The Disposition Effect, Individual Differences, Stability, and Learning: An Experimental Investigation*

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Abstract: We test experimentally for individual differences, stability, and learning in individual level disposition effects. While we observe the disposition effect on aggregate, the extent to which a single decision maker is affected varies considerably across subjects. We find overwhelming evidence for stability of individual disposition effects within one task, across different individual choice tasks, as well as across different parts of the experiment, i.e. across time. Interaction between subjects, however, seems to impact individual trading behavior to such an extend that stability is no longer present. In addition, learning attenuates the magnitude of the effect strongly within tasks and over time.

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1 Introduction

Behavioral finance builds on the fact that individual as well as professional investors in some situations systematically violate neoclassic theory. Thereby it commonly assumes that investors – depending e.g. on their financial sophistication – exhibit these biases to different degrees and that the magnitude of an individual bias is stable over different market regimes, different economic situations, and time. Biases need to be stable if we want to identify biased investors, if we want to come to a consistent explanation of its causes, and if we want to apply counteractive measures to overcome the bias. Stability is especially needed and implicitly assumed in multi-agent models like e.g. Grinblatt and Han (2005), which try to forecast the impact of individual biases on market prices and volume. We want to test whether this general stability assumption holds for individual investors. We therefore pick one of the most important biases in behavioral finance, the so called disposition effect.

The disposition effect describes investors' common tendency of quitting a winning investment too soon and holding on to losing investments too long (Shefrin and Statman (1985)). Prior literature has documented the disposition effect for various tasks and investor types, including individual as well as professional investors (See Odean (1998), Weber and Camerer (1998), Genesove and Meyer (2001), and Garvey and Murphy (2004) for evidence among individual stock market investors, student subjects in an individual choice experiment, house holders, and professional stock market investors respectively). As for most biases discussed in behavioral finance, it is still nevertheless unknown whether a subject's tendency of being affected by the disposition effect is actually a stable personality trait, or only temporary behavior strongly influenced by day-to-day changes in mental attitude or mood. By documenting evidence for stability in individual level disposition effects, our paper provides the basis for prior, as well as further research concerning individual differences in the disposition effect, its causes, its impact on market prices and volume, and possible counteractive measures.

Our paper aims to investigate individual differences, stability, and learning in the disposition effect. We try to answer the question of whether the disposition effect on the individual level is stable within one task, across different tasks, and across time. Our analysis is based on an experiment run at the University of Mannheim. We use an experiment because real data on the individual level for the same investor under different market regimes and especially across different tasks, i.e. stock investment and housing decisions, is hardly available. The experiment consists of two parts, which are separated by a four week interval to test for time stability. In each part of the experiment, subjects are confronted with two different individual choice tasks.

The individual choice tasks differ in multi dimension to capture a broad spectrum of how disposition effects might emerge. While the first task is similar to the stock market design of Weber and Camerer (1998), the second task is framed as a simple housing task. At the end of the second part our subjects also participate in an interactive group task, i.e. a market experiment.

For each of the three tasks we measure the extent to which a subject exhibits the disposition effect as the difference between proportions of winners and losers realized. We then test for stability within tasks, across tasks, and across time by correlating individual disposition effect measures across different rounds of the same task, different tasks, and different parts of the experiment respectively. Our results suggest that the disposition effect is indeed stable for all the tested dimensions, as long as there is no interaction between subjects. We also find that subjects learn within tasks as well as over time, with learning being most pronounced within the high disposition effect group.

The paper is structured as follows. In section 2 we review related literature concerning the disposition effect. We describe our hypotheses in section 3 and explain the experimental design for all tasks played in our experiment, as well as the procedure in section 4. Section 5 discusses our results and section 6 draws conclusion.

2 Related Literature

The term „disposition effect“ dates back to Shefrin and Statman (1985). Stock market investors exhibit the tendency to sell their winning stocks too early and hold on to their losing stocks too long. This behavior is typically explained by prospect theory (Kahneman and Tversky (1979) and Tversky and Kahneman (1992)) in combination with mental accounting (Thaler (1980, 1985)), using a stock’s purchase price as the reference point. Prospect theory argues that decision makers in general exhibit risk aversion after gains and risk seeking behavior following losses. In economic terms, they are more willing to sell if their mental account for a certain investment contains unrealized gains rather than if it contains unrealized losses. Since Shefrin and Statman (1985), the disposition effect has been replicated in a variety of different economic settings like stock markets, housing markets, or economic experiments; for different investor types, including individual investors as well as professionals; and for many different countries.

Heisler (1994) documents the disposition effect among small speculators in the U.S. treasury bond futures market. He shows that these investors hold trades with an initial paper loss significantly longer than trades that show an initial profit. Odean (1998) uses individual level discount broker data to uncover that individual stock market investors in the U.S. exhibit the disposition effect. He also shows that rational explanations like stock market mean reversion, portfolio rebalancing, or trading costs do not seem to drive the results. Odean's findings have been replicated for the Australian (Brown, Chappel, da Silva Rosa, and Walter (2003)), the Chinese (Chen, Kim, Nofsinger, and Rui (2004)), the Finnish (Grinblatt and Keloharju (2001)), and the Israeli stock market (Shapira and Venezia (2001)). These studies also test whether the disposition effect diminishes with increasing investment sophistication, using proxies like investment size, trading frequency, age, wealth, or professional occupation. Evidence on this issue, however, is mixed. While Brown et al. (2003), Grinblatt and Keloharju (2001), and Shapira and Venezia (2001) find that sophistication indeed weakens the disposition effect, Chen et al. (2004) find an opposite effect for the Chinese market.

While the studies mentioned above mainly investigate trading behavior of individual investors, there is another stream of literature which looks at behavioral biases among professional investors. Garvey and Murphy (2004) show that U.S. proprietary stock traders hold on to their losers too long and sell their winners too soon. Coval and Shumway (2005) investigate trading patterns of Chicago Board of Trade proprietary traders. They find that traders take above-average afternoon risk to recover from morning losses, a behavior related to the disposition effect. Disposition effects for professional future traders are documented by Frino, Johnstone, and Zheng (2004) as well as Locke and Onayev (2005). Contradicting evidence for institutional currency traders is documented by O'Connell and Teo (2003). Instead of exhibiting the disposition effect, institutional currency traders seem to reduce their risk aggressively in the wake of losses.

The disposition effect, however, does not only apply to real financial markets but can also be observed in different economic situations like housing markets or economic experiments. Genesove and Meyer (2001) find a disposition effect in the housing market in downtown Boston in the 1960s. Disposition effects in various kinds of experimental markets are documented in Oehler, Heilmann, Läger, and Oberländer (2002). Weber and Camerer (1998) investigate the disposition effect within an individual choice experiment and show that it is mainly driven by their subjects unwillingness to close a position at a loss. Once subjects are forced to close all their positions each trading period but given the opportunity to reopen these positions again, the effect weakens significantly. Chui (2001) replicates the study of Weber and Camerer (1998) and shows that the disposition effect is related to the psychological factor locus of control. Weber and Zuchel (2005) document that risk taking after gains and losses is highly affected by economic frames. When subjects are confronted with a stock market frame, they tend to exhibit the disposition effect. If the same decision is presented in a lottery frame, however, risk taking after gains exceeds risk taking following losses.

The question of whether the disposition effect is a stable bias, however, is mainly unanswered. To our knowledge, there is no study which compares individual level disposition effects across different settings, e.g. the stock and the housing market. In addition, it is quite unclear whether individual level disposition effects are stable within tasks, e.g. across different market regimes, and across time. Some evidence that the disposition effect might be time stable comes from Shumway and Wu (2005), who analyze individual account data from a Chinese brokerage firm. The authors document that individual investors' disposition effects measured with one year of data, forecast these investors' disposition effects in subsequent years. Note, however, that since investors are in the stock market for many years, they are continuously engaged in the same game. It would be desirable to let them alternatively clear their mental accounts and restart the game, thus having no unrealized gains or losses from previous rounds and less overlapping effects. This is exactly what we aim at with our experiment. Our experiment tries to fit the existing gap in the literature by investigating directly whether the disposition effect is stable within and across tasks, as well as across time. We also shed some light on whether and how learning attenuates individual investors' tendencies to exhibit the disposition effect.

3 Hypotheses

Our experiment aims to answer the question of whether the disposition effect on the individual level is a stable bias. For investigating this question it is, of course, inevitable that our subjects on average are affected by this bias and that we find individual differences in how far a subject is affected. Without variance in the distribution of individual disposition effects we are unable to distinguish among subjects. We therefore test the following two hypotheses for each experimental treatment:

Hypothesis 1: (Disposition effect on aggregate) Individual investors realize gains quicker than they realize losses.

Hypothesis 2: (Individual differences) There are individual differences in how far an investor is affected by the disposition effect.

In addition, as the disposition effect is a two-sided effect, it seems natural to investigate whether we can find symmetry. The question is whether investors who exhibit the disposition effect do so because they sell winners too early, losers too late, or both. We therefore test hypothesis 3:

Hypotheses 3: (Symmetry) Investors that exhibit the disposition effect tend to both sell their winners too early and their losers too late.

If we find a disposition effect within different treatments as well as individual differences in the degree to which a subject is affected by the bias, we are able to analyze whether subjects that exhibit a relatively strong disposition effect within one round of a task are also highly affected in other rounds of the same task, i.e. if the disposition effect is stable on a relative level within one task. We also test whether individual level disposition effects are correlated across different tasks. Furthermore, by repeating the experiment four weeks later, we are able to test for time stability. As we are interested in stability on the relative level, we assess the disposition effect as being time stable if investors belonging to the high disposition effect group in the first part of the experiment remain in the high disposition effect group in the second part of the experiment. Our stability hypotheses are therefore the following:

Hypothesis 4a: (Stability within tasks) Individual level disposition effects are correlated within tasks.

Hypothesis 4b: (Stability across tasks) Individual level disposition effects are correlated across different tasks.

Hypothesis 4c: (Stability across time) Individual level disposition effects are correlated across time.

Although individual level disposition effects might be time stable on a relative level in the way defined above, it might be that investors learn over time, thus lowering the disposition effect on aggregate. Learning might be induced by the fact that investors suffer from their bias in the way that it lowers their returns (Camerer (1990)). We apply hypothesis 5 to test for learning within tasks and over time:

Hypothesis 5: (Learning) Learning decreases disposition effects on aggregate.

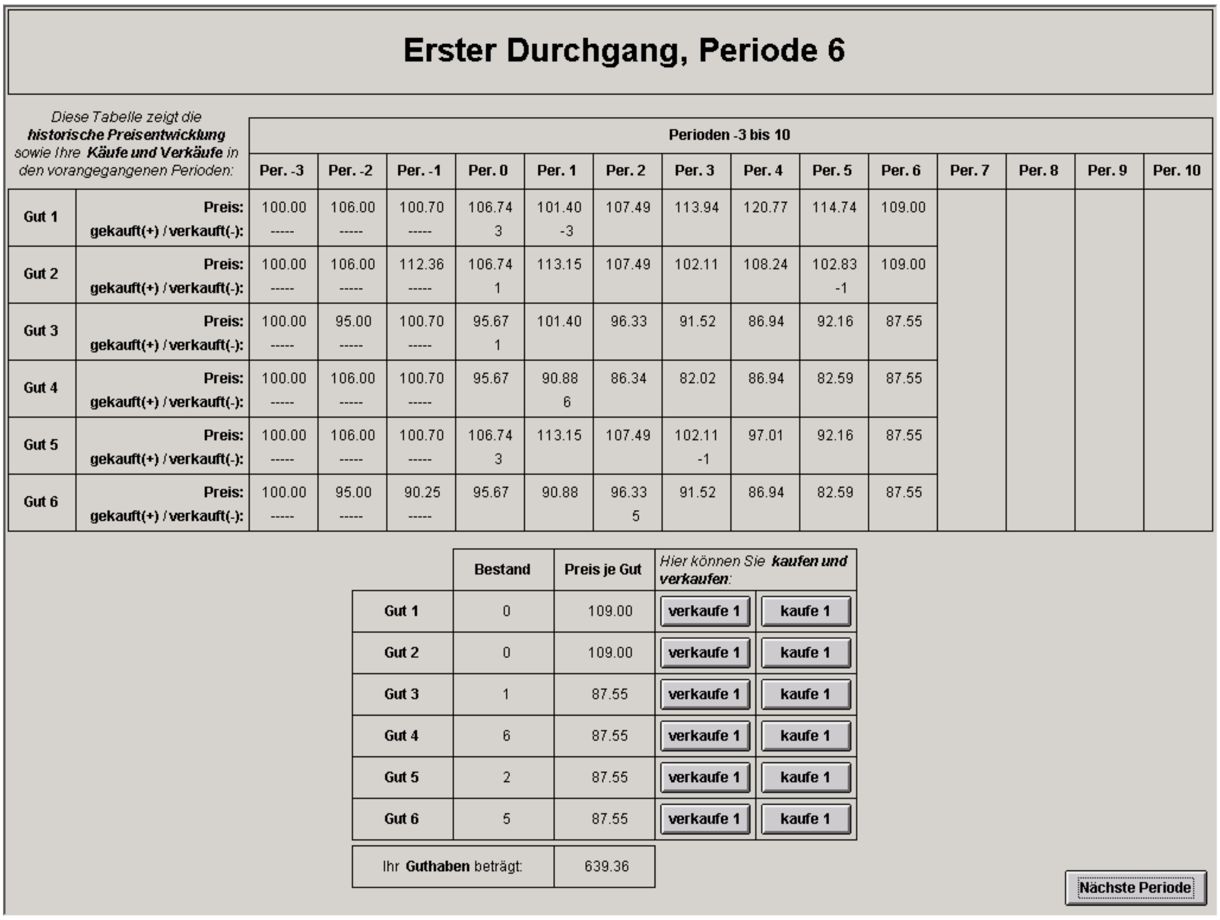
4 Experimental Design and Procedure

We measure individual level disposition effects using three different experimental designs. The designs are different in a multitude of dimensions to cover a broad spectrum of how disposition effects could emerge. The first and second designs are individual choice tasks. We measure individual level disposition effects both in a multiperiod investment task similar to Weber and Camerer (1998) and Weber and Welfens (2005) and a framed housing task. The third design is a market experiment and thus allows interaction between subjects. All tasks are conducted on the computer. In the following we explain these experimental designs as well as the experimental procedure in detail.

4.1 Individual Choice 1: Stock Market Design

The first treatment is an individual choice task. We call this treatment "Stock market design" because of its affinity to a stock market – although the terms "stock" and "market" are actually not used in the experiment to avoid framing effects. The treatment covers three rounds, with each round consisting of 14 periods numbered period -3 to 10. Our subjects trade in six different goods, labeled good 1 to 6. To make it easier to compare results across subjects, all subjects are faced with the same price paths, which means that price paths are fixed for each round of the treatment. We vary the order in which subjects pass through rounds 1 to 3 and the labels for the six goods in each round to avoid that subjects notice that they are all playing exactly the same game. The purpose of periods -3, -2, and -1 is only to provide price information, therefore our subjects are allowed to purchase and sell units of the six goods starting only at period zero. In period zero, our subjects get endowed with 2,000 units of experimental currency, but no units of any of the six goods. Over the following ten periods, i.e. period zero to 9, they can use their endowment to buy units of the six goods, and they can sell units, if they possess any. The only restrictions to our subjects' transactions are that their money account as well as the number of units held for each of the six goods have to remain non-negative. In period 10 the round ends and the subjects are informed about the final value of the six goods. Figure 1 shows the computer screen for this task.

