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Ort und Datum

Lisa Neuhofer

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Table of Content

1. *Introduction*

Financial markets as well as financial crisis are important issues in our society nowadays. Therefore it is getting more and more important to gain new knowledge about the behaviour of market participants.

One possibility to acquire this new knowledge is to do research with economic experiments. This is the kind of research used in this paper. Experimental economics is a growing field, which can help to find out if certain parameter variations influence the decisions of market participants.

Experiments may be used to learn about financial markets. One of the first relevant papers about experimental asset markets is a paper from Smith et al. (1988).

In my experiment most of the study design was taken from Smith et al. (1988). The reason why I used most of this study design is that this design is very good for studying bubbles.

In the study of Smith et al. (1988) they used double auction markets. In their double auction market every participant can make offers to buy and sell, as well as accept offers to buy and sell at all time. In every experiment that the study from Smith et al. (1988) describes there is a finite amount of trading periods. At the end of each period the participants get a randomly chosen dividend outcome out of a known set of dividend outcomes. The participants get paid the amount of money earned in the experiment, at the end of which the assets are worthless.

My research question is dealing with the effect of dividend variation on the bubble and crash phenomena as well as on the trading volume.
My hypothesis for the research question is that the bubble and crash phenomena as well as the trading volume are positively related to the probability of getting a positive dividend outcome. A dividend outcome is always bigger or equal to zero. An explanation for this hypothesis is risk aversion.

The two different treatments used in my experiment have a distinct amount of possible dividend outcomes. Also the outcomes are varied in the treatments. But the expected dividend outcome is the same for both treatments and additionally in both treatments the outcome 0 exists. The first treatment uses four different dividend outcomes (0, 8, 28 and 60) and is called 4Div treatment. The second treatment only uses two different dividend outcomes and is therefore called 2Div treatment. The second value in the 2Div treatment has to be 48 because I wanted one value to be 0 and the expected outcome to be the same as in the treatment with four different dividend outcomes. I want the zero outcome to occur in both markets because then the probability of getting a zero outcome falls with the amount of different dividend outcomes. The different outcomes occur in the 4Div treatment with a probability of 25 % and in the 2Div treatment with a probability of 50 %. Therefore the probability of getting a zero outcome is in the 2Div treatment higher. If people are risk-averse the dividend set in the 4Div treatment would be more optimal for them. An example of a risk-averse utility function can be found in the theory section.

There are different studies in experimental asset markets, where the number of dividend outcomes has been varied. In the papers of Lei et al. (2001) the dividend variation was not mentioned as an impact on the bubble and crash phenomena. Lei et al. (2001) used in the experiments of their paper two different dividend sets. One dividend set with four different dividend outcomes (0, 8, 28, 60), and one with two different dividend outcomes (20, 40).

In addition to that, I am interested in the trading behaviour of the participants in the two treatments, for examples if there are participants in a market that are prone to gambler's fallacy or if there are participants in the market that use a "bad strategy". Gambler's fallacy would occur if for example participants would buy a share at a higher value after the dividend outcome has been 0 for three times. The reason for this is that they believe the probability of a better outcome is higher than it actually is.
Bad strategy in this work is defined as a strategy in which a participant has in half or in more than half of the periods, in which he sells and buys shares a higher mean buying than mean selling price. The participant would lose money in periods where this happens only because of their buying and selling strategy. Periods in which the participant does not sell or buy a share are not counted.

Most results that are presented here are made descriptive, because only a single session of each treatment is run. To find out if gambler's fallacy occurs linear regression was made additionally to descriptive statistics.

The structure of this thesis is the following: First I introduce the underlying theory than the Research Questions are explained. After that the used methods and the used experimental design are described. The remaining chapters are the results, the discussion and the conclusion.

2. Theory

2.1. Risk Aversion

Risk aversion means that a person with this aversion don't like risk. Per example when a risk-averse person can choose between two lotteries and both have the same outcome, the person would choose the lottery with the fewest risk. The theory of risk aversion is important for this study because it is a possible explanation for my research hypothesis.

To describe risk aversion more precisely the example below is used. The example is fictive but uses as X values the possible dividend outcomes of the two treatments in the experiment.

Example: Risk Aversion

Simon wants to buy a lottery coupon. There are two different lotteries he can choose to buy from:

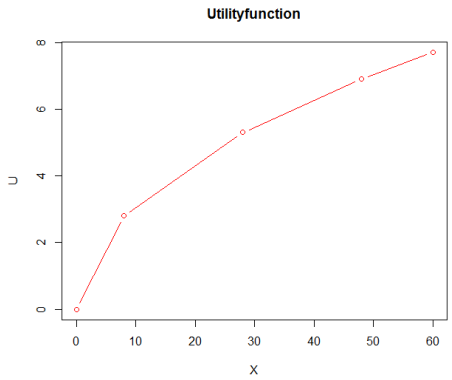
- Lottery 1: He gets 0 or 48 with a probability of 50 %
- Lottery 2: He gets 0 ,8, 28 or 60 with a probability of 25 %

The expected outcome in both lotteries is the same and can be calculated as following:

- Lottery 1: 0.5*0 + 0.5*48 = 24
- Lottery 2: 0.25*0 + 0.25*8 + 0.25*28 + 0.25*60 = 24

Simon's utility function is the following: $u = \sqrt{x}$.

In the next graphic his utility function is plotted for all possible values of both lotteries. The variable X in the graphic represents the outcomes. The points in the graphic are made for the five possible outcomes of the two lotteries.



Graphic 1: Utility function for the Example

Simon's utility for the two lotteries can be calculated as following:

- Utility Lottery 1: 0.5*0 + 0.5*$\sqrt{48}$ ≈ 3.46
- Utility Lottery 2: 0.25*0 + 0.25*$\sqrt{8}$ +0.25*$\sqrt{28}$ + 0.25*$\sqrt{60}$ ≈ 3.97

This means although the expected outcome is the same in both lotteries, Simon would choose lottery 2 because of the higher utility. The higher utility for lottery 2 is because the utility function of Simon is a risk-averse utility function.

2.2. Gambler's Fallacy

The study of Croson and Sundali (2005) describes gambler's fallacy as a belief about negative autocorrelation of a sequence, which in reality is random and without autocorrelation. The theory of gambler's fallacy is used in this study to find out about irrational believes of the participants.

With the help of the next table an example for gambler's fallacy can be described very easily. Gambler's fallacy occurs when people think that the probability of getting a five, when they roll the dice, is lower than 1/6, after the outcome five occurred the last three times. It is called fallacy, because the next outcome of the dice is independent of the outcomes before.

Table 1: Example for gambler's fallacy

	Former Outcomes	**Expected Probability of** 
Gambler's Fallacy		< 1/6
No Gambler's Fallacy		= 1/6

3. Research Hypothesis

3.1. Main Research Question

In many different settings of experimental asset markets four different dividends are used. Often the used dividends are 0, 8, 28 and 60 also Smith et al. (1988) used this dividend set in some of his experiments. With my experiment I am interested in dividend variation and therefore I am interested in the next question:

Does the variation of the dividend outcomes influence the bubble and crash phenomenon and the trading volume?

My hypothesis to this question is that the bubble as well as the trading volume is lower in the 2Div treatment. An explanation for this hypothesis is risk aversion. This means risk averse people should prefer a lottery with the outcomes 0, 8, 28 and 60 (25 % each) to a lottery with the outcomes 0 and 48 (50 % each). In the experiment buying a share in the market can be more or less seen as buying a lottery coupon. The only value a share actually has is the dividend outcomes per each period in which the share is held. And therefore in the four dividend case risk-averse people could be willing to pay more per share than their risk-averse colleagues in the two dividend case.

There are different studies in experimental asset markets where the number of dividend outcomes has been varied. In the papers of Lei et al. (2001) the divided variation was not mentioned as an impact on the bubble and crash phenomena. The main differences between his dividend variation and my variation are that in my experiment, also in the 2Div treatment one of the outcomes is zero and the expected dividend outcome is the same for both markets.

3.2. Additional Research Question 1

With this question I want to discover irrational behavior of the participants. The irrational behavior I am looking for is gambler's fallacy. If participants in experimental asset markets are prone to gambler's fallacy, then it makes it easier to estimate the trading prices in the next period given the last dividend outcomes. Therefore the first additional research question is:

Are the traders in the two markets prone to gamblers fallacy?

My hypothesis for this question is that there are traders prone to gamblers fallacy in the 2Div treatment and that there are no traders prone to gambler's fallacy in the 4Div treatment.

One reason why I expect gambler's fallacy to only occur in the 2Div treatment is that Croson and Sundali (2005) found out in there experiment that the longer a period with the same outcome lasts the higher is the probability that gambler's fallacy occur. Additionally Navarrete and Santamaria (2012) found out with their questionnaire that the occurrence of gambler's fallacy was lower when there are more possibilities. Both studies did not apply the theory of gambler's fallacy to an experimental asset market.

3.3. Additional Research Question 2

The second additional research question is important for the conclusion of the main research question. It is concerned about "bad strategies" of participants. A problem with those participants is that they may have not understood the computerized market and therefore influence the market in an unknown way. Because of this, the second additional research question is:

Are there traders with "bad strategies" in the two markets?

My hypothesis for this question is that there are traders with “bad strategies” in the two markets. A reason for this belief is that I have not taken precaution to exclude participants with bad strategies. There have been studies in the past where they adapted the study design in a way that makes it more difficult for people with “bad strategies” to participate in the market. With the answer to this research question additional information is generated. Participants with “bad strategies” have an unknown impact on the market therefore the results of the main research question may change in an unknown way.

3.4. Additional Research Question 3

With the third additional question can be examined which answers in the questionnaire and therefore which personal characteristics may help people to achieve better outcomes in experimental asset markets.

Is there a connection between the earnings of the subjects and their answers to the questionnaire?

My hypothesis is that a connection between the earnings and the answers to the questionnaire of participants exists.

4. Methods

In this chapter the used bubble measurements and the used programs are described.

4.1. Bubble measurements

The bubble measurements as well as Graphic 3 and Graphic 4 are used to answer the research question.

For my research it is important that there are some bubble measurements that can measure the level of mispricing and others that take the amount of trades into account.

To calculate the level of mispricing the bubble measurements “Relative Absolute Deviation” and “Relative Deviation”, introduced by Stöckl et al. (2010) are used. Most important for the authors was, that the measurements make it possible to compare different experiments although different fundamental values and different amount of periods were used.

In addition to the level of mispricing, the amount of trades per market as well as a combination of the amount of trades and mispricing is relevant.

For the amount of trades per market all executed trades are summated and for the combination of the amount of trades and the mispricing, the measurements “Overpriced Transactions” and “Underpriced Transactions” from Palan (2009) are used. The measurements are ordered alphabetically.

Amount of Trades

The measurement “Amount of Trades” calculates the number of trades per market.

$$\boldsymbol{Amount\ of\ Trades} = Sum(Number\ of\ transactions)$$

Overpriced Transactions

The measurement “Overpriced Transactions” is taken from Palan (2009). It calculates the percentage of transactions that are above the fundamental value.

$$\boldsymbol{Overpriced\ Transactions} = Sum\ (number\ transactions\ above\ fundamental\ value)/Total\ number\ transactions$$

Relative Absolute Deviation

The measurement “Relative Absolute Deviation” is taken from Stöckl et al. (2010) and calculates the average level of mispricing. In the formula below N stands for the total number of periods and p denotes the period.

$$\boldsymbol{Relative\ Absolute\ Deviation} = \frac{1}{N} * \sum_{p=1}^{N} \frac{|Mean\ price\ (p) - fundamental\ value(p)|}{Total\ mean\ fundamental\ value}$$

Relative Deviation

The only difference between the “Relative Absolute Deviation” and the “Relative Deviation” is that for example: by the “Relative Deviation” the negative differences between the mean price per period and the fundamental value per period can compensate for the positive differences.

$$\boldsymbol{Relative\ Deviation} = \frac{1}{N} * \sum_{p=1}^{N} \frac{Mean\ price\ (p) - fundamental\ value(p)}{Total\ mean\ fundamental\ value}$$

Underpriced Transactions

The measurement “Underpriced Transactions” calculates the percentage of transactions below the fundamental value.

$$\boldsymbol{Underpriced\ Transactions} = Sum(Number\ transactions\ below\ fundamental\ value)/Total\ number\ transactions$$

4.2. Descriptive Statistics

For further analysis of the results descriptive statistics like cross tabulation and values like the mean and the median are calculated. Additionally graphics like box plots and line diagrams are used.

4.3. Used Programs

For the experiment the program Darwin was used. Darwin is a program for running market experiments under development by Owen Powell at the University of Vienna.

The Programs R Version 2.15.2 and Excel 2007 were used for calculating and preparing the results.

5. The Experimental Design

General Design

The experiment consists of two different treatments in which participants have the opportunity to buy and sell assets. The treatments are called treatment 4Div and treatment 2Div. These two treatments are afterwards also called 4Div market and 2Div market in this paper, because every treatment has only been applied one time and therefore there is always only one market for one treatment.

The treatments are varied by the number of dividend outcomes. The dividend outcomes are paid in Talente. Talente is the currency used in the experiment. The expected dividend outcomes remain the same in both treatments. Additionally the dividend outcome zero is possible in both treatments. In the treatment 4Div there are 4 different possible dividend outcomes: 0, 8, 28 and 60 with expected dividend value of 24 and in the treatment 2Div there are 2 different possible dividend outcomes: 0 and 48 also with expected dividend value of 24. At the end of each period, there is always one dividend outcome chosen randomly and paid out per each asset. Each dividend outcome has the same probability.

The experiment consisted of two sessions. Both sessions took place on 21 May 2013 in Vienna. Only male students attended. The reason to have invited exclusively men is that the comparison of the markets is easier when the gender-distribution is the same in each market. Each session consists of 9 traders and 1 trade market. The treatment in the first session was the treatment 4Div and in the second session it was the treatment 2Div. As in many asset market experiments, every session consists of 15 trading periods per treatment. Every trading period takes 120 seconds.

