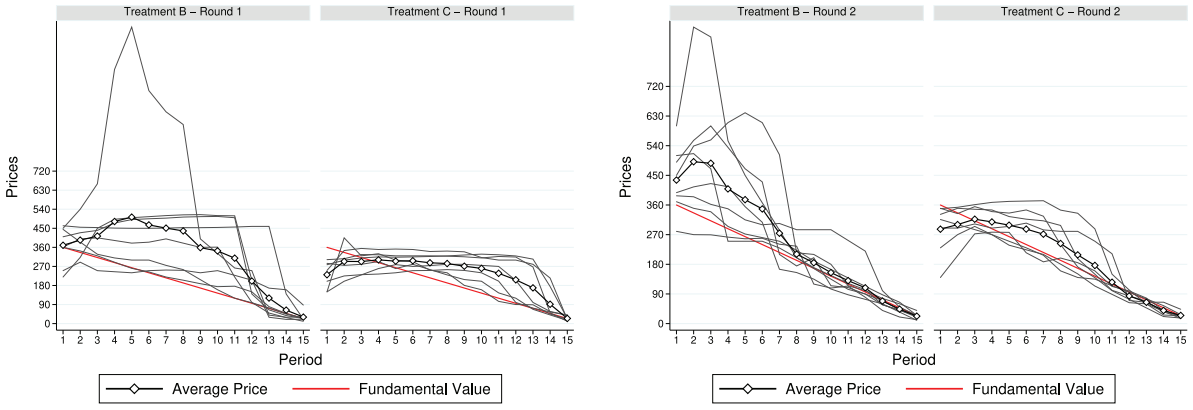

Fig. 1. Time series of median transaction prices. *Notes:* The figure depicts median prices of individual markets (gray lines), fundamental value (red straight line) and the average of median session prices (black line with diamonds) for each period.

collateral, and thus more shares can be purchased on margin. On the other hand, a price decline devalues the collateral while the debt remains constant. As soon as the debt to collateral ratio exceeds 50% a margin call is triggered. Immediately, i) the trader's buttons are disabled, ii) outstanding orders are canceled, and iii) the computer automatically quotes a limit sell order at the prevailing market price. The computer continuous selling shares until the margin requirements hold again, or until all shares have been sold.[6] Note that in contrast to other experimental asset market designs our design enables cash in- and outflows dependent on the market price, incorporating margin calls and forced asset sales. A margin call can lead to bankruptcy. However, the consequences of a margin call hold even during bankruptcy, i.e. outstanding positions are continuously being closed although subjects are bankrupt. One caveat with our implementation is that high dividend payments reduce debt quite substantial which reduces the threat of margin calls and the risk of bankruptcy.

In the experimental sessions, subjects interact when inexperienced (round 1), and when once-experienced (round 2) within the same cohort under identical conditions. Before the first round started, subjects participated in training periods and answered a computerized questionnaire. Payments equalled the final cash balance from both rounds exchanged to euro (100 Taler = 1 Euro) plus a show-up fee. We conducted the experiments at the MaXLab (University of Madgeburg) and the BonnEconLab (University of Bonn) using z-Tree (Fischbacher 2007) for the programming and ORSEE (Greiner 2004) for the recruitment. One hundred thirty-five students participated in seven *C* sessions and eight *B* sessions. Including comprehension questionnaires and payment, the session lasted up to 3.5 hours. The sessions paid on average 30 euro in *C* (SD 8.74) and 31 euro in *B* (SD 9.84) including show-up fee.

While textbook theory neglects loan defaults, recent models with heterogeneous agents argue that 'natural buyers' (or optimists) inflate prices when having sufficient funds from borrowing money (Fostel and Geanakoplos, 2008). Permitting margin purchases endows the natural buyers with sufficient liquidity to push up prices. Limiting the access to additional funds dampens inflationary pressures though. Thus, our primary hypothesis is that asset prices are higher under treatment *B* in which buy on margin is permitted than under the baseline treatment *C*.

2.2. Experimental results

Fig. 1 depicts the deviations of median prices from fundamental value for the treatments *B* and *C* by period and round. The (red) straight line represents the fundamental value, and positive values indicate prices exceeding the fundamental value. The grey curves show the trajectory for each session separately, while the black curves with diamonds show the treatment average for each period. In the control treatment, the trajectories form the standard pattern observed in these experiments, i.e. prices start below fundamental value, increase and intersect the fundamental value, reach the peak, and finally get back to fundamental value. The pattern is less pronounced in round 2, when subjects had more experiences. With margin purchases, the pattern is somewhat different as prices do not start below fundamental value but at or above fundamental value; a reason might be the higher liquidity in comparison to *C*. In round 2, we can see that prices are still above fundamental value, but only in the early periods; in later periods, prices follow fundamental value in *B* and also in *C*. In line with Haruvy et al. (2007) the price peaks move to earlier periods in round 2. Already from the start, we can see that prices are higher in *B* than in *C*

[6] For example, a subject has 300 Taler plus a share portfolio worth 2000 Taler (5 shares × prevailing market price of 400). This subject purchases three more shares on margin for a total of 1200 Taler. The debt to collateral ratio is thus (300–1200) / (8 × 400) = 28%. Now the price drops to 350; the new dept to collateral ratio is 900 / (8 × 350)=32%, which is still below 50%. A further drop to 180 yields a debt to collateral ratio of 900 / (8 × 180)=63% which triggers a margin call such that shares are offered at 180 Taler automatically.

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Table 1
Treatment averages by round - Buy on Margin and Control.

	Buy on Margin (B)			Control (C)		
	Round 1	Round 2	Difference	Round 1	Round 2	Difference
RD	0.72	0.30	−0.41*	0.22	0.05	−0.17**
RAD	0.78	0.38	−0.40*	0.40	0.21	−0.19**
PD	2145.16	974.56	−1170.59*	897.57	375.89	−521.68**
PMAX	571.75	517.25	−54.50	346.14	332.14	−14.00
CREDIT	1857.00	1671.38	−185.63	.	.	.

Notes: The table reports average measures for each round together with the difference between rounds. Asterisks indicate significance levels according to a two-sided Wilcoxon signed rank test evaluating the hypotheses that round differences are zero (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Definitions of measures can be found in the Appendix A.1.

To measure the deviation from fundamental value, we consider *Relative Deviation* (RD) and *Relative Absolute Deviation* (RAD) as suggested by Stöckl et al. (2010), *Positive Deviation* (PD) as suggested by Eckel and Füllbrunn (2015), and the highest deviation from fundamental value (PMAX).[7] When the relative deviation is 10%, then we say that the market is overpriced by 10 percent. When the relative absolute deviation is 15%, we say that the market is mispriced by 15%. Positive deviation equals the area between fundamental value and prices when prices are above fundamental value. Hence, it measures the absolute magnitude of overpricing in Taler. In the appendix section Appendix A.1, we define the applied measures. Additionally, we also consider the highest amount borrowed in a market (CREDIT). Table 1 reports the average outcomes of the above defined measures for each round and also the differences between rounds.

Overpricing in B is about 70% in round 1 and still 33% in round 2—significantly positive in both rounds ($p_1 = 0.012$, $p_2 = 0.0357$, using a sign rank test) but also significantly lower in round 2 ($p = 0.050$). Overpricing in the control C is much lower: 22% in round 1 and merely 5% in round 2—significantly lower in round 2 ($p = 0.028$). While overpricing is marginally significant in round 1 ($p = 0.063$), it is no longer significant in round 2 ($p = 0.500$). RAD shows a similar pattern as does PD; in both cases, the measured values decline with experience. However, the difference in peak prices (PMAX) is not significant between repetitions. Overall, we can conclude that the magnitude of overpricing is reduced from round 1 to round 2 which in line with other studies using similar setups (Dufwenberg et al., 2005; Haruvy et al., 2007). Hence, the results show prices to be clearly above fundamental value in round 1 for both treatments. However, while in C the prices are close to the fundamental value in round 2, we still see severe overpricing in round 2 when margin purchasing is permitted in B.

To analyze treatment effects, we consider hypothesis testing and random effects regression based on the following model 1.

$$X_{ir} = \alpha + \beta D_B + \gamma D_R + \delta (D_B \times D_R) + v_i + \varepsilon_{ir} \tag{1}$$

Let the dependent variable X_{ir} denote the measure of interest in cohort i in round r. The effect of the buy in margin treatment B is investigated by the dummy variable D_B which takes value 1 for treatment B and 0 for C. The repetition dummy variable D_R equals 0 in the first round when subjects are inexperienced and 1 in the second round when subjects are once-experienced. The product variable captures the interaction effect. Finally, v_i indicates the time constant session specific error and ε_{ir} indicates the idiosyncratic error term that varies over time and over sessions. Table 2 records the regression results for the bubble measures of interest.

Observation 1. Permitting buy on margin inflates asset prices.

Support: The relative deviation is three times higher in B than in C in round 1, and six times higher in round 2, respectively (Table 1). The regression 'RD' in Table 2 shows a significantly positive coefficient for the treatment dummy (D_B). Also the positive deviation is significantly higher in B ('PD') as well as the highest price ('PMAX'). Neither of the interaction effects is significant, suggesting no change of treatment effect between rounds. Using session level data observation considering RD as the relevant unit, with eight observation in B and seven observations in C, we find a weakly significant difference in round 1 but no significant difference in round 2 ($p_1 = 0.064$, $p_2 = 0.132$). Experiences seem to have a dampening effect on prices such that first round differences in overpricing are not available any more in the second round. Table A.10 in the appendix provides p-values for treatment comparisons.

Subjects actively use the ability to buy on margin. To find out how many of the trades are debt financed, we count the number of trades in which a trader purchased a share and ended up/remained in negative cash holdings. In treatment B, about 20% of all transactions in round 1 were margin purchases, about 23% in round 2. From Table 1 we can see that average CREDIT equals 1857 Taler in round 1 and 1671 in round 2. To put this number into perspective, we compare it to the cash available at that time (sum of cash endowments plus sum of cash dividends). The ratio of debt to cash available was 0.25 in round 1 and even about 0.30 in round 2; a substantial amount of debt.