Figure 1: Computer screen for stock market design



Erster Durchgang, Periode 6

Diese Tabelle zeigt die ***historische Preisentwicklung*** sowie Ihre ***Käufe und Verkäufe*** in den vorangegangenen Perioden:

		Perioden -3 bis 10													
		Per. -3	Per. -2	Per. -1	Per. 0	Per. 1	Per. 2	Per. 3	Per. 4	Per. 5	Per. 6	Per. 7	Per. 8	Per. 9	Per. 10
Gut 1	Preis:	100.00	106.00	100.70	106.74	101.40	107.49	113.94	120.77	114.74	109.00				
	gekauft(+) / verkauft(-):	-----	-----	-----	3	-3									
Gut 2	Preis:	100.00	106.00	112.36	106.74	113.15	107.49	102.11	108.24	102.83	109.00				
	gekauft(+) / verkauft(-):	-----	-----	-----	1					-1					
Gut 3	Preis:	100.00	95.00	100.70	95.67	101.40	96.33	91.52	86.94	92.16	87.55				
	gekauft(+) / verkauft(-):	-----	-----	-----	1										
Gut 4	Preis:	100.00	106.00	100.70	95.67	90.88	86.34	82.02	86.94	82.59	87.55				
	gekauft(+) / verkauft(-):	-----	-----	-----		6									
Gut 5	Preis:	100.00	106.00	100.70	106.74	113.15	107.49	102.11	97.01	92.16	87.55				
	gekauft(+) / verkauft(-):	-----	-----	-----	3			-1							
Gut 6	Preis:	100.00	95.00	90.25	95.67	90.88	96.33	91.52	86.94	82.59	87.55				
	gekauft(+) / verkauft(-):	-----	-----	-----			5								

	Bestand	Preis je Gut	*Hier können Sie **kaufen und verkaufen**:*	
Gut 1	0	109.00	verkaufe 1	kaufe 1
Gut 2	0	109.00	verkaufe 1	kaufe 1
Gut 3	1	87.55	verkaufe 1	kaufe 1
Gut 4	6	87.55	verkaufe 1	kaufe 1
Gut 5	2	87.55	verkaufe 1	kaufe 1
Gut 6	5	87.55	verkaufe 1	kaufe 1
Ihr **Guthaben** beträgt:	639.36			

Nächste Periode

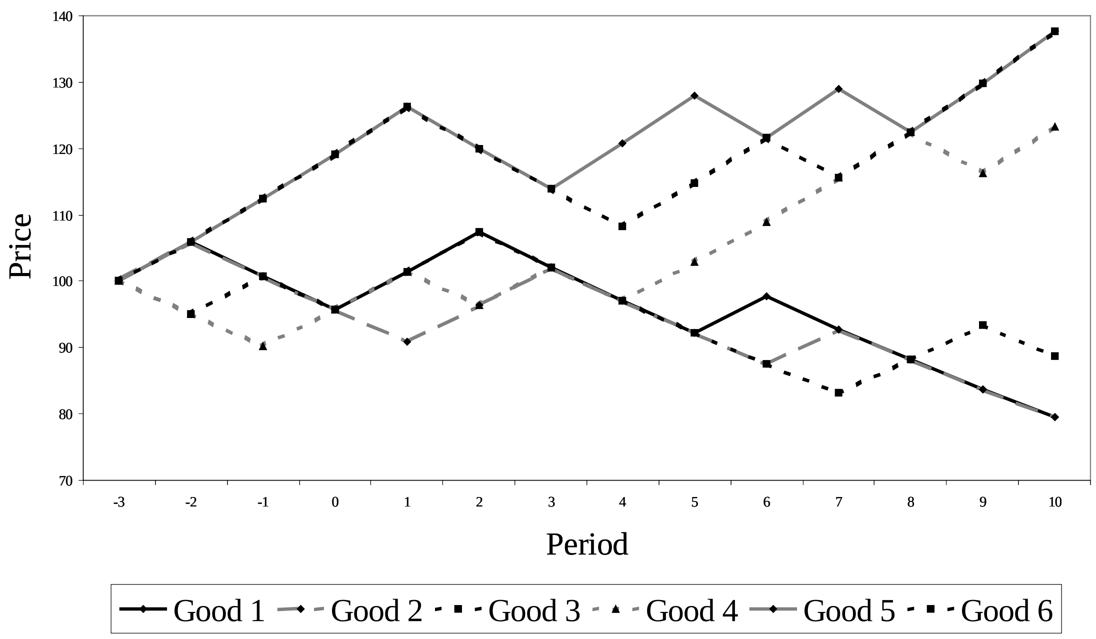
Every period, each of the six goods changes in value. Starting at 100 units of experimental currency, the price either increases by 6 % or decreases by 5 % while the probability with which a good increases in value is constant over the whole round. Price changes are independent from previous price changes of that good as well as current and previous price changes of all other goods. While subjects are informed how price changes are calculated and that probabilities are constant, they are not told what the probabilities for the six goods actually are. As they are not provided with a priory probabilities they cannot rely on simple Bayesian updating but have to deal with ambiguity. Probabilities are chosen to replicate three different kinds of market regimes: an upward moving market (round 1), a neutral (round 2), and a downward moving market (round 3). Table 1 gives an overview on probabilities used in the three different rounds for each of the six goods.

Table 1: Probabilities of price increases

	Round 1 (upward moving)	Round 2 (neutral)	Round 3 (downward moving)
Good 1	45 %	40 %	40 %
Good 2	50 %	45 %	40 %
Good 3	50 %	50 %	45 %
Good 4	55 %	50 %	50 %
Good 5	60 %	55 %	50 %
Good 6	60 %	60 %	55 %

Under the neutral market regime we have two goods exhibiting a negative trend, two goods set up to oscillate around the starting price of 100 units of experimental currency, and two goods with an upward moving trend. The upward and downward moving markets are similar to the neutral market but omit the one good that shows the worst or best price trend and exchange it with another good offering the same trend as the best or worst good respectively. As an example, figure 2 shows the price paths generated for round 1 of the first part of the experiment.

Figure 2: Price paths, first part, round 1



While our subjects are not informed about the real probabilities underlying the six goods, they could derive simple probability estimators by counting the number of times a certain good increased in value and dividing this measure by the number of periods played. A good that moved up in value more often than it decreased in value is likely to move up again while a good that decreased in value most of the time is likely to expect another price downturn. In period zero, subjects could assess the underlying probabilities by analyzing price changes between periods -3 to zero. In period 1, subjects should update these probability estimates based on the additional price change between period zero and 1.

Probability estimates thus change each period – and so should allocations. Depending on a subject's risk aversion, a variety of different strategies could be optimal. If a subject is risk neutral or risk averse, he or she should never buy or hold any units of a good with a current subjective probability estimate lower than 45.45 %.[2] Ignoring diversification effects, or assuming risk neutrality, a subject should always invest only in the highest priced good as long as its subjective probability estimate is high enough to satisfy his or her risk attitude.[3] If there are a couple of goods sharing the highest price, the subject should divide his endowment equally over these goods. Besides updating subjective probability estimates, an optimal strategy generally requires that a subject holds on to the goods that moved up in value and thus probably show unrealized gains, and to sell the goods that decreased in value and show unrealized losses. Hence, a disposition effect is a clear mistake under our design.

To determine a subject's payoff for this task, one round is chosen randomly. We calculate the subject's wealth at the end of period 10 as the sum of his or her money account and the current value of holdings in goods. Payoff equals 0.2 % of this sum.

4.2 Individual Choice 2: Housing Design

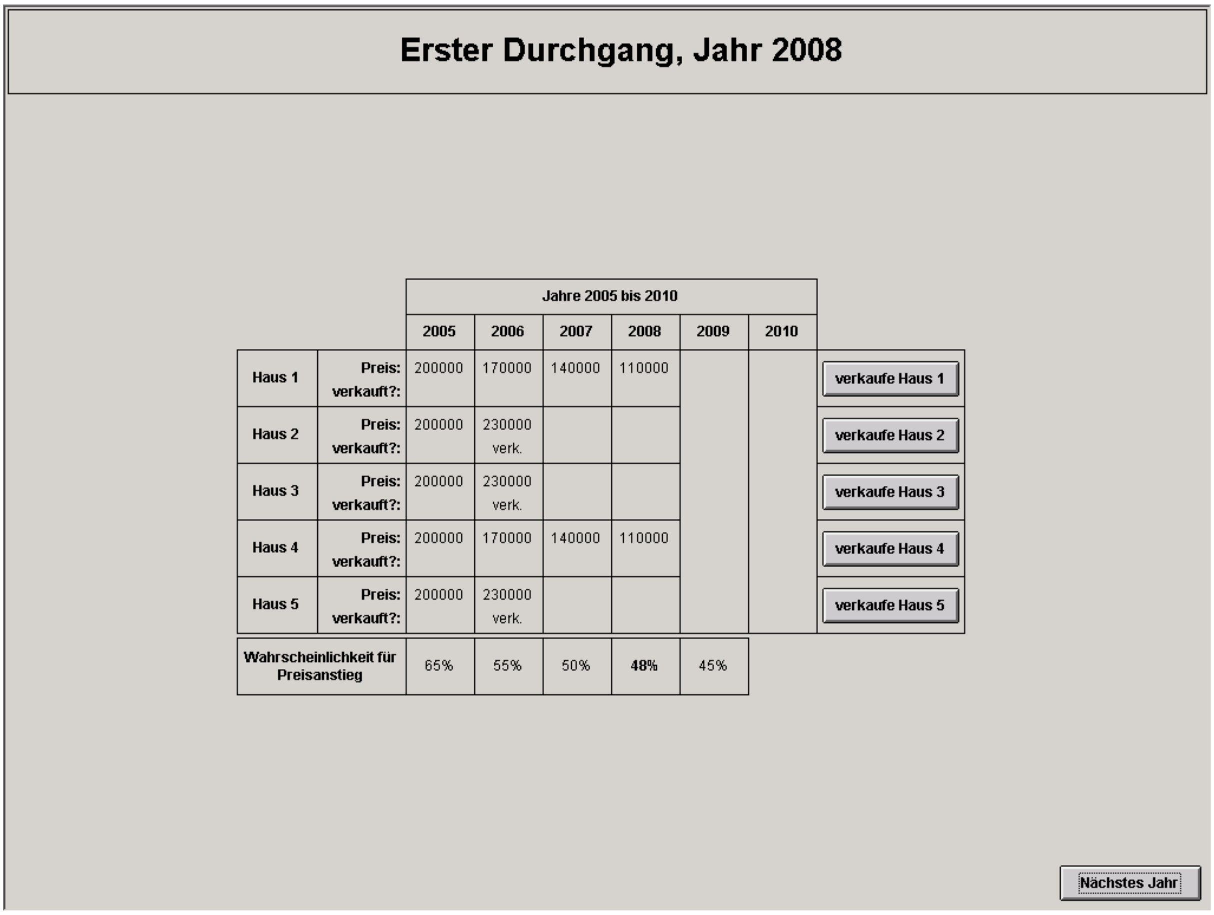
The second individual choice task, which we call "housing design", is distinct from the first one in a multitude of dimensions. While we try to avoid framing in the stock market treatment, our housing treatment is based on a real life background story. Subjects might compare the first individual choice task to a stock or commodity market. The background story for the second individual choice task is designed to replicate another aspect of every day life decision making, i.e. housing decisions. Another difference is that in our housing treatment, subjects only need to decide when to sell, while in the stock market treatment both purchasing and selling decisions have to be made. In addition, our second individual choice task does not rely on probability updating so that rational strategies are more easy to discover and implement. As the housing treatment is less time consuming than the stock market treatment, we play a total of six

[2] If the probability estimate is 45.45 % the expected price change is just $0.4545 \cdot 0.06 + 0.5454 \cdot -0.05 = 0$

[3] Although a subject might diversify by holding a portfolio of different goods, diversification is costly under our design as it means that a subject needs to hold units of a good which has a lower probability for further price increases than the best good in the market.

rounds. Price paths are again the same for all subjects, and the order in which subjects pass through rounds 1 to 6 as well as the house labels are again randomly assigned. Figure 3 shows the computer screen of the treatment.

Figure 3: Computer screen for housing design



Our subjects are told that they just inherited five different houses from a remote relative. They want neither to inhabit these houses on their own nor rent them to other people but want to sell them during the next five years, i.e. from 2005 until 2010. Hence, they need to decide each year if and which houses they want to sell. Once a house is sold, the subject can never repurchase it, and houses which are not sold in 2009 are sold automatically in 2010 for their current price. The current market value of each of the five houses is 200,000 € in 2005. In subsequent years each house price either increases or decreases by 30,000 €. Subjects are told that price changes are independent from previous price changes and – as all houses are situated in different residential areas – price changes are independent across houses. They are also informed that probabilities for price increases and decreases are equal for all houses but abate over time. If a subject decides not to sell a house in 2005, it increases in value with a probability of 65 %. In

2006, this probability decreases to 55 %, while it drops to 50 %, 48 %, and 45 % over the years 2007 to 2009. Table 2 gives a summary on the probabilities used.

Table 2: Probabilities of price increases over periods

2005	2006	2007	2008	2009
65 %	55 %	50 %	48 %	45 %

From a normative point of view, the game can be split up in a sequence of lotteries, which offer either a gain or a loss of both 30,000 €. Similar to the stock market treatment, optimal strategies depend on risk aversion. While almost all subjects should be willing to play the first lottery, which offers a 65 % chance of winning, a risk neutral subject should quit the lottery sequence 2007 or 2008. Holding a house longer than 2008 can – from a normative point of view – only be explained by risk prone attitudes, i.e. convex utility functions.[4] Note that unrealized gains and losses, which are building blocks of the disposition effect, do not affect – or by changing current wealth only marginally affect – rational strategies in this treatment. Subjects should sell their houses regardless of their current price, since the lottery is the same for every price level. Exhibiting the disposition effect in this task becomes costly if a subject sells a winner too early and thus misses lotteries with high probabilities of winning, or holds on to losers too long and thus accepts lotteries which he or she normally would refuse to play, e.g. lotteries with negative expected payoffs.

We determine a subject’s payoff for this task by choosing randomly one of the six rounds and calculating total revenues. Payoff equals 0.0002 % of this sum.

