Ostfalia
Hochschule für angewandte Wissenschaften

Wolfsburg
Fakultät Wirtschaft

WWP

Wolfsburg Working Papers

No. 17 - 1

Portfolio Diversification: the Influence of Herding, Status-quo Bias and Gambler´s Fallacy

An Experimental Study

Ibrahim Filiz, Thomas Nahmer, Markus Spiwoks and Kilian Bizer, February 2017

Portfolio Diversification: the Influence of Herding, Status-quo Bias and Gambler's Fallacy

An Experimental Study

Ibrahim Filiz, Thomas Nahmer, Markus Spiwoks and Kilian Bizer

Abstract:

This experimental study examines the influence of herding (following the majority of fellow gamblers or the most successful gambler (guru)), status-quo bias and gambler's fallacy on diversification behavior. We come to the result that neither herding nor status-quo biases significantly contribute to non-optimal portfolio choices. Gambler's fallacy, however, plays an important role in these decisions. Many participants are zealous to notice patterns in a history of random events and to infer from these pattern the sequence of future events. Gambler's fallacy crucially conduces to the fact that the optimal structure of a portfolio is considered in only 37.7% of all choices made by an investor.

Keywords: Behavioral Finance, Experiments, Portfolio Choice, Non-optimal Diversification, Herding, Guru, Status-quo Bias, Gambler's Fallacy.

JEL classification: G02, G11, D81, D84.

Ibrahim Filiz, Ostfalia University of Applied Sciences, Faculty of Business, Siegfried-Ehlers-Str. 1, 38440 Wolfsburg, Germany, phone: +49 5361 892 225 560, email: ibrahim.filiz@ostfalia.de

Thomas Nahmer, Georg August University Göttingen, Faculty of Economic Sciences, Platz der Göttinger Sieben 3, 37073 Göttingen, Germany, phone: +49 89 288 907 19; email: thomas.nahmer@hpkj-ev.de

Markus Spiwoks, Ostfalia University of Applied Sciences, Faculty of Business, Siegfried-Ehlers-Str. 1, 38440 Wolfsburg, Germany, phone: +49 5361 892 225 100, email: m.spiwoks@ostfalia.de

Kilian Bizer, Georg August University Göttingen, Faculty of Economic Sciences, Platz der Göttinger Sieben 3, 37073 Göttingen, Germany, phone: +49 551 39 4602, email: bizer@wiwi.uni-goettingen.de

1. Introduction

1.1. State of Research and Research Question

Markowitz (1952) showed that it is useful for risk-averse investors to split the capital among different investment instruments. Practice shows, however, that investors often have strongly underdiversified portfolios (see e.g. Dimmock *et al.*, 2016; Anderson, 2013; Hibbert, Lawrence and Prakash, 2012; Goetzmann and Kumar, 2008; Meulbroek, 2005; Polkovnichenko, 2005; Huberman and Sengmueller, 2004; Agnew, Balduzzi and Sundén, 2003; Guiso, Haliassos and Japelli, 2002; Benartzi, 2001; Benartzi and Thaler, 2001; Barber and Odean, 2000; Bode, van Echelpoel and Sievi, 1994; Blume and Friend, 1975; Lease, Lewellen and Schlarbaum, 1974).

Experimental economic research has increasingly been addressing the question why investors seem to find it so difficult to make useful portfolio diversifications: Gubaydullina and Spiwoks (2015) show that many investors have difficulties in dealing with the correlations of income return developments (for similar results see also Eyster and Weizsäcker, 2011; Kallir and Sonsino, 2009; Hedesstrom, Svedsater and Garling, 2006). The meaning of the correlations is systematically misjudged, which can be explained i.a. by taking the example of 1/n heuristics, where investors distribute their capital equally to all investment alternatives without minding how strongly the income return of these instruments are correlated. Morrin *et al.* (2012) prove the tendency of many subjects towards 1/n heuristics (for similar findings see Fernandes, 2013; Baltussen and Post, 2011). Rieger (2012) reveals that investors systematically miscalculate the probabilities of occurrence. Fellner, Güth and Maciejovsky (2004) conclude that investors are often liable to an illusion of expertise, hence overestimate the advantageousness of their own choice of investment. Choi, Laibson and Madrian (2009) note that diversification decisions are distorted by the phenomenon of mental accounting. Weber, Siebenmorgen and Weber (2005) detected that investors are subject to a home bias when assembling investment instruments for a portfolio.

We conducted expert discussions with high-ranking bank managers[1], which revealed further possible reasons for suboptimal diversification decisions. It seems possible that many subjects are distracted from optimal diversification by observing the investment choices of other investors (herding). Being guided by striking investment decisions of prominent investors can play a significant role in this process (guru effect). Furthermore, the optimal diversification can be hindered by the subjects holding on to existing portfolios (status-quo bias). Subjects can also be distracted from meaningful portfolio choice by exclusively following putative patterns of random events (gambler's fallacy).

The present study therefore addresses the question whether or not (1) herding or guru effect, (2) status-quo bias, (3) gambler's fallacy can also distract subjects from their ideal diversification decision. Research literature provides multiple indications of the significant influence that these phenomena can exert on economic decisions.

[1] We thank Mr Lothar Henning, Bethmann Bank Frankfurt, and Mr Frank Weber, Sparkasse Erwitte-Anröchte, for extensive talks concerning noticeable investment behavior of bank customers.

1.2. Herding

The observation that subjects take their bearings from one another and thereby form a herd traces back as far as Mackay (1841). Keynes (1936) points out herding as a behavioral phenomenon of financial market actors and presents two possible explanations for it (reputational herding and investigative herding). Scharfstein and Stein (1990) continued these statements and thereby ignited a fierce debate that has been raging for the past 25 years. Banerjee (1992) and Bikhchandani, Hirshleifer and Welch (1992) show that herding can even occur when subjects behave rationally and are zealous to make reasonable decisions (informational cascades). For the first time, Devenow and Welch (1996) clearly differentiate between rational herding (reputational herding, investigative herding and informational cascades) and irrational herding. There are numerous empirical findings that confirm herding of actors on the financial market (Huang, Wu and Lin, 2016; Choi, 2016; Galariotis, Rong and Spyrou, 2015; Chang, 2013; Kremer and Nautz, 2013; Lin, Tsai and Lung, 2013; Belhoula and Naoui, 2011; Boyson, 2010; Kim and Jegadeesh, 2010; Chiang and Zheng, 2010; Spiwoks, Bizer and Hein, 2008; Chen, Wang and Lin, 2008; Walter and Weber, 2006; Voronkova and Bohl, 2005; Spiwoks, 2004; Sias, 2004; Ennis and Sebastian, 2003; Chang, Cheng and Khorana, 2000; Nofsinger and Sias, 1999; Wermers, 1999; Choe, Kho and Stulz, 1999; Christie and Huang, 1995; Lakonishok, Shleifer and Vishny, 1992; Klemkovsky, 1977; Kraus and Stoll, 1972). Therefore, it seems reasonable to consider herding as a possible origin of non-optimal portfolio diversification. There have not yet been any experimental studies that have examined the potential influence of herding on diversification decisions.

Gurus are highly ranked religious authorities in hinduism and buddhism. In Western cultures, the term “guru” is also refers to leaders whose followers trust them blindly and uncritically and can therefore be transferred to any situation in which people show such a behavior. The strict orientation of many private investors towards the decisions of prominent, particularly successful investors is hence known as the “guru effect”. The guru effect can be considered a special case of herding. The gurus’ behavior is closely observed by many actors on the capital market, which is why it can lead to herding. In the research on this phenomenon, the field of capital market simulation with interacting artificial agents (agent-based computational economics) has established itself as a reliable research method. It shows that the network structure of the communication among the agents significantly influences the events on the capital market. Gurus are so-called “super nodes” that have numerous direct communication links with other capital market actors and, for this reason, can trigger herding (see e.g. Panchenko, Gerasymchuk and Pavlov, 2013; Hein, Schwind and Spiwoks, 2012; Tedeschi, Iori and Gallegati, 2012; Tedeschi, Iori and Gallegati, 2009; Hein, Schwind and Spiwoks, 2008; Markose, Alentorn and Krause, 2004). Furthermore, the guru effect can possibly contribute to distracting investors from optimal diversification decisions. There has not yet been any research on the influence of an investment guru on the optimal decisions of investors when compiling their portfolios.