[7] Alternative measures could be Geometric Deviation or Geometric Absolute Deviation as suggested by Powell and Shestakova (2016), however, the results would not change too much.

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Table 2
Random effects panel regressions—Buy on Margin (B) and Control (C).

	RD	RAD	PD	PMAX
D_B	0.49**	0.38**	1247.6**	225.6*
	(0.21)	(0.19)	(566.8)	(117.1)
D_R	−0.17	−0.19	−521.7	−14.0
	(0.14)	(0.14)	(402.4)	(66.3)
$D_B \times D_R$	−0.24	−0.21	−648.9	−40.5
	(0.20)	(0.19)	(551.0)	(90.8)
Constant	0.22	0.40***	897.6**	346.1***
	(0.15)	(0.14)	(413.9)	(85.5)
No. observations	30	30	30	30
No. Cohorts	15	15	15	15
Wald χ^2	15	14	15	4
Prob $>$ χ^2	0.002	0.003	0.002	0.218

Notes: The table reports results from a random effects regression with the model $X_{ir} = \alpha + \beta D_B + \gamma D_R + \delta D_B \times D_R + v_i + \varepsilon_{ir}$. The dependent variable is the measure of interest. The dummy variable D_B (Buy on Margin Dummy) equals 1 if margin purchasing is permitted, D_R (Round Two Dummy) is a round dummy and equals 1 for round two, and the product variable (Interaction) indicates the interaction effect between experience and the permission of margin purchases. Finally, v_i indicates the time constant cohort specific error and ε_{ir} indicates the idiosyncratic error term that varies over time and over cohorts. Parentheses record robust standard errors, clustered on independent sessions. *** p<0.01, ** p<0.05, * p<0.1. Definitions of measures can be found in the Appendix A.1.

Experimental results suggest that providing excessive liquidity in terms of cash leads to larger price bubbles (e.g. Caginalp et al., 2001). However, the literature so far neglected the endogenous inflow of cash via margin purchases. To test whether this inflow has an influence on overpricing, we consider the relationship between CREDIT and RD.

Observation 2. Active margin purchasing has a reinforcing effect on overpricing.

Support: The Spearman rank correlation coefficient between CREDIT and RD equals 0.762 ($p = 0.028$) in round 1 and 0.929 ($p < 0.001$) in round 2. Considering the number of executed margin purchases, we find the respective Spearman rank correlation with RD to be 0.786 ($p = 0.021$) in round 1 and 0.585 ($p = 0.127$) in round 2. The Spearman rank correlation coefficient between dept to cash available and RD equals 0.667 ($p = 0.071$) in round 1 and 0.929 ($p < 0.001$) in round 2. These results indicate a positive relationship between active margin purchasing and overpricing.

Margin trading is not without risk and our experimental results show that some traders bear too much of it. In four cohorts, margin calls were triggered. In these cohorts, the average number of margin calls was 5 in round 1 and 3.5 in round 2. In total, three traders ended up bankrupt following the leveraging of purchases on margin. To evaluate the question whether margin traders are compensated for bearing the increased risk, we classify traders into '*margin traders*', who purchased at least one share on margin, and others. We then calculate the difference of mean earnings at the end of a market between these two groups for each session and round. The average difference equals -110 Taler (SD 450) in round 1 and −163 Taler (SD 551) in round 2, i.e. margin traders on average earn less than others. However, using a sign rank test, we find no significant difference ($p_1 = 1.000,\ p_2 = 0.674$).[8]

The received theoretical literature makes some suggestions about how the ability to leverage purchases can impact portfolio concentration. According to theoretical considerations of Fostel and Geanakoplos (2008) and Miller (1977) and experimental evidence provided in Carlé et al. (2019), the most optimistic traders hold the largest number of risky shares in their portfolio when given the opportunity to do so. As treatment *B* provides sufficient liquidity for the 'optimists', we would expect an increased concentration of shares. We use two measures to test this prediction. First, we sum up the number of shares of the two subjects with the highest number of shares in their inventory. In round 1 (2) the average equals 10.93 (11.35) in *B* and 10.01 (10.10) in *C*. Using a Mann Whitney *U* test, we find a significant difference ($p_1 = p_2 = 0.037$) suggesting a higher concentration when margin purchases are permitted. Second, we look at the coefficient of variation (CV) of stock holdings at the most extreme situations in each market. We find a higher CV in *B* than in *C* in round 1, but a reversed result in round 2 (see A.8 in the appendix). However, in both rounds we find no significant difference. Hence, we cannot definitely conclude that a higher stock concentration exists in *B*.

Overall, we conclude that the opportunity to buy on margin inflates prices (between-treatment consideration) but also that active margin trading reinforces overpricing (within-treatment consideration).

[8] The categorization into a margin trader group is of course arbitrary. Other ways to categorize, such as whether subjects purchased on margin in both rounds, or whether the subjects' highest debt was at least −500 Taler, yield similar results.

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3. Permitting short sales

3.1. Experimental implementation

The reported results so far have been gathered under the condition that short sales are prohibited. In the second experiment, we permit short sales as a robustness check of the results on margin trading. The corresponding treatments are designated *BS* (buy on margin with short sales) and *CS* (control with short sales).

Traders make use of short sales when they sell shares without holding them in their inventory. In the margin account, cash serves as collateral on short sales. Short sellers assume a price decline to buy back the shares with a profit at a lower price. The amount of debt equals the market value of outstanding shares, i.e. debt fluctuates with market price (in contrast to margin purchases with a fixed debt amount). When the price exceeds a certain threshold, such that debt exceeds 50% of the cash, a margin call is triggered.[9] Immediately, i) the trader's buttons are disabled, ii) outstanding orders are cancelled, and iii) the computer automatically quotes a limit bid at the current market price. The computer continues buying back shares to cover short positions until the margin requirements are met again or until all short positions have been covered. Thus, in contrast to earlier studies, we do not restrict short interest and even allow for a short squeeze.

Short sellers pay dividends for their short positions at the end of each period such that a new period can already start with a margin call after the realisation of a high dividend. After period 15, both long and short positions are worthless. Note that margin traders can either margin purchase or short sell in treatment *BS* but only short sell in treatment *CS*. Since outstanding positions are closed even in case of bankruptcy, our implementation of the ability to short-sell shares differs to other asset market experiments, in which bankrupt short sellers are not able to close their positions and, thus, the share count is actually increased.[10]

Apart from the ability to short-sell assets, the experiment has the same parameters as in *B* or *C*. The total number of subjects in the eight *BS* sessions and the eight *CS* sessions was 144 students. No subject had ever participated in asset market experiments before. The experiments were conducted at the MaXLab of the University of Madgeburg and at the BonnEconLab of the University of Bonn. Including comprehension questionnaires and payment, the session lasted up to 3.5 h. The sessions paid on average 30.44 euro in *BS* (SD 10.25) and 31.04 euro in *CS* (SD 10.82) including show-up fee.

Permitting the ability to short-sell enables pessimistic traders to express their opinion in the market, leading prices to reduced price levels (Miller, 1977; Harrison and Kreps, 1978). In absence of the ability to short-sell, a situation arises in which optimistic traders alone determine prices when pessimists have run out of shares. Scheinkman and Xiong (2003) suggest that, due to overconfidence, heterogeneous beliefs create an opportunity to sell at a higher price to others in the future when short-selling is prohibited. Hence, we expect that the ability to sell short reduces overpricing which already has been confirmed in other asset market experiments (e.g., Haruvy and Noussair, 2006). The question is though, whether the ability to buy on margin still inflates prices when short selling is permitted. Therefore we are going to investigate our primary testable hypothesis also under the ability to short-sell assets; we conjecture that asset prices are higher under the treatment *BS* in which margin purchase is permitted relative to treatment *CS* in which margin purchasing is banned.

3.2. Experimental results

Analogously to Section 2.2, we compare the measures of interest between *BS* and *CS*. Fig. 2 depicts the median period prices together with the fundamental value for both treatments for round 1 and round 2. In treatment *BS* we find overpricing to be substantial in both rounds, less so in round 2 though. The visible deviations in *CS*, in contrast, are small already in round 1 and disappear further in round 2. Apparently, overpricing is higher in *BS* than in *CS*. However, the ability to short sale in *BS* does not seem to eliminate overpricing, i.e. the price-inflation forces from margin purchasing are stronger than the price-deflating forces from short selling.

Table 3 reports the average outcomes of the above defined measures for each round and also the differences between rounds. Overpricing in *BS*, as measured by RD, is about 51% in round 1 and still 31% in round 2—significantly positive in both rounds ($p_1 = 0.012,\ p_2 = 0.012$) but not significantly lower in round 2 ($p = 0.161$). Overpricing in *CS* is much lower, about 7 percent in round 1 and about 0 percent in round 2, and not significantly different from zero ($p_1 = 0.208,\ p_2 = 0.674$). For RAD and for PD we see an insignificant reduction in both treatments and the average of the measures are higher in *BS* than in *CS*. The peak prices do not change so much from round 1 to round 2 but are higher in *BS* than in *CS* in both rounds. Again, the magnitude of overpricing is reduced from round 1 to round 2 in both treatments. The results indicate that buy on margin inflates prices even with short sales. Finally, prices in *CS* are not different from the fundamental value which is in line with the literature when short sales are permitted.

[9] For example, a subject has 300 Taler plus a share portfolio worth 2000 Taler (5 shares × prevailing market price of 400). This subject sells eight shares for a total of 3000 Taler. The debt to cash ratio is thus 1200 / (8 × 400+300) = 34%. Now the price increases to 500. The new dept to cash ratio is 1500 / 3500 = 43%, which is still below 50%. A further increase to 600 yields a ratio of 1800 / 3500 = 51% which triggers a margin call. Immediately, the computer takes over and offers to buys the shares for 600 Taler.