4.3 Market Experiment

Unlike the other treatments, the third task is based on interaction between subjects. We apply a market experiment to investigate whether subjects that exhibit the disposition effect in individual choice tasks are affected to a similar extend when interaction between subjects allows information aggregation and learning. The experiment consists of four rounds.[5] In each round,

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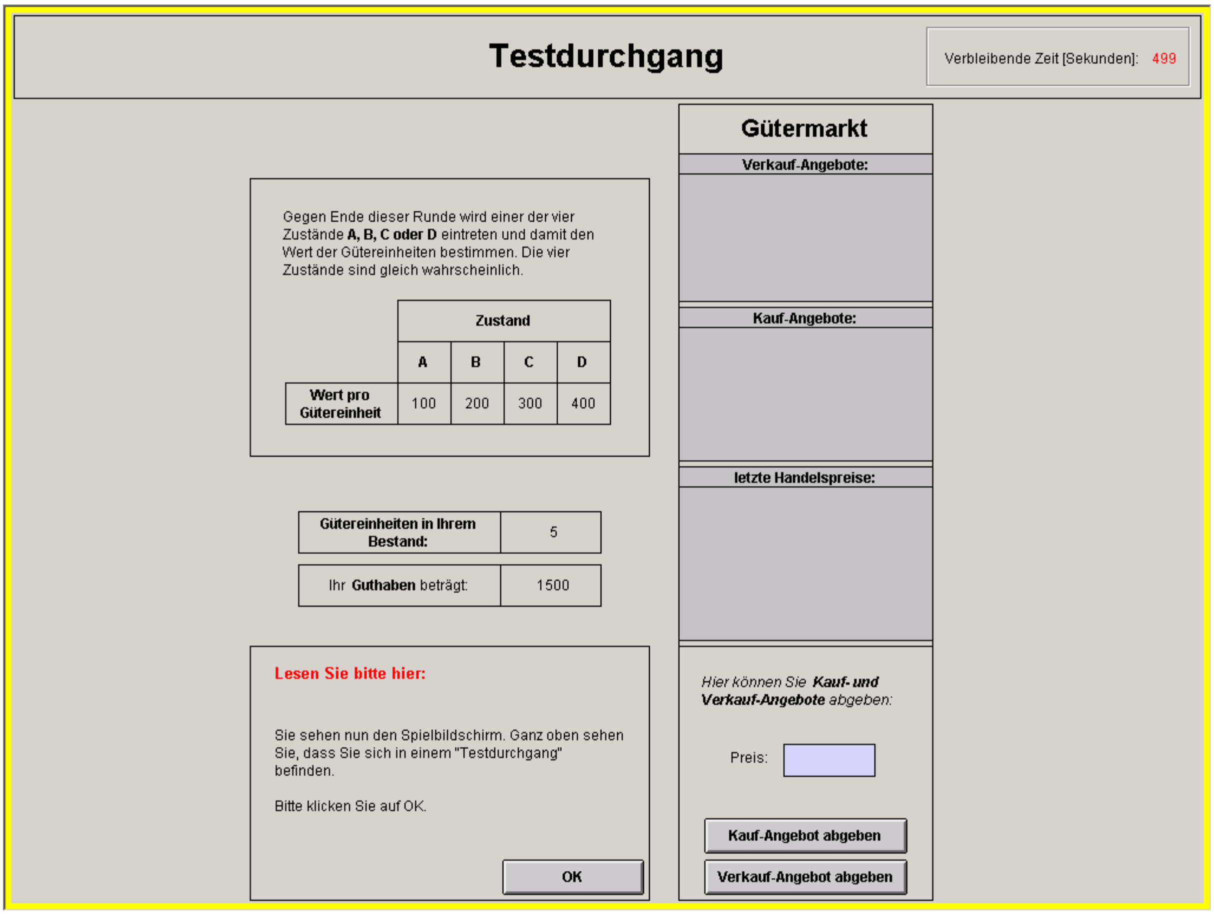
4 If we assume that subjects evaluate lotteries with an x^{α} utility function all subjects should play at least the first two lotteries. Only risk neutral (α=1) and risk prone (α>1) subjects should play the third lottery while extremely risk prone subjects (α>1.3 and α>1.53) are – depending on the current house price – even willing to play the fourth (fifth) one.

5 Actually, the experiment lasts over ten rounds. Rounds 5 to 10, however, are modified to investigate the effect of individual level disposition effects on prices and volume and are thus not applied to the current research question.

subjects in the laboratory are randomly split up into two groups of equal size with the number of subjects per group varying between 8 and 10. These groups form two separate single good markets. At the beginning of the round each player obtains 5 units of the single good and 1,500 units of experimental currency. During the market experiment, subjects are allowed to trade with other subjects in the same market. Figure 4 shows the computer screen.

Figure 4: Computer screen for housing design



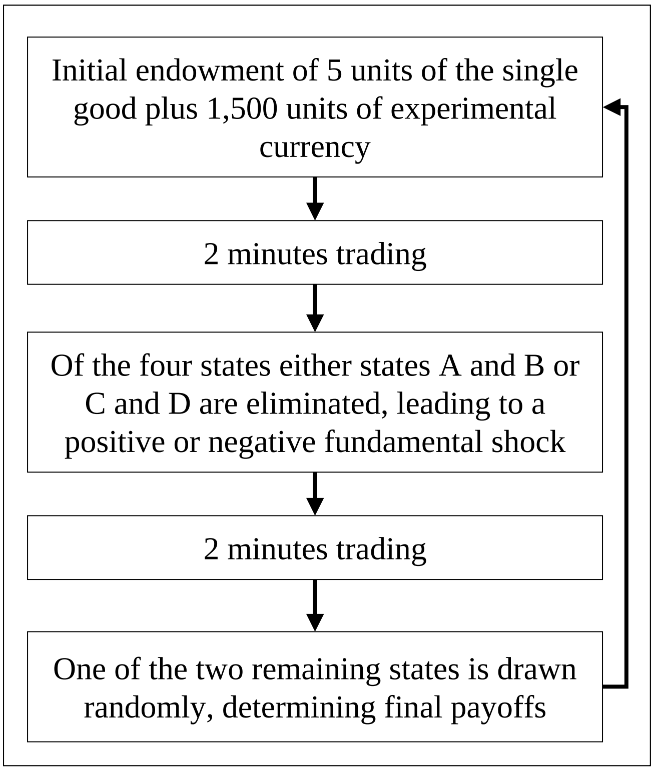
Each unit of the single good is worth a certain amount of money at the end of the round. The exact value is state dependent. Hence, holding units of the single good is a risky investment. At the beginning of the round, four different states are possible: A, B, C, and D. If at the end of the round state A applies, each unit of the single good is worth 100 units of experimental currency. States B, C, and D result in a final value of 200, 300, and 400 units of experimental currency respectively. Probabilities for each of the four states are equal and thus 25 %. Moreover, the state drawn in one round is independent from states drawn in all other rounds. Table 3 summarizes payoffs across states.

Table 3: State dependent value of the single good

State A	State B	State C	State D
100	200	300	400

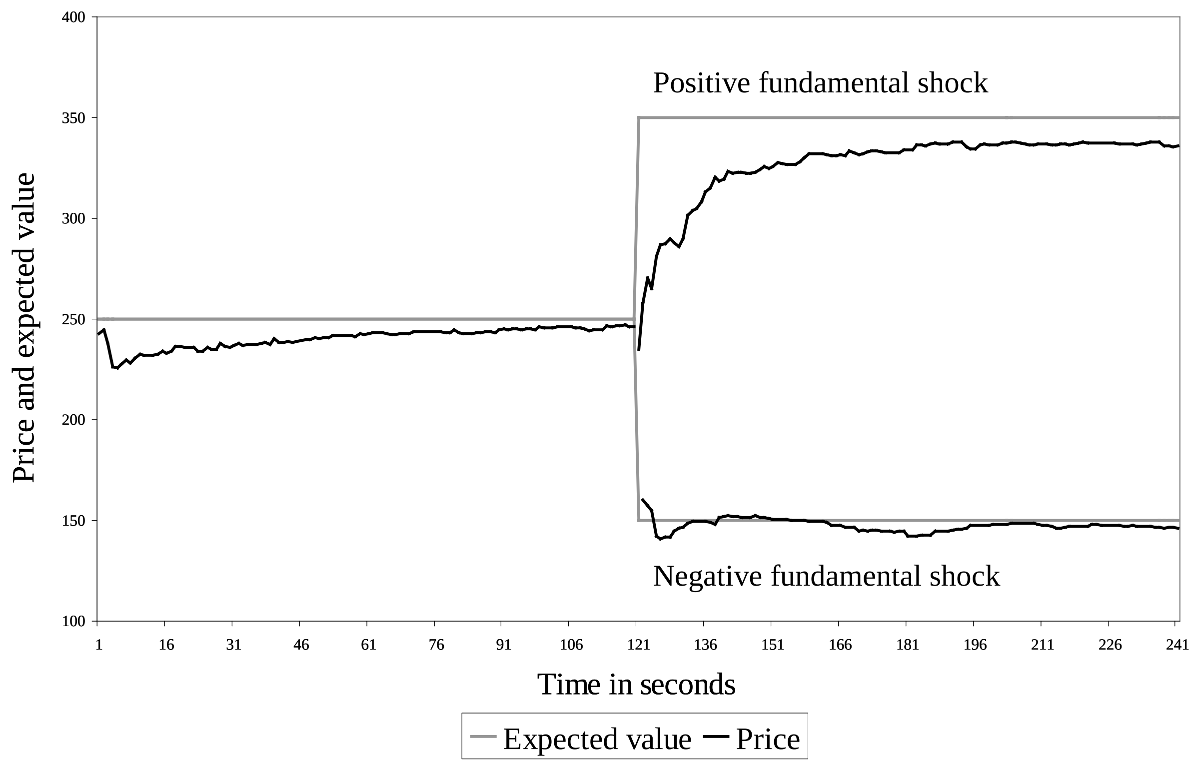
Every round is arranged as follows: In a first step, subjects are informed about the beginning of the next round and their initial endowment. Ensuing, they have two minutes to trade with each other in a single unit open book double auction market. Purchase orders only enter the book if a subject is able to pay the price specified in his or her order without moving his or her money account into debt. Selling orders require that the subject currently owns at least one unit of the single good. The market is cleared automatically, and the transaction price always equals the price specified in the senior order. Transaction prices are shown to all participants in the market. After two minutes, trading is interrupted and subjects are confronted with new information concerning the final value of the good. Therefore, two of the four possible states A, B, C, and D are automatically eliminated by random. We either eliminate states A and B or states C and D, leading to a positive or negative shock in fundamental value. The two remaining states remain equally likely. Subsequent to this new information trading continues for an additional two minutes. At the end of the round, subjects are informed about the true state and the final value of the single good. Figure 5 shows the course of the market experiment.

Figure 5: Course of the market experiment



From a rational point of view, subjects should only trade because of different degrees of risk aversion. Highly risk averse subjects might decide to sell some, or even all of their units to less risk averse market participants. Risk aversion on the whole should thus be reflected in market prices, leading to equilibrium prices that are lower than the expected value. Subjects might, in addition, decide to react to new information on the states and resulting income or substitution effects by reallocating their portfolios. However, as all subjects have to base their decisions on the same information, and a unit of the single good is worth the same to all subjects, there is no alternative rational explanation for volume. Assuming risk neutrality, for example, leads to a no-trade equilibrium. Figure 6 shows aggregated price paths following positive and negative fundamental shocks.

Figure 6: Aggregated price paths in the market experiment

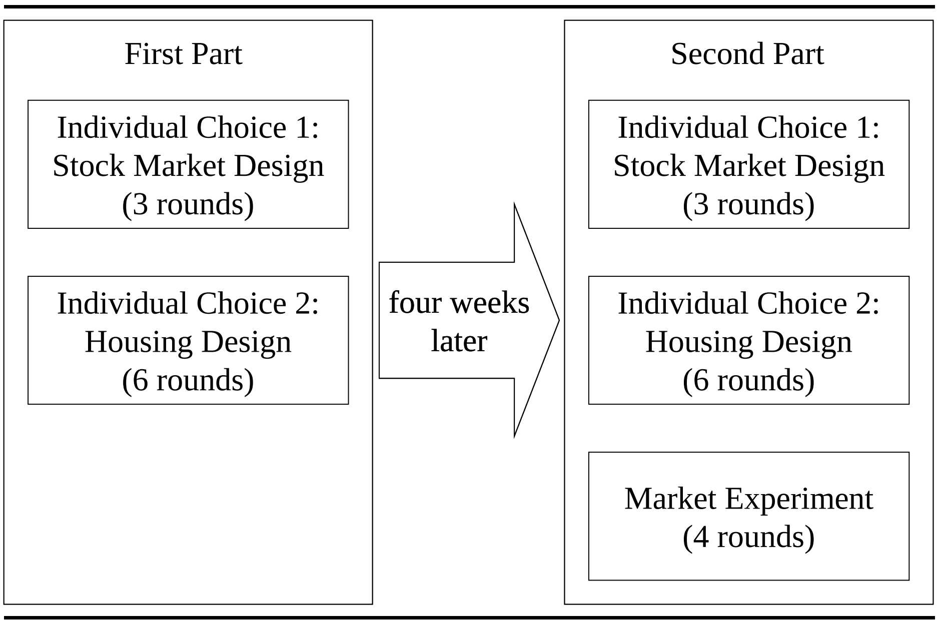


We determine a subject's payoff for this task by choosing one round randomly. Payoff equals 0.3 % of final wealth, which in turn consists of a subject's money account at the end of the round, plus the final value of the single good multiplied with the number of units held by this subject.

4.4 *Procedure*

The experiment was conducted in May and June 2005 at the University of Mannheim and consisted of two parts. The first part of the experiment took place on May 17 – 19, the second part four weeks later on June 13 – 17. We chose a four week interval between the first and the second part for testing time stability. The first part included the stock market treatment and the housing treatment. In the second part, subjects again participated in the stock market and the housing treatment – both with new price paths, of course. 75 of 113 subjects also participated in the market experiment, which was run in 4 sessions with 17, 18, 20 and 20 subjects. After the first part of the experiment subjects were not told that they were going to replay the stock market and the housing design. The market experiment was played at the very end to make sure that interactive learning does not bias the individual choice tasks. Figure 7 summarizes the schedule of the experiment.

Figure 7: Schedule of the experiment



Our analysis is based on 78 male and 35 female students which participated in both parts of the experiment. We exclude twelve subjects who only participated in the first part of the experiment so that there might be a selection bias. Approximately half of all subjects studied economics and business administration, while the other half's fields of study were not related to economics, like computer science, sociology or law. The average age was 24, the average academic year was 3.2. The experiment was run in a computer laboratory using the experimental software zTree. To make sure that everyone understood the rules and computer screens, subjects had to go through a short tutorial for each individual choice task, as well as for the market experiment. The average processing time was approximately 50 minutes for the first part and 110 minutes for the second part of the experiment. The average payoffs were 12.32 € in the individual choice tasks and 8.24 € in the market experiment, with standard deviations of 0.40 € and 0.85 € respectively. The entire experiment was held in German. A translation of the instructions for both individual choice experiments and the market experiment can be found in the appendix.

5 Results

5.1 Definition of Variables

We measure individual level disposition effects in both individual choice treatments and the market experiment by comparing selling behavior following gains and following losses. For simplicity and to better compare different treatments we calculate individual disposition effects based on the number of times a subject sells at gains or losses. Results are nevertheless unchanged if we base individual disposition effects on the amounts realized. Instead of only counting how many times a subject sells for a gain or loss, we relate actual sales to selling opportunities as done by Odean (1998). We do so to make sure that not a lack of selling opportunities drives our results. Proportions of winners realized (PWR) and proportions of losers realized (PLR) are calculated the following way:

(1) $$\text{PWR} = \frac{\#\text{of sales at gain}}{\#\text{of selling opportunities at gain}}$$

(2) $$\text{PLR} = \frac{\#\text{of sales at loss}}{\#\text{of selling opportunities at loss}}$$

The Individual level disposition effect is just the difference between these two variables and is thus calculated as

(3) $$\text{DE} = \text{PWR} - \text{PLR}\ .$$

DE measures vary between –1 and 1. Subjects with a measure of 1 quit an investment every time it contains an unrealized gain, while they never quit investments with unrealized losses. Hence, they exhibit the strongest possible disposition effect. The opposite is true for subjects with a DE measure of –1. A measure of zero means that the subject does not seem to base his or her selling decisions on unrealized gains and losses.