The initial endowment consists of 10 assets and 5000 Talente. Talente is the currency used in the experiment. In the trading screen Talente are called money. I did not use the different endowment classes from Smith et al. because for my work it was better to use the same endowment for each participant, so that the results of the participants can be compared. Also Noussair and Tucker (2006) used equal endowments for each participant (10.000 Talente and 10 units of assets).

The experiment takes place at the experimental laboratory of the University of Vienna where each participant has his own computer with the trading program already opened.

The participants are allowed to make offers to buy and sell and to accept offers to buy and sell. When the participants are out of money they cannot buy or make offers to buy as long as they are out of money. But they can get money by selling stocks or by obtaining dividend outcomes. They cannot sell stocks or make offers to sell stocks as long they are out of stocks. But they can get stocks by buying from other participants. When they are out of stocks and money they cannot trade anymore.

After the experiment ends, the participants get the last dividend outcome and the remaining Talente are calculated and converted into Euro. The remaining shares are not worth anything.

Every session takes about 50 minutes.

Course of Action per Session

First the participants get the instructions for the practice period. While reading them they can ask questions. Before the practice period starts they are asked if there are any questions left.

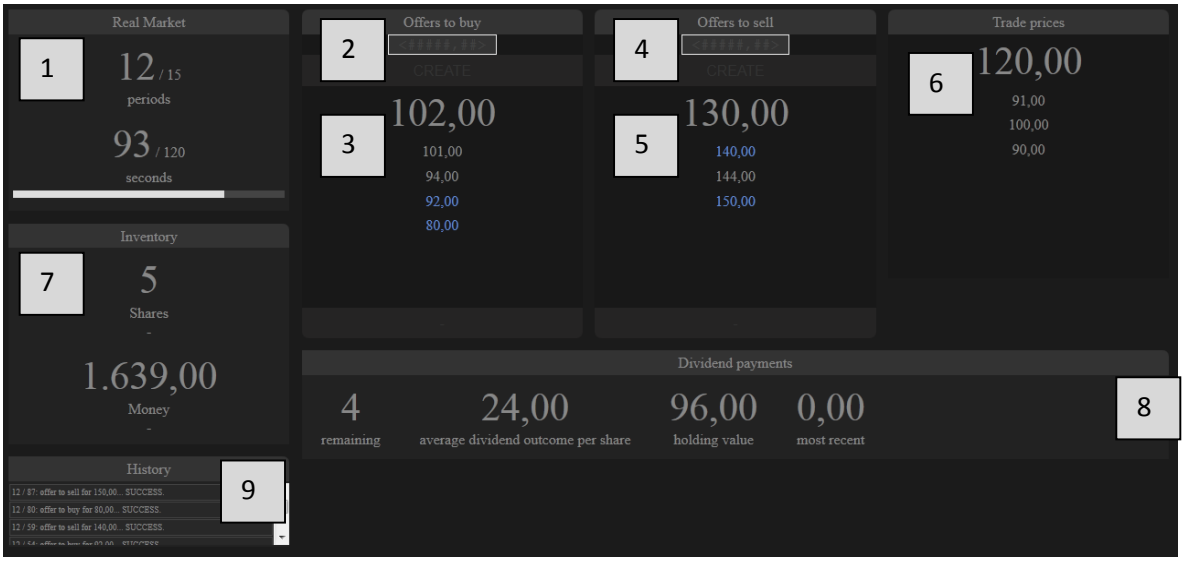
Then the practice period starts. In the practice period there are no dividend outcomes. The main purpose of the practice period is that the participants get to know the computerised market. The participants are also allowed to still ask questions during the practice period. The outcome of the practice period does not affect the outcome in the real trading market.
After the practice period the participants get an additional set of instructions and can ask questions if something remains unclear.

After all the questions are answered, the real experiment starts. After each period the participants can see the dividend outcome of the former round.

After the last period ends, they are asked to fill out a questionnaire. The questionnaire can be seen in the appendix D. After the questionnaire every participant gets the money he has earned throughout the experiment, but the money has to be transformed from Talente into Euro first.

Trading Screen

The trading screen can be seen in Graphic 2.



Graphic 2: Trading screen

In Part 1 of the trading screen, the participants see in which period they are at the moment and how much time is left in that period.

In Part 2 the participants make offers to buy a share. After writing down a price and pressing the button “CREATE” their offer can be seen below (in Part 3). The own offers are coloured blue. As long as nobody accepts the offer it can be deleted by the person that created it.

The grey coloured numbers in Part 3 are offers to buy a share from other participants. These offers can be accepted, which means a share can be sold to the offered price.

In Part 4 the participants make offers to sell a share. After writing down a price and pressing the button “CREATE” they can see the offer below (in Part 5). The own offers are blue coloured. As long as nobody has accepted the offer, it can be deleted by the person that created it.

The grey coloured numbers in Part 5 are offers to sell a share from other participants, Those offers can be accepted, which means an asset can be bought at the offered price.

In Part 6 the participants see a list of the latest trade prices.

Part 7 shows the participants the actual numbers of shares and the actual amount of Talente they have. In the trading screen the Talente are called money.

In Part 8 the participants can see the remaining number of dividend outcomes, the average dividend outcome per share, the holding value (remaining number of outcomes * average dividend outcome) and the dividend outcome per share of the last period.

Convert wealth of the experiment into earnings

Wealth of the experiment at the end:

The wealth of one subject in the experiment is calculated as shown in the next table.

Table 2: Wealth of the Experiment

	Initial Money
+	Sum of the Dividends
+	Money for selling shares
-	Money for buying shares
=	**Wealth of the Experiment**

The wealth of the experiment is converted with a rate of 1 Euro for 800 Talente. Talente is the currency used in the experiment. With this calculation the mean outcome per person should be about 10.75 Euro.

6. Results

In this chapter the results for the different hypothesis are presented. The headings of the different results are the names of the hypothesis they should answer to.

Most of the used results are descriptive. The main reason for this is the low amount of observations (one market per treatment).

6.1. Main hypothesis

The results for the main hypothesis compare the two different markets with each other, entirely. To be able to achieve that, bubble measurements were used. In addition, graphics were used to display the trading prices per period as well as the amount of trades per period and therefore the bubble and crash phenomena.

Bubble measurements

The results of the bubble measurements for the two different markets can be found in the table below. The description of the used bubble measurements can be found in Chapter 4.1.

The “Relative Deviation” of the 2Div market is positive and with 0.46 quite high when compared to the “Relative Deviation” of the 4Div market. In Stöckl et al. (2010) the definition of “Relative Deviation” is that the asset is on average over- or undervalued by the percentage that is calculated. In the two dividend case, this means that the assets are overvalued with 46 %.

The 4Div market on the other hand is undervalued by 27 %, when compared to the mean fundamental value.

The measurements “Relative Absolute Deviation” and “Relative Deviation” have in the 2Div market with 0.12 a higher difference than in the 4Div market. The 4Div market shows with 0.01 only a very tiny difference.

The participants of the 4Div market had with 203 trades more trades than the participants of the 2Div market with 169 trades.

In the market with four different dividend outcomes most transactions are underpriced, whereas in the market with two different dividend outcomes most transactions are overpriced. Underpriced means in this context that the trading price of a share lies under the fundamental value of this period.

Table 3: Bubble Measurements

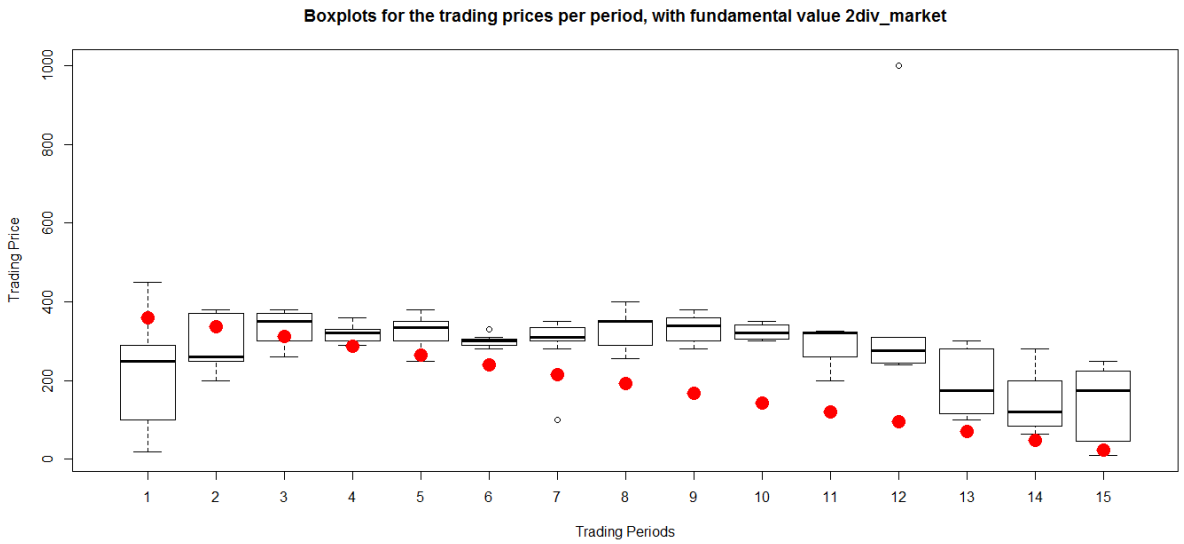
	Market 2Div	Market 4Div
Relative Absolute Deviation	0.58	0.28
Relative Deviation	0.46	-0.27
Amount of Trades	169	203
Overpriced Transactions	80 %	30 %
Underpriced Transactions	20 %	70 %

Trading prices per period

In the next graphics the trading prices of the markets per period can be found. The first two graphics show all trading prices summarized in a box plot and the third and fourth graphics show either the mean or the median price per period.

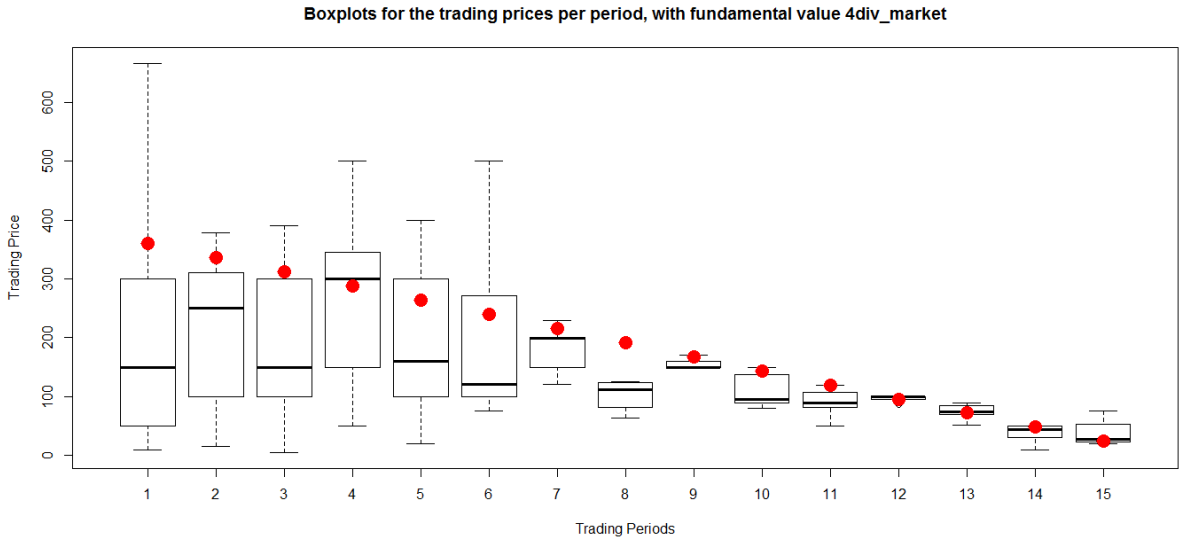
In the next two graphics the red points show the fundamental value per period and box plots are used to illustrate the trading prices per period. With the help of box plots one can see for example the spreading of the trading prices per period as well as the median trading price per period. The thick black lines show the median trading prices per period. In the box, the median 50 % of the trading prices can be found.

In Graphic 3 the results of the 2Div market can be found. In period 12 there was one outlier. In the time between period eight and period fourteen not one trade was made which is under the fundamental value. The only two periods where the median trading price is under the fundamental value are the periods 1 and 2.



Graphic 3: Trading prices per period (2Div market)

In Graphic 4 results of the market with the four different dividend outcomes (4Div market) can be found. The graphic shows that there is no real outlier in this market. Most of the median transaction prices per period are under the fundamental value. Only in period 4 the median price is slightly over the fundamental value. In most periods there are at least a few transactions with a price over the fundamental value, but there are also periods like period 8 where no transaction is over the fundamental value.

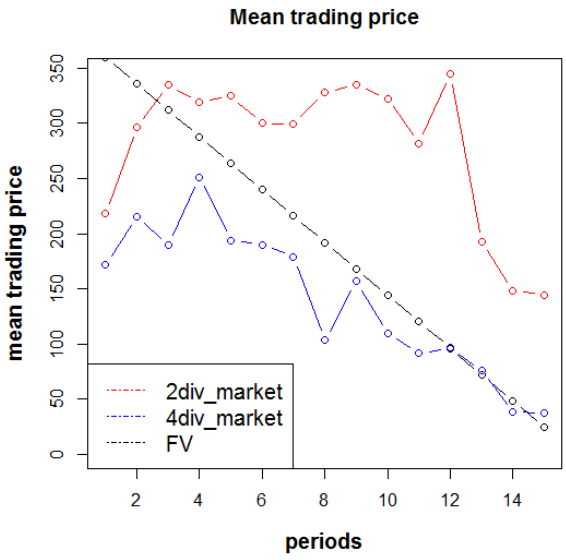


Graphic 4: Trading prices per period (4Div market)

The trading behaviour in the 4Div market (Graphic 3) and the trading behaviour in the 2Div market (Graphic 4) were entirely different. In Graphic 4, the trading price was mostly under the fundamental value and for Graphic 3 the opposite holds.

Palan (2013) pointed out in his paper that the typical price patterns in experimental asset markets with 15 periods are the following: In the first two periods the price is below the fundamental value, after the fifth period the bubble starts and the crash of the bubble is between period 10 and period 15. The trading prices of my 2Div treatment look similar to the described patterns of Palan (2013). But the trading prices of my 4Div treatment are not really similar to the founded typical price patterns from Palan (2013).