[10] Students are less familiar with the concept of short selling and even though we carefully explained it, some were still hesitant to make use of this tool when appropriate. However, financial professionals and students qualitatively yielded similar results in asset market experiments when short selling was permitted (Weitzel et al., 2020).

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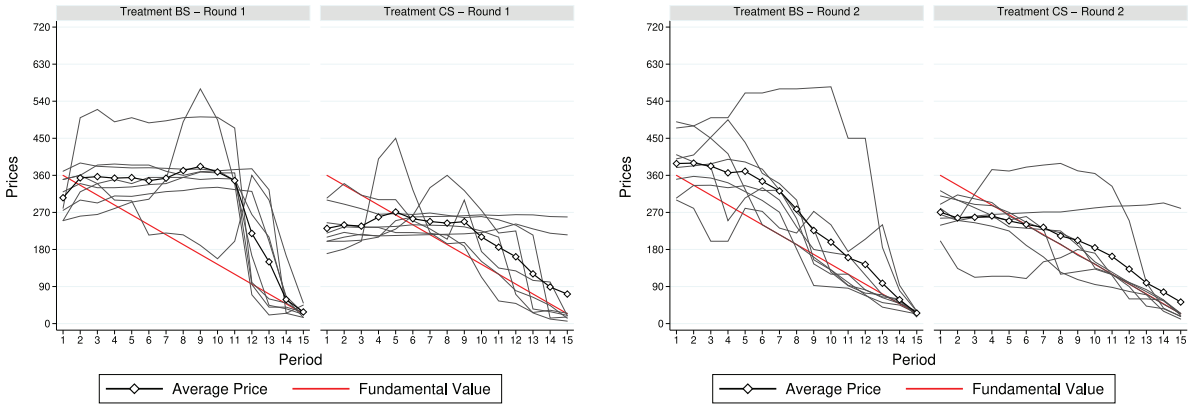

Fig. 2. Time series of median transaction prices. *Notes:* The figure depicts median prices of individual markets (gray lines), fundamental value (red line) and the average of median session prices (black line with diamonds) for each period.

Table 3
Treatment averages by round - Buy on Margin (BS) and Control (CS).

	Buy on Margin (BS)			Control (CS)		
	Round 1	Round 2	Difference	Round 1	Round 2	Difference
RD	0.51	0.31	−0.20	0.07	0.00	−0.07
RAD	0.58	0.39	−0.19	0.36	0.28	−0.08
PD	1582.44	995.28	−587.16	623.25	412.57	−210.68
PMAX	432.50	436.63	4.13	320.63	314.25	−6.38
CREDIT	1991.25	1784.00	−207.25	.	.	.
SHORT	5.63	5.63	0.00	8.50	6.38	−2.13

Notes: The table reports average measures for each round together with the difference between rounds. Asterisks indicate significance levels according to a two-sided Wilcoxon signed rank test evaluating the hypotheses that round differences are zero (*** p<0.01, ** p<0.05, * p<0.1). Definitions of measures can be found in the Appendix A.1.

Table 4
Random effects panel regressions—Buy on Margin (BS) and Control (CS).

	RD	RAD	PD	PMAX
D_B	0.44***	0.22*	959.2***	111.9***
	(0.14)	(0.13)	(366.2)	(39.4)
D_R	−0.066	−0.084	−210.7	−6.37
	(0.12)	(0.12)	(324.7)	(33.8)
$D_B \times D_R$	−0.13	−0.11	−376.5	10.5
	(0.17)	(0.17)	(459.1)	(47.8)
Constant	0.068	0.36***	623.3**	320.6***
	(0.100)	(0.089)	(259.0)	(27.9)
No. observations	32	32	32	32
No. Cohorts	16	16	16	16
Wald χ^2	14	6	11	14
Prob $>$ χ^2	0.003	0.099	0.012	0.003

Notes: The table reports results from a random effects regression with the model $X_{ir} = \alpha + \beta D_B + \gamma D_R + \delta D_B \times D_R + v_i + \varepsilon_{ir}$. The dependent variable is the measure of interest. The dummy variable D_B (Buy on Margin Dummy) equals 1 if margin purchasing is permitted, D_R (Round Two Dummy) is a round dummy and equals 1 for round two, and the product variable (Interaction) indicates the interaction effect between experience and the permission of margin purchases. Finally, v_i indicates the time constant cohort specific error and ε_{ir} indicates the idiosyncratic error term that varies over time and over cohorts. Parentheses record robust standard errors, clustered on independent sessions; *** p<0.01, ** p<0.05, * p<0.1. Definitions of measures can be found in the Appendix A.1.

Observation 3. Permitting buy on margin inflates asset prices even if short selling is permitted.

Support: Applying the same analysis as in Section 2.2, we find that all measures RD, RAD, PD, and PMAX are significantly higher in *BS* than in *CS* (see Table 3) in both rounds. The regression analysis in line with model 1 reported in Table 4 also show a clear effect as the coefficients in the columns RD, PD and PMAX are significantly positive. Using a Mann Whitney *U* test with market level measures, we find a significant difference for round 1 in all measures ($p \leq 0.024$) and still some support for a difference in round 2 ($p \leq 0.059$).

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Table 5
Treatment comparison: RD, PMAX.

	Round 1			Round 2		
RD	C	BS	CS	C	BS	CS
B	.49*	.21	.65**	.25	−.01	.30*
	(.064)	(.753)	(.016)	(.132)	(.834)	(.059)
C	.	−.28	.16	.	−.26*	.05
	.	(.105)	(.355)	.	(.064)	(.643)
BS	.	.	.44***	.	.	.31*
	.	.	(.001)	.	.	(.059)
PMAX	C	BS	CS	C	BS	CS
B	225.61**	139.25	251.13***	185.11**	80.63	203**
	(.028)	(.4)	(.009)	(.018)	(.345)	(.013)
C	.	−86.36	25.52	.	−104.48**	17.89
	.	(.104)	(.353)	.	(.015)	(.246)
BS	.	.	111.88**	.	.	122.38***
	.	.	(.024)	.	.	(.003)

Notes: The table reports the difference of treatment averages (row minus column) together with the *p*-value of a Mann Whitney *U* test comparing relative deviation (RD) and the highest price (PMAX) across treatments (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). A positive number indicates a higher value for the row treatment. Definitions of measures can be found in the Appendix A.1.

Again, subjects actively use the ability to buy on margin. In treatment *BS*, about 18 percent of all transactions in round 1 were margin purchases, about 24% in round 2. From Table 3 we can see that average CREDIT equals 1991 Taler in round 1 and 1784 in round 2. To put this number into perspective, we compare it to the cash available at that time (sum of cash endowments plus sum of cash dividends). The ratio of debt to cash available was 0.29 in round 1 and about 0.27 in round 2; again a substantial amount of margin debt.

However, in contrast to the results without short sales we find no significant correlation between active margin purchasing and overpricing.

Similarly to the above reported results without short selling, margin calls were issued in four sessions and three subjects went bankrupt on their margin purchases in *BS*. There is no indication of higher or lower earnings of subjects who use leverage in their purchases.[11] Again, shareholding concentration, as measured by CV, seems to be higher in *BS* but we find no significant effect (see Tables A.9 and A.11 in the appendix).

To conclude, our data suggest that the ability to purchase assets on margin inflates prices even if short-selling is permitted.

3.3. Overview of results

Although our focus is on margin purchases, we want to briefly combine selected results in a classical 2x2 design overview. Table 5 shows the differences in treatment averages for the relative deviation (RD) and the highest price (PMAX). Additionally, we report p-values for a Mann Whitney *U* test with seven (*C*) or eight observations per treatment. The tables for all measures can be found in the appendix (Tables A.10 and A.11).

As discussed above, margin purchases increase overpricing by about 50% without short selling and 44% with short selling. The average highest price is more than 200 Taler higher without short selling and more than 100 Taler higher with short selling. The table thus provides an overview of the results we have discussed above. In line with the literature (e.g. Haruvy and Noussair, 2006; Ackert et al., 2006; Weitzel et al., 2020), we find lower overpricing in markets with short selling but also lower maximum prices (*B* vs *BS*, *C* vs *CS*).

We find the highest differences when comparing *B* and *CS*, which is of course no surprise as the measures for *B* are higher than for *C* and the measures of *CS* are lower than for *C*. If the dampening price effect of short selling and the enhancing price effect of margin purchases neutralized each other, then we should observe that the difference between *C* and *BS* should be about zero. However, we find the relative deviation and the maximum price averages to be lower in *C* than in *BS*, significantly so in round 2 only. These results suggest that the price effect of margin purchasing is stronger than the price effect of short selling, at least for our experimental implementation of the two institutions.

4. Discussion and conclusion

For the first time, we have tested the effect of the ability to buy on margin along with the threat of margin calls and forced liquidation in an experimental asset market environment. In contrast to other studies, the purchasing power of the

[11] The Spearman rank correlation coefficients between CREDIT and RD are −0.5629 (p=0.1463) and 0.6190 (p=0.1017), respectively. The Spearman rank correlation coefficients between executed margin purchases and RD are −0.2788 (p=0.5037) and 0.4762 (p=0.2329).

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market participants endogenously expands or tightens when asset prices move higher or lower. Again, laboratory experiments serve as a test-bed for market regulation designs which cannot be tested in real-world exchanges without implementing an expensive natural experiment(Bloomfield and Anderson, 2010).

Our main results are quite intuitive and in line with the theory. With margin purchases, we observe price inflation relative to the baseline. These qualitative results are unaffected when short selling is permitted. Leverage on individual portfolio decisions seems to increase risk-taking characterized by higher concentrations of risky assets, eventually resulting in individual bankruptcies. Thus, our experimental results are in line with theories of margin purchasing by Fisher (1933) and by recent heterogeneous agents models, Geanakoplos (2010) that conjecture such effects on asset pricing and portfolio decisions.