1.3. Status-quo Bias

Many people experience difficulties in making active decisions. Instead of doing so, they tend to leave things as they are. This behavior is known as status-quo bias (cf. Samuelson and Zeckhauser, 1988). The psychological processes of this behavior are explained in detail by Anderson (2003). Especially in situations when investors accede to an existing security portfolio (for instance by inheritance), they often tend to postpone or even omit to adjust the portfolio structures. Even if different performances of the stocks in the portfolio lead to an unintended imbalance, many investors dread adjusting the portfolio at the right time. This is often grounded in reluctance to take responsibility for the future investment profit of a portfolio. Many investors are afraid of regretting their own actions (cf. Inman and Zeelenberg, 2002; Zeelenberg *et al.*, 2002; Kahnemann and Tversky, 1982). There are now some empirical findings on the status-quo bias in the behavior of financial market actors (see e.g. Freiburg and Grichnik, 2013; Bryant, Evans and Bishara, 2012; Gubaydullina, Hein and Spiwoks, 2011; Kempf and Ruenzi, 2006; Choi *et al.*, 2004; Agnew, Balduzzi and Sundén, 2003; Patel, Zeckhauser and Hendricks, 1991). The status-quo bias has also been proven by numerous experimental studies (see e.g. Geng, 2016; Yen and Chuang, 2008). Hence, it seems reasonable to consider the status-quo bias as a possible reason for non-optimal diversification decisions. There is yet only one experimental study which goes further into this question. Brown und Kagel (2009) yield information on the influence of the status-quo bias on non-optimal portfolio choices.

1.4. Gambler’s Fallacy

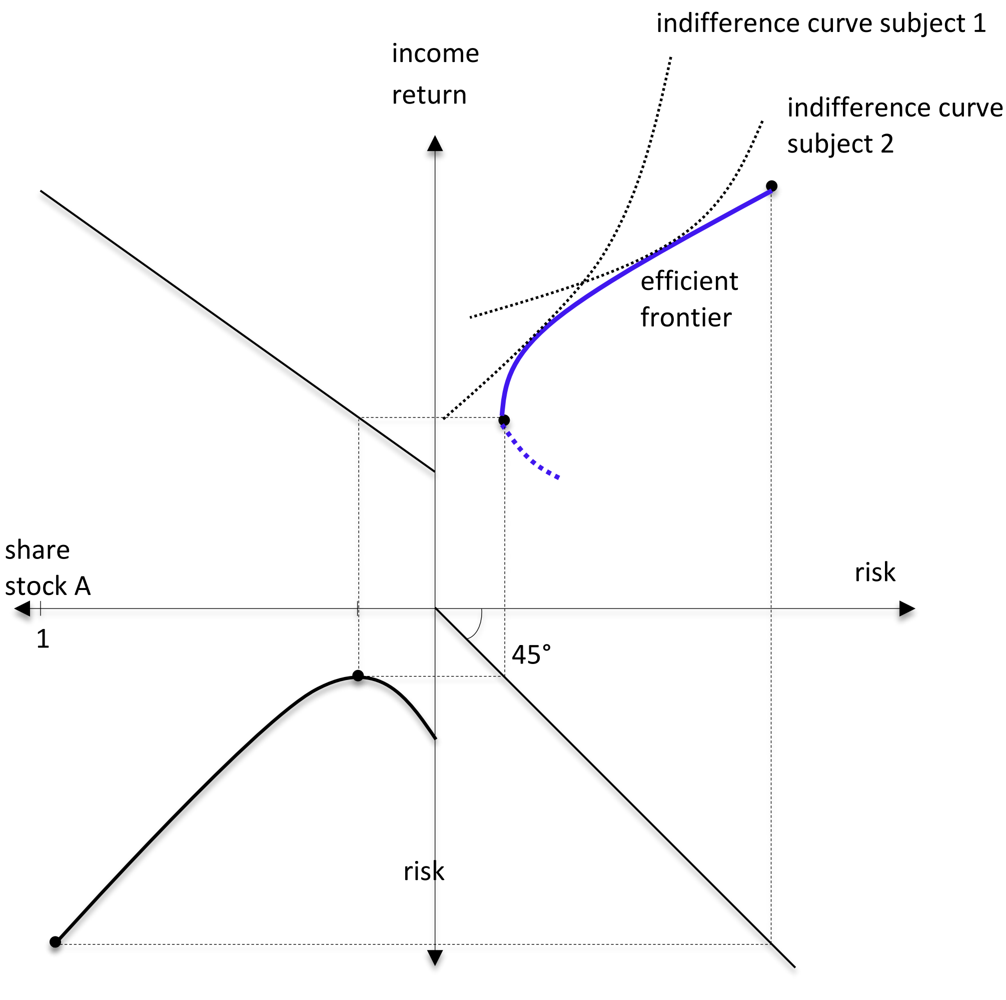
The experimental study by Gubaydullina and Spiwoks (2015) has already conveyed that irrelevant information can distract the participants from optimal diversification decisions. Considering the history of random events in evaluating random processes seems particularly tempting to many subjects. If a coin toss shows “heads” three times in a row, many people are liable to assuming that “tails” will show next. The history of unconnected random events, however, does not reveal anything about their future. The possibility for “heads” in the fourth toss is also exactly 50%. This deception resulting from the character of unconnected random events is called “gambler’s fallacy”. This phenomenon has been known and proven for a long time (see e.g. Chen, Moskowitz and Shue, 2016; Suetens, Galbo-Joergensen and Tyran, 2016; Stöckl *et al.*, 2015; Powdthavee and Riyanto, 2012; Barron and Leider, 2010; Ayton and Fischer, 2004; Clotfelter and Cook, 1991; Tversky and Kahneman, 1974; Tversky and Kahneman, 1971). We suggest more research regarding the distraction of subjects in making optimal diversification decisions as a result of gambler’s fallacy. Up to this point, experimental economic research has not yet devoted itself to the question to what extent the gambler’s fallacy can contribute to non-optimal portfolio compilations.

2. Hypotheses and Experimental Design

2.1. Identification of Optimal Portfolios

Identifying optimal decisions of diversification remains difficult even in the easiest of cases, as in the evaluation of two stocks (A and B) that are independent in their income return development. Not only must the efficient frontier of all possible stock combinations be determined but the form of the indifference curves of the investors in question must be considered (see figure 1).