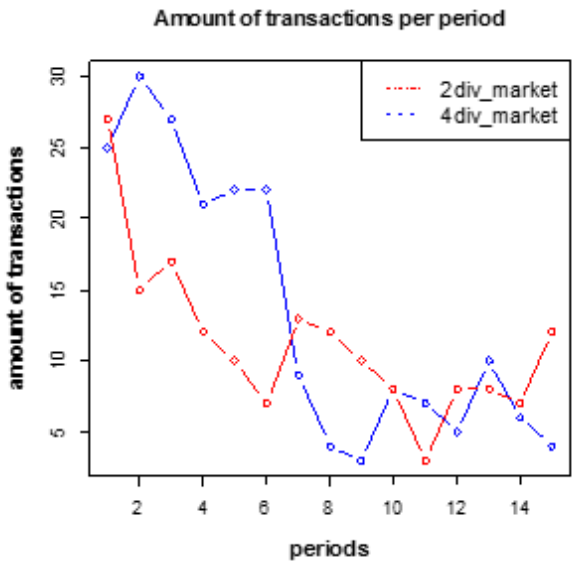
With the help of the next graphic the mean prices per period can be compared between the markets. It is not hard to see that the mean trading price in every period of the 2Div treatment is higher than the mean trading price in every period of the 4Div treatment. In addition the graphic shows that the mean price in the 4Div treatment is in nearly every period under the fundamental value (FV), for the 2Div treatment the opposite holds.



Graphic 5: Mean trading price

Amount of trades per period

In Graphic 6 the amount of trades per period are shown. In the first periods the participants of the 4Div market traded more than the participants of the 2Div market. In the last periods the amount of trades decreases in both markets.



Graphic 6: Amount of trades per period

About the typical volume patterns in experimental asset markets Palan (2013) pointed out that the amount of trades get lower around the crash of the bubble. In the 2Div treatment, the lowest amount of trades can be seen around the start of the bubble. The 4Div market had a bubble under the fundamental value and the mean trading price was near the fundamental value after period 11. Therefore “the crash” of the bubble in the 4Div market was around period 11, this was the period where the amount of trades was the lowest in the 4Div market.

Summary

The hypothesis concerning the main research question does not hold. The bubble in the 4Div treatment was lower than the bubble in the 2Div treatment. Only the amount of trades was as expected by the hypothesis. This means the amount of trades was lower in the 2Div treatment.

6.2. Gambler's fallacy

Before I come to the actual results of the gambler's fallacy, additional results that are important for gambler's fallacy are presented, and those are the distribution of the dividend outcomes and the estimation of the participant how often the outcome zero occurred. The distribution of the outcomes should be kept in mind, because when an outcome does not occur often, this might be a problem for linear regression. The estimation of the participants for the amount of zero that occurred is important, because gambler's fallacy is something that should occur mostly when the former dividend outcomes have been taken into account. Highly wrong estimations may be evidence for ignoring the dividend outcomes. The results for gambler's fallacy are descriptive plots and linear regressions.

Dividend Frequencies

In the next table the frequencies of the dividend outcomes per market are listed. At this point it is mainly important how often the different outcomes occur. Later the trading behavior according to the last dividend outcome will be reviewed.

In the 4Div market the outcome zero only occurred twice, whereas in the 2Div market the outcome zero occurred eight times. This means in the 4Div market the outcome zero occurred less often then it could be expected. Because the outcome zero should occur in the 4Div market with a probability of 25% and there are 15 periods. Noticeable is that in the four dividend case the outcome 8 occurs very often.

Table 4: Frequencies of dividend outcomes

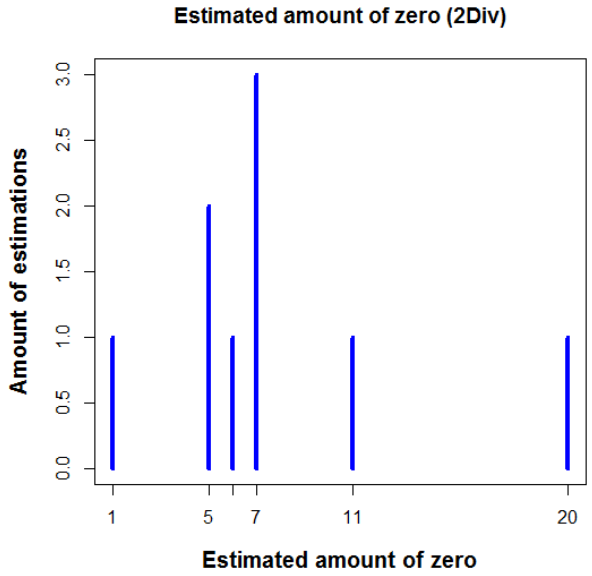
	Dividend Outcomes				
	0	**8**	**28**	**48**	**60**
2Div	8	-	-	7	-
4Div	2	8	3	-	2

Additionally with the table above it can be calculated that the mean dividend outcomes are lower in both markets than the expected dividend outcome (24). In the 2Div market it was 22.4 and in the 4Div market it was around 17.9.

Estimation of outcome zero

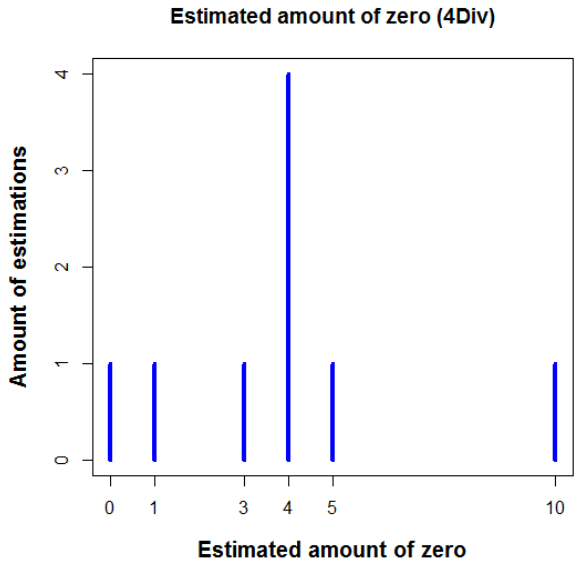
The question about the estimation was asked in the questionnaire after the experiment, and the exact question was the following: *"How often do you think a dividend outcome of zero occurred in the experiment (there were 15 dividend outcomes in total)?"* With this question, one may find out how much the participants had cared about the dividend outcomes in general.

The results of the answers in the 2Div market are shown in the next graphic. As there can be seen in the table above the outcome zero occurred eight times in the 2Div market. That means that the best guess the participants could have given was eight, but this guess was not chosen by the participants. The best given guess therefore was seven, which was given by three participants. The worst bet was the bet twenty, because there were only fifteen rounds and therefore fifteen possible dividend outcomes.



Graphic 7: Estimated amount of zero (2Div)

The answers of the participants in the 4Div market are shown in the next graphic. In this market the outcome zero occurred two times. Therefore the best bets were one and three. Four and three would have been the most likely answers caused by the study design. The guess four was the guess mostly taken from the participants. Four out of nine made this guess. Highly wrong was only the one guess that zero had occurred 10 times.



Graphic 8: Estimated amount of outcome zero (4Div)

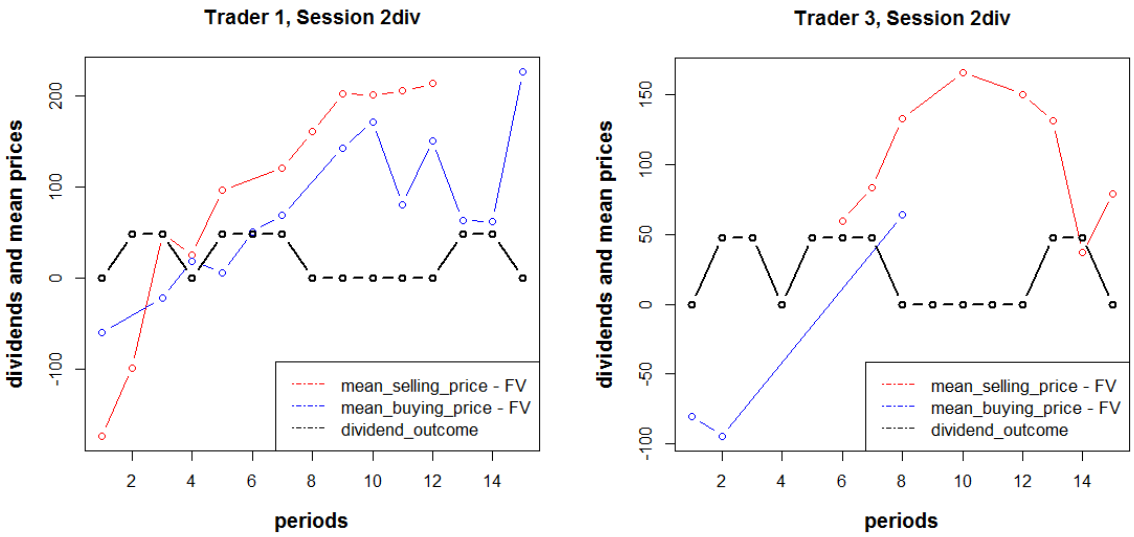
This means in both markets no participant guessed the amount of the outcome zero right. But most of the guesses were not too far away from the real value.

Descriptive Plots (2Div)

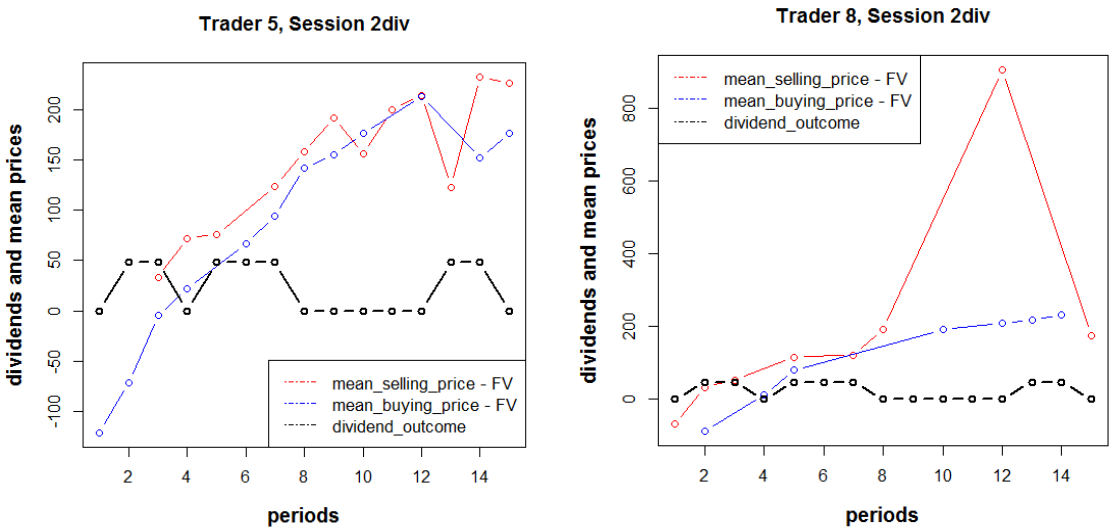
In the next graphics the dividend outcomes after the periods are displayed. In addition the difference between the mean selling price and the fundamental value and the difference between the mean buying price and the fundamental value are plotted. The black points in the following graphics represent the dividend outcomes. This line is the same for all participants in the 2Div market. The red and the blue points are the mean selling and the mean buying price per period without the fundamental value of this period.

Below only the graphics of four selected participants are shown. The used graphics are selected to show the differences of the participants. The graphics of the other participants can be found in Appendix E. Between the periods 8 and 12 were a sequence of zero outcomes. All traders, except trader 5, had their highest difference between the mean selling price and the fundamental value between the periods 9 and 12. Also the highest difference between the mean buying price and the fundamental value were for all, except for trader 8 and trader 1 between period 9 and 12, if they had bought assets in this period. Two traders did not buy in this period. The graphics, show us that there might be participants with false believes.

When gambler's fallacy occurs then the trading price should rise with low former dividend outcomes and fall with high former dividend outcomes. By distinguishing between selling and buying price both should rise with low former dividend outcomes. But trader 3 might only sells at a high price after low former dividend outcomes because he uses the gambler's fallacy of the others to get a better outcome.

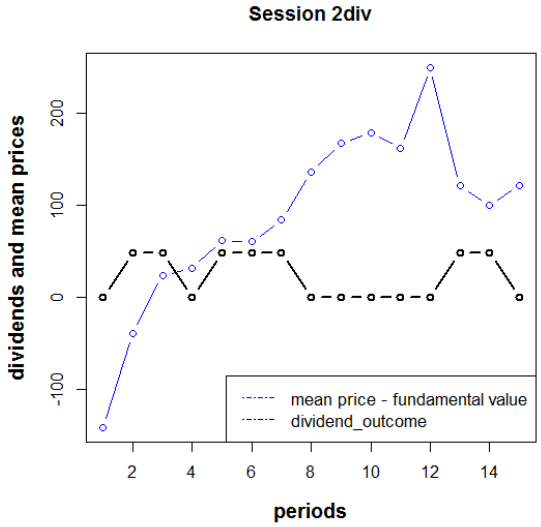


Graphic 9: Trading prices and dividends (Trader 1 and 3, 2Div market)



Graphic 10: Trading prices and dividends (Trader 5 and 8, 2Div market)

The next graphic shows the mean difference between the trading prices and the fundamental value for the whole 2Div market. The highest mean trading price was in period number 12. Period number 12 was the last of five periods of the sequence in which the outcome zero occurred.