As in any laboratory experiment, the experimental design choice might affect the results. For example, Duchêne et al. (2019) implemented 'borrowing treatments' where traders had to pay back half of their endowment at the end of the market. Furthermore, they considered call markets where borrowing and short selling depended on the clearing price. In our setting, the market price determined the borrowing capacity, and traders explicitly chose to buy on margin. In fact, Füllbrunn et al. (2014) showed that feedback in dynamic trading environments changes the performance in comparison to feedback in static trading environments.

In a *Wall Street Journal* article "Margin Calls: Should the Fed Step In?" (Shiller, 2000b), Shiller proposed an active margin regulation in times of significant market misalignment to mitigate the Minsky credit cycle (e.g., Nikolaidi and Stockhammer, 2017). Asset market experiments might help to understand margin requirements. In particular, testing time-varying margin regulation policies might inform policymakers regarding potential implementation strategies. Our contribution takes only the first step by considering a situation in which margin purchases are either permitted or not. Thus, we confirm that a ban on margin purchases significantly reduces overpricing. We suggest future research to take further steps by considering different maintenance margin amounts or overpricing-related margin policies

Appendix A. Measures for each session

Table A.1
Definition of measures considered.

Measures 1	
Relative Deviation (RD)	$\frac{1}{15}\sum_{t=1}^{15}\left(\tilde{P}_t - F_t\right)/\tilde{F}$
Relative Absolute Deviation (RAD)	$\frac{1}{15}\sum_{t=1}^{15} \mid \tilde{P}_t - F_t \mid /\tilde{F}$
Positive Deviation (PD)	$\sum_{i=1}^{15}\left(\tilde{P}_t - F_t\right)_{\tilde{P}_t > F_t}$
PMAX	Highest price observed in a market
SHORT	Highest number of short interest observed in a period
CREDIT	Highest amount of credit observed in a period
Measures 2	
Geometric Deviation (GD)	$\left(\prod_{t=1}^{15}\tilde{P}_t/F_t\right)^{1/15} - 1$
Geometric Absolute Deviation (GAD)	$exp(\frac{1}{15}\sum_{t=1}^{15} \mid \ln(\tilde{P}_t/F_t) \mid) - 1$
Average Bias (AB)	$\frac{1}{15}\sum_{t=1}^{15}\left(\tilde{P}_t - F_t\right)$
Total Deviation (TD)	$\sum_{t=1}^{15} \mid \tilde{P}_t - F_t \mid$
Boom	Greatest number of consecutive periods that median transaction prices are above fundamental values
Turnover (TO)	$\sum_{t=1}^{15} Q_t/18$
Measures 3	
Volatility (VOL)	$\frac{1}{\sum_{t=1}^{15} Q_t - 1}\sum_{t=1}^{15}\sum_{i=1}^{Q_t}(p_{it} - \tilde{p}_t)^2$
Variance (VAR)	$\frac{1}{\sum_{t=1}^{15} Q_t - 1}\sum_{t=1}^{15}\sum_{i=1}^{Q_t}(P_{it} - \tilde{P}_t)^2$
Excess Demand (EXD)	$\sum_{t=1}^{15}(Q_t^B - Q_t^A)$
SPREAD	$\sum_{t=1}^{15}(A_t - B_t)$
Re-trade ratio (RTR)	$\frac{1}{15}\sum_{t=1}^{15}\frac{US_t^B + UB_t^S}{US_t^S + UB_t^B}$
Measures 4	
Shareholdings (SH)	Average number of shares held by the two traders with largest holdings
Coefficient of Variation (CV)	$CV_t^{MONEY} = \sqrt{\sum_{j=1}^{9}(M_{jt} - \tilde{M}_t)^2}/\tilde{M}_t$
	$CV_t^{STOCK} = \sqrt{\sum_{j=1}^{9}(S_{jt} - \tilde{S}_t)^2}/\tilde{S}_t$

Notes: Variables are $\tilde{P}_t$ (average price in period t), $\tilde{P}_t$ (median price in period t), F_t (fundamental value in period t), $\tilde{F}$ (average fundamental value), Q_t (number of executed trades in period t), Q_t^B/Q_t^A (Number of open buy/sell offers at the end of period t), A_t (lowest open ask at the end of period t), B_t (highest open bid at the end of period t), $p_{it} = \ln P_{it}/F_t$. For RTR: US_t (US_t) is the units sold (purchased) as a net buyer (B) or a net seller (S). If for a period the RTR is 0, then net buyers only purchased and net sellers only sold. If RTR is 1/3, then one third of the trades had no effect on the net change of share holdings in a period. S_{jt}/M_{jt} equals the number of stocks/amount of money hold by subject j at time t

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Table A.2
Measures 1 — Buy on Margin (B) vs. Control (C).

Session ID	RD	RAD	PD	PMAX	CREDIT
Treatment *B*, **Round 1**					
1	0.45	0.51	1408	415	1701
2	0.07	0.08	208	369	1009
3	2.01	2.04	5806	1500	3996
4	0.87	1.01	2670	520	2438
5	0.91	0.92	2656	510	1415
6	0.15	0.38	773	300	132
7	0.15	0.15	451	480	1421
8	1.11	1.11	3191	480	2744
Total	0.72	0.78	2145	572	1857
Treatment *C*, **Round 1**					
1	−0.00	0.17	267	310	
2	0.45	0.51	1345	400	
3	0.47	0.57	1508	339	
4	0.54	0.61	1685	380	
5	0.03	0.20	338	450	
6	0.10	0.41	745	285	
7	−0.02	0.29	396	259	
Total	0.22	0.40	898	346	
Treatment *B*, **Round 2**					
1	0.09	0.27	516	425	1191
2	0.36	0.36	1025	390	1326
3	0.69	0.73	2018	900	3500
4	0.71	0.71	2041	650	2637
5	0.18	0.19	534	517	1596
6	−0.11	0.17	87	285	565
7	0.09	0.09	264	371	829
8	0.42	0.48	1313	600	1727
Total	0.30	0.38	975	517	1671
Treatment *C*, **Round 2**					
1	−0.14	0.19	62	285	
2	0.14	0.19	482	355	
3	0.34	0.38	1041	375	
4	0.11	0.20	434	362	
5	−0.11	0.11	0	330	
6	0.15	0.26	601	323	
7	−0.11	0.12	13	295	
Total	0.05	0.21	376	332	

Notes: The table reports measures for each market separately and the average for the treatment (Total) by round. The measures are defined in Table A.1.

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Table A.3
Measures 1 — Buy on Margin (BS) vs. Control (CS).

Session ID	RD	RAD	PD	PMAX	CREDIT	SHORT
Treatment *BS*, **Round 1**						
1	0.41	0.51	1304	350	1846	4.0
2	0.25	0.36	852	360	2876	8.0
3	0.52	0.55	1554	400	1509	11.0
4	0.67	0.69	2021	390	1925	7.0
5	0.89	0.95	2695	600	1093	0.0
6	0.54	0.54	1548	380	822	4.0
7	0.39	0.44	1189	390	1413	5.0
8	0.39	0.62	1498	590	4446	6.0
Total	0.51	0.58	1582	433	1991	5.6
Treatment *CS*, **Round 1**						
1	−0.01	0.31	426	450		6.0
2	0.15	0.50	929	250		7.0
3	0.09	0.48	820	365		4.0
4	−0.08	0.29	307	250		2.0
5	0.10	0.15	387	380		6.0
6	0.28	0.62	1296	270		4.0
7	0.20	0.33	775	320		3.0
8	−0.19	0.22	47	280		36.0
Total	0.07	0.36	623	321		8.5
Treatment *BS*, **Round 2**						
1	0.12	0.20	475	340	1876	11.0
2	0.15	0.37	676	350	1243	8.0
3	0.22	0.27	700	400	2009	9.0
4	0.31	0.36	1001	499	1579	6.0
5	0.17	0.25	599	500	910	0.0
6	1.32	1.32	3678	590	4216	3.0
7	0.02	0.18	288	364	1180	5.0
8	0.18	0.21	546	450	1259	3.0
Total	0.31	0.39	995	437	1784	5.6
Treatment *CS*, **Round 2**						
1	−0.04	0.05	9	320		2.0
2	0.44	0.59	1520	390		5.0
3	−0.03	0.10	94	320		3.0
4	−0.24	0.24	0	270		2.0
5	−0.02	0.09	88	340		14.0
6	0.42	0.60	1483	294		6.0
7	−0.12	0.16	58	290		6.0
8	−0.38	0.41	49	290		13.0
Total	0.00	0.28	413	314		6.4

Notes: The table reports measures for each market separately and the average for the treatment (Total) by round. The measures are defined in Table A.1.

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Table A.4
Measures 2 — Buy on Margin (B) vs. Control (C).

Session ID	GD	GAD	AB	TD	BOOM	TO
Treatment *B*, **Round 1**						
1	0.27	0.58	90	1463	12.00	3.06
2	0.10	0.10	14	211	8.00	3.94
3	1.21	1.54	384	5856	12.00	6.00
4	0.52	1.11	162	2907	10.00	7.28
5	0.73	0.81	176	2673	12.00	5.28
6	0.41	0.61	33	1058	10.00	5.78
7	0.12	0.13	30	454	10.00	3.17
8	1.22	1.26	213	3194	14.00	4.17
Total	0.57	0.77	138	2227	11.00	4.83
Treatment *C*, **Round 1**						
1	0.01	0.20	5	460	7.00	6.61
2	0.44	0.65	83	1446	12.00	5.28
3	0.64	0.73	93	1629	11.00	4.39
4	0.69	0.82	105	1798	13.00	4.78
5	0.01	0.19	7	574	9.00	2.94
6	0.20	0.53	19	1201	11.00	5.33
7	0.07	0.32	-2	826	10.00	3.78
Total	0.30	0.49	44	1133	10.43	4.73
Treatment *B*, **Round 2**						
1	−0.09	0.35	17	769	6.00	1.39
2	0.38	0.38	68	1025	15.00	2.00
3	0.29	0.41	131	2072	8.00	1.78
4	0.50	0.51	136	2046	10.00	3.06
5	0.06	0.15	31	608	7.00	2.17
6	−0.20	0.32	−21	486	3.00	4.22
7	0.12	0.12	18	264	15.00	1.72
8	0.18	0.33	82	1395	6.00	2.56
Total	0.16	0.32	58	1083	8.75	2.36
Treatment *C*, **Round 2**						
1	−0.11	0.19	−27	532	3.00	2.11
2	0.07	0.19	27	558	9.00	4.28
3	0.24	0.38	66	1086	11.00	2.78
4	−0.03	0.27	21	550	7.00	3.00
5	−0.16	0.19	−22	325	0.00	1.28
6	0.20	0.34	30	760	8.00	5.06
7	−0.07	0.12	−22	351	3.00	1.50
Total	0.02	0.24	10	595	5.86	2.86

Notes: The table reports measures for each market separately and the average for the treatment (Total) by round. The measures are defined in Table A.1.