Figure 1: Identification of Optimal Stock Combinations in Consideration of the Efficient Frontier and the Individual Risk Aversion, or the Individual Indifference Curves

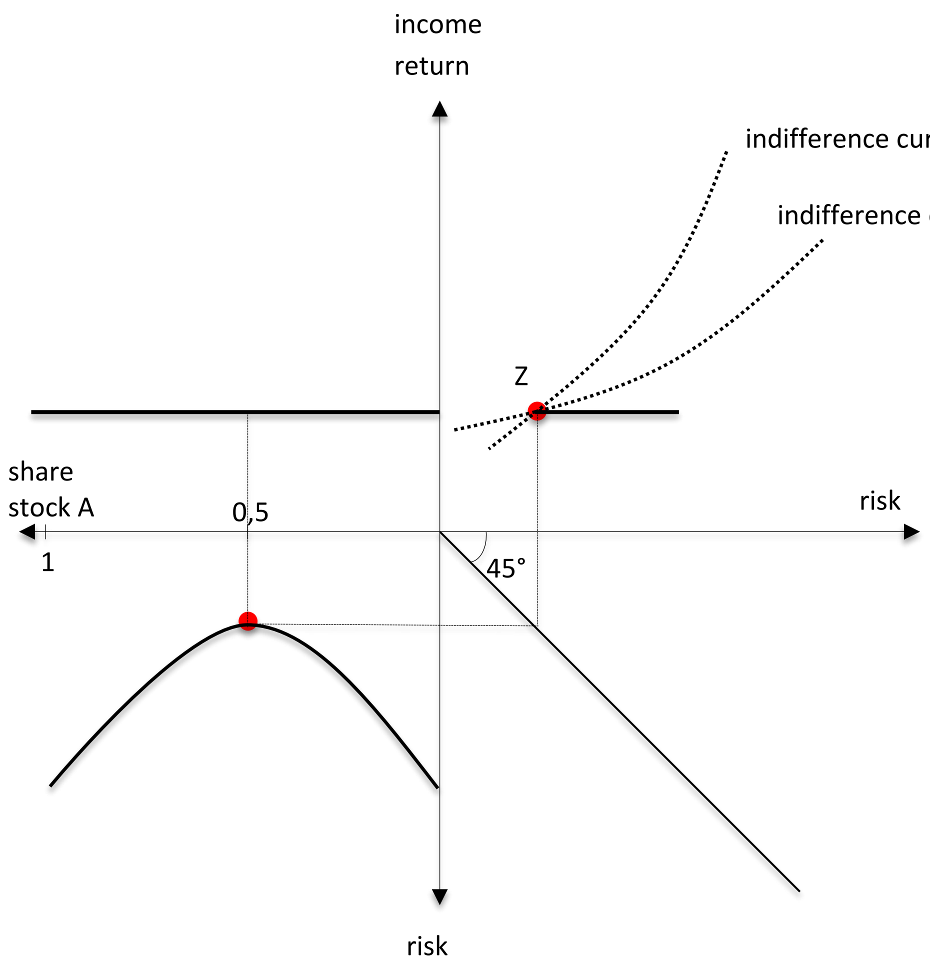


A strongly risk-averse investor (subject 1) finds their ideal combination of stocks in the lower margin of the efficient frontier. A less risk-averse investor (subject 2) however, finds their ideal combination of stocks in the upper margin of the efficient frontier. There might be reliable empirical methods to differentiate between risk-averse, risk-neutral and risk-loving subjects (see e.g. Lönnqvist *et al.*, 2015; Charness, Gneezy and Imas, 2013; Crosetto and Filippin, 2013; Dohmen *et al.*, 2011; Eckel and

Grossmann, 2008; Lejuez et al., 2003; Holt and Laury, 2002; Eckel and Grossmann, 2002; Gneezy and Potters, 1997) but capturing the exact layout of the indifference curves for a specific subject remains impossible. Some studies try to solve this problem by considering all stock combinations on the efficient frontier as an ideal choice. However, this approach does not take into account that only one exact point of the efficient frontier can be deemed the optimal combination of stocks for an individual investor.

To oppose this severe vagueness in the interpretation of results, we employ the method of Gubaydullina and Spiwoks (2015): The subjects are offered two entirely uncorrelated alternatives for investment (A and B), which are identical regarding the expected income return and risk. By doing so, the efficient frontier is reduced to a single point (point Z in figure 2). For such a constellation, it is of no importance whether a strongly or a less risk-averse subject makes the decision. In both cases, only the exactly equal mix of both investment alternatives (A and B) can be interpreted as the ideal combination of stocks. Only with this methodology precise results in an experiment on diversification can be obtained.

Figure 2: Precise Identification of an Ideal Combination of Stocks with a Punctate Efficient Frontier (Point Z).



The participants can choose between two different risky securities A and B. They can freely assemble a portfolio from these four stocks. The possible portfolios are AAAA, AAAB, AABB, ABBB and BBBB. Both stock A and stock B generate an income return of ±0 play dollars or +7 play dollars in each round. Both possible returns occur with a probability of 50% and follow a random process. The performance of stock A is independent of the performance of stock B. Both stock A and stock B are therefore expected to be chosen with a value of 3,5 play dollars. A portfolio consisting of four stocks is expected to generate a return equaling the value of 14 play dollars per round (see table 1). The play dollars are calculated into Euros in the ratio 10:1, resulting in an expected value of € 1.40 per round. Hence, he participants profit directly from the success of their investment behavior.

The five possible portfolios may have the same expected income return of 14 play dollars per round but the exposure to risk—henceforth expressed by the standard deviation—is different for each portfolio. The standard deviation of the combination AAAA is 14.0, whereas the standard deviation of the combination AABB is only 9.9 (see table 1). The standard deviation (*SD*) is calculated as follows:

(1) $$SD = \sqrt{\left(\sum_{i=1}^{n} [r_i - E(r)]^2 \cdot p_i \right)}$$

The index *i* stands for the possible random events, *r* is the respective income return, *E(r)* the expected value of the income return and *p* the probability of occurrence regarding the possible random events (see e.g. Auckenthaler, 1994, p. 133; Elton and Gruber, 1995, pp. 49-50).

Table 1: Expected Values and Standard Deviations of the Income Return for the Five Portfolios Considering the Possible Random Events for Stocks A and B in Play Dollars

Random Events	A: +7; B: +7 (p_1 = 0.25)	A: +7; B: ±0 (p_2 = 0.25)	A: ±0; B: +7 (p_3 = 0.25)	A: ±0; B: ±0 (p_4 = 0.25)	*E(r)*	*SD*
AAAA	+28	+28	±0	±0	14	14.0
AAAB	+28	+21	+7	±0	14	11.1
AABB	+28	+14	+14	±0	14	9.9
ABBB	+28	+7	+21	±0	14	11.1
BBBB	+28	±0	+28	±0	14	14.0

p = probability of occurrence; *E(r)* = expected value of income return; *SD* = Standard Deviation

2.2. Rational Strategy

A rational, risk-averse subject should always choose the security combination AABB. Since the expected income return of the five possible portfolio compilations are identical, it is rational for each risk-averse subject to choose the portfolio with the minimum variance—independent of the fact that the subject is less or more risk-averse.

These circumstances are easy to capture intuitively. Regarding the structured components of the given stocks, the participants can recognize the portfolio with the minimum variance without having to do any mathematical calculations. Using simple plausibility, it can be established that the income return level most when both stocks A and B are equally represented in the portfolio (see table 1).

Considering the numerous empirical findings on the incapability or reluctance of subjects to make reasonable diversification decisions, we expect clear deviations from the rational strategy (always portfolio AABB) to occur in this experiment.

We therefore formulate *hypothesis 1*: the participants are not going to behave rationally, which means that they are not going to exclusively choose the portfolio with the minimum variance (AABB).

2.3. Herding

As we aim to investigate herding, or the influence of the guru effect, the participants must be given the opportunity to follow the portfolio of the majority or that of the most successful fellow gambler—if required, in each round. This must result in an experiment that is structured in multiple periods. The portfolios can be rearranged for free before the start of each round.

In the basic treatment, the portfolios of each participant as well as their investment success are published in a ranking. Before they might restructure their own portfolio, the participants thereby gain insight into their fellow gamblers' portfolio choices in the past round and into the portfolio of the most successful participant. By doing so, the participants may follow the majority or the most successful gambler (guru).

In control treatment 1, the participants do not receive any information on the other participants' behavior or their investment success. They are solely informed about their own success and therefore not given the possibility to follow a guru or the majority opinion because both are non-detectable.

Given the numerous empirical findings on the occurrence of herding on the financial market, we expect the portfolios to assimilate in the course of the basic treatment.

Hypothesis 2 therefore reads as follows: the participants are going to converge in the 15 rounds of the basic treatment and will form a herd.

Since the investment behavior and success of the other participants cannot be observed in control treatment 1, we expect the participants to be less distracted from the rational strategy (always portfolio AABB).

Hypothesis 3 therefore reads as follows: the average deviation from the rational strategy (always portfolio AABB) is going to be stronger in the basic treatment than in control treatment 1.