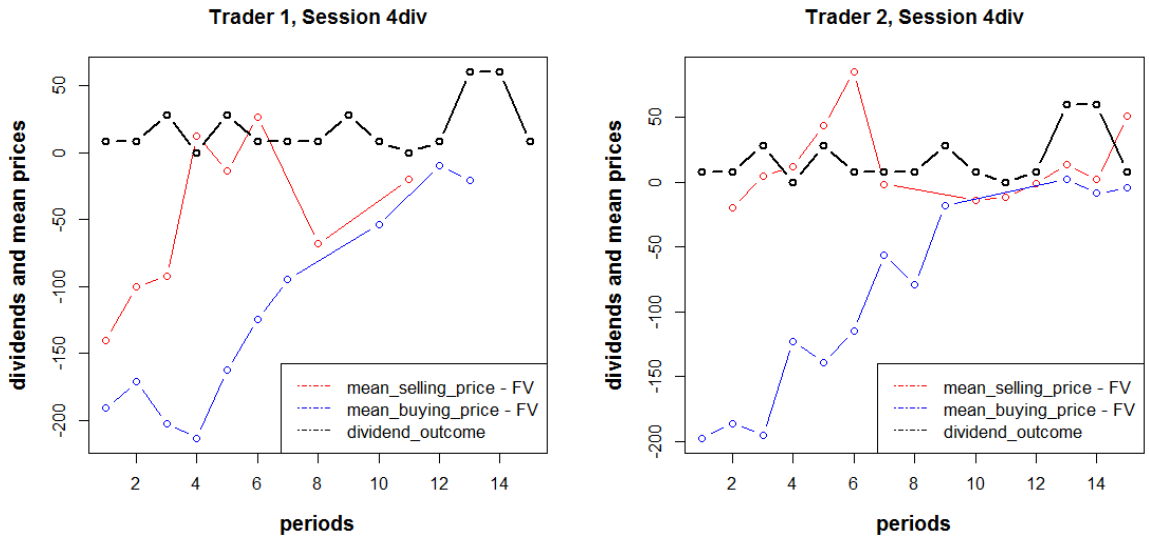
Graphic 11: Graphic Gambler's Fallacy (2Div)

Descriptive Plots (4Div)

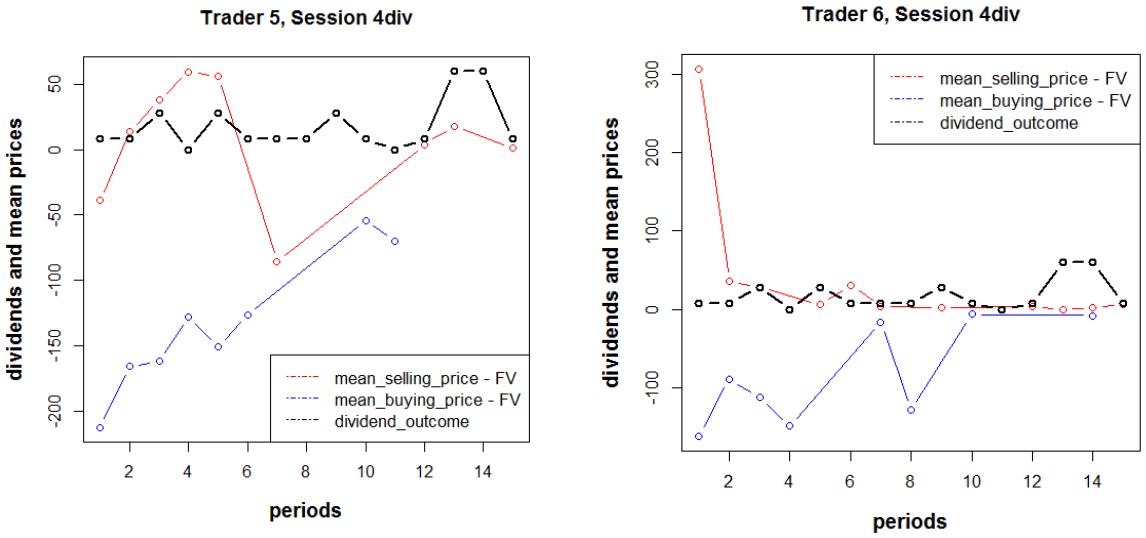
In this graphics the dividend outcomes after the periods are displayed. In addition the difference between the mean selling price and the fundamental value as well as the difference between the mean buying price and the fundamental value are plotted.

The black points in the following graphics represent the dividend outcomes. The red and the blue points are the mean selling and the mean buying price per period without the fundamental value of this period.

Below only the graphics of four selected participants are shown. The used graphics are selected to show the differences of the participants. The graphics of the other participants can be found in Appendix E. In the graphics of all participants a connection between the mean trading prices (selling and buying) and the former dividend outcome in the 4Div market cannot be seen.

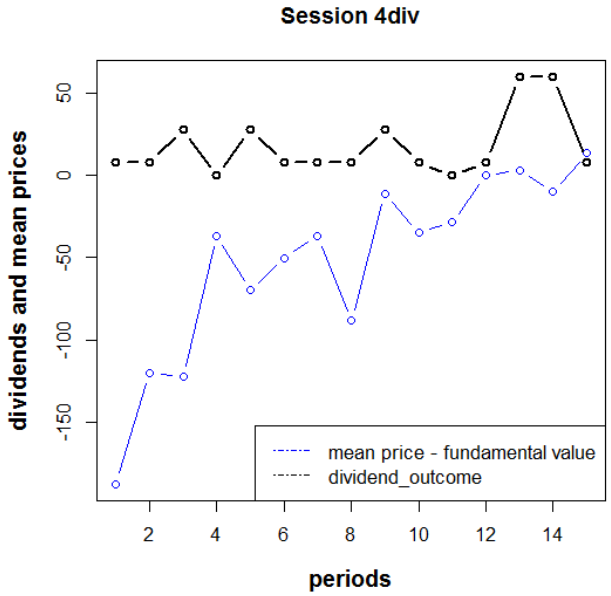


Graphic 12: Trading prices and dividends (Trader 1 and 2, 4Div market)



Graphic 13: Trading prices and dividends (Trader 5 and 6, 4Div market)

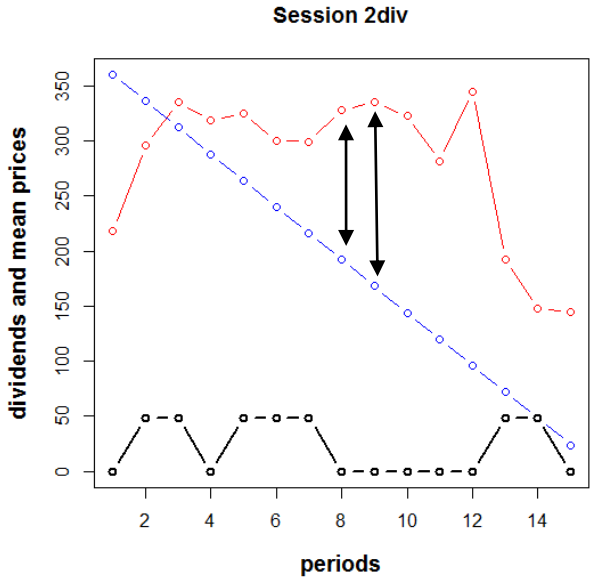
In the next graphic the difference between the mean trading price and the fundamental value for the whole market can be seen. Also in this graphic, no real connection between the dividend outcome and the difference between the trading price and the fundamental value can be seen.



Graphic 14: Graphic Gambler's Fallacy (4Div)

Linear Regression Model

The following graphic makes it easier to describe the used linear regression models. It uses the data of the 2Div market. I am interested in the difference between the two arrows. Because of the theory of gambler's fallacy, after a high dividend outcome the probability for this high dividend outcome to occur the next period gets smaller (< 50 %) than it actually is. Therefore after a low dividend outcome occurs (per example 0) the trading price should rise depending to the fundamental value. In the graphic, the red line stands for the mean trading price and the blue line for the fundamental value. The dividend outcomes can be seen in the black line.



Graphic 15: Graphic for explanation of the linear regression models

In the following linear regression models the dividend outcome of the round before was used as an explanation variable. The first model contains the data of the 2Div treatment and the second model contains the data of the 4Div treatment. The variable d(t-1) has two different values in the treatment 2Div and four different values in the treatment 4Div. The variable d(t-1) is used in the model as a categorical variable. One reason for this is that in many applications of gambler's fallacy the variable outcomes are categorical. One example for this is the search of gambler's fallacy in the game roulette from Croson and Sundali (2005).

The used models can be found below, in which t stands for the period number, P(t) for the median price in period number t, f(t) for the fundamental value in period number t, d(t-1) for the dividend outcome in the period before, I stands for an Index variable and ε stand for the error.

Model 1: 2Div Treatment

$$|\mathbf{P(t)} - \mathbf{f(t)}| - |\mathbf{P(t-1)} - \mathbf{f(t-1)}| = \beta(0) + \beta(1) * \mathrm{I}(\mathrm{d(t-1)} = 48) + \varepsilon$$

Model 2: 4Div Treatment

$$|\mathbf{P(t)} - \mathbf{f(t)}| - |\mathbf{P(t-1)} - \mathbf{f(t-1)}| = \beta(0) + \beta(1) * \mathrm{I}(\mathrm{d(t-1)} = 8) + \beta(2) * \mathrm{I}(\mathrm{d(t-1)} = 28) + \beta(3) * \mathrm{I}(\mathrm{d(t-1)} = 60) + \varepsilon$$

The results of the linear regression models show that both models have no significant variable, not even the intercept of the models is significant. The direction of the price-changes depending on the dividend outcome of the former period is different between the two treatments. This means that the difference between the median price and the fundamental value does not raise with former zero dividend outcomes in the 2Div treatment. In the 4Div treatment the difference raise with former zero dividend outcomes. But only 2 zero outcomes occur in the 4Div treatment. There should not be given too much importance to these results because the multiple R-squared is with about 0.02 very low and the adjusted R-squared has with about -0.20 even a negative value. This means that the used regression models do not fit the data. In addition the amount of observations (= 1 observation per treatment and 15 periods per observation) is very low, actually too low for using a regression model. Therefore detailed results can only be found in the appendix F.

Summary

The used linear regressions could not show that the former dividend outcomes had an impact on price formation. But the linear regressions do not fit the data. By looking at the descriptive plots of the participants and the markets some evidence for gambler's fallacy can be found in the 2Div treatment. The graphics of the 4Div treatment show no evidence for gambler's fallacy.

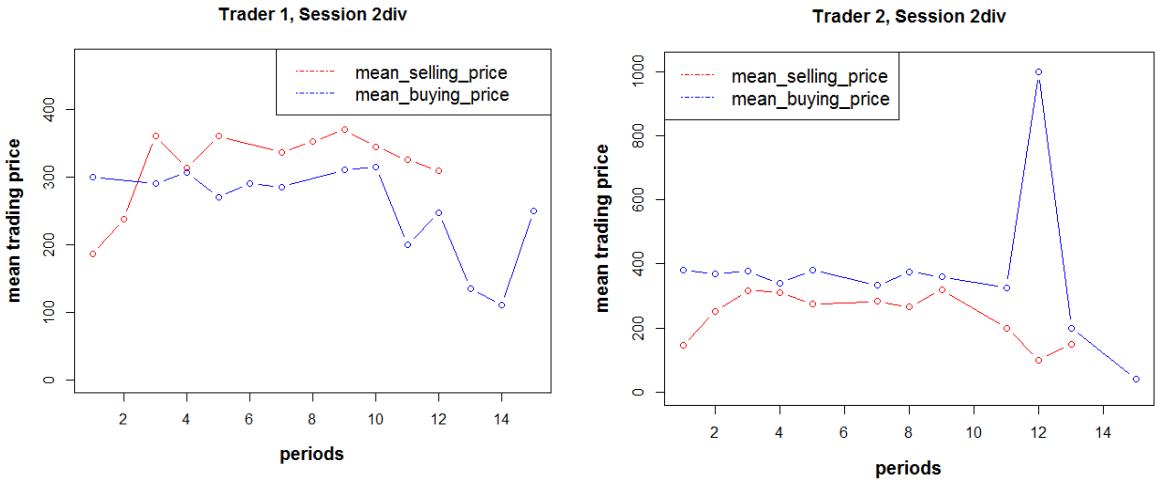
6.3. Bad Strategy

The results in this chapter help to get to know the strategies of the participants. Each participant has his own strategy. The mean buying and the mean selling price per period for each participant are displayed in a graphic, to identify participants with “bad strategies”. In all graphics of this part the red points show the mean selling price per period and the blue points show the mean buying price per period. The red points as well as the blue points are connected with a line. This line makes it easier to see the trend of both time series. When there is for example no blue point in period 8 of a trader, this means that he has not bought a share in this period. Additionally the earnings, purchases and sales for the participants are displayed in a table. The earnings help to find out, if participants with bad strategies have earned less than the other participants in their market. The amount of purchases and sales show how much participants with bad strategies traded and therefore how much they probably did influence the market.

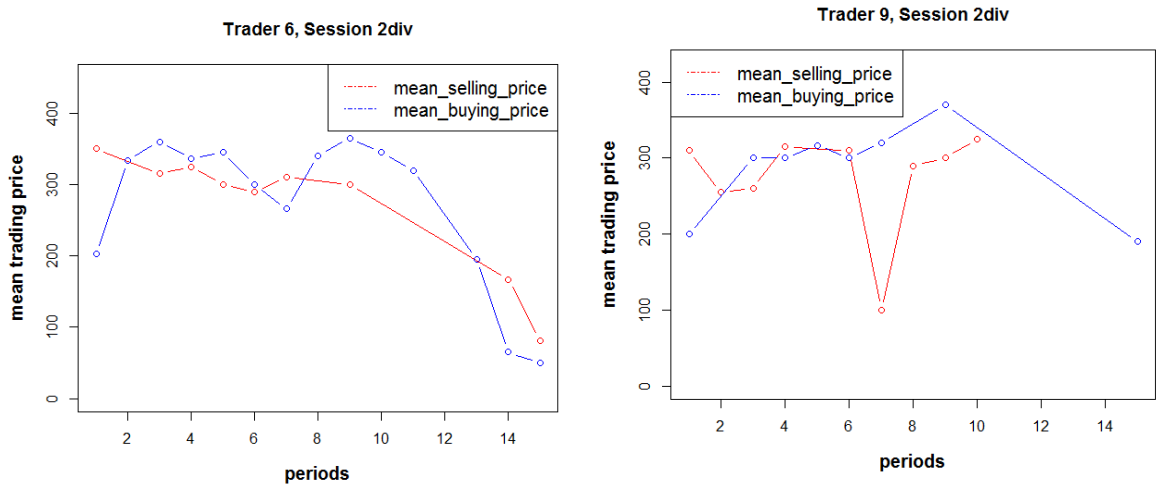
2Div market

Only the graphics of four out of nine participants are displayed. These are the graphics of the three participants with a bad strategy (trader 2, 6 and 9) and the graphic of participant 1, where the trading strategy of participant 1 is an example for a trading strategy that is not a “bad strategy”. The other graphics can be found in Appendix E.