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Table A.5
Measures 2 — Buy on Margin (BS) vs. Control (CS).

Session ID	GD	GAD	AB	TD	BOOM	TO
Treatment *BS*, **Round 1**						
1	0.50	0.59	78	1444	12.00	11.06
2	0.42	0.53	47	1003	9.00	8.50
3	0.42	0.58	101	1595	12.00	4.50
4	0.74	0.90	133	2054	12.00	5.83
5	0.70	0.80	174	2787	11.00	2.22
6	0.55	0.66	102	1567	13.00	6.00
7	0.30	0.46	74	1270	10.00	4.61
8	0.13	0.79	77	1848	7.00	5.89
Total	0.47	0.67	98	1696	10.75	6.08
Treatment *CS*, **Round 1**						
1	−0.09	0.32	−5	922	7.00	4.83
2	0.43	0.85	28	1441	8.00	10.33
3	0.04	0.61	18	1370	7.00	3.72
4	−0.23	0.63	−15	834	5.00	6.06
5	0.16	0.22	22	447	11.00	7.50
6	0.58	1.04	53	1793	10.00	9.44
7	0.16	0.55	38	979	9.00	6.56
8	−0.25	0.38	−37	656	3.00	9.11
Total	0.10	0.58	13	1055	7.50	7.19
Treatment *BS*, **Round 2**						
1	0.07	0.21	23	603	7.00	8.89
2	0.26	0.47	24	992	11.00	4.50
3	0.10	0.26	42	776	8.00	5.56
4	0.19	0.31	62	1078	8.00	3.72
5	−0.00	0.24	32	714	5.00	1.00
6	1.30	1.30	245	3678	15.00	3.22
7	−0.08	0.24	3	525	6.00	2.22
8	0.16	0.19	34	586	8.00	3.44
Total	0.25	0.40	58	1119	8.50	4.07
Treatment *CS*, **Round 2**						
1	−0.02	0.03	−7	121	1.00	4.56
2	0.40	0.67	86	1745	11.00	4.83
3	0.00	0.09	−6	274	8.00	1.44
4	−0.27	0.38	−47	702	0.00	2.28
5	−0.07	0.14	−5	249	5.00	5.78
6	0.77	0.99	82	1740	11.00	7.72
7	−0.09	0.18	−22	451	3.00	2.17
8	−0.32	0.57	−74	1212	2.00	5.28
Total	0.05	0.38	1	811	5.13	4.26

Notes: The table reports measures for each market separately and the average for the treatment (Total) by round. The measures are defined in Table A.1.

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Table A.6
Measures 3 — Buy on Margin (B) vs. Control (C).

Session ID	VOL	VAR	EXD	SPREAD	RTR
Treatment *B*, **Round 1**					
1	0.19	433.67	2.33	25.14	0.09
2	0.05	101.85	3.20	17.00	0.17
3	0.16	5451.68	5.00	171.93	0.08
4	0.20	1214.43	3.40	41.54	0.26
5	0.08	523.50	1.73	41.33	0.17
6	0.30	580.02	−0.73	29.73	0.22
7	0.10	1175.24	−0.73	23.40	0.33
8	0.03	45.86	4.87	8.20	0.26
Total	0.14	1190.78	2.38	44.79	0.20
Treatment *C*, **Round 1**					
1	0.14	753.19	1.33	24.40	0.08
2	0.16	327.34	−0.27	20.29	0.00
3	0.09	375.79	2.20	11.50	0.20
4	0.10	386.11	0.27	18.87	0.09
5	0.39	3413.22	−0.47	50.27	0.10
6	0.20	892.76	−0.60	29.00	0.30
7	0.11	332.53	−1.27	15.86	0.25
Total	0.17	925.85	0.17	24.31	0.15
Treatment *B*, **Round 2**					
1	0.04	125.68	4.87	32.67	0.09
2	0.03	83.18	1.67	25.47	0.00
3	0.12	3760.47	0.27	42.50	0.14
4	0.07	512.98	4.40	80.36	0.00
5	0.12	1985.69	0.67	44.80	0.20
6	0.19	100.29	1.80	14.07	0.00
7	0.01	5.88	3.93	36.43	0.00
8	0.06	222.20	10.20	35.21	0.13
Total	0.08	849.55	3.48	38.94	0.07
Treatment *C*, **Round 2**					
1	0.08	67.97	4.27	32.60	0.00
2	0.07	34.89	2.33	10.93	0.09
3	0.10	90.41	2.07	21.20	0.00
4	0.04	111.81	−4.00	23.53	0.27
5	0.05	7.62	−2.87	25.50	0.00
6	0.08	198.72	0.20	23.21	0.17
7	0.07	232.80	3.20	38.64	0.08
Total	0.07	106.32	0.74	25.09	0.09

Notes: The table reports measures for each market separately and the average for the treatment (Total) by round. The measures are defined in Table A.1.

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Table A.7
Measures 3 — Buy on Margin (BS) vs. Control (CS).

Session ID	VOL	VAR	EXD	SPREAD	RTR
Treatment *BS*, **Round 1**					
1	0.13	395.68	−0.47	19.33	0.27
2	0.25	1088.44	−4.20	43.93	0.11
3	0.14	331.53	−6.47	18.29	0.14
4	0.15	638.55	1.60	24.00	0.25
5	0.20	2936.65	−0.73	22.50	0.00
6	0.12	235.67	−0.53	18.00	0.27
7	0.04	122.67	0.47	15.29	0.00
8	0.12	427.90	2.20	36.73	0.00
Total	0.14	772.14	−1.02	24.76	0.13
Treatment *CS*, **Round 1**					
1	0.14	275.43	−1.73	25.20	0.24
2	0.03	33.81	1.33	4.00	0.56
3	0.07	42.72	0.73	33.47	0.00
4	0.06	46.60	−3.27	19.33	0.37
5	0.10	395.79	−0.47	16.00	0.29
6	0.04	78.16	0.80	5.13	0.08
7	0.21	120.23	−2.13	15.47	0.11
8	0.10	78.75	−4.20	7.27	0.33
Total	0.09	133.93	−1.12	15.73	0.25
Treatment *BS*, **Round 2**					
1	0.06	71.77	0.80	11.14	0.09
2	0.20	897.84	−0.07	20.87	0.13
3	0.17	183.22	−1.13	14.80	0.05
4	0.06	162.14	−1.27	34.21	0.00
5	0.02	35.08	−2.00	50.21	0.09
6	0.03	226.87	7.27	44.14	0.00
7	0.07	66.99	−1.00	21.33	0.00
8	0.14	373.40	0.80	43.73	0.00
Total	0.09	252.16	0.43	30.06	0.04
Treatment *CS*, **Round 2**					
1	0.03	67.37	−1.67	4.33	0.00
2	0.14	184.26	0.47	25.60	0.11
3	0.05	28.04	−0.73	28.20	0.00
4	0.02	10.78	1.27	15.73	0.20
5	0.08	25.91	0.87	10.73	0.00
6	0.04	98.31	−1.07	1.50	0.16
7	0.07	71.21	−0.60	14.13	0.00
8	0.15	302.90	−2.53	16.87	0.00
Total	0.07	98.60	−0.50	14.64	0.06

Notes: The table reports measures for each market separately and the average for the treatment (Total) by round. The measures are defined in Table A.1.

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Table A.8
Measures 4 — Buy on Margin (B) vs. Control (C).

Session ID	SH	CV MONEY	CV STOCK
Treatment *B*, Round 1			
1	10.87	1.39	1.51
2	11.53	0.81	2.35
3	11.00	2.39	1.93
4	11.00	1.45	1.49
5	9.53	1.19	1.75
6	10.60	0.70	1.62
7	10.53	1.46	2.13
8	12.33	1.36	1.93
Total	10.93	1.34	1.84
Treatment *C*, Round 1			
1	9.47	0.76	1.22
2	9.73	0.82	1.67
3	11.07	0.75	1.62
4	9.20	0.88	1.43
5	10.00	0.94	1.43
6	10.20	0.70	1.99
7	10.40	0.68	2.01
Total	10.01	0.79	1.62
Treatment *B*, Round 2			
1	11.00	1.26	1.35
2	12.07	1.31	1.58
3	9.93	2.60	1.15
4	12.47	1.57	1.70
5	12.27	1.53	2.66
6	9.93	0.95	1.22
7	11.53	1.13	1.97
8	11.60	1.64	1.37
Total	11.35	1.50	1.63
Treatment *C*, Round 2			
1	11.87	0.69	2.31
2	9.20	0.63	1.62
3	9.60	0.67	1.25
4	9.47	0.70	1.22
5	8.73	0.55	1.51
6	10.47	0.75	2.49
7	11.40	0.62	1.53
Total	10.10	0.66	1.70

Notes: The table reports measures for each market separately and the average for the treatment (Total) by round. The measures are defined in Table A.1.