If deviations from the rational strategy occur more often and are stronger in the basic treatment, this should show in the average exposure to risk.

Hypothesis 4 therefore reads as follows: the average exposure to risk is significantly higher in the basic treatment than in control treatment 1.

2.4. Status-quo Bias

To investigate the aspect of status-quo bias, we equipped the participants with different stocks in the basic treatment. 20% of the participants each started with portfolio AAAA, portfolio AAAB, portfolio AABB, portfolio ABBB and portfolio BBBB. The participants were allowed to freely reassemble their portfolios before the first round. In control treatment 2, all participants receive the optimal portfolio

(AABB) at the beginning of the experiment, which they can again reassemble before it starts. As the status-quo bias has often been empirically proven, we assume that the optimal portfolio (AABB) is more frequently selected during the 15 rounds of control treatment 2 than during the basic treatment.

Hypothesis 5 therefore reads as follows: the average deviation from the rational strategy (always portfolio AABB) will be stronger in the basic treatment than in control treatment 2.

If the deviations from the rational strategy are stronger and occur more often in the basic treatment, this should show in the average exposure to risk.

Hypothesis 6 therefore reads as follows: the average exposure to risk will be higher in the basic treatment than in control treatment 2.

2.5. Gambler's Fallacy

To detect whether the participants are liable to gambler's fallacy, we questioned them in all three treatments as well as between rounds 4 and 5 and rounds 10 and 11 about the reasons for their portfolio choices (in round 5 and round 11). As gambler's fallacy is a phenomenon that can often be observed, we expect the participants to try and detect patterns in the history of random events which do not exist. "After stock A has generated a high income return, I will put my faith in stock B." "After stock B has lastly returned no income, I will choose stock B." Responses like this show the gambler's fallacy. We think that answers like this will often occur.

Hypothesis 7 therefore is: gambler's fallacy is going to be one of the main reasons for certain portfolio choices.

Gambler's fallacy can also be detected when looking at the history of the game. If a positive (negative) event for stock A (stock B) frequently leads to a reduced (increased) interest in stock A (stock B) in the following round, the influence of gambler's fallacy can be detected.

Hypothesis 8 therefore reads as follows: a positive (negative) income return in the current round reduces (increases) the popularity of this stock in the next round.

2.6. Capture of Risk Attitude and Conduction of the Experiment

The exclusive rational strategy for risk-averse investors is to always choose the portfolio compilation AABB. Possible deviations from the rational strategy can therefore only be identified if only risk-averse participants are admitted to the experiment. This is the reason why we tested each participant according to Holt und Laury (2002) and cleaned the starting field of risk-neutral and risk-loving participants.

To ensure that the task was fully understood by all participants, we asked them control questions. Only those who answered all control questions correctly were allowed to participate in the experiment. The complete instructions and control questions can be found in appendix 1.

The experiment was conducted from 19 May 2016 to 27 May 2016 at the Ostfalia Laboratory for Experimental Economic Research (Ostfalia Labor für experimentelle Wirtschaftsforschung *OLEW*) of the Ostfalia University of Applied Sciences in Wolfsburg. 188 participants took part in the experiment, 38 of whom proved to be risk-neutral or risk-loving. 150 participants showed risk-averse behavior and could therefore be admitted to take part in the actual experiment. 53 participants completed the basic treatment, 46 participants sat control treatment 1 and 51 took part in control treatment 2. The participants were students of the Ostfalia University of Applied Sciences in Wolfsburg, 84 of whom study at the Faculty of Business (44.7%), 28 at the Faculty for Health Services (14.9%) and 76 at the Faculty of Automotive Engineering (40.4%). 16 sessions were conducted in total. Ten to twelve participants took part in each session.

The experiment was implemented in z-Tree (see Fischbacher, 2007). At the Ostfalia Lab, we used 12 work spaces, each equipped with a monitor and a separating wall between the participants. The experiments were consistently overseen by a game master to avoid that the participants communicated with each other or used unauthorized devices (like smartphones). The participants did not receive a general show-up fee. When assessing their willingness to take risks, € 2.18 were paid out to each participant. The actual experiment resulted in a payout of averagely € 21.89. In total, the participants received an average payout of € 24.07. The highest payout amounted to € 31.85, the lowest to € 17.40. The experiment lasted 45 minutes on average. The payout can therefore be deemed highly attractive. All participants seemed motivated and concentrated.

3. Results

3.1. Rational Strategy

The results of the experiments partly met the expectations but also revealed some surprising facts. Table 2 clearly shows that hypothesis 1 cannot be rejected. The optimal portfolio (AABB) was the most frequently chosen alternative in all three treatments but it must be admitted that more than 60% of all portfolio choices do not equate to the logical consideration. Many participants therefore show a non-rational investment behavior, which meets our expectations.

Table 2: Percental Distribution of the Portfolios in the Three Treatments

	Percentage of AAAA Portfolios	Percentage of AAAB Portfolios	Percentage of AABB Portfolios	Percentage of ABBB Portfolios	Percentage of BBBB Portfolios
Rational Strategy for all Three Treatments	0%	0%	100%	0%	0%
Basic Treatment	11.68%	18.73%	39.75%	19.36%	10.44%
Control Treatment 1	8.68%	22.45%	31.89%	22.46%	14.49%
Control Treatment 2	8.36%	21.69%	40.93%	18.29%	10.71%
Total	9.63%	20.88%	37.74%	19.95%	11.77%

3.2. Herding

It is surprising in the basic treatment, however, that neither the leading gambler (guru) nor the majority of gamblers influence the other participants to a crucial extent. Neither do the participants, in their decision making, follow the opinion of the majority nor the actions of the leading gamblers (as can be seen on the course of the six sessions of the basic treatment as portrayed in tables A-1 to A-6 in appendix 2).

On occasion, we can observe the forming of a herd but this only ever lasts a short while. In session 1 of the basic treatment (see table A-1 in appendix 2), for instance, already 60% of the participants settle on portfolio AABB. This number increases to 70% in round 2. Subject to some variations, is increases to 80% in round 7. In round 10, however, it recedes to 30%. In session 2 of the basic treatment (see table A-2 in appendix 2), we can again observe a plus in the stock combination AABB. In the first round, 44% of the participants chose this portfolio structure, and 67% do so in the second round. Subsequently, however, these decisions recede to 11% in round 13, only to end at 22% in the last round. In session 3 of the basic treatment (see table A-3 in appendix 2), an increasing number of participants chooses portfolio BBBB. None of the participants in round 3 decides for this combination. In round 4, 11% make this decision, and as much as 22% do so in round 5, and even 44% in round 6. This development, however, is not continued but collapses rather quickly. In session 4 of the basic treatment (see table A-4 in appendix 2), similar results are achieved. The portfolio structure ABBB is increasingly considered by the participants. In round 7, this portfolio is selected by 10% of the participants, and by 20%, 30% and 40% percent in the subsequent rounds. This development stops abruptly after that. In rounds 13 to 15, this combination is no longer chosen. In session 5 of the basic treatment (see table A-5 in appendix 2), the combination ABBB proves popular again for some time. The number of participants deciding for this portfolio structure increases from round 5 (14%), over rounds 6 and 7 (29%) to round 8 with 57%. Subject to some variations, this affirmation recedes to 14% in round 15. In session 6 of the basic treatment (see table A-6 in appendix 2), no herding can be established for portfolio AAAB. In round 1, this combination is chosen by 13% of the participants, by 25% in round 2, by 38% in round 3, and by as much as 63% in round 4. In the following round, this development suddenly stops. As early as round 7, this portfolio is no longer chosen by any of the participants.

The investment guru, too, exerts only little influence on the participants. In session 2 of the basic treatment (see table A-2 in appendix 2), the leader kept AAAA as their portfolio structure after round 11. Despite this decision, none of the participants chose this combination in round 12. One round later, the leader chose the portfolio BBBB, which was only selected by 11% of all participants in round 13. The other sessions produced similar results.