In the graphic of trader 2 can be seen that he had a “purely bad strategy” this means that his mean buying price was in every period higher than his mean selling price. When looking at the graphics of trader 6 and trader 9 it is not that clear that they used a bad strategy. But because only periods are counted where the participants sold and bought shares, both traders used a bad strategy.



Graphic 16: Trader 1 and 2 (2Div market)



Graphic 17: Trader 6 and 9 (2Div market)

In the next table the earnings, the sales and the purchases of the participants of the 2Div market can be seen, the values of the participants with a “bad strategy” are marked blue. It can be seen that the participants with bad strategies (traders 2, 6 and 9) had also the three worst outcomes in the two-dividend-market (7, 13 and 10.5 Euro). Therefore the definition of “bad strategy” was well chosen in this market. This means that a “bad strategy” of a participant in the 2Div market actually leads to low earnings.

Additionally most of the sales were made by trader 2. Trader 6 had purchased the second most shares in the market. The participant with the most trades did not have a bad strategy, but trader 6 (bad strategy) traded only one share less. Altogether all three participants with bad strategies traded just as much as the median trading amount (33) or more.

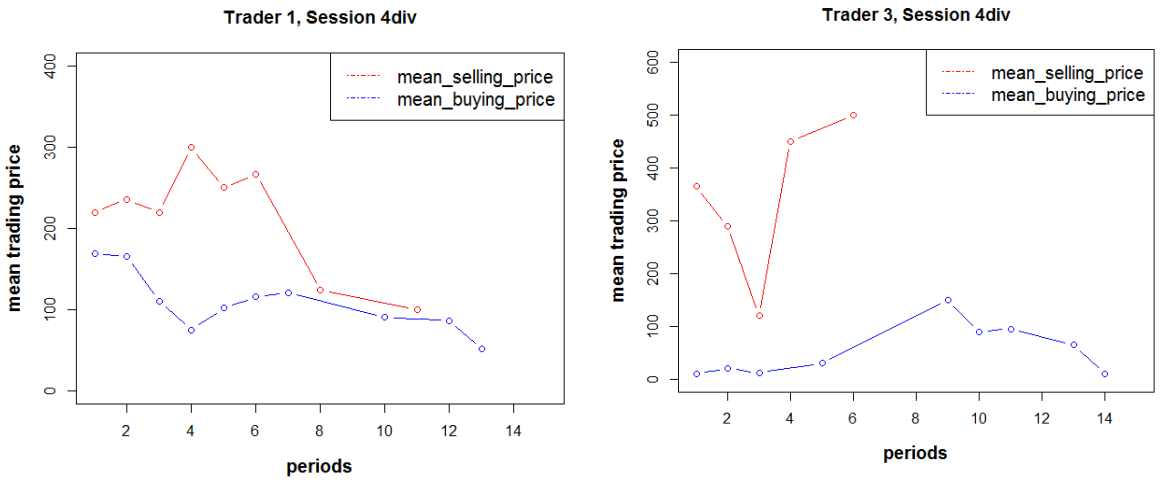
Table 5: Earnings, Purchases, Sales (2Div)

	Subject Number								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Earnings	13	7	22.5	18.5	16.5	13	16	15.5	10.5
Purchases	24	18	9	13	38	35	4	10	18
Sales	26	29	17	19	19	21	9	14	15
Trades	50	47	26	32	57	56	13	24	33

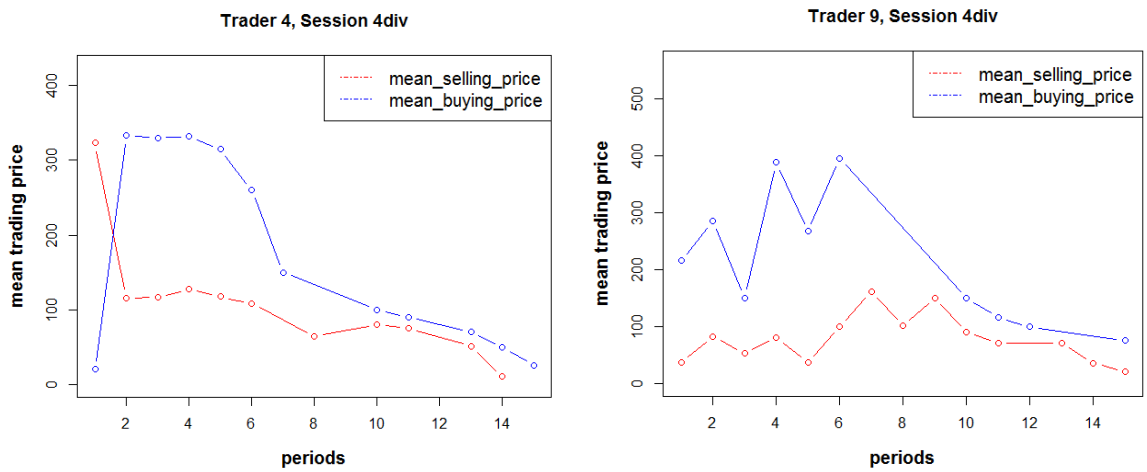
4Div market

Only the graphics of four out of nine participants are displayed. These are the graphics of the two participants with a bad strategy (trader 4 and 9) and the graphic of two participants with other trading strategies (trader 1 and 3). The not displayed graphics can be found in Appendix E.

In the graphic of trader 3 can be seen that he stopped selling shares after period number six. It is not unusual that participants do not sell and buy shares in each period. Also the other three participants did not sell or buy shares in each period. Trader 9 had a “purely bad strategy”. This means that in every period in which he sold and bought shares his mean buying price was higher than his mean selling price. Trader 4 sold at a much higher mean price in the first period and then he always bought shares at a higher mean price than he sold them.



Graphic 18: Trader 1 and 3 (4Div market)



Graphic 19: Trader 4 and 9 (4Div market)

In the next table the earnings, the sales and the purchases of the participants of the 4Div market can be seen, the values of the participants with a "bad strategy" are market blue. The participants with "bad strategies" (trader 4 and 9) also had the worst outcomes in the 4Div market (0.5 and 5.5 Euro). Additionally they had the highest amount of trades in the market. And trader 4 had also the highest amount or purchases and the highest amount of sales. Remarkable is also that trader 4 was a part of 91 out of 203 trades. Therefore especially trader 4 influenced the market very much.

Table 6: Earnings, Purchases, Sales (4Div)

	Subject Number								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Earnings	16.5	18	19.5	0.5	18	16.5	16	13	5.5
Purchases	18	22	16	42	18	20	9	30	28
Sales	25	25	7	49	13	17	18	20	29
Trades	43	47	23	91	31	37	27	50	57

Comparison of the two markets

In both markets persons with a bad strategy participated. In the 2Div market 3 participants had a bad strategy, in the 4Div market only 2 participants had a bad strategy. The sum of the earnings in the 4Div market is lower than the sum of the earnings in the 2Div market. This is the case because the dividend outcomes in the 4Div market were less optimal for the participants than in the 2Div market.

Summary

The hypothesis concerning participants with bad strategies holds. In both markets and therefore in both treatments, participants with bad strategies are found.

6.4. Earnings and Questionnaire

After the experiment, the participants had to answer a questionnaire beforehand of getting their payment. In this chapter selected questions are analysed. The answers to the questions are compared with the earnings of the participants. This was realized to find out if, for example, having stocks in the real world helps the participants to achieve good earnings in the experiment. The questionnaire can also help to find out if the participants are good at self-assessment.

The selected questions are:

1. Have you ever had or do you have stocks?
2. How often have you been to a casino?
3. When being in a casino or playing cards, how would you describe your gambling behaviour?
4. When participating in the experiment again, would you change your behaviour?
5. What is the main reason for you to take part in economic experiments?

The third question had four possible answers: “not risky at all”, “not too risky”, “risky” and “very risky”. Only in the 4Div market all four answers were used. To be able to compare the answers for both markets the first two answers were merged to “not risky” and the last two were merged to “risky”.

In the following table the results for the questions from above are summarized. The results in the table are rounded to one digit. Holding stocks in real life, casino visits and money as motivation for taking part in the experiment are reasons for higher mean and median earnings in both markets. Participants in the 2Div market had higher mean and median earnings when their gambling behaviour is not risky and when they would not want to change their trading behaviour after the experiment. For the traders in the 4Div market the opposite holds.

Table 7: Summary Questionnaire

		Mean Earnings		Median Earnings	
		2Div	**4Div**	**2Div**	**4Div**
Stocks	**Yes**	15.7	13.8	15.5	16.5
	No	14.3	13.7	14.5	16.0
Casino	**Yes**	16.0	14.3	15.5	18.0
	No	13.1	13.4	14.3	16.3
Gambling behaviour	**Not risky**	16.8	13.7	16.5	16.3
	Risky	11.8	13.8	13.0	16.5
Change trading behaviour	**Yes**	15.0	8.9	15.5	9.3
	No	14.6	17.5	14.5	18.0
Reason taking part	**Interest**	12.9	12.9	13.0	16.5
	Money	17.0	14.8	16.5	17.0

Summary

The hypothesis concerning the answers to the questionnaire and the earnings was not tested with a statistical test, because there are very few data. The descriptive statistics show that there might be evidence for the hypothesis to be true.

7. Discussion

In this chapter the limitations of the data and the results of the experiment are discussed. Unfortunately some of the limitations are so huge that the results of the study are limited. Therefore I feel that one of the most important things this study can contribute to the field of experimental asset markets is, to give an idea of how to avoid some of the limitations that did arise in my study and may also arise in other experimental asset markets.

7.1. Limitation

Low amount of observations

One of the biggest limitations of the data is the low amount of observations. There is only one observation for each market. The low number is because of the high cost for each observation in experimental asset markets. For example, in the underlying experiment, nine people trade in one market and therefore nine people were used for getting one observation.

Despite the low number of observations it was possible to execute the experiment, analyse the results of the data and get an impression of what to look at. Nevertheless it is not possible to conclude something from the data and their results.

To avoid the first limitation enough sessions have to be conducted to generate an adequate amount of data.

Participants with bad strategies

Another important limitation is that some of the participants had a bad strategy. Especially in the 4Div market participant 4 had a bad strategy and influenced the trading in the market very much, because he has been part of 91 trades out of 203 trades. The participants with a bad strategy probably did not understand the computerized market correctly.

Participants with bad strategies may influence the bubble and crash phenomena very much. In this experiment there were no control-mechanisms for participants with “bad strategies”.

The limitation caused by participants with a bad strategy, can be disarmed by selecting only participants which have successfully traded in training or validation rounds. A possibility of how to evaluate the participants before they start trading is to ask about personal characteristics of them. The results of the questionnaire combined with the earnings help to understand which personal characteristics may help participants to achieve good outcomes. The results show that high mean and median earnings have been achieved by participants that have stocks in the real world, have been in a casino or have taken place in the experiment because of money and not interest. Important to note is that the participants may answer differently when the questionnaire is asked before and when their participation is linked to the answers they gave in the questionnaire. Furthermore the higher mean and median earnings of the participants do not mean that there are no participants left with a “bad strategy”.

Questionnaire at the end

All questions of the questionnaire were asked after the experiment.

Because all the questions were asked only after the experiment, there are two different aspects influencing the answers. Firstly the answers are influenced by the real characteristics of the participants and additionally the answers could change because of the self-evaluation from the participants of their performance in the experiment.

To avoid this limitation two different questionnaires, one before the experiment and one after the experiment, should be handed out.

7.2. Discussion

The outcome of my research question was that the trading volume was lower in the treatment with a higher probability of a zero outcome than with a lower probability of a zero outcome. In the treatment with a lower probability of a zero outcome a negative bubble occurred. By comparing the results of the relative absolute deviation, it becomes quite clear that the bubble with the lower probability of a zero outcome was smaller. Therefore I was not able to show with my experiment that my hypothesis regarding the research question holds. But there are three things to keep in mind:

1. There is only one observation for each market.
2. Every market had at least two traders with a “bad strategy” influencing the market.
3. The incorrect answers of the participants to the question: “*How often do you think a dividend outcome of zero occurred in the experiment (there were 15 dividend outcomes in total)?”* let assume that the participants did not show much attention to the dividend outcomes.

Therefore my results must not mean that the 2Div treatment really does not have an effect on the bubble and crash phenomena. It may be possible that the effects of the last two mentioned points are too huge, for the treatment effect to be seen. How to possibly avoid the second point was mentioned in the limitations above. The third point, that participants may not show much attention to the dividend outcomes, may be solved by an idea of the paper of Huber and Kirchler (2012). They asked the participants at the beginning of each period what value the fundamental value has at the moment. Because the fundamental value is estimated out of the expected dividend outcome and the periods that are left, this might help participants to take the dividend outcomes more into account. In the paper of Huber and Kirchler (2012) they as well show that less mispricing occurs if the fundamental value for each period is shown in a graphic and if participants get a question about the value of the fundamental value at the beginning of each period. They argue that these two changes help the participants to better understand the fundamental value.

In my work I did not research the risk aversion of participants. If the risk behavior of the participants would have been measured in my experiment, this would make it easier to interpret the results of the research question. In the study of Fellner and Maciejovsky (2007) two different approaches of how to measure risk behavior of people are mentioned. The first approach is to measure it over their choices on lottery games. The second approach is to give people a questionnaire which consists of different statements to answer. With the agreement to special statements the level of risk aversion can be measured.