In the stock market treatment, we derive individual level disposition effects by analyzing our subjects' selling behavior through periods 1 to 9. In Period zero, our subjects do not own any units of the six goods, so there are no selling opportunities. As period 10 is the last period of the round, subjects are not allowed to trade any more. For each round and each period 1 to 9, we count the number of selling opportunities at gains and losses. We apply the weighted average purchase price as a reference point, counting a selling opportunity at a gain (loss) whenever a subject owns at least one unit of the considered good and the price of the good is above (below) the average purchase price. Whenever a subject decides to sell one or more units of the good, we count a sale at a gain or at a loss respectively. Note that following a rational strategy in most rounds requires selling more often at a loss than at a gain, which results in low or most of the time even negative DE measures.[6]

In the housing treatment, we measure our subjects' disposition effects over the years 2006 to 2009. In 2005 our subjects do not face any gains or losses, while in 2010 the round ends and all houses are sold automatically. Each round and each year from 2006 to 2009 we check whether houses 1 to 5 are still in the subject's possession and whether their prices are below or above the starting price. We count a selling opportunity at a gain (loss) whenever the house is still in the subject's possession and its value is above (below) 200.000 €. If the subject actually decides to sell the house, we count a sale at a gain or loss respectively. As in the stock market treatment, a rational strategy normally leads to negative DE measures.

As in the market experiment, the number of selling opportunities strongly depends on the price the subject is willing to trade at, we need to apply a different procedure for measuring individual level disposition effects. We therefore count the number of times a subject sells at a gain (loss) following a positive (negative) fundamental shock. We make sure that these transactions could be driven by both counterparties' disposition effects by eliminating all transactions at prices above (below) expected value following a positive (negative) shock. The procedure is based on the model of Grinblatt and Han (2005). Following this model, transaction prices in a market consisting of rational and disposition investors should underreact to changes in fundamental value. Although differences in risk aversion might lead to trade between subjects we believe that subjects manage to generate their individual risk profile in the first half of the trading period, i.e. before the fundamental shock. Trades after the fundamental shock should thus be caused by differences in wealth or substitution effects or – in our point of view much more important – by differences in individual level disposition effects. AWR describes the average number of winners realized, ALR the average number of losers realized. Individual DE measures are derived as the difference between AWR and ALR. Note that at the rational, risk neutral no-trade equilibrium, all DE measures should be zero.

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[6] DE measures resulting from a simple heuristic strategy are provided in section 5.2.

5.2 Disposition Effect on Aggregate

We test whether subjects in our experimental treatments exhibit the disposition effect, i.e. hypothesis 1. Therefore, we compare the distribution of individual DE measures with two different benchmarks: If subjects are unaffected by unrealized gains and losses and apply a random trade strategy, we expect an average DE measure of zero in all treatments. If subjects, on the other hand, follow a rational strategy, we expect low and most of the time even negative DE measures.[7, 8] Table 4 shows mean PWR, PLR, and DE measures for each round of each of the individual choice treatments as well as AWR, ALR, and DE measures for the market experiment. In addition, the column "Rational DE" gives DE measures which would arise from a simple heuristic strategy where a subject always holds the good with the highest price in the stock market treatment or sells all his houses in the year 2008 in the housing treatment. We apply t-tests for comparing mean DE measures with both the zero DE benchmark as well as the simple heuristic strategy. P-values are documented in the right hand columns of table 4.

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7 Sometimes it can be rational to sell a good with unrealized capital gains. This is the case if during a round another good catches up in price and is now as likely to increase in value as the good the subject already possesses. If this is the case the subject should sell some of the units of the good he already possesses and buy units of the other good to decrease his portfolio risk.

8 As this strategy underlies strong assumptions concerning our subjects' rationality, their mathematical capabilities, and their risk attitudes, and in addition, is strongly path dependent, we do not want to put too much weight on this benchmark. As our subjects' trading behavior is obviously not driven by rational considerations, we believe that the zero benchmark is a much better comparison.

Table 4: Disposition effect

Part	Treatment	Round	Mean PWR (AWR)	Mean PLR (ALR)	Mean DE	Rational DE	p (zero)	p (rational)
First	Stocks	1	0.39	0.12	0.27	-0.49	0.0000	0.0000
		2	0.35	0.14	0.21	-1.00	0.0000	0.0000
		3	0.40	0.17	0.24	0.18	0.0000	0.0294
	Housing	1	0.52	0.23	0.30	-0.06	0.0000	0.0000
		2	0.46	0.21	0.25	-0.21	0.0000	0.0000
		3	0.49	0.17	0.32	-0.33	0.0000	0.0000
		4	0.42	0.22	0.20	-0.50	0.0000	0.0000
		5	0.53	0.23	0.31	0.00	0.0000	0.0000
		6	0.51	0.29	0.22	0.00	0.0000	0.0000
Second	Stocks	1	0.30	0.26	0.04	-0.83	0.1613	0.0000
		2	0.27	0.18	0.10	0.00	0.0007	0.0007
		3	0.31	0.20	0.12	-0.50	0.0010	0.0000
	Housing	1	0.44	0.23	0.21	-0.03	0.0000	0.0000
		2	0.44	0.33	0.10	-0.03	0.0057	0.0006
		3	0.18	0.25	-0.08	-0.56	0.0217	0.0000
		4	0.42	0.22	0.20	-0.31	0.0000	0.0000
		5	0.41	0.30	0.12	-0.33	0.0052	0.0000
		6	0.50	0.25	0.26	0.15	0.0000	0.0046
	Market	1–4	1.39	0.46	0.92	0.00	0.0000	0.0000

Table 4 provides strong evidence of a disposition effect. In all tasks and all rounds – except one – subjects sell their winners more frequently than their losers.[9] Subjects use their selling opportunities in the stock market treatment following gains nearly twice as often as they use their selling opportunities following losses. They also sell their houses in the housing treatment nearly twice as often if the house price exceeds the starting price of 200.000 € rather than if its below the starting price. In the market experiment, subjects sell an average number of 1.39 units following a price increase, while they sell only 0.46 units following a price decrease. All DE measures – except the first round of the stock market treatment and the third round of the housing treatment in the second part of the experiment – are significantly higher than zero. These

[9] In the third round of the housing treatment in the second part of the experiment the average DE measure is significantly negative. In addition, the average DE measure in the first round of the stock market treatment is non significant from zero. In both rounds, however, the simple heuristic strategy would lead to extremely low DE measures.

exceptional rounds, however, also lead to extremely small DE measures if the simple heuristic strategy is applied. Compared to this benchmark, all DE measures are significant. Note that by exhibiting the disposition effect, our subjects leave money on the table.[10]

We find it worthwhile to report that there are significant gender effects in our data set. Table 5 therefore shows aggregated DE, PWR (AWR), and PLR (ALR) measures for women and men separately for each part and task of the experiment. Since DE measures for subsamples are not all normally distributed we compare DE measures of women and men with a Wilcoxon ranksum test. P-values are given in the right hand column.

Table 5: Gender effects

		Men			Women			
Part	Treatment	Mean PWR (AWR)	Mean PLR (ALR)	Mean DE	Mean PWR (AWR)	Mean PLR (ALR)	Mean DE	p
First	Stocks	0.33	0.13	0.20	0.48	0.17	0.32	0.0497
	Housing	0.45	0.21	0.24	0.50	0.17	0.33	0.1596
Second	Stocks	0.24	0.23	0.01	0.36	0.17	0.19	0.0043
	Housing	0.36	0.25	0.10	0.48	0.22	0.26	0.0012
	Market	1.27	0.47	0.80	1.58	0.45	1.13	0.3789

Women in our experiment exhibit larger disposition effects than do men. They realize their winners much faster and hold on to their losers a bit longer. Differences in DE measures are significant for all individual choice treatments except the housing treatment in the first part of the experiment. The same if true for PWR measures while we find no significant differences for PLR measures. One interpretation of these effects might be that men are more sophisticated in financial concerns and are thus better able to control and fight their individual biases. However, regressions controlling for different aspects of financial sophistication (including age, kind of studies, length of studies, apprenticeships, points in a knowledge test on financial topics, self-reported interest on financial topics, and a dummy for subjects that invest in stocks in real life) still show the above reported gender effects. One should therefore question whether these effects are only driven by financial sophistication as reported in the literature (See e.g. Brown et al. (2003), Chen et al. (2004), Grinblatt and Keloharju (2001), and Shapira and Venezia (2001)).

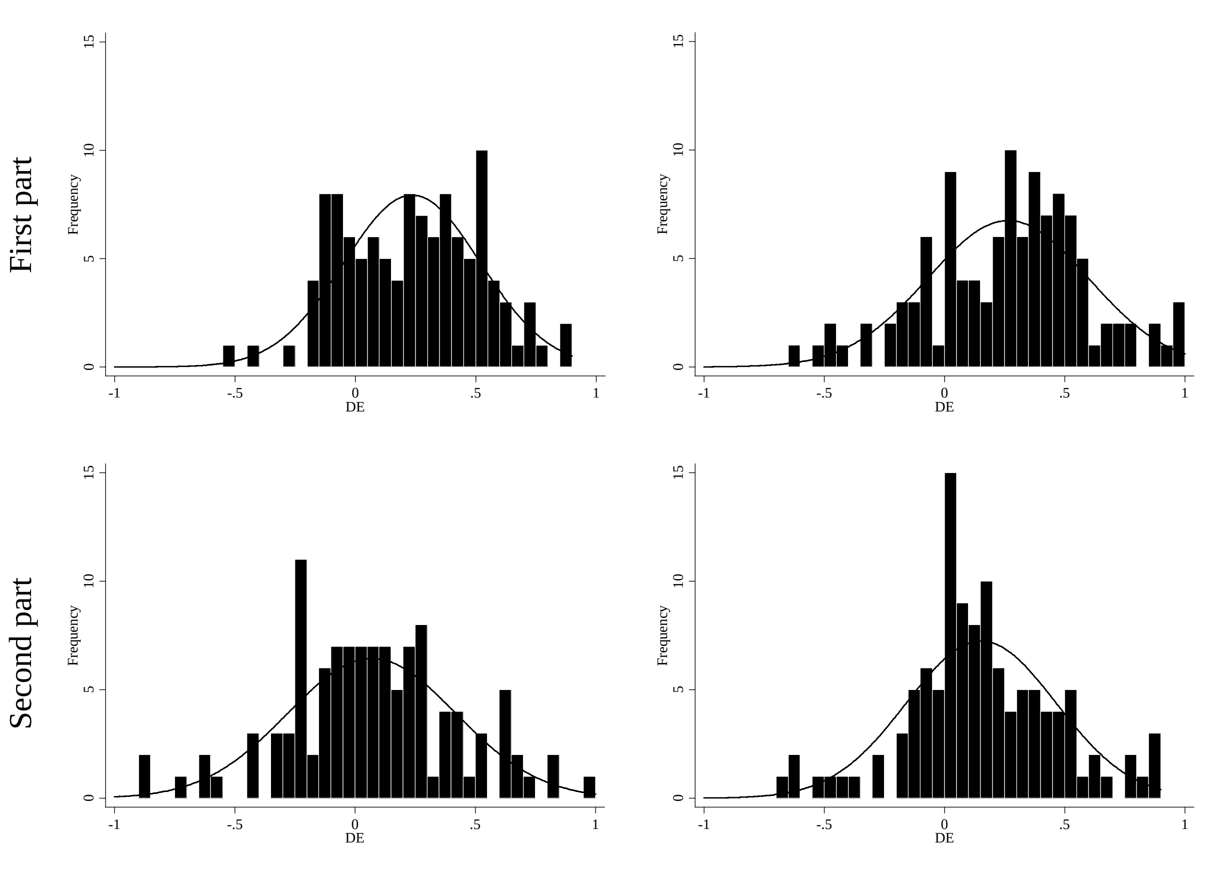
[10] The strategies our subjects play in their individual choice tasks lead to an average payoff of 12.32 €, compared to a payoff of 13.28 € if the simple heuristic strategy was applied.

5.3 *Individual Differences and Symmetry*

As documented in section 5.2, we find strong evidence of a disposition effect on aggregate. The effect, however, does not seem to affect all subjects to the same extend. In favor with hypothesis 2 we find instead strong individual differences concerning how far a subject is influenced by this bias. Figures 8, 9, and 10 show the distributions of DE, PWR, and PLR measures for the two individual choice tasks and both parts of the experiment.

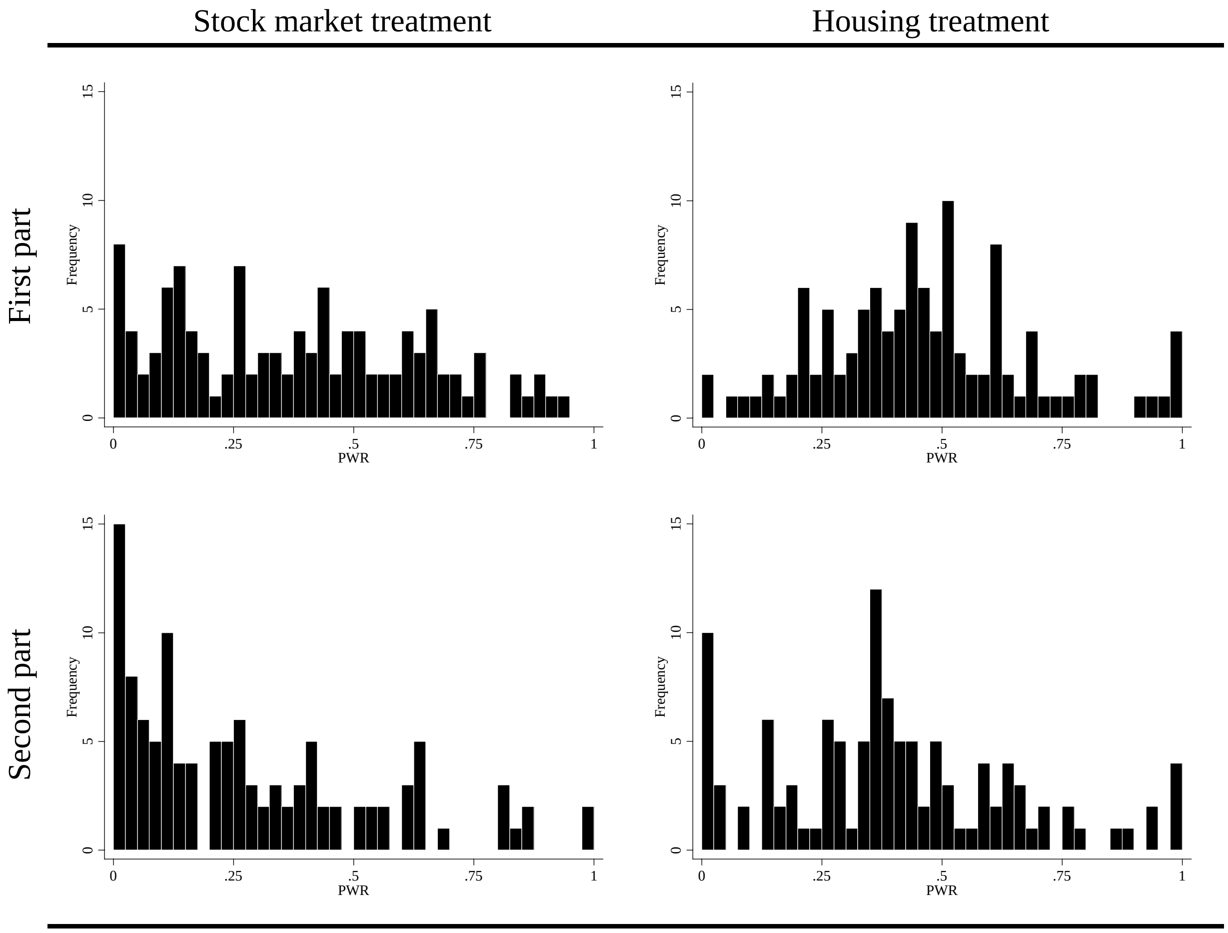
Figure 8: Distributions of DE measures within individual choice tasks

Stock market treatment | Housing treatment



Distributions of individual level DE measures share a couple of similarities. All distributions show positive means as well as medians with means (medians) of 0.24 (0.24) and 0.07 (0.06) in the first and second part of the stock market treatment as well as 0.26 (0.29) and 0.15 (0.12) in the first and second part of the housing design. Standard deviations are 0.28 and 0.35 in the first and second part of the stock market treatment as well as 0.33 and 0.31 in the second individual choice task. Although subjects, on average, exhibit the disposition effect, we find many subjects acting exactly opposite to this bias. Under the first individual choice task 30 and 24 of the total of 113 subjects show DE measures smaller or equal to zero. Under the second treatment, 50 and 33 of 113 subjects act this way.