Table 3 shows that the participants' behavior stays fragmented until the last round and that no herding occurs. Therefore, hypothesis 2 must be discarded.

Table 3: Percental Distribution of the Portfolios at the End of the Game in the Basic Treatment

	Percentage of AAAA Portfolios in Round 15	Percentage of AAAB Portfolios in Round 15	Percentage of AABB Portfolios in Round 15	Percentage of ABBB Portfolios in Round 15	Percentage of BBBB Portfolios in Round 15
Session 1	30.0%	10.0%	50.0%	10.0%	0.0%
Session 2	33.3%	33.3%	22.2%	11.1%	0.0%
Session 3	11.1%	33.3%	44.4%	0.0%	11.1%
Session 4	30.0%	20.0%	40.0%	0.0%	10.0%
Session 5	0.0%	42.9%	28.6%	14.3%	14.3%
Session 6	37.5%	25.0%	0.0%	12.5%	25.0%

It can also be observed that—contrary to our expectations—the portfolio with the minimum variance is chosen more often in the basic treatment than in control treatment 1. We assumed that, by observing and following their fellow participants' behavior, the participants would be frequently deviated from choosing the optimal stock combination AABB. In control treatment 1, where the other participants' behavior cannot be observed, herding is generally impossible. As a matter of fact, the contrary is the case. While the portfolio with minimum variance (AABB) was chosen in 39.8% of all cases in the basic treatment, it was selected in only 31.9% of all cases in control treatment 1 (see table 2). This means that hypothesis 3 must be rejected.

We had expected that the possibility to follow other participants would lead to a significantly higher exposure to risk in the basic treatment than in control treatment 1. Since herding did not develop, the exposure to risk was not increased. The average standard deviation of the portfolios in the basic treatment was 11.37. The average standard deviation of the portfolios in control treatment 1 was 11.49. Following the Wilcoxon-Mann-Whitney Test, this difference is not relevant. The value p is 0.5485 (see table 4). Hence, hypothesis 4 must also be discarded.

Table 4: Exposure to Risk (Average Standard Deviation of the Portfolios) in the Basic Treatment and in Control Treatment 1

Exposure to Risk (Average Standard Deviation)		
Basic Treatment	Control Treatment 1	Value P
11.37	11.49	0.5485

*** = significant with an error rate of 1%, ** = significant with an error rate of 5%, * = significant with an error rate of 10%.

As an interim result, we can conclude that the participants do not behave rationally in making most of their portfolio choices. The optimal portfolio (AABB) is only chosen in 30-40% of all cases (39.8% in the basic treatment, 31.9% in control treatment 1). Herding, as it seems, is clearly not responsible for this. There is neither a lasting orientation towards the portfolio structure of the majority of gamblers nor a lasting orientation towards the portfolio structure of the most successful gambler.

3.3. Status-quo Bias

To investigate the aspect of the status-quo bias, we now compare the basic treatment with control treatment 2. In the basic treatment, 20% of the participants are given the security combination AAAA, AAAB, AABB, ABBB and BBBB before the start of the experiment (see table A-7 in appendix 3). In control treatment 2, the portfolio with the minimum variance (AABB) is given to every participant (see table A-9 in appendix 3). The participants can freely reassemble their portfolios before the beginning of the first round.

We expected the tendency to follow the status quo, as has often been explained in research literature, would also occur in the present experiment. In control treatment 2, that all participants start with the optimal portfolio (AABB), the optimal portfolio structure should have been selected more often than in the basic treatment, in which only every fifth participant was provided with an ideally structured portfolio. As a matter of fact, the participants did not keep their initial portfolio. In control treatment 2, 39.2% of the participants reassembled their portfolio before the start of the first round, resulting in only 60.8% of the portfolios having the ideal structure (AABB) before the start of the first round (see table A-9 in appendix 3). Over the course of the game, this percentage recedes even further. In the basic treatment, 39.8% of all portfolios have the optimal structure. In control treatment 2, only 40.9% of portfolios with this structure remain. This difference is small and non-relevant according to the Wilcoxon-Mann-Whitney Test. The value p is 0.6626 (table 5). Hypothesis 5 must hence be discarded.

Table 5: Percentage of the Optimal Portfolios in all Portfolios of the Basic Treatment and Control Treatment 2

Share of Optimal Portfolios in %		
Basic Treatment	Control Treatment 2	Value P
39.8%	40.9%	0.6626

*** = significant with an error rate of 1%, ** = significant with an error rate of 5%, * = significant with an error rate of 10%.

We assumed that, given the status-quo bias in control treatment 2, the optimal portfolio (AABB) would be chosen more often than in the basic treatment. This could have resulted in a significantly lower exposure to risk. As a matter of fact, the average exposures to risk (standard deviation) are 11.37 in the basic treatment and 11.29 in control treatment 2. According to the Wilcoxon-Mann-Whitney Test, this difference is not relevant. The value p is 0.9741 (see table 6), wherefore hypothesis 6 must be discarded.

Table 6: Exposure to Risk (Average Standard Deviation of the Portfolios) in the Basic Treatment and in Control Treatment 2

Exposure to Risk (Average Standard Deviation)		
Basic Treatment	Control Treatment 1	Value P
11.37	11.29	0.9741

*** = significant with an error rate of 1%, ** = significant with an error rate of 5%, * = significant with an error rate of 10%.

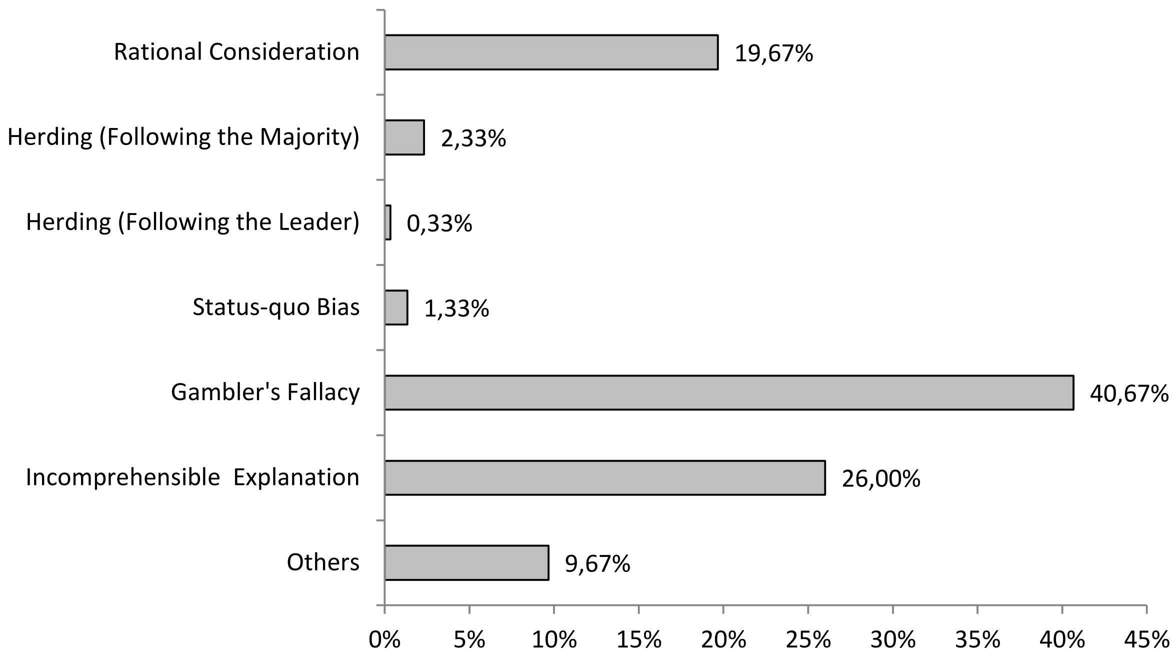
As an intermediate result, we can conclude that most participants do not behave rationally when compiling their portfolios. The serious deviation from the rational strategy, however, cannot be explained by the status-quo bias. Hence, we cannot confirm the result by Brown and Kagel (2009).