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Table A.9
Measures 4 — Buy on Margin (BS) vs. Control (CS).

Session ID	SH	CV MONEY	CV STOCK
Treatment *BS*, **Round 1**			
1	11.73	1.46	2.49
2	13.20	1.43	3.69
3	13.33	1.48	3.44
4	13.27	1.89	3.33
5	9.73	1.17	1.53
6	10.80	1.11	1.45
7	12.80	1.23	2.01
8	14.27	2.27	3.43
Total	12.39	1.51	2.67
Treatment *CS*, **Round 1**			
1	10.80	1.09	2.57
2	10.33	0.86	2.19
3	9.80	0.83	1.39
4	9.33	0.70	1.45
5	11.40	1.04	2.03
6	9.60	0.65	1.45
7	11.33	0.78	2.01
8	15.00	1.23	6.64
Total	10.95	0.90	2.47
Treatment *BS*, **Round 2**			
1	14.80	1.44	2.56
2	12.07	1.66	2.57
3	13.53	1.57	2.57
4	12.93	1.68	2.51
5	8.80	1.17	1.18
6	14.73	1.99	2.04
7	11.53	1.54	1.80
8	11.00	1.47	2.48
Total	12.43	1.57	2.21
Treatment *CS*, **Round 2**			
1	8.80	0.68	1.72
2	10.73	1.04	2.16
3	10.13	1.00	1.45
4	10.40	0.78	1.41
5	11.13	0.62	3.31
6	13.13	0.83	2.11
7	11.33	0.79	1.94
8	15.13	0.93	2.87
Total	11.35	0.83	2.12

Notes: The table reports measures for each market separately and the average for the treatment (Total) by round. The measures are defined in Table A.1.

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Table A.10
Treatment comparison: RD, RAD, PD, PMAX.

	RD Round 1			RD Round 2		
	C	BS	CS	C	BS	CS
B	.49	.21	.65**	.25	-.01	.30*
	.064	.753	.016	.132	.834	.059
C	.	-.28	.16	.	-.26*	.05
	.	.105	.355	.	.064	.643
BS	.	.	.44***	.	.	.31*
	.	.	.001	.	.	.059
	RAD Round 1			**RAD Round 2**		
	C	BS	CS	C	BS	CS
B	.38	.19	.41	.17	-.02	.1
	.418	.834	.172	.203	.916	.294
C	.	−.19*	.03	.	−.19	−.07
	.	.083	.728	.	.105	1
BS	.	.	.22**	.	.	.12
	.	.	.016	.	.	.401
	PD Round 1			**PD Round 2**		
	C	BS	CS	C	BS	CS
B	1247.58	562.72	1521.91*	598.67*	−20.72	561.99*
	.165	.916	.074	.083	1	.059
C	.	−684.87*	274.32	.	−619.39	−36.68
	.	.083	.487	.	.105	.772
BS	.	.	959.19***	.	.	582.71*
	.	.	.002	.	.	.059
	PMAX Round 1			**PMAX Round 2**		
	C	BS	CS	C	BS	CS
B	225.61**	139.25	251.13***	185.11**	80.63	203**
	.028	.4	.009	.018	.345	.013
C	.	−86.36	25.52	.	−104.48**	17.89
	.	.104	.353	.	.015	.246
BS	.	.	111.88**	.	.	122.38***
	.	.	.024	.	.	.003

Notes: The table reports the difference of treatment averages together with the *p*-value of a Mann Whitney U test comparing the measures across treatments (*** p<0.01, ** p<0.05, * p<0.1). Definitions of measures can be found in the text or in the Appendix A.1.

Table A.11
Treatment comparison: SH, CV STOCK.

	SH Round 1			SH Round 2		
	C	BS	CS	C	BS	CS
B	.92**	−1.47**	−.02	1.25**	−1.08	0
	.037	.046	.528	.037	.226	.674
C	.	−2.38***	−.94	.	−2.32**	−1.25
	.	.009	.247	.	.028	.247
BS	.	.	1.44*	.	.	1.08
	.	.	.083	.	.	.227
	CV STOCK Round 1			**CV STOCK Round 2**		
	C	BS	CS	C	BS	CS
B	.21	−.84*	−.63	−.08	−.59*	−.49*
	.223	.093	.752	.772	.074	.059
C	.	−1.05**	−.84	.	−.51*	−.42
	.	.024	.117	.	.064	.247
BS	.	.	.21	.	.	.09
	.	.	.268	.	.	.599

Notes: The table reports the difference of treatment averages together with the *p*-value of a Mann Whitney *U* test comparing the measures across treatments (*** p<0.01, ** p<0.05, * p<0.1). Definitions of measures can be found in the text or in the Appendix A.1.

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Appendix B. Instructions

Fig. A.1 shows a screenshot of the trading screen. On the left hand subjects were able to post or delete limit bids and limit asks. Information on demand and supply at each point in time were available. Traders were able to vote to end the period and a embedded calculator helps to make decisions. On the right hand information on the margin account were given, a history graph on recent prices along with a table with information (open, high, low, close, volume, dividends, cumulated dividends, shares in inventory, cash balance). Subjects can hold shares or exchange shares and cash in real time. To buy a share, subjects submit bids; to sell a share, subjects submit asks. Asks and bids are submitted as limit orders, stating the receivable or payable Taler amount for one share, respectively. Unless a trade occurs, orders are quoted in the open order book that is common information. Enhancing orders are listed first; non-enhancing orders are listed second. Hence, traders observe the depth at ask and the depth at bid. The difference between the top listed bid and the top listed ask is the bid-ask-spread. Orders are filled, i.e. a trade is executed when a new bid (ask) exceeds (undercuts) or equals the best offer to sell (buy). Upon submission of a matching order, a trade closes. The best outstanding order in the open book is accepted as the trading price and the quote of the order is eliminated from the open book. The seller's cash balance is increased by the amount of the price and the number of shares held is reduced by one. The buyer's accounts are treated correspondingly. Subjects can withdraw asks and bids from the open order book by deleting the quotes. Trading prices are displayed in chronological order in a table visible to all subjects.

The following instructions (translated from German) show instructions from treatment B. In most of the time, the wording is almost the same as in the other treatments and was adjusted where necessary. After the instructions you will find the main treatment changes in BS and M. MS includes both instructions. The German instructions as well as the questionnaire for training the institutions can be obtained on request. Comments are in brackets.

Instructions

Welcome to the experiment. Please read these instructions carefully. Each participant has the same instructions. If you have any questions, please address them to us. Do not speak to other participants and please stay quiet for the duration of the experiment. Please switch off your mobile phone now, leaving it switched off until the end of the experiment. If you dis-

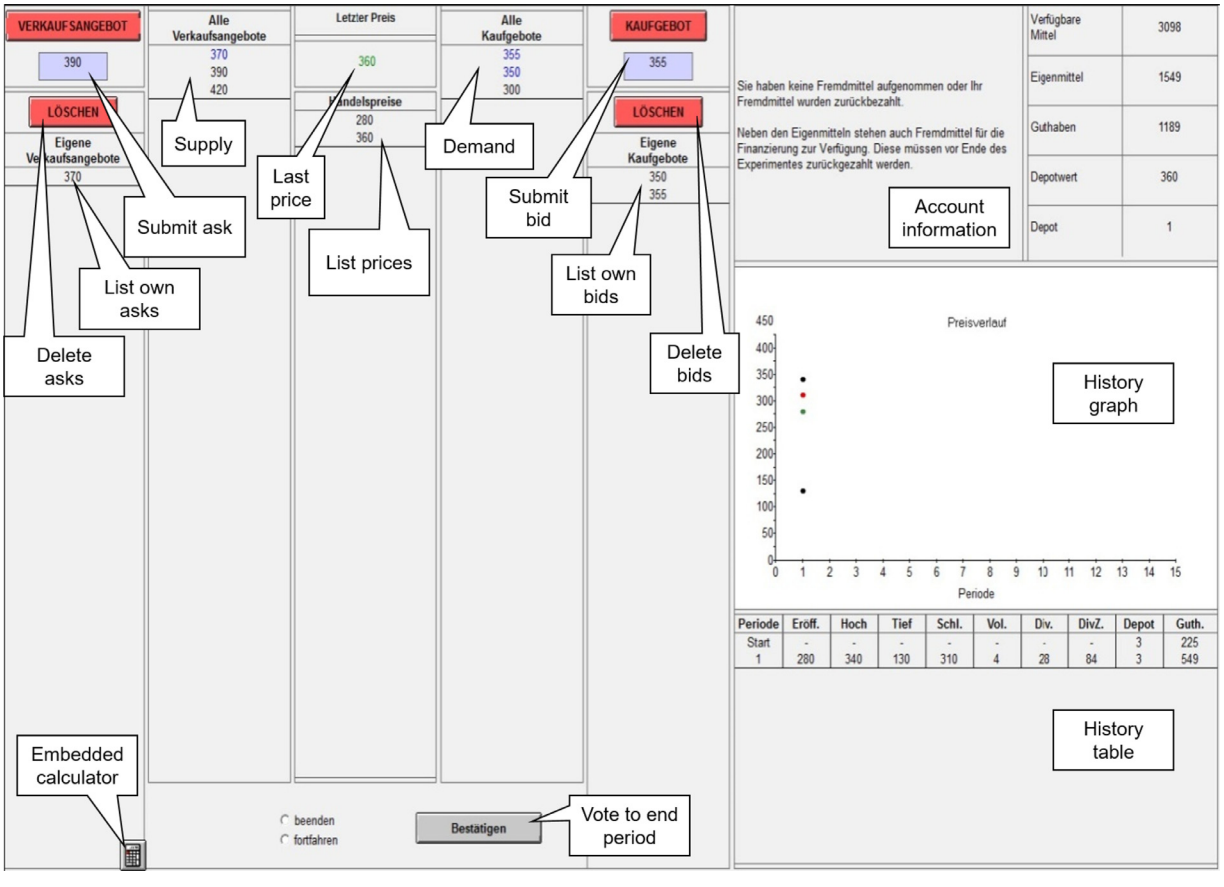

Fig. A.1. Order driven continuous electronic market with Open Order Book.