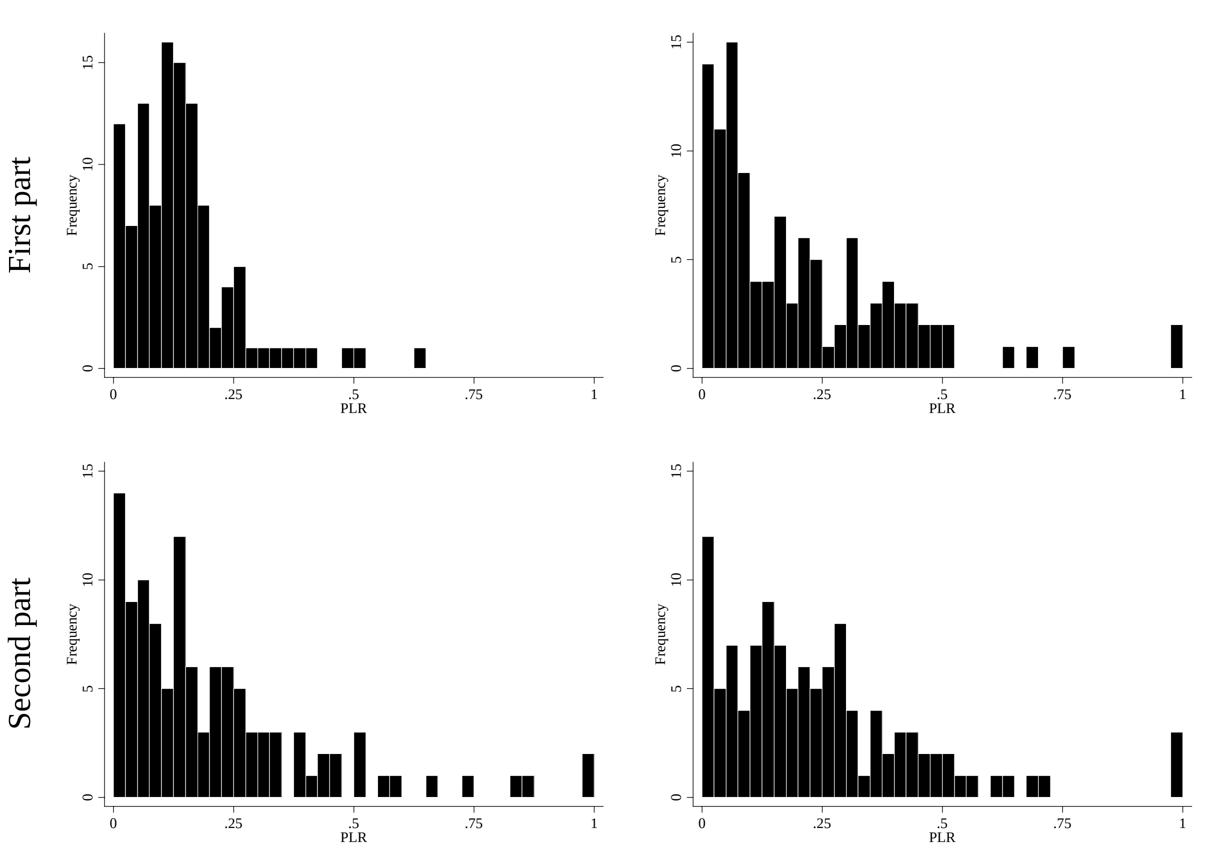
Figure 9: Distributions of PWR measures within individual choice tasks



PWR measures vary to a similar extent – although they are obviously not normally distributed. Mean (median) PWR measures are 0.38 (0.37) and 0.28 (0.22) for the first as well as 0.46 (0.44) and 0.40 (0.37) for the second individual choice treatment. Standard deviations again vary only insignificantly with 0.26, 0.25, 0.22, and 0.25 in the first and second part of the first and second task. The distributions document quite strongly that subjects react differently given unrealized gains. While some subjects never sell their winners and thus exhibit PWR measures of zero, other subjects sell their winners whenever they have an opportunity to do so, resulting in PWR measures of one.

Figure 10: Distributions of PLR measures within individual choice tasks

Stock market treatment | Housing treatment



Compared to PWR measures, distributions of PLR measures put more weight on the left hand side of the scale, leading to lower means and medians. Mean (median) PLR measures are 0.14 (0.12) and 0.21 (0.14) for the first and second part of the stock market treatment, while we get measures of 0.20 (0.15) and 0.24 (0.20) for the first and second part of the housing design. Standard deviations of PLR measures vary between 0.11 for the first part of the stock market treatment and 0.21, 0.22, and 0.21 for the second part of the stock market design, as well as for the first and second part of the housing treatment. While almost all subjects avoid selling for a loss, it is striking that some subjects do not sell for a loss at all during the entire treatment and thus show the strongest possible degree of loss realization aversion.

We find strong similarities when comparing these results with DE, AWR, and ALR measures of the market experiment. Individual DE measures in the market experiment group around a mean (median) of 0.92 (0.67) with a standard deviation of 1.55. While subjects sell an average (median) number of 1.39 (1.00) units following a gain, they only sell 0.46 (0.00) units following a loss. We again observe strong differences in our subjects' attitudes concerning selling for a gain and a common sense across subjects that selling for a loss is not acceptable. It is quite astonishing that of 75 subjects in the market experiment the majority, i.e. 41 subjects, refuse to sell at a loss at all and thus exhibit AWR measures of zero.

When comparing distributions of PWR and PLR measures, one gets the idea that holding on to losers too long is more common among subjects than selling winners too soon. We test this hypothesis using a robust Levene tests for the equality of variances.[11] Table 6 shows the results.

Table 6: Tests for the equality of variances between PWR and PLR measures

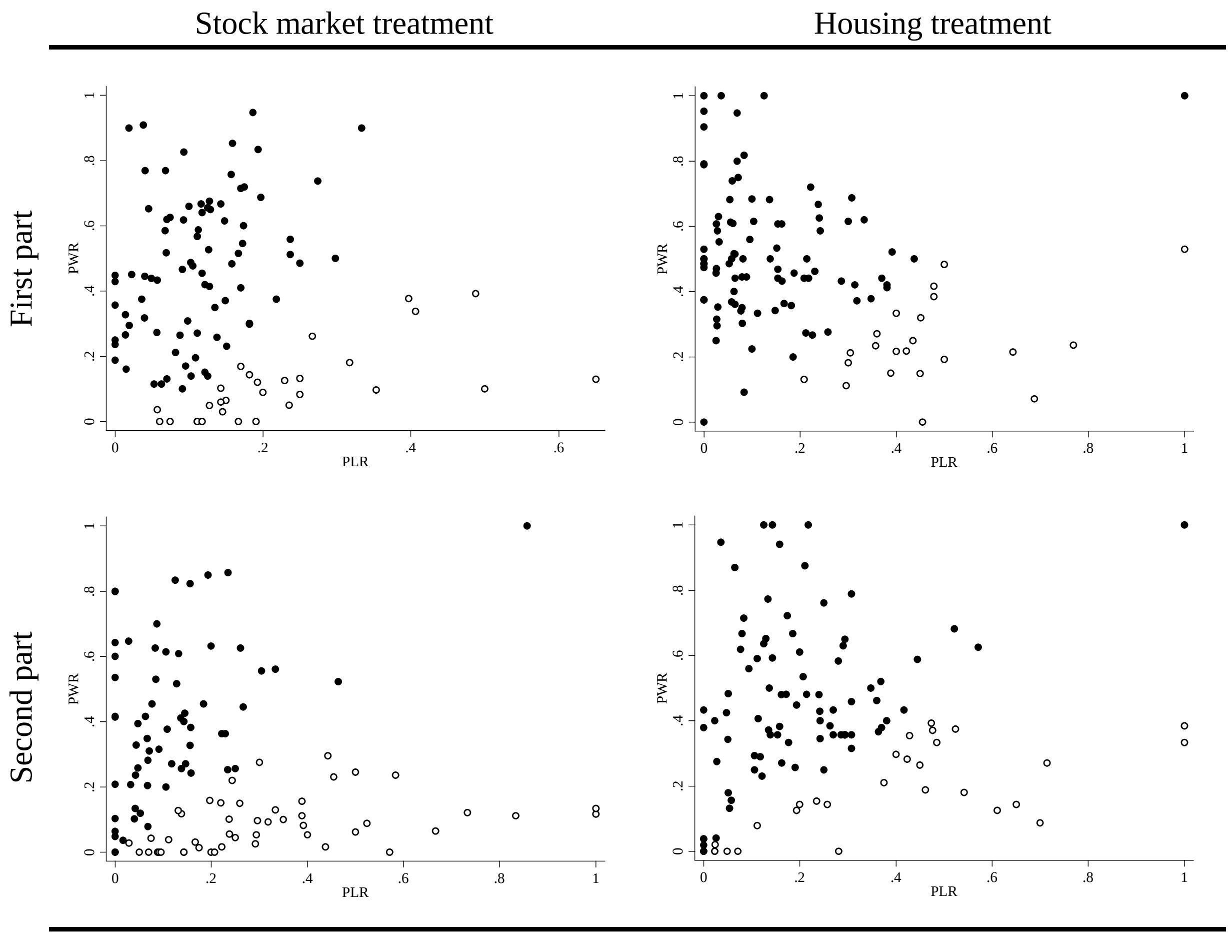
Part	Treatment	Measure	Mean	Median	Standard deviation	p
First	Stocks	PWR	0.3759	0.3704	0.2562	0.0000
		PLR	0.1412	0.1233	0.1088	
	Housing	PWR	0.4645	0.4444	0.2185	0.3609
		PLR	0.1996	0.1481	0.2099	
Second	Stocks	PWR	0.2764	0.2195	0.2535	0.0112
		PLR	0.2089	0.1440	0.2099	
	Housing	PWR	0.3962	0.3714	0.2519	0.0581
		PLR	0.2433	0.2000	0.2089	
	Market	AWR	1.3867	1.0000	1.4332	0.0000
		ALR	0.4622	0.0000	0.6776	

As table 6 documents individual differences are much more pronounced when subjects are faced with opportunities to sell their winners, while it is much more difficult to distinguish between subjects based on their loss realization aversion.

While we find individual differences among all investigated measures, we still do not know how these individual differences interact with each other: Are those subjects with a pronounced attitude of selling their winners very quickly the same subjects that are extremely reluctant to sell their losers? If this is the case we would expect a negative relationship between PWR and PLR measures. Figure 11 provides a first overview on the interaction between these measures. Each dot in the graphs stands for a subject’s PWR / PLR combination. Black dots mark DE measures higher or equal to zero, while DE measures smaller than zero are marked by a white dot.

[11] We replace the mean with the median to correct for asymmetric distributions.

Figure 11: Correlations between PWR and PLR measures



A first look at figure 11 reveals no systematic correlations between PWR and PLR. Only in the housing treatment of the first part of the experiment there seems to be a negative relationship between both sides of the disposition effect. To prove these relationships we calculate Spearman rank correlation coefficients for the combination of DE and PWR (AWR), DE and PLR (ALR), as well as PWR (AWR) and PLR (ALR) measures. Correlation coefficients as well as p-values are documented in table 7.

Table 7: Correlations between DE, PWR (AWR), and PLR (ALR) measures

Part	Treatment	Correlation	ρ	p
First	Stocks	DE & PWR	0.94	0.0000
		DE & PLR	-0.33	0.0003
		PWR & PLR	-0.03	0.7183
	Housing	DE & PWR	0.83	0.0000
		DE & PLR	-0.77	0.0000
		PWR & PLR	-0.37	0.0001
Second	Stocks	DE & PWR	0.81	0.0000
		DE & PLR	-0.62	0.0000
		PWR & PLR	-0.11	0.2255
	Housing	DE & PWR	0.77	0.0000
		DE & PLR	-0.45	0.0000
		PWR & PLR	0.14	0.1288
	Market	DE & AWR	0.93	0.0000
		DE & ALR	-0.42	0.0002
		AWR & ALR	-0.12	0.2919

While – as expected by the definition of variables – we find strong correlations between individual level disposition effects and the proportion of winners realized, as well as between disposition effects and proportion of losers realized, we find no systematic relationship between PWR and PLR or between AWL and ALR measures. Only in the housing treatment of the first part of the experiment there is a significantly negative correlation between both measures while in the other four treatments correlations are insignificantly negative or – in the case of the housing treatment in the second part of the experiment – even positive. Although, on average, high DE measures correspond with high PWR and low PLR measures, on the individual level, PWR and PLR measures are not necessarily related. Hence, a subject that tends to realize his or her winners after only a few rounds of the game is not necessarily the same subject which holds losers until they catch up with their purchase price. A subject with a certain level of disposition effect might exhibit the bias to this amount because he never sells his losers while holding on to his winners quite long or because he always sells his winners while also selling his losers frequently. In both cases the subject only shows one side of the disposition effect, i.e. loss realization aversion or a tendency for locking in his gains immediately, while his behavior concerning gains or losses respectively is close to the rational benchmark.

5.4 Relative Stability within Tasks, across Tasks, and across Time

We test for relative stability of individual level disposition effects within tasks, across tasks, and across time, i.e. hypotheses 4a, 4b, and 4c. To disentangle stability from learning, we define the disposition effect as being stable if subjects exhibiting a relatively strong disposition effect in one round, task, or part also belong to the high disposition effect group in another round of the same task, another task, or the next part of the experiment respectively. Hence, stability does not necessarily mean that subjects do not learn over time. It only means that – if subjects even learn at all – learning does not change the ranking of subjects concerning DE, PWR, PLR, AWR, and ALR measures. Due to the fact that the last four measures are not normally distributed, we base all tests on Spearman rank correlation coefficients. Table 8 shows correlation coefficients as well as p-values in parentheses for the three different market regimes in the stock market design of the first and the second part of the experiment.