Additionally, only male persons participated in my experiment. Suetens and Tyran (2012) found out that in the case of gambler's fallacy there is a strong difference between men and women. Women are less prone to gambler's fallacy than men are. Suetens and Tyran (2012) used field data in their study. They used data from "Systemlotto" in Denmark. Gambler's fallacy arises in this example when players avoid picking numbers that have been the winning numbers the rounds before. Therefore the results of the male participants may not hold for both genders. Additionally the paper of Fellner and Maciejovsky (2007) shows that men are less risk-averse than women. Therefore the effect of the dividend variation may be higher for women than for men.

In this work I also examine the results for the occurrence of gambler's fallacy. In the experiment between the periods 8 and 12 the outcome zero occurred five times in a row. In the periods between 9 and 12 many participants had the highest differences between the buying/selling price and the fundamental value. This may be evidence for gambler's fallacy. But the interpretation of these results should be made carefully because of the following four points:

1. The participants gave incorrect answers about the appearance of the dividend outcome zero. Participants that have not noticed the previous dividend outcomes cannot take them into consideration.
2. There are always nine people trading in one market and a single person prone to gambler's fallacy can influence the whole market.

3. The results of the used linear regression models are not significant. And in the linear regression model for the 2Div treatment, the measured effect of a former zero outcome goes not in the expected direction. But the used linear regression models do not fit the data.
4. There are typical price and volume patterns of experimental asset markets. These typical patterns for experimental asset markets with 15 periods are listed by Palan (2013). He merged different papers and came to the conclusion that a price bubble occurs mostly between the periods 4 and 10, but it also can last until period 15. Therefore the occurrence of the high differences between the mean buying/selling price and the fundamental value between the periods 9 and 12 may have only occurred because of the typical bubble structure.

The first point here may be resolved like described before. In contrast the second point cannot be prevented in experimental asset markets. Therefore it is only possible to say that there are participants prone to gambler's fallacy in the market but not which and how much participants. The third may arise because there have not been enough observations and additionally only the former dividend outcome was looked at. If for example a zero outcome occurs three times in a row, participants may react more than if the zero has occurred only in the last period before. For point four to be resolved it is important to have more observations with different sequences of the same dividend at different periods.

The results of the nine participants are dependent to each other. Therefore the results on the subject level and on the subject and period level are mostly done to understand what was going on in the market and which strategy the participants had. But the results of the different traders are not independent. Therefore while interpreting the results this is an important thing to keep in mind.

8. Conclusion

Financial markets have a high impact on our economy. Therefore it gets more and more important to do research in this kind of field. With my research I tried to contribute something to this field. My study design was made in a way that allows searching for irrational behavior of market participants and comparing the two treatments with different amounts of possible dividend outcomes to each other. In my experiment the irrational behavior I was searching for was gambler's fallacy. The way the 2Div treatment was constructed (with one zero dividend and one positive dividend) makes it easier to search for gambler's fallacy in this treatment, because there is one extremely bad dividend outcome (0) and one extremely good dividend outcome (48).

With the underlying experiment I was not able to show that the hypothesis for the main research question holds. This means that the 2Div treatment had no smaller bubble than the 4Div treatment, actually the opposite holds, only the trading volume was smaller in the 2Div treatment.

In each of the two markets, there have been participants with bad strategies. Therefore the additional hypothesis concerning bad strategies in my observed markets holds.

The descriptive statistics for the additional research question concerning gambler's fallacy show that in the 2Div market, some participants may have been prone to gambler's fallacy. But as mentioned in the discussion, this effect that can be seen in the graphic might be independent of the dividends and has only occurred because of the typical bubble structure in experimental asset markets. Additionally, the used linear regression models for this research question show no significant results. This could be evidence for a non-appearance of gamblers fallacy in both markets. But the used linear regression models do not fit the data. Two problems of the used linear regression models are the fact that the number of observations was too less and that only the last dividend outcome was considered. That is not what is usually done when searching for gambler's fallacy.

The descriptive results for the last additional research question, concerning the earnings and given answers to the questionnaire, show that there might be a connection between these two.

A special result I got in my experiment was that the bubble in the 4Div market was a bubble under the fundamental value.

Because of the low amount of observations one should not conclude anything from the results. They are only holding for the data of the two underlying markets.

The contribution of my thesis to the field of experimental asset market is the used design, the use of gamblers fallacy in experimental asset markets and the description of the occurred limitations as well as suggestions of how to get rid of these limitations.

Appendix A

Zusammenfassung

Einleitung

Finanzmärkte haben einen großen Einfluss auf unsere Wirtschaft. Deshalb wird es immer wichtiger in diesem Bereich zu forschen. Durch diese Forschung soll neues Wissen über das Verhalten von Marktteilnehmern generiert werden. Zusätzlich kann nach irrationalem Verhalten der Marktteilnehmer gesucht werden. Die Forschungsfrage dieser Studie ist folgende: „Beeinflusst die Variation von Dividenden das Phänomen von Finanzmarkt Blasen, das Platzen dieser Blasen und den Umfang von Aktienhandel?“ Die Hypothese hinter dieser Forschungsfrage ist jene: Wenn Menschen risikoavers sind, dann ist das 2Div Treatment weniger optimal als das 4Div Treatment. Grund dafür ist, dass bei dem 2Div Treatment mit einer höheren Wahrscheinlichkeit eine Dividende mit dem Wert Null eintritt als beim 4Div Treatment. Deshalb sollten bei dem 2Div Treatment die Blase und der Umfang von gehandelten Aktien kleiner sein als in dem 4Div Treatment.

Studie

In dieser Studie werden experimentelle Vermögensmärkte verwendet. Der Großteil des Studiendesigns wurde von Smith et al. (1988) übernommen. Auf diese Märkte werden zwei verschiedene Treatments angewendet. Im ersten Treatment können vier verschiedene Dividenden auftreten (0, 8, 28, 60), jede Dividende tritt mit einer Wahrscheinlichkeit von 25 % auf. Das zweite Treatment besteht aus zwei verschiedenen Dividenden (0, 48), jede Dividende tritt mit einer Wahrscheinlichkeit von 50 % auf. Die verwendeten Theorien dieser Studie waren die Theorie von „Gambler’s Fallacy“ und die Theorie von Risikoaversion. Um verschiedene Treatments und verschiedene Märkte zu vergleichen wurden spezielle Kennzahlen zum Messen von Finanzmarktblasen sowie Deskriptive Statistiken angewendet. Das Experiment wurde mithilfe des Programms Darwin durchgeführt. Für die Auswertung der Resultate wurden die Programme R (Version 2.15.2) und Excel 2007 verwendet.

Resultate

Im 2Div Markt ist eine Finanzmarktblase aufgetreten. Circa 80 Prozent der Transaktionen wurden über dem „Fundamental Value“ und 20 Prozent darunter gehandelt. Die Kennzahl „Relative Absolute Deviation“ hat einen Wert von 0,58. Es wurden insgesamt 169 Transaktionen in diesem Markt durchgeführt. Die mittlere Dividende betrug in diesem Markt 22,4, die zu erwartende Dividende war 24. Im Vier-Dividenden-Markt ist eine negative Finanzmarktblase aufgetreten. Das heißt es wurden 30 % der Transaktionen über dem „Fundamental Value“ und 70 Prozent darunter gehandelt. Die Kennzahl „Relative Absolute Deviation“ war in diesem Markt mit einem Wert von 0,28 viel kleiner als in dem 2Div Markt. Im 4Div Markt wurden 203 Transaktionen durchgeführt. Die meisten davon in den ersten sechs Perioden (147 von 203). Die mittlere Dividende betrug 17,9, die zu erwartende Dividende war 24. Aktien im wahren Leben, Casino-Besuche oder Geld als Hauptmotivator zur Teilnahme an dem Experiment bringen den Teilnehmern ein höheres mittleres Einkommen sowie ein höheres Median-Einkommen beim Experiment. Im 2Div Markt gab es fünf aufeinander folgende Perioden (Periode 8 bis 12) mit einer Dividende von Null. Die meisten Teilnehmer hatten die größte positive Differenz zwischen dem mittleren Verkaufs-/Einkaufspreis und dem tatsächlichen Wert einer Aktie in den Perioden 9 bis 12.

Diskussion

Meine Ergebnisse sprechen nicht dafür, dass durch das 2Div Treatment das Phänomen von Finanzmarkt Blasen und das Platzen dieser Blasen abgeschwächt wird. Aber es gibt unterschiedliche Gründe welche beachtet werden sollten. Es gab zum Beispiel nur eine Beobachtung pro Markt und in jedem Markt gab es zumindest zwei Personen mit einer schlechten Strategie. Die Deskriptiven Resultate meines Experiments können Hinweise auf das mögliche Vorliegen von “Gambler’s Fallacy“ liefern. Aber die Interpretation dieser Resultate sollte trotzdem vorsichtig gemacht werden. Es gibt in jedem Markt neun Teilnehmer und bereits eine einzige Person mit „Gambler’s Fallacy“ kann den ganzen Markt beeinflussen. Zusätzlich gibt es typische Muster bei experimentellen Finanzmärkten welche von Palan (2013) genannt werden. Bei diesem typischen Muster tritt die Finanzmarktblase zwischen den Perioden 4 und 15 auf.

Appendix B

Abstract

Introduction

Financial markets have a high impact on our economy. Therefore it gets more and more important to do research in this field. With this research, new knowledge about the behavior of market participants should be generated. In addition to that it can be examined for irrational behavior of the market participants. The research question of this study is: “Does the variation of dividend outcomes influence bubble and crash phenomenon and trading volume?” The hypothesis behind this research question is that the 2Div treatment is less optimal than the 4Div treatment. Therefore a lower bubble as well as lower trading volume should be found in the 2Div market. A reason behind this hypothesis is the theory of risk aversion. In the 2Div market is a higher probability of getting a dividend outcome of zero.

Study Design

In this study experimental asset markets are used. Most of the design is taken from Smith et al. (1988). In this experimental asset market, two different treatments are executed. In the first treatment, four different dividend outcomes (0, 8, 28 and 60) can arise, each with a probability of 25 %. The second treatment consists of two different dividend outcomes (0, 48) each outcome appears with a probability of 50 %. The used and underlying theories are the theory of gambler’s fallacy and the theory of risk aversion. To compare different treatments and different markets elected bubble measurements and descriptive statistics are used. The experiment was executed with the computerized market of the program Darwin. For preparing the results the programs R (version 2.15.2) and Excel 2007 were used.

Results

In the 2Div market a bubble occurred. About 80 % of the transactions were above and 20 % below the fundamental value. The relative absolute deviation was 0.58 and the amount of trades was 169. The mean dividend outcome in this market was 22.4, whereas the expected dividend outcome is 24. In the 4Div market a negative bubble occurred. There were about 30 % of the transactions above the fundamental value and 70 % below the fundamental value. The relative absolute deviation in this market was with 0.28 much lower than the one in the other market. In this market 203 trades were executed. Most of those trades were executed in the first six periods (147 from 203). The mean dividend outcome in this market was 17.9, whereas the expected dividend outcome is 24. Stocks in the real world, previous casino visits and money as motivation for taking part in the experiment are reasons in both markets for higher mean and median earnings. In the 2Div market the dividend outcome between the periods 8 and 12 was zero. Most of the traders had the highest difference between the mean selling/buying price and the fundamental value in the periods between 9 and 12.

Discussion

With my experiment I was not able to show that the 2Div treatment reduces the bubble and crash phenomena. But one should realize the next two arguments. There is only one observation for each market. And every market had at least two traders with a “bad strategy” influencing the market.

There may be evidence for gambler’s fallacy in the results of the experiment for the 2Div market. But the interpretation of those results should be made carefully. There are always nine people trading in one market and even one person prone to gambler’s fallacy can influence the whole market. There are typical price and volume patterns of experimental asset markets mentioned in the study of Palan (2013) in which price bubbles occur between the periods 4 and 15.

Appendix C

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Curriculum Vitae

Personal Data:

Name:	Lisa Maria Neuhofer
Date of birth/Place of birth:	19.07.1989 / Ried im Innkreis

Education:

2008-2011	Bachelor of Statistic at the University of Vienna
2009-2011	Bachelor of Economics at the University of Vienna
2011-lfd	Master of Statistic at the University of Vienna
2011-lfd	Master of Economics at the University of Vienna

Employment:

October 2010	Freelancer at SORA
February 2011	Internship by Austrian Airlines (as statistician)
July, September 2011	Freelancer at Austrian Airlines
January 2012 – July 2012	Project collaborator at the Medical University of Vienna
February 2013 – September 2013	Project collaborator at the Medical University of Vienna

Projects at the Medical University:

2012	Arzneimittelsicherheit — Krankenhausaufenthalte infolge unerwünschter Arzneimittelwechselwirkungen
2013	ADE2-Projekt
2013	Analyse von Behandlungsnetzwerken österreichischer Gesundheitsdienstanbieter

Conference contribution (first author):

Statistische Woche 2012	Nutzung von administrativen Daten des Gesundheitswesens für Fragen der Arzneimittelsicherheit
Eurocast 2013	Modeling Temporal Associations in Process Analysis

Appendix D

Additional Table

Table 8: Questionnaire

What is your age?
What is your gender?
What is your main field of study?
Are you studying more than one subject?
When yes, what are your other subjects?
How much money do you spend per month (please count the money without the rent)?
Do you spend more money a month than you would like to?
How often have you been to a casino?
When being in a casino or playing cards, how would you describe your gambling behavior?
How often do you think a dividend outcome of zero occurred in the experiment (there were 15 dividend outcomes in total)?
When participating in the experiment again, would you change your behavior?
When yes, how would you change your behavior?
Have you ever had or do you have stocks?
What is the main reason for you to take part in economic experiments?
Have you participated in a similar experiment before?