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Table B.1
Sum of the average future dividend payments of the share.

1 Current Period	2 Remaining Dividend Payments	×	3 Average Dividend	=	4 Sum of Average Dividend Payments	5 Range of Possible Dividend Payments
1	15		24		360	0 - 900
2	14		24		336	0 - 840
3	13		24		312	0 - 780
4	12		24		288	0 - 720
5	10		24		264	0 - 660
6	11		24		240	0 - 600
7	9		24		216	0 - 540
8	8		24		192	0 - 480
9	7		24		168	0 - 420
10	6		24		144	0 - 360
11	5		24		120	0 - 300
12	4		24		96	0 - 240
13	3		24		72	0 - 180
14	2		24		48	0 - 120
15	1		24		24	0 - 60
End of the round	0		-		0	0

obey these rules, you will be excluded from the experiment, losing any right to payment. This experiment is about trading assets. You own shares and buy or sell them in a market. A market consists of nine participants. During the entire experiment, you always negotiate with the same eight other participants, whose identity remains unknown to you. All transactions are in "Taler". All Taler that you earn are converted into Euro and paid to you in cash at the end of the experiment. The rate of exchange is 100 Taler = 1 €. In addition to the payoff at the end of the experiment, you will receive 4 Euro for show up. The experiment consists of two rounds of 15 periods each. Before the beginning of each round, there is a short practice round. In this practice round, you can acquaint yourself with the market situation and the computer program. Transactions in the practice round have no effect on payment. The experiment will last for about 2–3 h, including the introduction and the practice round.

1. Description of a Round

One round consists of 15 periods. In each period, you can buy and sell shares on the market. At the end of the period, the owner of a share is paid a dividend. The dividend is a sum of money that is credited to the owner and remains at his disposal for the rest of the round. The amount of the dividend is randomly decided (by the computer) at the end of each period. It is the same for every share: 60, 28, 8, or 0 Taler. Each of these sums is equally likely, i.e., the likelihood is one quarter (or 25%), independent of how high previous or subsequent dividends are. The dividend is on average, 24 Taler per period (= 0.25*0 + 0.25*8 + 0.25*28 + 0.25*60), 48 Taler in two periods... and 360 Taler in 15 periods. The Table B.1 recapitulates the sum of the average future dividend payments for each period.

The table can be read as follows: assume you are in Period 8 (column 1, line 9). Including the dividend that is due at the end of the period, there remain 8 dividend payments (column 2, line 9). Each of these dividends has a 25 % chance of being 0, 8, 28, or 60 Taler, and on average 24 Taler (column 3, line 9). The sum of all average future dividend payments is therefore 192 Taler (= 8*24), as you can see in the fourth column of the table (column 4, line 9). In the most convenient case, if from the 8th period on wards a dividend of 60 Taler is paid each time, then the maximum possible dividend payments add up to 480 Taler, as can be seen in the last column of the table. However, it is also worth noting that the most disadvantageous situation could mean the sum of all dividends being 0. Please note also that the share becomes worthless at the end of the round, i.e. after the 15th dividend payment; there are no further payments (last line). After the last period, the depot is closed.

2. Market Organization and Trading Rules a) Conducting a Trading Period

In a trading period, you have the chance to buy and sell shares. In order to buy shares, you need money. On the right-hand side of the screen, you will see the sum of money currently available to you. In order to sell shares, you need shares. Your depot shows your shares currently available to you. During a trading period, you may conduct the following actions (see Figure 1):

Figure 1: Conducting a Trade [*skipped*]

I. Sale Offer: You can offer a share from your depot for sale. In the field underneath the button Sale Offer, you key in the minimum price you wish to receive for a share. Then, you confirm this minimum price by clicking the button Sale Offer. Your sale offer is then added to the list All Sale Offers, where all offers are placed in descending order, from the highest to the lowest. All market participants can see this list. If two or more sale offers are the same, they are listed in chronological order. Your own sale offer is displayed in blue, while the other sale offers are visible to you in black. In addition, the list

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Own Sale Offers is established. Each sale offer stands for one share. You cannot offer more shares than you possess in your depot.

II. Purchase Offer: You may put in a bid for the purchase of a share. In the field underneath the button Purchase Offer, you key in the minimum price you wish to pay for a share, i.e., the maximum sum you wish to pay. Then, you confirm this maximum price by clicking the button Purchase Offer. Your purchase offer is then added to the list All Purchase Offers, where all offers are placed in ascending order, from lowest to highest. All market participants can see this list. If two or more purchase offers are the same, they are listed in chronological order. Your own purchase offer is displayed in blue, while the other purchase offers are visible to you in black. In addition, the list Own Purchase Offers is established. Each purchase offer stands for one share. The sum of your purchase offers may not exceed your assets.

III. Deleting Sale Offers and Purchase Offers: You may retract a purchase offer by double-clicking a purchase offer in the list Own Purchase Offers, marking it and deleting it. You may retract a sale offer by double-clicking a sale offer in the list Own Sale Offers, marking it and deleting it.

Conclusion of a Trade:

A trade is concluded as soon as an offer to sell is lower than or as high as an offer to buy. The price at which the trade is executed is determined by chronological order: 1. if a new sale offer is lower than or as high as the highest existing purchase offer, the trade price is the same as the highest purchase offer. 2. If a new purchase offer is higher than or as high as the lowest existing sale offer, the trade price is the same as the lowest sale offer. If a sale is executed, the transaction price is entered in the list of trading prices, and the purchase offer of the buyer and the sale offer of the seller are deleted from all lists. The depots of the buyer and the seller are automatically updated: The seller's depot is lowered by one share, and one share is added to the buyer's depot. At the same time, the trade price is subtracted from the buyer's account balance and added to the seller's account balance. Please note the trade restrictions: you may only buy a share or make a purchase offer if you have enough cash at your disposal. You may only sell a share or offer it for sale if it is in your depot. You may not sell shares to yourself. Your sale offers must lie above your purchase offers.

Insert further instructions from other treatments here

A trading period lasts 180 seconds. The remaining time is shown at the top right of the screen. If you quit your trading activities before the end of a trading period, you may activate END by clicking on the corresponding field with your mouse and then pressing ENTER (Fig. 2). After that, you can still trade, but the period ends prematurely if all traders have simultaneously clicked on END. If you wish to change your decision, you may activate CONTINUE (this is the default setting) by clicking on the corresponding field with your mouse and then pressing ENTER. In that case, the trading periods only ends when the time is up.

Figure 2: Ending trade prematurely [*skipped*] b) Information at the end of the period

A detailed account follows each trading period. You are informed of the dividend achieved; the total proceeds from the dividend and your new balance. An overview of the period accounts can also be found in a table on your screen. Here, you will see the opening price of the period, the highest price, the lowest price, the final price, the number of sales agreement contracts, the amount of the dividend, the income from the dividends, the number of shares in the depot and the balance at the end of the trading period. In addition, you will find, on the left, a graph showing the prices from the past periods. The graph also shows the opening price (green) and the closing price (red), as well as high (black, above) and low (black, below), so that a chronology of the past trading periods can be drawn up. The account is visible for only 20 seconds. You will also find the graphs and the table during the trading period. To continue more quickly, click Continue.

3. Initial Endowment

A market consists of 9 participants. At the beginning of each round 18 shares will be provided to the participants. The allocation of shares is due to a random process. Each participant is endowed with money and shares at the beginning of each round. There are 3 possible endowments:

Endowment Class	Money	Share
I	225	3
II	585	2
III	945	1

3 participants receive endowment class I, 3 participants receive endowment class II, and 3 participants receive endowment class III.

4. Initial Endowment

The experiment procedure is as follows:

- Practice round for a trading period
- *Round 1*: Allocation of initial endowment, 15 (Trading periods + Dividend payments) → Account balance after Round 1.
- *Round 2*: Allocation of initial endowment, 15 (Trading periods + Dividend payments) → Account balance after Round 2.

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In other words, the same rules count for each round. At the beginning of each round, the initial endowments are allocated via the distribution process. The balance from the first round is no longer at your disposal in the second round, but is instead paid to you at the end of the experiment along with your second-round balance.

The account balance in each period consists of the following elements: Initial endowment according to the distribution process + Income from dividend payments + Income from the sale of shares − Expenses relating to the purchase of shares

The sum you are paid in Euro at the end of the experiment is calculated as follows: (account balance after Round 1 + account balance after Round 2)*0.01 Euro + X Euro.

Instructions for selling short [Treatments *BS* and *CS*]

Borrowing shares: You are able to sell shares without possessing them, i.e. you lend a share to sell it (Short Sale). A short sale increases your cash account. It also increases your debt. As long as you do not cover the short sale with buying a new one your debt exists. During having short positions your debt equals your outstanding shares evaluated by the current market price, i.e. your debt varies with the trading price. You equity equals your cash minus the value of your short positions (debt). Your available funds equal your equity minus your debt, i.e. your debt cannot exceed your equity. For each borrowed share at the end of a period you have to pay the dividend. Your dividend reduces your cash and, thus, your equity. With decreasing prices, your debt decreases because the value of shares that you have to buy back decreases. With increasing prices the value of shares increases and, thus, your debt as well. If your debt exceeds your equity due to a price increase or due to dividend payments, you have no more available funds. The price threshold at which your debt exceeds your equity is provided at your screen. When the price exceeds this price threshold, all your current offers are canceled and an offer to buy at the current market price is automatically submitted. The purchase will decrease your debt. If afterwards your debt still exceeds your equity, this process will repeat until your equity exceeds your debt again. Then you are allowed to submit or delete orders. After the final period, shares remain worthless. When at this point you have borrowed shares outstanding you automatically cover them for a zero price. During trading periods you will be informed about your available funds, your cash at hand, the value of your shares at current market price, your equity, your debt and the price threshold. Why should you borrow shares? When you buy a share later for a lower price that you received now, you make a profit that equals the price difference. However, note the dividend payments at the end of the period. Thought selling short can lead to higher profits when prices decrease. When prices increase or you have to pay dividends, also losses may occur.