Table 8: Correlations of DE measures within the first and the second part of the stock market treatment

	Round 1	Round 2	Round 3
Round 1	1.00		
Round 2	0.59 (0.0000)	1.00	
Round 3	0.57 (0.0000)	0.59 (0.0000)	1.00

	Round 1	Round 2	Round 3
Round 1	1.00		
Round 2	0.72 (0.0000)	1.00	
Round 3	0.73 (0.0000)	0.54 (0.0000)	1.00

DE measures across rounds are highly correlated – with all correlation coefficients significantly higher than 0.5. Cronbach alphas are 0.80 for the first and 0.84 for the second part of the experiment, which means that behavior in all rounds is highly inter-correlated and all DE measures seem to capture the same underlying personal characteristic.[12,13] Hence, subjects exhibiting a relatively strong disposition effect in one round also tend to show higher-than-average disposition effects in all other rounds of the same task. Moreover, disposition effects measured in one round seem to be a good predictor of how far a subject is affected by the same bias in other rounds. The magnitude of the effect is particularly striking if one considers that the three rounds

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12 Cronbach alphas higher than 0.7 are often regarded as acceptable reliability coefficients. See Nunnally (1978).

13 Glaser, Langer, and Weber (2005) calculate correlation coefficients of various overconfidence measures within tasks and find correlations of a similar extend. Their correlation coefficients vary between 0.92 and 0.19, while Cronbach alphas in their study vary between 0.96 and 0.59.

are set up with different underlying probabilities for price increases and totally different price paths.

For investigating these findings in more depth, we calculate rank correlation coefficients for PWR and PLR measures, the two components DE measures are built of. Results are shown in tables 9 and 10.

Table 9: Correlations of PWR measures within the first and the second part of the stock market treatment

	Round 1	Round 2	Round 3
Round 1	1.00		
Round 2	0.62 (0.0000)	1.00	
Round 3	0.63 (0.0000)	0.61 (0.0000)	1.00

	Round 1	Round 2	Round 3
Round 1	1.00		
Round 2	0.68 (0.0000)	1.00	
Round 3	0.75 (0.0000)	0.64 (0.0000)	1.0000

Table 10: Correlations of PLR measures within the first and the second part of the stock market treatment

	Round 1	Round 2	Round 3
Round 1	1.00		
Round 2	0.31 (0.0009)	1.00	
Round 3	0.32 (0.0009)	0.39 (0.0000)	1.00

	Round 1	Round 2	Round 3
Round 1	1.00		
Round 2	0.61 (0.0000)	1.00	
Round 3	0.58 (0.0000)	0.35 (0.0005)	1.0000

The tables reveal that both PWR as well as PLR measures in the stock market treatment are highly and significantly correlated. Cronbach alphas are 0.82 and 0.81 for PWR as well as 0.60 and 0.76 for PLR measures. Both, pairwise correlations as well as Cronbach alphas show that consistency in behavior within a task is stronger for PWR than for PLR measures. Consistent with our findings in section 5.3, it is easier to distinguish among subjects by their attitude concerning realization of winners. Realization of losers, on the other hand, is so unpopular that differences across subjects are less obvious and changes in ranks happen more frequently.

We perform the same tests for the second individual choice treatment. Under the housing design, similar to the stock market treatment, DE measures are highly and significantly correlated across rounds, with correlation coefficients lasting from 0.19 to 0.76 and Cronbach alphas of 0.89 and 0.88. Again, PWR measures are correlated to a stronger extent than PLR measures.

Correlation coefficients for PWR measures vary between 0.45 and 0.79 with Cronbach alphas of 0.89 and 0.91 while PLR measures lead to coefficients between 0.18 and 0.65 as well as Cronbach alphas of 0.84 and 0.86.

Based on our findings for both the stock market as well as the housing treatment, we conclude that individual level disposition effects are actually stable within one task. Splitting up the disposition effect into its two building blocks, i.e. a subject's proportions of winners and losers realized, reveals that both components are stable within tasks. Stability for PWR measures, however, appears to be more pronounced, which corresponds to our findings concerning individual differences investigated in section 5.3.

Stability across tasks (hypothesis 4b) is investigated by comparing individual DE measures across both the individual choice tasks as well as the market experiment for *one and the same part* of the experiment. On the other hand, we test for stability across time (hypothesis 4c) by analyzing changes in individual level disposition effects *between* the first and the second part of the experiment.[14, 15] Again, test statistics are based on Spearman rank correlation coefficients. Table 11 documents the results.

Table 11: Correlations of DE measures across tasks and time

		First part		Second part		
		Stocks	Housing	Stocks	Housing	Market
First part	Stocks	1.00				
	Housing	0.23 (0.0157)	1.00			
Second part	Stocks	0.67 (0.0000)	0.30 (0.0014)	1.00		
	Housing	0.27 (0.0040)	0.44 (0.0000)	0.36 (0.0001)	1.00	
	Market	0.11 (0.3452)	-0.05 (0.6430)	0.08 (0.4831)	0.08 (0.5018)	1.00

The correlation matrix can be split up into three different parts. The upper left-hand and the lower right-hand part of the matrix show correlations across tasks for the first and the second

[14] Subsample correlations show that there are no systematic differences in stability between men and women.

[15] Note that the two parts of the experiment are separated by a four weeks interval.

part of the experiment. Correlation coefficients across time are documented in the lower left-hand part of the matrix.

We find significant correlations across the two individual choice tasks, i.e. the stock market and the housing treatment, with correlation coefficients of 0.23 for the first and 0.36 for the second part of the experiment. In contrast, correlations between both individual choice parts and the market experiment are insignificantly low. While subjects seem to show similar tendencies of being influenced by the disposition effect when faced with different decisions they need to solve on their own, interaction between subjects seems to impact individual level disposition effects to such an extend that correlations with the individual choice tasks do not exist. Correlations across time for the same task are, with coefficients of 0.67 for the stock market and 0.44 for the housing treatment, obviously stronger than correlations across tasks. The magnitude of the effect lets us conclude that individual level disposition effects do not seem to vary over time but seem to be a stable personal characteristic. Even a combination of different individual choice tasks and different points in time leads to significant correlations with coefficients of 0.27 and 0.30 respectively. Correlations between the two individual choice tasks in the first part of the experiment and the market experiment are again insignificant. We get a Cronbach alpha of 0.70 when only comparing DE measures in the individual choice tasks. Including the stock market treatment decreases Cronbach alpha to 0.29. This, again, supports our hypothesis that while the disposition effect is stable within individual choice tasks, measuring the same effect with interaction between subjects means measuring a different concept of behavior.

To gain more insight about these effects we calculate two more correlation matrices: one for PWR (AWR) and one for PLR (ALR) measures. These correlations are shown in tables 12 and 13.

Table 12: Correlations of PWR (AWR) measures across tasks and time

		First part		Second part		
		Stocks	Housing	Stocks	Housing	Market
First part	Stocks	1.00				
	Housing	0.15 (0.1079)	1.00			
Second part	Stocks	0.73 (0.0000)	0.18 (0.0536)	1.00		
	Housing	0.26 (0.0062)	0.38 (0.0000)	0.29 (0.0017)	1.00	
	Market	0.13 (0.2517)	0.03 (0.8138)	0.12 (0.3140)	0.13 (0.2582)	1.00

Table 13: Correlations of PLR (ALR) measures across tasks and time

		First part		Second part		
		Stocks	Housing	Stocks	Housing	Market
First part	Stocks	1.00				
	Housing	0.30 (0.0011)	1.00			
Second part	Stocks	0.47 (0.0000)	0.28 (0.0028)	1.00		
	Housing	0.28 (0.0027)	0.53 (0.0000)	0.34 (0.0003)	1.00	
	Market	-0.04 (0.7620)	-0.27 (0.0214)	0.11 (0.3695)	-0.05 (0.6617)	1.00

We obtain strong evidence that both measures are stable across the two individual choice tasks. Correlation coefficients for PWR measures across tasks are 0.15 and 0.29 for the two individual choice tasks in the first and second part of experiment, while the same correlations for PLR measures lead to coefficients of 0.30 and 0.34. Just as in the DE measure, correlations across time are nevertheless much stronger, with correlation coefficients of 0.73 and 0.47 for the stock market and 0.38 and 0.53 for the housing design. Even if both dimensions, i.e. tasks and time, are varied simultaneously, correlation coefficients for both individual choice tasks are still significant. Again, there are no systematic effects for the market experiment. Cronbach alphas for

PWR are 0.65 and 0.24 without and with the market experiment while Cronbach alphas for PLR are 0.63 and 0.36 respectively.

To sum up, we find striking evidence for stability across tasks and time as long as we stick to our individual choice treatments. If instead, subjects are given the opportunity to communicate with each other via the price mechanism of the market experiment, individual disposition effects change in ranks considerably.

5.5 Learning

As already discussed at the beginning of section 5.4, relative stability does not necessarily mean that subjects do not learn within a task or over time. While a subject in all rounds of a task or both parts of the experiment might belong to the high disposition effect group, learning might nevertheless decrease individual disposition effects of all investors in this and all other groups. We test for learning, i.e. hypothesis 5, in two different ways. First we test whether subjects learn within a task, i.e. whether individual disposition effects decrease from round to round. Second, we test whether subjects learn over time, i.e. whether in the second part of the experiment, i.e. four weeks after the first part, disposition effects are significantly lower.

We test whether subjects learn within tasks by comparing average individual level disposition effects in the first round(s) played by a subject with average individual disposition effects in later rounds. In the stock market treatment we compare DE, PWR, and PLR measures in the first round played by the subject with measures in the second and third round. In the housing treatment we compare disposition effects in the first three rounds with disposition effects in the later three rounds. Table 14 shows the results. P-values given in the table are based on signtests.

Table 14: Learning within tasks

		Stock market treatment			Housing treatment		
		Mean DE	Mean PWR	Mean PLR	Mean DE	Mean PWR	Mean PLR
First part	First round(s)	0.27	0.40	0.14	0.30	0.50	0.20
	Later rounds	0.23	0.38	0.15	0.24	0.48	0.24
	p	0.1713	0.2754	0.0519	0.0407	0.3468	0.1204
Second part	First round(s)	0.11	0.33	0.23	0.15	0.39	0.24
	Later rounds	0.08	0.27	0.21	0.12	0.41	0.29
	p	0.0898	0.0092	0.5429	0.0297	0.2060	0.0009

As table 14 reveals, subjects reduce their individual disposition effects significantly in the housing treatment as well as the second part of the stock market treatment. Average DE measures in the stock market treatment attenuate from 0.27 and 0.11 in the first round to 0.23 and 0.08 in the second and third round. Under the housing design learning decreases DE measures from 0.30 and 0.15 to 0.24 and 0.12 respectively. The attenuation of the disposition effect is based on both a reduction of subjects' tendencies to sell winners too quickly, i.e. PWR measures, and an increase in subjects' willingness to sell their losers, i.e. PLR measures.[16]

We perform an additional test to investigate whether subjects with different initial disposition effects learn at the same pace. Therefore, we split our subject pool into three quintiles either based on our subjects' DE measures in the first round of the stock market treatment or the first three rounds of the housing task. For each quintile we then apply signtests as done above. Average DE, PWR, and PLR measures as well as p-values for the first and second part of the experiment are given in tables 15 and 16.

Table 15: Learning within tasks within DE quintiles, first part

		Stock market treatment			Housing treatment		
Quintile		Mean DE	Mean PWR	Mean PLR	Mean DE	Mean PWR	Mean PLR
High DE	First round(s)	0.65	0.71	0.07	0.68	0.74	0.06
	Later rounds	0.45	0.59	0.13	0.56	0.67	0.12
	p	0.0013	0.0144	0.0001	0.0288	0.1077	0.0758
Medium DE	First round(s)	0.27	0.35	0.08	0.35	0.46	0.11
	Later rounds	0.26	0.38	0.13	0.28	0.48	0.20
	p	0.5000	0.2557	0.1077	0.0365	0.2557	0.0748
Low DE	First round(s)	-0.11	0.14	0.27	-0.12	0.31	0.43
	Later rounds	-0.02	0.16	0.18	-0.07	0.32	0.40
	p	0.0939	0.4253	0.0147	0.2498	0.4321	0.2434

[16] There are no significant differences in learning between men and women.

Table 16: Learning within tasks within DE quintiles, second part

Quintile		Stock market treatment Mean DE	Mean PWR	Mean PLR	Housing treatment Mean DE	Mean PWR	Mean PLR
High DE	First round(s)	0.58	0.67	0.09	0.55	0.65	0.09
	Later rounds	0.38	0.47	0.11	0.35	0.58	0.23
	p	0.0003	0.0004	0.2210	0.0001	0.1481	0.0000
Medium DE	First round(s)	0.10	0.25	0.17	0.15	0.34	0.18
	Later rounds	0.04	0.24	0.23	0.14	0.42	0.26
	p	0.0662	0.2366	0.2291	0.0814	0.1553	0.0251
Low DE	First round(s)	-0.33	0.09	0.39	-0.26	0.18	0.43
	Later rounds	-0.17	0.11	0.31	-0.14	0.23	0.36
	p	0.0069	0.5000	0.0494	0.0251	0.0610	0.2858

The tables document that learning is significantly present at almost all parts, tasks, and DE quintiles. While subjects in the high DE quintile reduce their disposition effects over rounds from 0.65 (0.68, 0.58, and 0.55) to 0.45 (0.56, 0.38, and 0.35), subject in the low DE quintile increase their DE measures from –0.11 (-0.12, -0.33, and –0.26) to –0.02 (-0.07, -0.17, and –0.14) into the direction of the zero DE benchmark. Learning, however, seems to be most pronounced among those subjects that exhibit relatively high initial disposition effects and thus suffer the most from their bias. To test this hypothesis we calculate Spearman rank correlation coefficients between initial DE measures and absolute attenuations in DE measures for all these subjects exhibiting positive initial disposition effects.[17] Rank correlations are 0.35 (p = 0.0012) and 0.28 (p = 0.0238) for the first as well as 0.06 (p = 0.5913) and 0.28 (p = 0.0151) for the second part of the experiment, thus supporting our hypothesis.

In another test we question whether subjects also learn over time, i.e. between the first and the second part of the experiment. A signtest is applied to find out whether individual level disposition effects exhibit the tendency to decrease between both parts. Table 17 documents average DE, PWR, and PLR measures as well as p-values.

[17] We skip subjects with negative initial DE measures because – depending on what benchmark we use – both increases and decreases in individual DE measures might be rational.

Table 17: Learning over time

	Stock market treatment			Housing treatment		
	Mean DE	Mean PWR	Mean PLR	Mean DE	Mean PWR	Mean PLR
First part	0.24	0.38	0.14	0.26	0.46	0.20
Second part	0.07	0.28	0.21	0.15	0.40	0.24
p	0.0000	0.0000	0.0018	0.0003	0.0035	0.0000

Although the disposition effect is present in both parts of the experiment, individual level DE measures decrease considerably over time. While in the first part of the experiment subjects exhibit an average DE measure of 0.24 in the stock market and 0.26 in the housing treatment, individual level disposition effects drop to 0.07 and 0.15 in the second part of the experiment. Subjects reduce their bias by both selling losers more often and winners less often.