Table 9: Amount of trades per period

	Periods														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Trades 2Div	27	15	17	12	10	7	13	12	10	8	3	8	8	7	12
Trades 4Div	25	30	27	21	22	22	9	4	3	8	7	5	10	6	4

Table 10: Stocks in real world and Earnings per subject (2Div)

		Earnings							
		7	**10.5**	**13**	**15.5**	**16**	**16.5**	**18.5**	**22.5**
Stocks	**No**	1	1	1	0	1	1	0	1
	Yes	0	0	1	1	0	0	1	0

Table 11: Stocks in real world and Earnings per subject (4Div)

		Earnings						
		0.5	**5.5**	**13**	**16**	**16.5**	**18**	**19.5**
Stocks	**No**	1	0	1	1	1	2	0
	Yes	0	1	0	0	1	0	1

Table 12: Casino visits and Earnings (2Div)

		Earnings							
		7	**10.5**	**13**	**15.5**	**16**	**16.5**	**18.5**	**22.5**
Number of casino visits	**Never**	1	0	1	0	1	1	0	0
	1-5 times	0	1	1	0	0	0	0	1
	6-10 times	0	0	0	0	0	0	1	0
	More often	0	0	0	1	0	0	0	0

Table 13: Casino visits and Earnings (4Div)

		Earnings						
		0.5	**5.5**	**13**	**16**	**16.5**	**18**	**19.5**
Number of casino visits	**Never**	1	0	1	1	2	1	0
	1-5 times	0	1	0	0	0	1	1

Table 14: Gambling behavior and Earnings (2Div)

		Earnings							
		7	**10.5**	**13**	**15.5**	**16**	**16.5**	**18.5**	**22.5**
Gambling behaviour	**Not too Risky**	0	1	0	0	1	1	1	1
	Risky	1	0	2	1	0	0	0	0

Table 15: Gambling behavior and Earnings (4Div)

		Earnings						
		0.5	**5.5**	**13**	**16**	**16.5**	**18**	**19.5**
Gambling behaviour	**Not risky at all**	1	0	0	0	0	1	0
	Not too risky	0	0	1	1	1	1	0
	Risky	0	0	0	0	0	0	1
	Very risky	0	1	0	0	1	0	0

Table 16: Earnings and Change of trading behavior (2Div)

		Earnings							
		7	**10.5**	**13**	**15.5**	**16**	**16.5**	**18.5**	**22.5**
Change trade behaviour	**No**	1	1	1	0	1	0	1	1
	Yes	0	0	1	1	0	1	0	0

Table 17: Earnings and Change of trading behavior (4Div)

		Earnings						
		0.5	**5.5**	**13**	**16**	**16.5**	**18**	**19.5**
Change trade behaviour	**No**	0	0	0	1	1	2	1
	Yes	1	1	1	0	1	0	0

Table 18: Reason taking part and Earnings per subject (2Div)

		Earnings							
		7	**10.5**	**13**	**15.5**	**16**	**16.5**	**18.5**	**22.5**
Reason	**Interest**	1	1	1	1	0	0	1	0
	Money	0	0	1	0	1	1	0	1

Table 19: Reason taking part and Earnings per subject (4Div)

		Earnings						
		0.5	**5.5**	**13**	**16**	**16.5**	**18**	**19.5**
Reason	**Interest**	1	0	1	0	2	1	0
	Money	0	1	0	1	0	1	1

Table 20: Estimated occurrence of outcome zero (2Div)

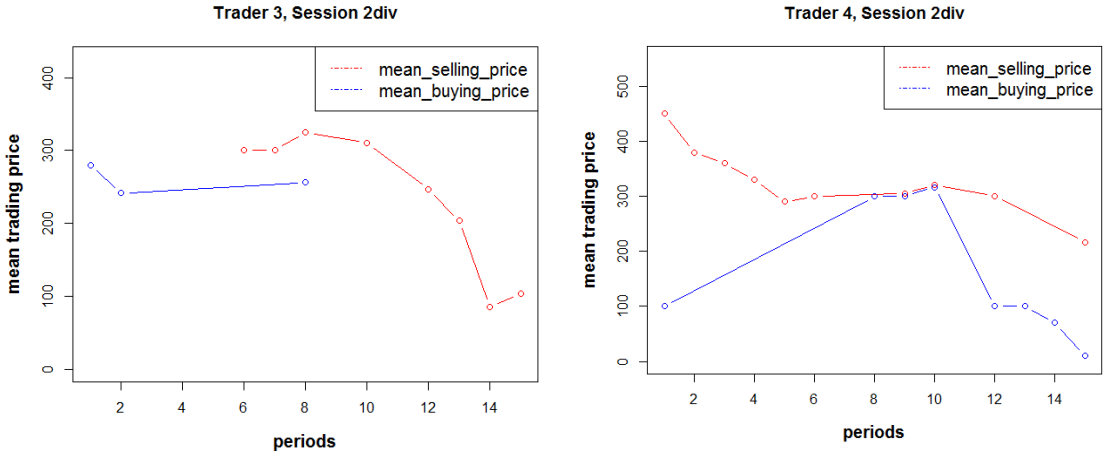
		Earnings							
		7	**10.5**	**13**	**15.5**	**16**	**16.5**	**18.5**	**22.5**
Estimated occurrence of dividend zero	**1**	0	0	1	0	0	0	0	0
	5	0	0	1	0	1	0	0	0
	6	0	0	0	0	0	0	0	1
	7	0	1	0	0	0	1	1	0
	11	1	0	0	0	0	0	0	0
	20	0	0	0	1	0	0	0	0

Table 21: Estimated occurrence of outcome zero (4Div)

		Earnings						
		0.5	**5.5**	**13**	**16**	**16.5**	**18**	**19.5**
Estimated occurrence of dividend zero	**0**	0	0	1	0	0	0	0
	1	1	0	0	0	0	0	0
	3	0	0	0	0	1	0	0
	4	0	1	0	1	0	2	0
	5	0	0	0	0	0	0	1
	10	0	0	0	0	1	0	0

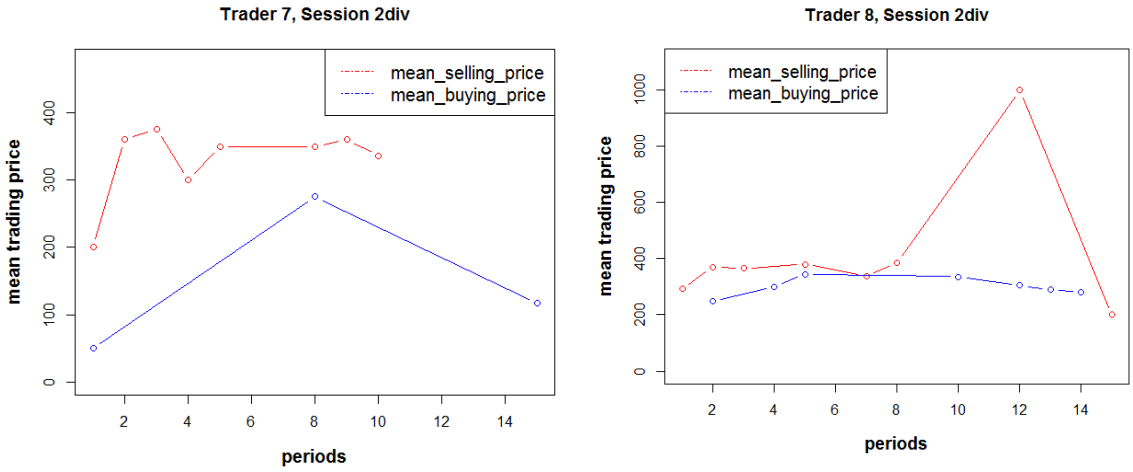
Appendix E

Additional Graphics

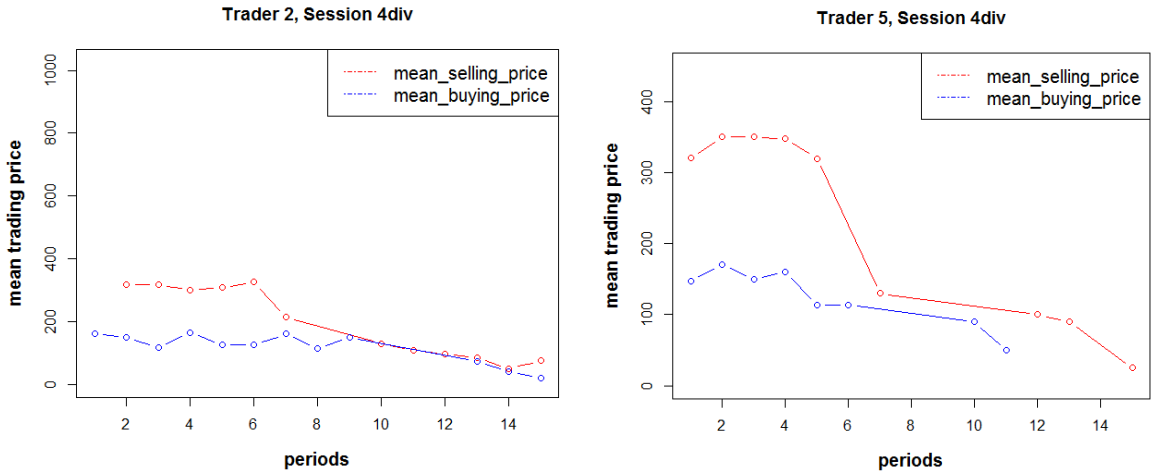


Graphic 20: Trader 3 and 4 (2Div market)

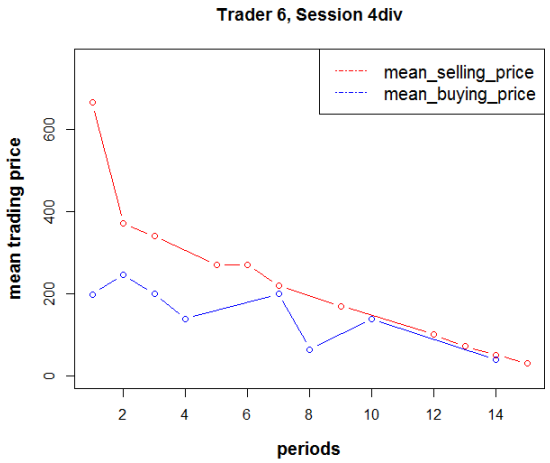
Graphic 21: Trader 5 (2Div market)



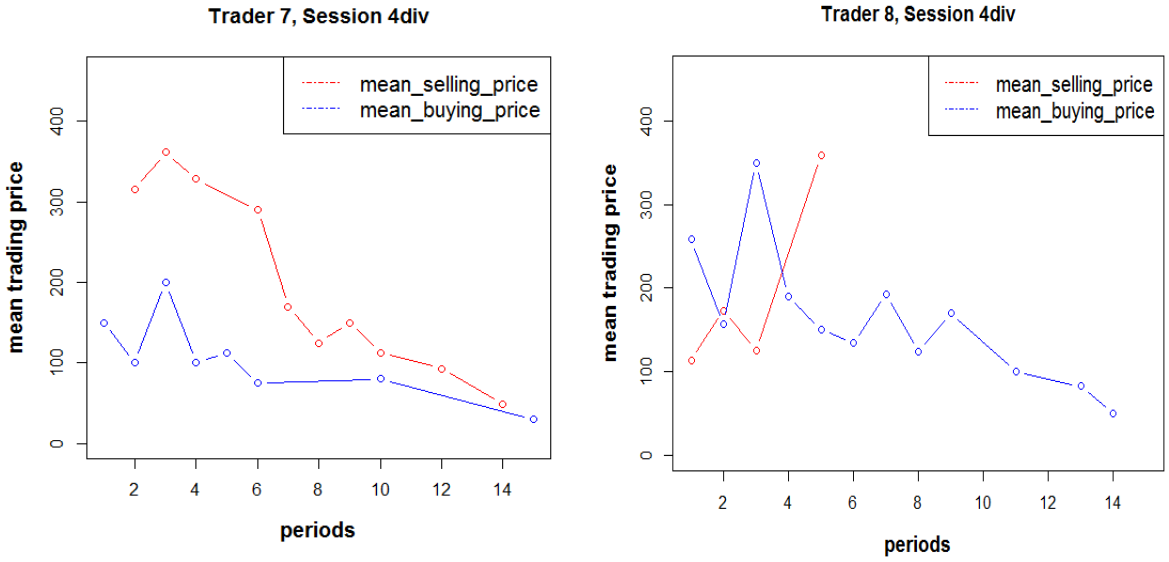
Graphic 22: Trader 7 and 8 (2Div market)



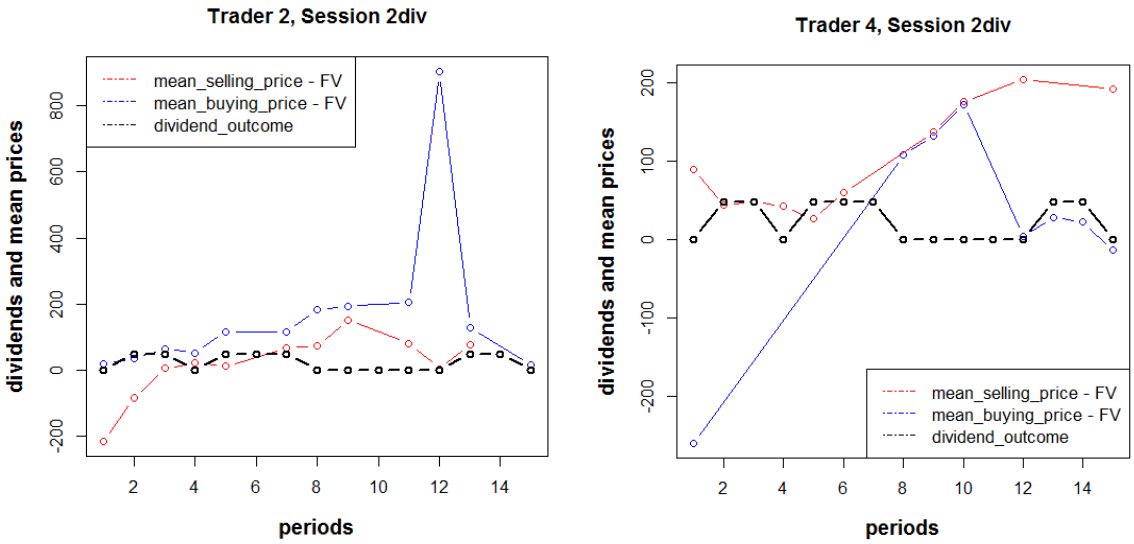
Graphic 23: Trader 2 and 5 (4Div market)