3.4. Gambler's Fallacy

Gambler's fallacy becomes the center of attention. It is reasonable to think that the participants inferred from past random events that a certain sequence of events is going to happen in the future although this is impossible for independent random events. To understand this, we assess the reasons that the participants gave for their portfolio choices at the beginning of round 5 and at the beginning of round 11. In the experiment, the participants were asked to provide the following information: "Please give a short explanation for your decision in period 5 (period 11)! This explanation does not affect your result! You can openly state your considerations." We expected to receive many answers that prove the influence of gambler's fallacy. "After stock A returned a high income twice in a row, I will select stock B." "After stock B returned no income, I will choose stock B." Answers like these reveal gambler's fallacy.

We differentiate between the following clusters of reasons: 1. rational consideration (suitable orientation towards the expected value of the income return and the risk), 2. herding (following the majority of gamblers), 3. herding (following the most successful gambler, the guru), 4. status-quo bias (following the present portfolio), 5. gambler's fallacy (following the history of random events), 6. Incomprehensible explanations[2] and 7. other reasons[3].

Figure 3: Percentage of the Named Reasons for the Portfolio Choices



[2] Incomprehensible explanations are, for instance, the input of random letters or numbers only to fill in the box and to start the next round.
[3] Other reasons are, for example: "I have to take a higher risk in order to achieve a higher ranking."

It can be concluded that participants often tried to reason future random events from past random events. This consideration was detected in 40.67% of the answers (see figure 3). That is why hypothesis 7 cannot be discarded. It appears that gambler's fallacy significantly contributes to irrational portfolio choices.

The question remains whether a behavioral pattern explaining the gambler's fallacy can be directly explained by analyzing the portfolio choices. The sequence of random events (income return of stock A and stock B) was structured by coin toss in advance and then taken as a basis in all treatments (see table 7).

Table 7: Sequence of Random Events for both Stocks A and B in 15 Rounds

Round	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Random Event of Stock A	±0	+7	±0	+7	+7	±0	±0	+7	±0	±0	+7	+7	±0	±0	+7
Random Event of Stock B	+7	+7	+7	±0	+7	±0	+7	±0	±0	+7	±0	+7	+7	±0	±0

Table 8 shows that the gambler's fallacy consistently influenced the participants' portfolio choices indeed. The first column lists those rounds of the game in which gambler's fallacy took effect. No random events existed before round 1, which is why gambler's fallacy could not take effect before the portfolio choice in round 2. The second and third column of table 8 list the random events of the *previous* rounds. The fourth column shows which stock is preferred by the participants who are subject to gambler's fallacy. In round 1, for instance, stock A has an income return of ±0 play dollars and stock B has an income return of +7 play dollars. This is the development that the gamblers can see before round 2. This results in a preference for stock A. Before the start of round 3, the "errant gambler" again prefers stock A. This is due to the following consideration: In the previous round, both stocks had a positive income return (+7 play dollars) but for stock A, it is the first in succession, while it is the second in succession for stock B. Before round 4, the consideration of round 2 is repeated and results in yet another preference for stock A. Round by round, considerations such as these lead to preferences that are listed in the fourth column of table 8.

The columns 5, 6, 7, 8 and 9 of table 8 show the percentages of the five possible portfolio compilations (AAAA, AAAB, AABB, ABBB and BBBB) for all three treatments (basic treatment, control treatment 1 and control treatment 2; for detailed results see tables A-7, A-8 and A-9 in appendix 3). Column 10 in table 8 displays an unweighted spread, calculated by subtracting the portfolio choices that prefer stock B (columns 8 (Y) and 9 (Z)) from those that prefer stock A (columns 5 (W) and 6 (X)). We calculate: (W+X) – (Y+Z). In round 2 this means: (8.00 + 25.33) – (20.00 + 6.67) = 6.67.

Table 8: Manifestation of Gambler's Fallacy in the Portfolio Choices of all Treatments

1	2	3	4	5	6	7	8	9	10	11
Round	Random Event of the Previous Round for Stock A	Random Event of the Previous Round for Stock B	Expected Preference with Gambler's Fallacy	Percentage of AAAA Portfolios (W)	Percentage of AAAB Portfolios (X)	Percentage of AABB Portfolios	Percentage of ABBB Portfolios (Y)	Percentage of BBBB Portfolios (Z)	Surplus (W+X) – (Y+Z)	Answers the Expectation
2	±0	+7	A	8.00%	25.33%	40.00%	20.00%	6.67%	6.67%	Yes
3	+7	+7	A	8.00%	23.33%	40.00%	20.00%	8.67%	2.67%	Yes
4	±0	+7	A	11.33%	29.33%	27.33%	18.00%	14.00%	8.67%	Yes
5	+7	±0	B	6.00%	18.00%	46.00%	16.00%	14.00%	-6.00%	Yes
6	+7	+7	B	10.00%	16.67%	39.33%	21.33%	12.67%	-7.33%	Yes
7	±0	±0	B	8.00%	20.00%	40.00%	21.33%	10.67%	-4.00%	Yes
8	±0	+7	A	8.67%	28.67%	34.67%	17.33%	10.67%	9.33%	Yes
9	+7	±0	B	5.33%	17.33%	34.00%	27.33%	16.00%	-20.67%	Yes
10	±0	±0	B	5.33%	10.67%	40.67%	28.00%	15.33%	-27.33%	Yes
11	±0	+7	A	18.67%	21.33%	35.33%	14.67%	10.00%	15.33%	Yes
12	+7	±0	B	6.00%	14.00%	37.33%	27.33%	15.33%	-22.67%	Yes
13	+7	+7	B	7.33%	20.67%	29.33%	26.67%	16.00%	-14.67%	Yes
14	±0	+7	A	17.33%	26.00%	33.33%	14.67%	8.67%	20.00%	Yes
15	±0	±0	A	19.33%	24.00%	36.00%	8.67%	12.00%	22.67%	Yes

If the subtraction results in a positive value, it can be concluded that the participants preferred stock A to stock B when compiling their portfolios. If the subtraction results in a negative value, it can be concluded that the participants preferred the stock B to stock A when assembling their portfolios. Consequently, we can expect that a preference for stock A results in a positive balance and that a preference for stock B results in a negative balance. In column 11 of table 8, we analyze which rounds answer our expectations, and we can see that this is true without exception. When in column 4 the stock A (stock B) is listed then the balance in column 10 is positive (negative).

Considering that the participants are subject to gambler's fallacy and accordingly develop preferences for stock A or stock B (column 4 of table 8), then we can find a suitable explanation for the surplus of A stocks (positive indication in column 10) or, respectively, for the surplus of B stocks (negative indication in column 10) in all rounds. Hypothesis 8, therefore, cannot be discarded. It is obvious that the gambler's fallacy affects the participants' portfolio choices and thereby contributes to the fact that the rational consideration (to always chose the portfolio with the minimum variance) can only be observed in 37.7% of all decisions made by the participants.

4. Summary

The present experimental study examines the participants' diversification behavior. It focuses on the research question if herding (being guided by most fellow gamblers or by the most successful gambler (guru)), status-quo bias and gambler's fallacy can properly explain that many subjects keep clearly under-diversified portfolios. Although much empirical evidence has been found in the meanwhile to explain the influence of these phenomena (herding, status-quo bias and gambler's fallacy) on many economic decisions, it has not been experimentally examined with relation to diversification decisions.

This experiment follows the approach by Gubaydullina and Spiwoks (2015): there are only two alternatives for investment (stock A und stock B), which can only produce two results. Either they bring an income return of ±0 play dollars or a return of +7 play dollars per round. Both results occur with a probability of 50%. The return of stock A and the return of stock B are independent events. In this constellation, the efficient frontier is reduced to one point (equal mixture of stock A and stock B), so that the participants' extent of risk aversion does not influence the optimal portfolio choice.