We again split our subject pool into three quintiles based on our subjects' DE measures in the first part of the stock market or the housing treatment and apply signtests to find out whether there are differences in the degree of learning. Table 18 shows average DE, PWR, and PLR measures as well as p-values.

Table 18: Learning over time within DE quintiles

		Stock market treatment			Housing treatment		
Quintile		Mean DE	Mean PWR	Mean PLR	Mean DE	Mean PWR	Mean PLR
High DE	First part	0.55	0.67	0.11	0.61	0.67	0.05
	Second part	0.31	0.47	0.17	0.29	0.45	0.16
	p	0.0000	0.0000	0.2025	0.0000	0.0006	0.0000
Medium DE	First part	0.25	0.36	0.11	0.30	0.44	0.14
	Second part	0.11	0.28	0.17	0.17	0.39	0.22
	p	0.0168	0.0717	0.0045	0.0069	0.2088	0.0002
Low DE	First part	-0.08	0.11	0.20	-0.11	0.29	0.40
	Second part	-0.20	0.08	0.29	0.00	0.34	0.34
	p	0.0001	0.0035	0.0939	0.2025	0.3679	0.2498

As documented in the table, DE measures under the stock market design are reduced to a similar extent in all three quintiles. In the housing treatment, however, subjects seem to learn much faster if they initially belong to the high disposition effect group. While the first quintile strongly reduces its average DE measure from 0.61 to 0.29, the lowest quintile increases its DE measure only slightly from -0.11 towards the zero benchmark of 0.00. We again calculate Spearman rank correlation coefficients to test for an interaction between initial DE measures and absolute attenuations. Again, subjects with negative initial DE measures are excluded. We obtain rank correlation coefficients of 0.16 (p = 0.1545) for the stock market and 0.43 (p = 0.0000) for the housing treatment, which supports our hypothesis stated above. We conjecture that while the second individual choice task was not based on probability updating like the first one, learning in this task was much easier. Subjects might have discovered that they are actually playing a sequence of lotteries and that their decision to sell one of the five houses should not depend on its current value. Once a subject finds out, he might discipline himself to sell all of his houses always in the same period, thus greatly reducing his disposition effect. Subjects not possessing basic knowledge about the calculus of probabilities might have much more difficulties in finding out the rational strategy under the stock market treatment.

6 Conclusion

Our experiment allows us to derive a couple of new insights concerning individual level disposition effects. On average, our subjects tend to hold their losers twice as long as their winners and thus lower their monetary payoff. On an individual level, however, the degree to which subjects are affected by this bias varies considerably within our data set. Women are e.g. stronger affected than are men. While most subjects exhibit the disposition effect to some degree, some subjects act completely opposite to it. Splitting up the disposition effect into its components, i.e. proportions of winners and losers realized, reveals that subjects act quite differently with respect to gains while loss realization aversion is a common mistake across all subjects. Our test for symmetry shows that high disposition effects on average are accompanied by tendencies of both selling winners too soon and holding losers too long. On the individual level, however, both sides of the disposition effect are not systematically related with each other. Those subjects exhibiting a strong tendency for quitting winning investments quickly are not necessarily the same subjects who stick to their losing ones.

The major goal of our paper was to investigate whether the disposition effect is stable within tasks, across tasks, and across time. We answer these questions by correlating individual level disposition effects as well as proportions of winners and losers realized across different rounds of one and the same task, across different tasks of the same part, and across different parts of the experiment. We find that subjects exhibiting high level disposition effects in one round of one individual choice task also tend to belong to the high-disposition-effect group in all other rounds of the same task. In addition, individual disposition effects seem to be stable across both individual choice tasks and across different parts of the experiment, thus providing strong evidence for stability across tasks and time. The same is true for proportions of winners and losers realized. As, on the other hand, we find no systematic correlations between the individual choice tasks and the market experiment, we conclude that individual disposition effects are influenced considerably by interaction between subjects.

Although our subjects' tendencies of being affected by the disposition effect seem stable on a relative level, we find that learning within tasks and over time reduces the magnitude of this bias. While the disposition effect is present in all rounds as well as both parts of the experiment, subjects in later rounds or the second part of the experiment respectively are much more willing to hold on to their winners and sell their losers. Splitting up our subject pool into high, medium, and low disposition effect investors reveals that all investor classes learn over time. However, in the housing treatment, i.e. a task quite easy to understand after some rounds of playing, learning is more pronounced within the high disposition effect group.

By proving evidence on stability within individual level disposition effects our paper sets the fundament for previous as well as future research concerning the identification of disposition effect investors, the causes of the disposition effect, its impact on market prices and volume, and possible counteractive measures. While investors might be classified as being more or less affected by the disposition effect one should take care about the fact that individual level disposition effects could be caused by either both or only one side of the bias, i.e. immediate gain realizations or loss realization aversion. One should also be careful if investors are interacting with each other, i.e. if they are not price takers but might influence other market participants, trading volume, and prices. Interaction might impact individual behavior to such an extent that it changes the degree of individual level disposition effects dramatically. Especially agent based models should consider these effects. Based on our finding it might also be valuable to investigate why certain investors exhibit the disposition effect and others do not, i.e. the interdependence between an investor's personal characteristics, financial sophistication, etc. on one side and his investment decisions on the other side. The question is whether those people exhibiting above-average disposition effects do so because of a lack of understanding the market they trade in or the game they play, a lack of general or specific financial sophistication, or emotional reactions unrelated to rational decision making.

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Appendix A: Instructions for Individual Choice 1: Stock Market Design (translated from German)

This is the first of two games. On the following pages the procedure of the game will be explained to you. Please read these instructions carefully. Your financial reward partly depends on your success in this game.

In this game you trade in six different goods: Good 1 to good 6. The game consists of a total of 14 periods (periods -3 to 10) and will be repeated three times. During periods -3 to -1 you cannot purchase or sell any goods. You only receive information on the price development of the six goods during these three periods.

In period 0 you receive an amount of 2,000 monetary units but no goods. With this amount you can purchase units of goods during the following 10 periods (period 0 to 9). In addition, you can also sell the goods you possess.

Starting at a price of 100 monetary units in period –3, the price of each good changes each period. Either the price increases by 6 % or decreases by 5 %. Each of the 6 goods has its own individual probability for price increases. These probabilities remain constant within the 14 periods of the game. You are not told the individual probabilities of the 6 goods.

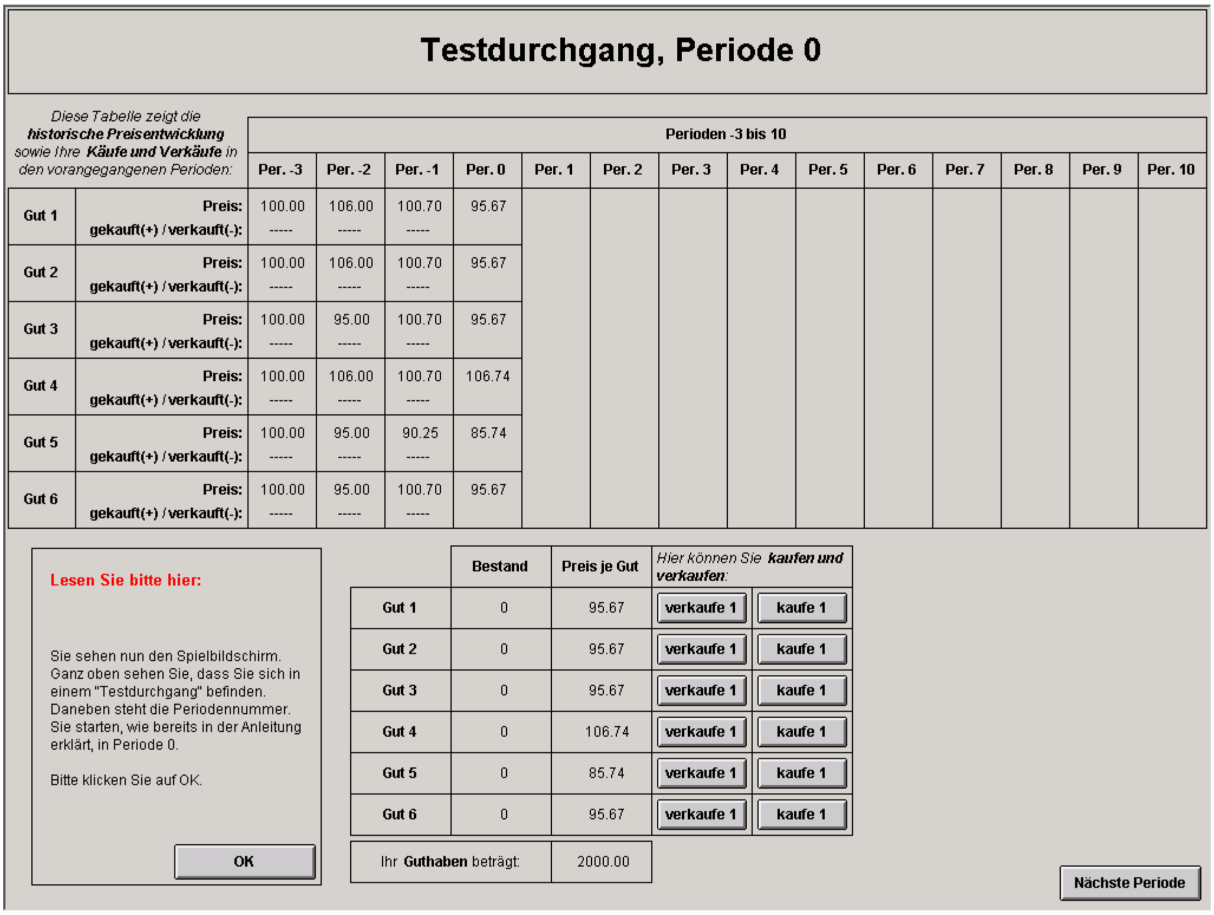
Price changes in one period are independent of price changes in previous periods and price changes of one good are independent of price changes of all other goods.

You play this game three times. Individual probabilities remain constant during one game but differ between the three repetitions of the game, which means that individual probabilities for price increases as well as actual price changes are determined randomly in each of the 3 runs.

You receive your financial reward after the second experiment. For the reward, one of the 3 repetitions is chosen at random. Your payoff depends on your final wealth at the end of this run, i.e. period 10. It equals 0.2 % of your final wealth, which in turn is calculated as the sum of your money account plus the current value of your goods.

On the following pages we show you the elements of the computer screen.

(In the following we present the text of the computer tutorial.)



You are looking at the game screen. At the top you can see that this is a “test run.” Next to this is the period number. As explained in the instructions you start in period 0. Please click OK.

The rest of the screen is divided into two parts: In the upper part you can see a big table showing price developments of goods 1 – 6 as well as your purchases and sales across previous periods. Underneath you see a smaller table containing your number of goods currently held, current prices, buttons for purchasing and selling, and your current money account.

Please inspect the upper table first. The rows in this table stand for the 6 goods, the columns for periods -3 to 10. Since you are in period 0, only the columns of periods -3 to 0 contain entries. The cells in the upper table contain two types of information: The upper figure is the price of the corresponding good in this period. The number underneath shows how many units of this good you purchased (positive number) or sold (negative number) in this period.

An example: Please study the entries concerning good 1 in the first row of the table. As you see, the price of the good changed from 100 in period -3 to 106 and 100.70 in periods -2 and –1, and to 95.67 monetary units in period 0. Since you were not allowed to buy and sell the good during periods -3 to -1 (the game just starts in periods 0) you see the entry “----“ in the row “bought(+)

/ sold(-)”. Since you have not bought anything in period 0 so far, there is no entry in “bought(+) / sold(-)” in this period either. As soon as you purchase a good, you will be able to see the number of units bought (positive number) or sold (negative number) here.

Now, please look at the smaller table at the lower part of the screen. The first column shows your current holding of the 6 goods. Since you currently do no possess any goods, all entries are “0”. In the next column you see again the current price per unit of the corresponding good. Please compare the prices shown in this table with period 0 prices in the upper table. Next to the prices, the lower table contains two buttons labeled “sell 1” and “purchase 1” for each of the 6 goods. Below the small table you see your current money account. Since you did not purchase a good yet, your money account contains 2,000 monetary units.

Please try it out now: Purchase some units of good 1. To do so click repeatedly on “purchase 1” in the row of good 1 in the lower table. You see that the number of units increases by one with each click while your money account decreases by the price of the good. In addition, the number of units bought in period 0 is documented in the upper table in the row “bought(+) / sold(-)”. Now that you have bought several units you can sell them back, of course. For this just click on the button “sell 1”. The number of units of the particular good decreases by one with each click. At the same time your money account increases by the current price of that good.

If you have finished your purchases and sales, you can move on to the next period, i.e. period 1, by clicking the button “next period” in the lower right-hand corner of the screen. As soon as you click on “next period,” the prices of the 6 goods change in the lower table. Moreover, another column is added to the upper table. Please move on to period 1! Very good! Please inspect how the screen has changed. As you can see the price of good 1 has risen to 101.40. In the game, you could now purchase and sell again. However, we want to shorten this for now. Please click on OK to switch to period 10.

We just skipped periods 2 to 9 and are now in the final period, i.e. period 10. As you can see, the upper table is filled completely now. In addition, the buttons to purchase and sell have vanished. Since this is the last period and prices do not change any more, there is no need to sell or buy. Please leave the test run now and start the real game by clicking on the button “end of test run” in the lower right-hand corner of the screen.

Appendix B: Instruction for Individual Choice 2: Housing Design (translated from German)

You are now in the second game. On the following pages we explain the procedure. Please read these instructions carefully. Your financial reward partly depends on your success in this game.