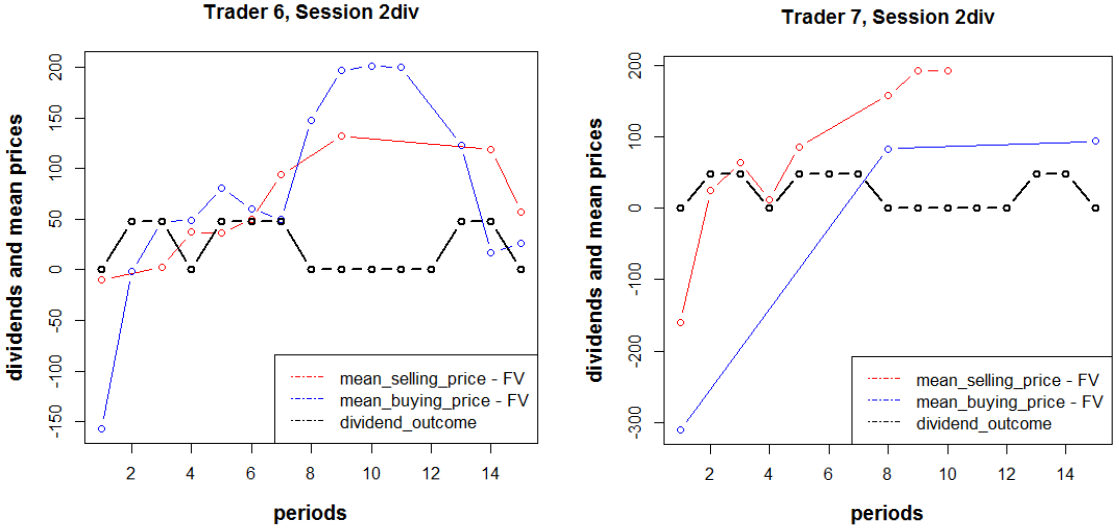
Graphic 24: Trader 6 (4Div market)



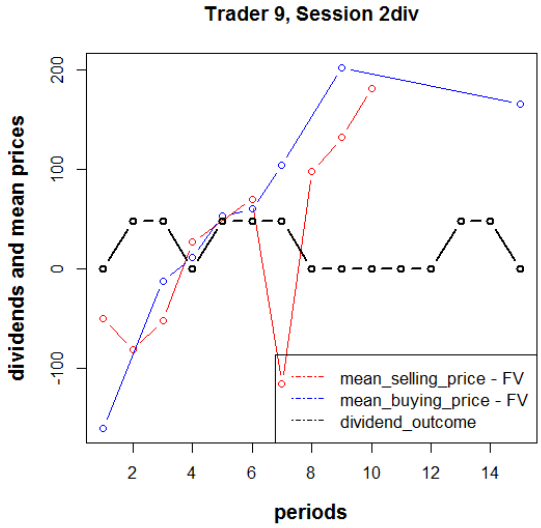
Graphic 25: Trader 7 and 8 (4Div market)



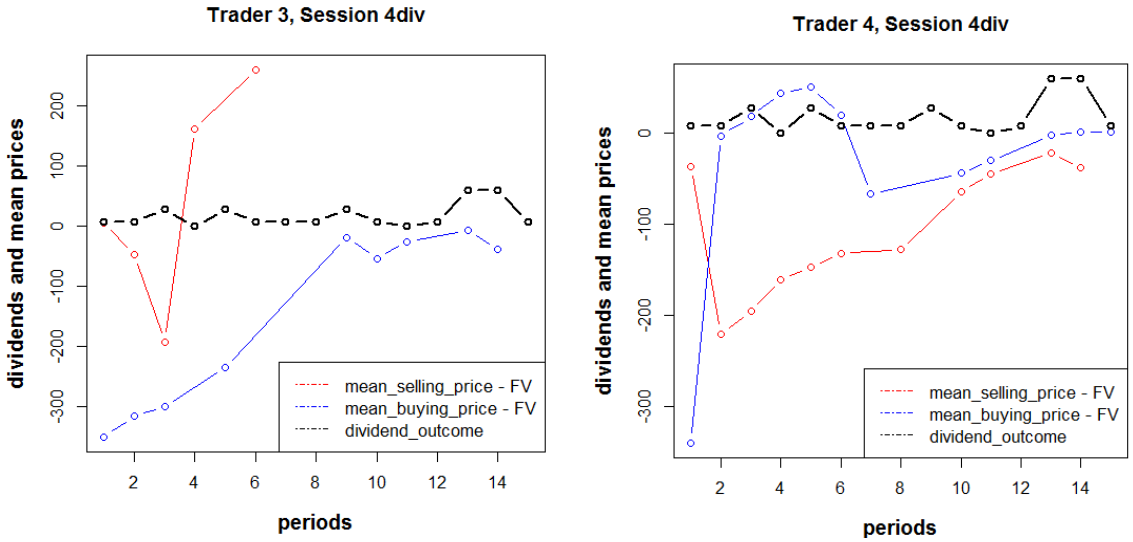
Graphic 26: Trading prices and dividends (Trader 2 and 4, 2Div market)



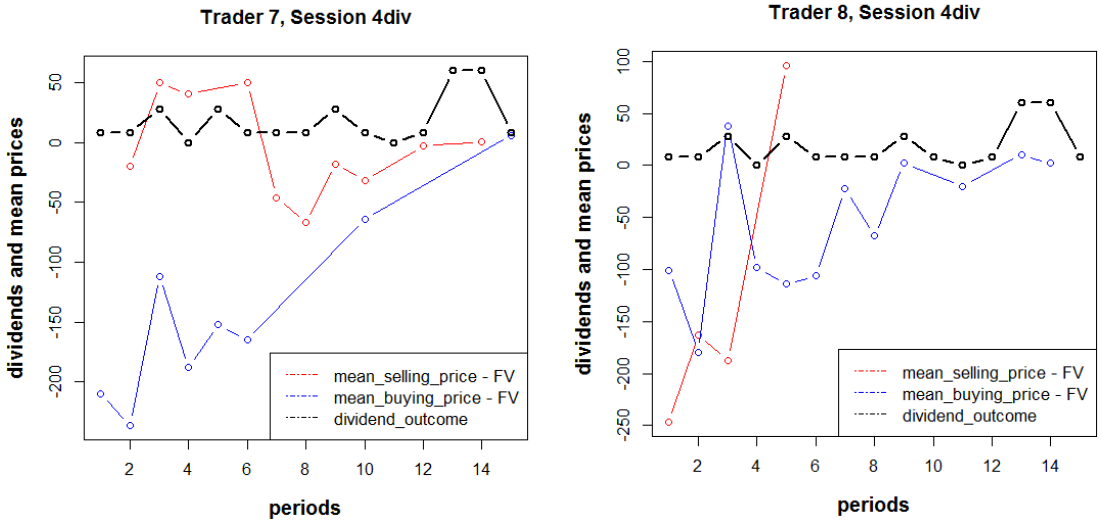
Graphic 27: Trading prices and dividends (Trader 6 and 7, 2Div market)



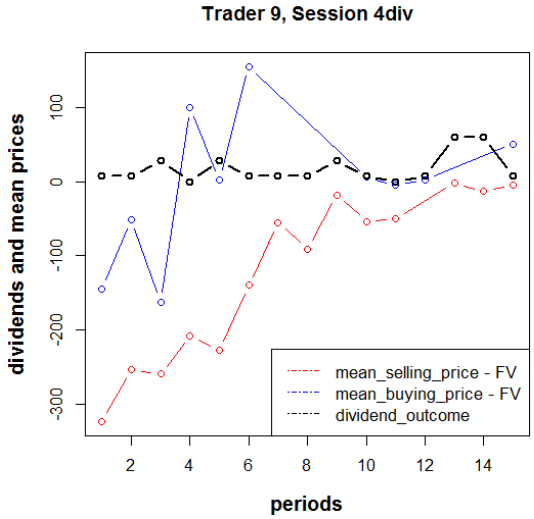
Graphic 28: Trading prices and dividends (Trader 9, 2Div market)



Graphic 29: Trading prices and dividends (Trader 3 and 4, 4Div market)



Graphic 30: Trading prices and dividends (Trader 7 and 8, 4Div market)



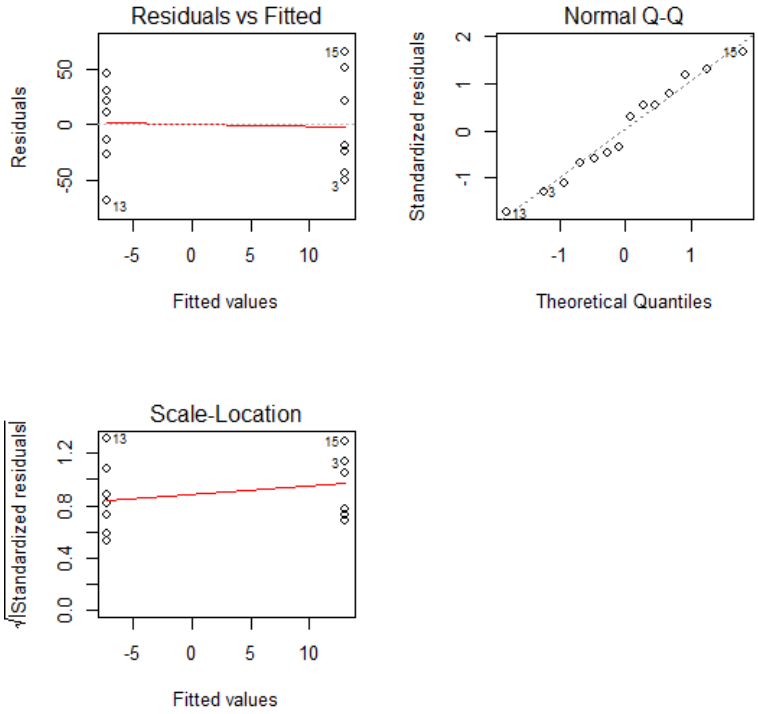
Graphic 31: Trading prices and dividends (Trader 9, 4Div market)

Appendix F

Results: Linear Regression Model

Table 22: Results Linear Regression Model 1

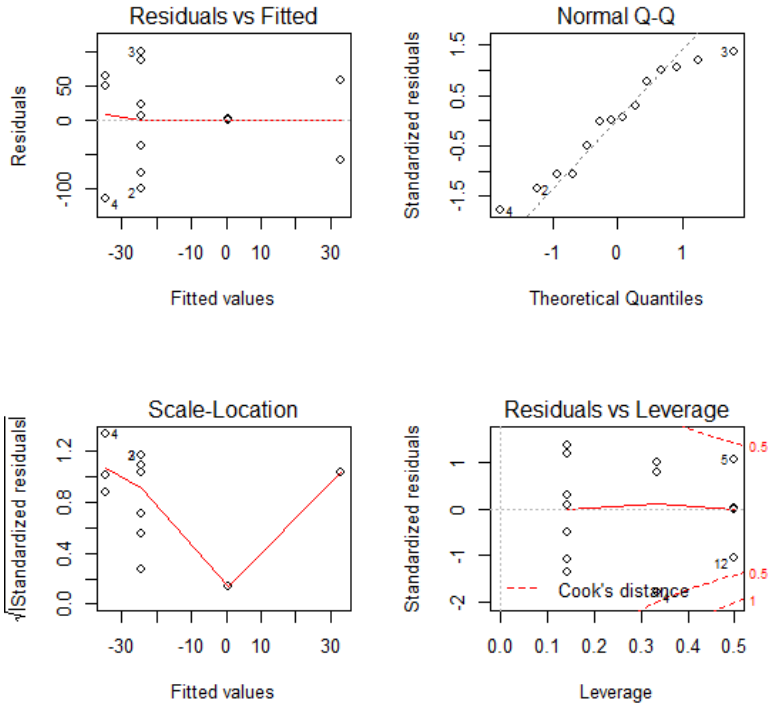
	Estimate	Std.Error	t_value	Pr(>|t|)
(Intercept)	-7.143	16.256	-0.439	0.668
dividend_vorperiode48	20.143	22.989	0.876	0.398
Additional Results				
Residual standard error: 43.01 on 12 degrees of freedom				
Multiple R-squared: : 0.06013, Adjusted R-squared: -0.01819				
F-statistic: 0.7677 on 1 and 12 DF, p-value: 0.3981				



Graphic 32: Plots for the Linear Regression Model 1

Table 23: Results Linear Regression Model 2

	Estimate	Std.Error	t_value	Pr(>|t|)
(Intercept)	33.0	55.97	0.590	0.569
dividend_vorperiode28	-67.50	72.26	-0.934	0.372
dividend_vorperiode60	-32.24	79.15	-0.407	0.692
dividend_vorperiode8	-57.36	63.46	-0.904	0.387
Additional Results				
Residual standard error: 79.15 on 10 degrees of freedom				
Multiple R-squared: 0.09866, Adjusted R-squared: -0.1717				
F-statistic: 0.3648 on 3 and 10 DF, p-value: 0.7799				



Graphic 33: Plots for the Linear Regression Model 2

Appendix G

Important terms and definitions

Expected Dividend Outcome

The expected dividend outcome is an expected value that takes the probability of each dividend outcome into consideration. In the following experiment the expected dividend outcome is always 24. The calculation for the expected dividend outcome is the following: When for example there are two different dividend outcomes, like it is the case in one of the two markets, the possible dividend outcomes are 0 and 48 and both occur in each period with a probability of 50 %. The expected dividend outcome therefore is: 0*0.5 + 48*0.5 = 24.

Experimental Asset Markets

Economic laboratory experiments can be used to try out policy proposals before they come into operation. A benefit of economic laboratory experiments is that many conditions of the experiment can be controlled. This is something that is not possible in field experiments. But to be able to conclude something from results of laboratory experiments only one condition can be varied at a time. This means the number of experiments increases with the number of variations. With experimental asset markets can be tested, how people may react to changes in financial markets.

Fundamental Value

The fundamental value, is the value at which should be traded. The fundamental value is calculated as following: expected dividend outcome * number of periods left. In my experiment the expected dividend outcome is 24 and the number of periods is 15, therefore the fundamental value in the first period is 360 (24 * 15). After the last dividend payout in period 15, the shares lose their value. The fundamental value decreases from round to round.

Table of Figures

List of Tables

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