Instructions for margin purchasing [Treatments *CS* and *BS*]

Available funds: You can dispose of equity and debt. Your equity equals the sum of your cash at hand and your shares in your inventory evaluated by the current market price (stock deposit value). If your cash at hand is not enough to buy shares, you will receive additional funds without any interest payment (this is negative cash). You can borrow money as long as debt does not exceed equity. Your available funds to buy further shares equal your equity less your debt. Thus, your share inventory can be finance with debt equaling half of the value of your inventory. Borrowed money has to be returned until the end of period 15. Equity and available funds vary with prices. Debt is reduced (and cash is increased) with each dividend payment. An increase in market prices increases your stock deposit value and, thus, your equity and your available funds. A decrease in prices reduces your equity and, thus, available funds. When your debt due to a fall in prices exceeds your equity, you have no available funds left. The price threshold at which debt exceeds equity is provided at the screen. A drop in prices below this threshold will cancel all your current offers and an offer to sell at the current market price is automatically submitted. The purchase will decrease your debt. When your debt still exceeds your equity after the forced sale, this process will repeat until your equity exceeds debt again. Then you are allowed to submit or delete orders. During trading periods you will be informed about your available funds, your cash at hand, the value of your shares at current market price, your equity, your debt and the price threshold. Why should you borrow money? When you sell a share later for a higher price that you paid now, you make a profit that equals the price difference. Thus, purchasing shares with additional money can increase your profit. Thought borrow money to buy shares can lead to higher profits when prices increase. When prices decrease also losses may occur.

References

Ackert, L.F., Charupat, N., Church, B.K., Deaves, R., 2006. Margin, short selling, and lotteries in experimental asset markets. South. Econ. J. 73(2) (2), 419–436.
Armantier, O., Holt, C.A., Plott, C.R., 2013. A procurement auction for toxic assets with asymmetric information. Am. Econ. J. 5 (4), 142–162.
Bloomfield, R., Anderson, A., 2010. Experimental finance. In: Baker, H.K., Nofsinger, J.R. (Eds.), Behavioral Finance: Investors, Corporations, and Markets. Wiley-Blackwell, pp. 113–130.
Brunnermeier, M.K., 2009. Deciphering the liquidity and credit crunch 2007–2008. J. Econ. Perspect. 23 (1), 77–100.
Caginalp, G., Porter, D., Smith, V., 2001. Financial bubbles: excess cash, momentum, and incomplete information. J. Psychol. Financ. Markets 2 (2), 80–99.
Carlé, T.A., Lahav, Y., Neugebauer, T., Noussair, C.N., 2019. Heterogeneity of beliefs and trade in experimental asset markets. J. Financ. Quant. Anal. 54 (1), 215–245.
Charness, G., Neugebauer, T., 2019. A test of the Modigliani-Miller invariance theorem and arbitrage in experimental asset markets. J. Financ. 74 (1), 493–529.
Cohen, J., 1966. Federal Reserve margin requirements and the stock market. J. Financ. Quant. Anal. 1 (3), 30–54.
Duchêne, S., Guerci, E., Hanaki, N., Noussair, C.N., 2019. The effect of short selling and borrowing on market prices and traders' behavior. J. Econ. Dyn. Control 107, 103734.
Dufwenberg, M., Lindqvist, T., Moore, E., 2005. Bubbles and experience: an experiment. Am. Econ. Rev. 95 (5), 1731–1737.
Eckardt, W.L., Rogoff, D.L., 1976. 100% margins revisited. J. Financ. 31 (3), 995–1000.
Eckel, C.C., Füllbrunn, S.C., 2015. Thar she blows? Gender, competition, and bubbles in experimental asset markets. Am. Econ. Rev. 105 (2), 906–920.

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Fischbacher, U., Hens, T., Zeisberger, S., 2013. The impact of monetary policy on stock market bubbles and trading behavior: evidence from the lab. J. Econ. Dyn. Control 37 (10), 2104–2122.
Fisher, I., 1933. The debt-deflation theory of great depressions. Econometrica 1 (4), 337–357.
Fostel, A., Geanakoplos, J., 2008. Leverage cycles and the anxious economy. Am. Econ. Rev. 98, 1211–1244.
Füllbrunn, S., Neugebauer, T., Nicklisch, A., 2019. Underpricing of initial public offerings in experimental asset markets. Exp. Econ. doi:10.1007/s10683-019-09638-7, In press.
Füllbrunn, S., Rau, H.A., Weitzel, U., 2014. Does ambiguity aversion survive in experimental asset markets? J. Econ. Behav. Organ. 107, 810–826.
Geanakoplos, J., 2010. The leverage cycle. NBER Macroecon. Annu. 24 (1), 1–66.
Grube, R.C., Joy, O.M., Panton, D.B., 1979. Market responses to federal reserve changes in the initial margin requirement. J. Financ. 34 (3), 659–674.
Hardouvelis, G.A., Peristiani, S., 1992. Margin requirements, speculative trading, and stock price fluctuations: the case of Japan. Q. J. Econ. 107 (4), 1333–1370.
Harrison, J.M., Kreps, D.M., 1978. Speculative investor behavior in a stock market with heterogeneous expectations. Q. J. Econ. 92 (2), 323–336.
Haruvy, E., Lahav, Y., Noussair, C.N., 2007. Traders' expectations in asset markets: experimental evidence. Am. Econ. Rev. 97 (5), 1901–1920.
Haruvy, E., Noussair, C.N., 2006. The effect of short selling on bubbles and crashes in experimental spot asset markets. J. Financ. 61 (3), 1119–1157.
Holt, C.A., Porzio, M., Song, M.Y., 2017. Price bubbles, gender, and expectations in experimental asset markets. Eur. Econ. Rev. 100, 72–94.
Janssen, D.-J., Füllbrunn, S., Weitzel, U., 2019. Individual speculative behavior and overpricing in experimental asset markets. Exp. Econ. 22 (3), 653–675.
Keser, C., Özgümüs, A., Peterlé, E., Schmidt, M., 2017. An experimental investigation of rating-market regulation. J. Econ. Behav. Organ. 144, 78–86.
Kirchler, M., Huber, J.J., Stockl, T., Stöckl, T., 2012. Thar she bursts: reducing confusion reduces bubbles. Am. Econ. Rev. 102 (2), 865–883.
Kocher, M.G., Lucks, K.E., Schindler, D., 2018. Unleashing animal spirits: self-control and overpricing in experimental asset markets. Rev. Financ. Stud. 32 (6), 2149–2178.
Kofman, P., Moser, J.T., 2001. Stock margins and the conditional probability of price reversals. Econ. Perspect. 25 (2).
Kupiec, P.H., 1989. Initial margin requirements and stock returns volatility: another look. In: Regulatory Reform of Stock and Futures Markets. Springer, pp. 189–203.
Largay III, J.A., West, R.R., 1973. Margin changes and stock price behavior. J. Polit. Econ. 81 (2, Part 1), 328–339.
Lee, S.B., Yoo, T.Y., 1991. Margin regulation and stock market response: further evidence from the US and some Pacific-Basin countries. Rev. Financ. Econ. 1 (1), 79–98.
Luckett, D.G., 1982. On the effectiveness of the federal reserve's margin requirement. J. Financ. 37 (3), 783–795.
Miller, E.M., 1977. Risk, uncertainty, and divergence of opinion. J. Financ. 32 (4), 1151–1168.
Nikolaidi, M., Stockhammer, E., 2017. Minsky models: a structured survey. J. Econ. Surv. 31 (5), 1304–1331.
Palan, S., 2013. A review of bubbles and crashes in experimental asset markets. J. Econ. Surv. 27 (3), 570–588.
Powell, O., 2016. Numeraire independence and the measurement of mispricing in experimental asset markets. J. Behav. Exp. Financ. 9, 56–62.
Powell, O., Shestakova, N., 2016. Experimental asset markets: a survey of recent developments. J. Behav. Exp. Financ. 12, 14–22.
Scheinkman, J.A., Xiong, W., 2003. Overconfidence and speculative bubbles. J. Polit. Econ. 111 (6), 1183–1220.
Seguin, P.J., 1990. Stock volatility and margin trading. J. Monet. Econ. 26 (1), 101–121.
Selten, R., Neugebauer, T., Penasse, J., 2018. Uncertainty and asset prices: Stock market "puzzles" observed in an experimental production economy. mimeo Submitted for publication.
Sentana, E., Wadhwani, S., 1992. Feedback traders and stock return autocorrelations: evidence from a century of daily data. Econ. J. 102 (411), 415–425.
Shiller, R., 2000. Irrational Exuberance. Princeton Univ.
Shiller, R., 2000. Margin calls: should the fed step in? Wall Street J. A46.
Smith, V.L., Suchanek, G.L., Williams, A.W., 1988. Bubbles, crashes, and endogenous expectations in experimental spot asset markets. Econometrica 56 (5), 1119–1151.
Snyder, C., 1930. Brokers' loans and the pyramiding of credit. J. Am. Stat. Assoc. 25 (169A), 88–92.
Stöckl, T., Huber, J., Kirchler, M., 2010. Bubble measures in experimental asset markets. Exp. Econ. 13 (3), 284–298.
Weber, M., Duffy, J., Schram, A.J.H.C., 2019. Credit default swap regulation in experimental bond markets. Tinbergen Institute Discussion Paper 2019-039/I. Available at SSRN: https://ssrn.com/abstract=3401706.
Weitzel, U., Huber, C., Huber, J., Kirchler, M., Lindner, F., Rose, J., 2020. Bubbles and financial professionals. Rev. Financ. Stud. 33 (6), 2659–2696.

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