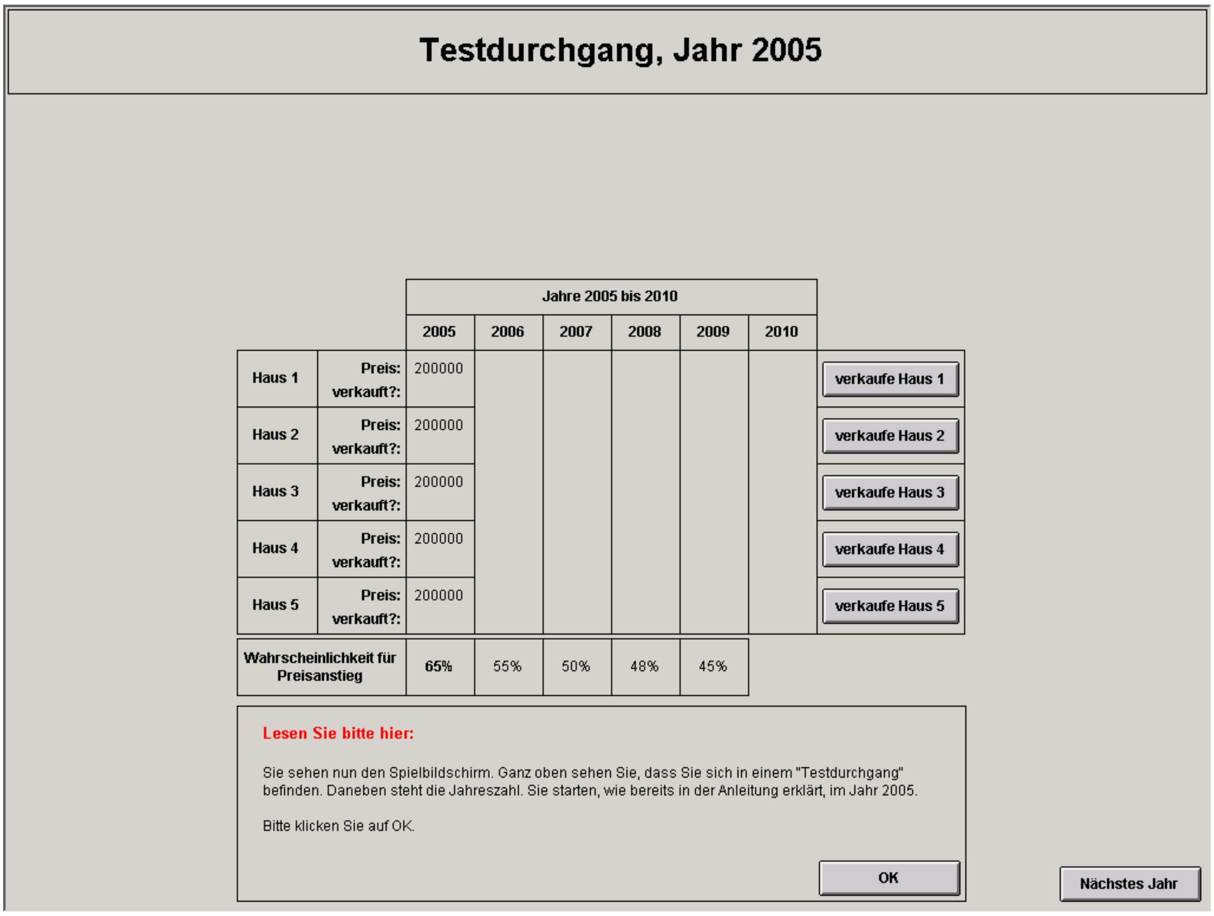
For this game please imagine that you just, in the year 2005, inherited 5 houses from a remote relative. You neither want to live in these houses yourself nor rent them out. Instead you want to sell them by the year 2010 at the latest. Therefore, you need to decide each year whether and which of the houses you want to sell. Houses that have not been sold until the end of 2009 are automatically sold in 2010. Houses that once have been sold cannot be repurchased again.

Currently (in the year 2005) each of the 5 houses has a price of 200,000 €. You know, however, that these prices change every year: In each year, house prices either increase by 30,000 € or decrease by 30,000 €. After your decision in the year 2005 the probability for a price increase is 65 %. Following your decision in 2006 the probability is 55 %. After 2007 the price rises with a probability of 50 %. After 2008 the probability is 48 % and after 2009 45 %. Since the houses are situated in 5 different residential areas, price changes of the 5 houses are independent from each other. In addition, price changes do not depend on changes in previous years.

You play this game a total of 6 times. You receive your financial reward after the second experiment. For the reward, one of the 6 runs is chosen randomly. Your payoff is based on your final wealth at the end of this run, i.e. in the year 2010. It equals 0.002 % of your final wealth, which in turn is calculated as the sum of the prices at which you have sold your 5 houses.

On the following pages we show you the elements of the computer screen.

(In the following we present the text of the computer tutorial.)



You are looking at the game screen. At the top you can see that this is a “test run.” Next to this is the year. As explained in the instructions you start in 2005. Please click OK.

In the center of the screen you see a table. The rows of this table represent the 5 houses you have inherited: House 1 to house 5. The columns stand for the 6 years of the game: 2005 to 2010. Since you are in the year 2005 now, there are only entries in the first column. Next to the columns you also see 5 buttons you can use to sell your houses at the current prices. Under the table you see the probabilities for price increases.

There are two types of information in the cells: The upper entry is the price of the house in the corresponding year. If you have sold your house in a particular year you see the comment “sold” underneath the price. Since you have not sold a house yet, there are no entries underneath the prices so far. Under the table you see a row containing the probabilities for an increase in prices for the following 5 years. The bold probability is the current one. For example, if you decide in 2005 not to sell one or several houses, the price of each of these houses increases until 2006 with a probability of 65 %. Next to the table you see 5 buttons labeled “sell house 1” to “sell house 5”. If you want to sell one or more houses at their current prices, you just need to click on the corresponding button. As soon as you have sold a house you see the remark “sold” in the table.

Please try it out now: Sell one of the 5 houses by clicking the corresponding button. After the sale, the comment “sold” appears underneath the price of that house. Please click on the button “next year” in the bottom right-hand corner of the screen to move on to the year 2006.

As you see, another column has been added to the table. There is a new price for each house that you have not sold yet. Furthermore, you can see in the row “probabilities for price increases” that the current probability is now 55 %. Now, in the year 2006 you need to decide again whether and which of the houses you want to sell at their current prices. We want to shorten this for now. Please click OK to move on to the final year 2010. Very good! As you see, the table is filled completely now. In addition, the five buttons to sell house 1 to house 5 have vanished. Since you are in the final year the houses that you have not sold yet are now sold automatically. Please leave the test run now and start the real game by clicking on the button “end of test run” in the lower right-hand corner of the screen.

Appendix C: Instruction for the Market Experiment (translated from German)

This is the third of the three games. On the following pages we explain the procedure of the game. Please read these instructions carefully. Your financial reward partly depends on your success in this game.

You play this game together with all other players who are currently present in the laboratory. The game consists of a total of 10 rounds. In the first 4 rounds, the players present in this laboratory are divided randomly into two equal sized groups. From round 5 on, groups remain the same till the end of the game. Each round you play together only with the other players in your group. Together with the other players of your group you form a market. At the beginning of each run, each player receives 5 units of goods as well as 1,500 monetary units. With your goods and money, you can trade with the other players in your group, i.e. purchasing units from other players or selling units to other players.

At the end of each run, each unit of the good is worth a certain amount of experimental money. The value of each unit is unknown, however, at the beginning of the round. The exact value is determined randomly in the following way: At the end of the round, one of four states occurs at random: State A, B, C, or D. At the beginning of the round, each state is equally likely. If state A occurs, each unit has a final value of 100 monetary units. If state B occurs, each unit is worth 200 units of experimental money. In state C, each unit of the good has a value of 300 and in state D of 400 monetary units. The following table summarizes this:

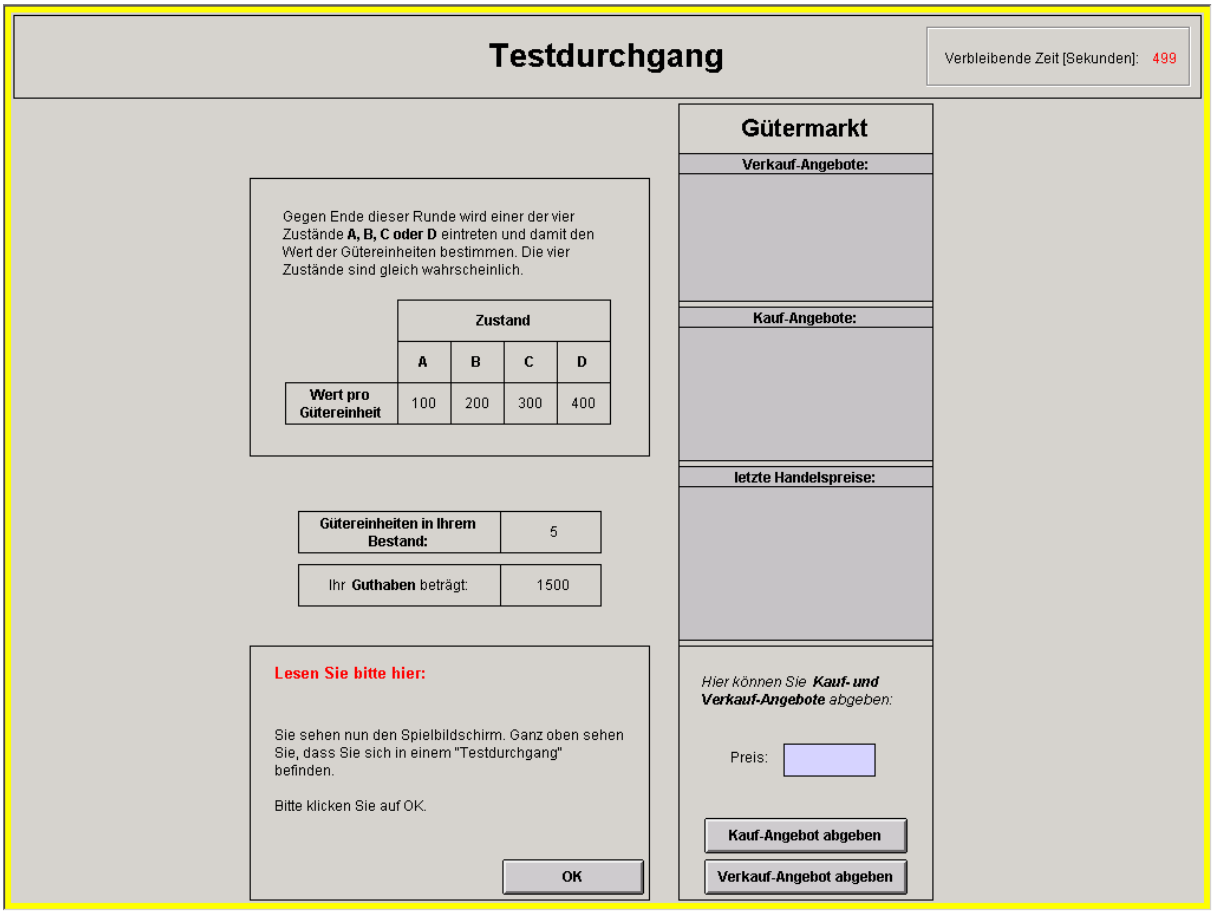
(A table similar to table 4 is added to the instructions.)

Every round proceeds as follows: First you are told in an information screen that a new run is going to start. Then you have two minutes to trade with the other players in your market. For this, you can make purchase and selling offers. At the same time you see the current offers of all other players in your market. Whenever a purchase and selling offer match, i.e. the price of the purchase offer is equal or higher than the price of the selling offer, a trade is settled automatically between these two players. The transaction price is always the price of the older bid. The buyer automatically pays the price to the seller, and a unit of the good is automatically transferred from the seller to the buyer. Both offers are then taken out of the market and the transaction price is shown to all market participants. After 2 minutes, the trade is interrupted and all players receive new information about the value of the traded good. For this, you and all other players in your market are informed that either one of the states A and B or one of the states C and D occur at the end of the round. The remaining two states are still equally likely. After this new information, you have 2 more minutes to trade with the other players in your market in the way described above. After these 2 minutes the round ends. On an information screen you are told which of the two states actually occurred and about the value of the traded units of the good. The game consists of a total of 10 such rounds.

To determine your financial reward for this game, one of the 10 rounds is chosen randomly. Your payoff equals 0.3 % of your final wealth at the end of this round. Your final wealth in turn consists of your money account plus the value of your goods.

On the following pages we show you the elements of the computer screen.

(In the following we present the text of the computer tutorial.)



You are looking at the game screen. At the top you can see that this is a “test run”. Please click OK.

In the left upper corner you see a little box with the remaining time in seconds. You always trade with the other players in your market for 120 seconds. As soon as this time is expired, all players leave the trading screen automatically. For this test run we expanded the time to 500 seconds so that you have enough time to get to know all parts of the screen.

The rest of the screen is divided into a left and a right part. On the left side you see some information about the future value of the traded good, your current holdings of this good, as well as your current money account. On the right side, you see the current offers to buy or sell, recent transaction prices, as well as an input box and two buttons for making you own bids.

Please look at the top left box. This box again shows the information you know from the instructions: The value of the good is determined by random. At the beginning, all of the 4 states are still possible. In the course of a round, after you have traded with the other players for 2 minutes, you learn that only 2 of the 4 states remain possible: Either A and B or C and D. The box in the top left-hand corner is updated accordingly. After this new information you have again 2 minutes to trade with the other players in your market.

Underneath this box you see two more little boxes. The first shows your current holding of the good. In the second box you see your current amount of money. At the beginning of each round you always have 5 units of goods and 1,500 monetary units on your account. If you trade with other players in your market, i.e. if you purchase or sell goods, these boxes adapt automatically.

Now please look at the right side, which is labeled “market for goods”. Among other things, you can see three grey boxes. Later, the first grey box will show the selling offers, and the second one the bids for purchasing. In these boxes you can see the prices at which a potential seller or buyer is willing to sell or buy. The bids always refer to one unit of goods.

The bids for selling are arranged with ascending order of prices which means that the bid with the lowest selling price is placed at the top. The bid with the highest price is placed at the bottom. In contrast, the bids for purchasing are arranged with decreasing prices. This means that the purchasing bid with the highest price is placed at the top of the box, whereas the one with the lowest price is to be found at the bottom. If you have made an own bid for selling or purchasing, this bid also appears in the box for offers to sell or to buy. Your bid appears in blue, whereas the bids of the other players appear in black color. This ensures that you are able to distinguish your bid from the others.

In the third grey box you later see latest transaction prices, i.e. prices at which transactions have already been settled between players in the market in this round. Transaction prices are arranged chronologically. The most recent transaction price is displayed on top. The second latest underneath the latest price and so on.

A transaction is settled between two players if the price at which a buyer is willing to purchase is higher or equal to the price a seller is willing to sell at. The bargain is closed based on the price of the senior bid. As soon as a transaction is settled, both bids vanish from the two boxes with purchase and selling offers. This means that they are no longer available. At the same time, the transaction price immediately appears in the grey box containing "recent transaction prices".

In the bottom right hand corner you see another box. With the help of this box you can create your own purchasing and selling offers. For this, you just enter the price at which you are willing to buy or sell in the box named "price". Then you click on the button "make an offer to buy" if you are willing to buy at this price or on the button "make an offer to sell" if you are willing to sell at this price. If your offer immediately leads to a transaction between you and another player in the market, you only see that the other player's offer is taken off the market and that a new entry is added to the box "last transaction prices". If your offer does not immediately lead to a transaction, it remains in the corresponding grey box.

You can only have one purchase and one selling offer in the market at a time. If you already made a bid for selling or buying and then make a new one your old offer is eliminated automatically. This means that you just have to make a new offer if you want to change the price at which you are willing to purchase or sell. Please notice that it does not make sense if the price you are willing to buy at is higher than the one you are willing to sell at. Therefore, the program does not accept such offers.

Please try it out now: Create a purchase or selling offer! Very good. You created a purchase offer. Your offer is now displayed in the box containing purchase offers in blue color. Let us assume another player in the market would be willing to sell a good but claims a price which is one unit higher than your current bid. Please click on OK to make the computer create such an order automatically for this test run. Additionally, let us assume you want to accept the other player's offer. Please increase the price of your purchase offer by at least one monetary unit and observe what happens. Very good! You have now accepted the offer. As you can see, the two bids have vanished from the market and a new transaction price has been added to the list "recent transaction prices". Furthermore, your holdings of goods and your money account have been updated. Please click on OK now to leave the test run and start the real game.