In the basic treatment, the participants receive information on their fellow gamblers in each round. They learn who chose which portfolio and how successful everyone was with their decisions. In the control treatment 1 this information is not provided. The comparison of the basic treatment and control treatment 1 is supposed to indicate to which extent the participants are distracted from making optimal portfolio choices by herding (being guided by most fellow gamblers or by the most successful gambler (guru)). Herding, however, cannot be observed. Neither do the participants follow most of their fellow gamblers nor the most successful gambler (guru). We must draw the conclusion that herding does not play a significant role in explaining non-optimal portfolio choices.

In the basic treatment, the participants start with different portfolios. Each of the portfolios AAAA, AAAB, AABB, ABBB and BBBB is given to 20% of the participants at the start of the experiment. In control treatment 2, 100% of the participants receive the optimal portfolio (AABB). If the phenomenon of the status-quo bias took effect, the optimal portfolio should be chosen more often in control treatment 2 and the average exposure to risk should be less than in the basic treatment. However, the experiment did not reveal a significant difference between the basic treatment and the control treatment 2 regarding the choice of optimal portfolios or the average exposure to risk. Hence, the status-quo bias does not play a crucial role in explaining non-optimal portfolio choices.

Over the course of the experiment, the participants are asked twice about their reasons for making a certain decision. We can conclude from their answers that many participants are zealous to infer future developments from past random events. If a positive event (+7 play dollars) has occurred for stock A (stock B), the participants tend to assume that stock B (stock A) will be the optimal choice in the next round. Conversely, if a negative event (±0 play dollars) has occurred for stock A (stock B), the participants tend to assume that stock A (stock B) will be the optimal choice in the next round. This phenomenon known as gambler's fallacy can be clearly detected when analyzing the participants' portfolio choices.

Overall, we can conclude that most portfolio choices (62.3%) in this experiment are non-optimal. However, neither herding nor status-quo bias essentially contributed to this irrational behavior. The gambler's fallacy, on the opposite, has a substantial influence on the participants' portfolio choices.

Literature

Agnew, J., Balduzzi, P., Sundén, A., Portfolio Choice and Trading in a Large 401(k) Plan, *The American Economic Review,* **93**(1), (2003), 193-215.

Anderson, A., Trading and Under-Diversification, *Review of Finance*, (2013), 1-43.

Anderson, C. J., The Psychology of Doing Nothing: Forms of Decision Avoidance Result From Reason and Emotion, *Psychological Bulletin*, **129**(1), (2003), 139-167

Auckenthaler, C., Theorie und Praxis des modernen Portfolio-Managements, 2nd ed., Paul Haupt, Bern, (1994).

Ayton, P., Fischer, I., The Hot-Hand Fallacy and the Gambler's Fallacy: Two Faces of Subjective Randomness?, *Memory & Cognition*, **32**(8), (2004), 1369-1378.

Baltussen, G., Post, G. T., Irrational Diversification: an Examination of Individual Portfolio Choice, *Journal of Financial and Quantitative Analysis,* **46**(5), (2011), 1463-1491.

Barber, B. M., Odean, T., Trading is Hazardous to your Wealth: The Common Stock Investment Performance of Individual Investors, *Journal of Finance*, **55**(2), (2000), 773-806.

Barron, G., Leider, S., The Role of Experience in the Gambler's Fallacy, *Journal of Behavioral Decision Making*, **23**, (2010), 117-129.

Belhoula, M., Naoui, K., Herding and Positive Feedback Trading in American Stock Market: a Two-directional Behavior of Investors, *International Journal of Business and Management*, **6**, (2011), 244-252.

Benartzi, S., Excessive Extrapolation and the Allocation of 401(k) Accounts to Company Stock, *The Journal of Finance***, 56**(5), (2001), 1747-1764.

Benartzi, S., Thaler, R. H., Naïve Diversification Strategies in Defined Contribution Saving Plans, *American Economic Review,* **91**(1), (2001), 79-98.

Blume, M. E., Friend, I., The Asset Structure of Individual Portfolios and Some Implications for Utility Functions, *The Journal of Finance*, **30**(2), (1975), 585-603.

Bode, M., van Echelpoel, A., Sievi, C. R., Multinationale Diversifikation: Viel zitiert, kaum befolgt, *Die Bank*, **94**(4), (1994), 202-206.

Boyson, N. M., Implicit Incentives and Reputational Herding by Hedge Fund Managers, *Journal of Empirical Finance*, **17**, (2010), 283-299.

Brown, A. L., Kagel, J. H., Behavior in a Simplified Stock Market: the Status-quo Bias, the Disposition Effect and the Ostrich Effect, *Annals of Finance*, **5**, (2009), 1-14.

Bryant, L. L., Evans, J., Bishara, J.: Status Quo Bias in the Mutual Fund Market: Consumer Inertia Amidst Benefitless Fee Increases, *Banking and Finance Review*, **1**, (2012), 89-107.

Chang, C. H., The Relationship between the Disposition Effect and Herding Behavior: Evidence from Taiwan's Information Technology Stocks, *International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, **7**(7), 2013, 1971-1975.

Chang, E. C., Cheng, J. W., Khorana, A., An Examination of Herd Behavior in Equity Markets: an International Perspective, *Journal of Banking and Finance*, **24**, (2000), 1651-1679.

Charness, G., Gneezy, U., Imas, A., Experimental Methods: Eliciting Risk Preferences, *Journal of Economic Behavior & Organization*, **87**, (2013), 43-51.

Chen, D., Moskowitz, T. J., Shue, K., Decision Making under the Gambler's Fallacy: Evidence from Asylum Judges, Loan Officers and Baseball Umpires, NBER Working Papers Series, Working Paper 22026, (2016).

Chen, Y., Wang, C., Lin, F., Do Qualified Foreign Institutional Investors Herd in Taiwan's Securities Market?, *Emerging Markets Finance and Trade*, **44**, (2008), 62-74.

Chiang, T. C., Zheng, D., An Empirical Analysis of Herd Behavior in Global Stock Markets, *Journal of Banking and Finance*, **34**, (2010), 1911-1921.

Choe, H., Kho, B. C., Stulz, R. M., Do Foreign Investors Destabilize Stock Markets? The Korean Experience in 1997, *Journal of Financial Economics*, **54**, (1999), 227-264.

Choi, J. J., Laibson, D., Madrian, B. C., Metrick, A., For Better or For Worse: Default Effects and 401(k) Savings Behavior, in: Wise, D.A., Perspectives in the Economics of Aging, University of Chicago Press, (2004), 81-121.

Choi, S., Herding Among Local Individual Investors: Evidence from Online and Offline Trading, *Economics Letters*, **144**, (2016), 4-6.

Christie, W. G., Huang, R. D., Following the Pied Piper: Do Individual Returns Herd around the Market? *Financial Analysts Journal*, **51**, (1995), 31-37.

Clotfelter, C. T., Cook, P. J., The "Gambler's Fallacy" in Lottery Play, NBER Working Papers Series, Working Paper 3769, (1991).

Crosetto, P., Filippin, A., The "Bomb" Risk Elicitation Task, *Journal of Risk and Uncertainty*, **47**, (2013), 31-65.

Dimmock, S. G., Kouwenberg, R., Mitchell, O. S., Peijnenburg, K., Ambiguity Aversion and Household Portfolio Choice Puzzles: Empirical Evidence, *Journal of Financial Economics*, **119**, (2016), 559-577.

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J., Wagner, G. G., Individual Risk Attitudes: Measurement, Determinants, and Behavioral Consequences, *Journal of the European Economic Association*, **9**(3), (2011), 522-550.

Duttle, K., Disentangling Two Causes of Biased Probability Judgment – Cognitive Skills and Perception of Biased Probability Judgment – Cognitive Skills and Perception of Randomness, Ruhr Economic Papers 568, (2015).

Eckel, C. C. and Grossman, P. J., Sex differences and statistical stereotyping in attitudes toward financial risk, *Evolution and Human Behavior*, **23**(4), (2002), 281-295.

Eckel, C. C. and Grossman, P. J., Forecasting risk attitudes: An experimental study using actual and forecast gamble choices, *Journal of Economic Behavior & Organization*, **68**(1), (2008), 1-17.

Elton, E. J., Gruber, M. J., Modern Portfolio Theory and Investment Analysis, 5th ed., John Wiley & Sons Inc., New York, (1995).

Ennis, R. M., Sebastian, M. D., A Critical Look at the Case for Hedge Funds, *Journal of Portfolio Management*, **29**, (2003), 103-112.

Eyster, E., Weizsäcker, G., Correlation Neglect in Financial Decision Making, *DIW Discussion Papers*, **No. 1104**, Berlin (2011).

Fernandes, D., The 1/N Rule Revisited: Heterogeneity in the Naïve Diversification Bias, *International Journal of Research in Marketing*, **30**(3), (2013), 310-313.

Fischbacher, U., z-Tree: Zurich Toolbox for Ready-made Economic Experiments, *Experimental Economics*, **10**(2), (2007), 171–178.

Freiburg, M., Grichnik, D., Institutional Reinvestments in Private Equity Funds as a Double-Edged Sword: the Role of the Status-quo Bias, *The Journal of Behavioral Finance*, **14**, (2013), 134-148.

Galariotis, E. C., Rong, W., Spyrou, S. I., Herding on Fundamental Information: a Comparative Study, *Journal of Banking & Finance*, **50**, (2015), 589-598.

Geng, S., Decision Time, Consideration Time and Status-quo Bias, *Economic Inquiry*, **54**(1), 2016, 433-449.

Gneezy, U. and Potters, J., An Experiment on Risk Taking and Evaluation Periods, *The Quarterly Journal of Economics*, **112**(2), (1997), 631-645.

Goetzmann, W. N., Kumar, A., Equity Portfolio Diversification, *Review of Finance*, **12**(3), (2008), 433-463.

Gubaydullina, Z., Hein, O., Spiwoks, M., The Status-quo Bias of Bond Market Analysts, *Journal of Applied Finance and Banking*, **1**(1), (2011), 31-51.

Gubaydullina, Z., Spiwoks, M., Correlation Neglect, Naïve Diversification, and Irrelevant Information as Stumbling Blocks for Optimal Diversification, *Journal of Finance and Investment Analysis*, **4**(2), (2015), 1-19.

Guiso, L., Haliassos, M., Japelli, T., Household Portfolios, MIT Press, Cambridge, MA, (2002).

Hedesstrom, T. M., Svedsater, H., Garling, T., Covariation Neglect among Novice Investors, *Journal of Experimental Psychology-Applied*, **12**(3), (2006), 155-165.

Hein, O., Schwind, M., Spiwoks, M., Network Centrality and Stock Market Volatility: the Impact of Communication Topologies on Prices, in: *Journal of Finance and Investment Analysis*, **1**(1), (2012), 199-232.

Hein, O., Schwind, M., Spiwoks, M., Frankfurt Artificial Stock Market – A Microscopic Stock Market Model with Heterogeneous Interacting Agents in Small-World Communication Networks, *Journal of Economic Interaction and Co-ordination*, **3**(1), (2008), 59-71.

Hibbert, A. M., Lawrence, E. R., Prakash, A. J., Can Diversification Be Learned?, *The Journal of Behavioral Finance*, **13**(1), (2012), 38-50.

Holt, C. A., Laury, S. K., Risk Aversion and Incentive Effects, *American Economic Review*, **92**(5), (2002), 1644-1655.

Huang, T. C., Wu, C. C., Lin, B. H., Institutional Herding and Risk-return Relationship, *Journal of Business Research*, **69**, (2016), 2073-2080.

Huberman, G., Sengmueller, P., Performance and Employer Stock in 401(k) Plans, *Review of Finance*, **8**(3), (2004), 403-443.

Inman, J. J., Zeelenberg, M., Regret in Repeat Purchase versus Switching Decisions: the Attenuating Role of Decision Justifiability, *Journal of Consumer Research*, **29**(1), (2002), 116-128.

Kahneman, D., Tversky, A., The Psychology of Preference, *Scientific American*, **246**, 160-173.

Kallir, I., Sonsino, D., The Neglect of Correlation in Allocation Decisions, *Southern Economic Journal*, **75**(4), (2009), 1045-1066.

Kempf, A., Ruenzi, S., Status Quo Bias and the Number of Alternatives: an Empirical Illustration from the Mutual Fund Industry, *The Journal of Behavioral Finance*, **7**, (2006), 204–213.

Kim, W., Jegadeesh, N., Do Analysts Herd? An Analysis of Recommendations and Market Reactions, *Review of Financial Studies*, **23**, (2010), 901-937.

Klemkosky, R. C., The Impact and Efficiency of Institutional Net Trading Imbalances, *Journal of Finance*, **32**, (1977), 79-86.

Kraus, A., Stoll, H. R., Parallel Trading by Institutional Investors, *Journal of Financial and Quantitative Analysis*, **7**, (1972), 2107-2138.

Kremer, S., Nautz, D., Causes and Consequences of Short-term Institutional Herding, *Journal of Banking & Finance*, **37**, (2013), 1676-1686.

Lakonishok, J., Shleifer, A., Vishny, R. W., The Impact of Institutional Trading on Stock Prices, *Journal of Financial Economics*, **32**, (1992), 23-43.

Lawrence, E. R., Prakash, A. J., Can Diversification Be Learned?, *The Journal of Behavioral Finance*, **13**, (2012), 38-50.

Lease, R. C., Lewellen, W. G., Schlarbaum, G. G., The Individual Investor: Attributes and Attitudes, *The Journal of Finance*, **29**(2), (1974), 413-433.

Lejuez, C. W., Aklina, W. M., Zvolenskyb, M. J. and Pedullac, C. M., Evaluation of the Balloon Analogue Risk Task (BART) as a predictor of adolescent real-world risk-taking behaviours, *Journal of Adolescence*, 26(4), (2003), 475-479.

Lien, J. W., Yuan, J., The Cross-sectional "Gambler's Fallacy": Set Representativeness in Lottery Number Choices, *Journal of Economic Behavior & Organization*, **109**, (2015), 163-172.

Lin, W., T., Tsai, S.-C., Lung, P.-Y., Investors' Herd Behavior: Rational or Irrational?, Asia-*Pacific Journal of Financial Studies*, **42**, (2013), 755-776.

Lönnqvist, J.-E., Verkasalo, M., Walkowitz, G., Wichardt, P. C., Measuring Individual Risk Attitudes in the Lab: Task or Ask? An Empirical Comparison, *Journal of Economic Behavior & Organization*, **119**, (2015), 254-266.

Markose, S., Alentorn, A., Krause, A., Dynamic Learning, Herding and Guru Effects in Networks, University of Essex, Economics Department, Working Paper No. 582, 2004.

Markowitz, H., Portfolio Selection, *Journal of Finance*, **7**(1), (1952), 77-91.

Meulbroek, L., Company Stock in Pension Plans: how costly is it?, *The Journal of Law and Economics*, **48**(2), (2005), 443-474.

Morrin, M., Inman, J. J., Broniarczyk, S. M., Nenkov, G. Y., Reuter, J., Investing for Retirement: The Moderating Effect of Fund Assortment Size on the 1/N Heuristic, *Journal of Marketing Research*, **49**(4), (2012), 537-550.

Nofsinger, J., Sias, R., Herding and Feedback Trading by Institutional and Individual Investors, *Journal of Finance*, **54**, (1999), 2263-2295.

Panchenko, V., Gerasymchuk, S., Pavlov, O., V., Asset Price Dynamics with Local Interactions under Heterogeneous Beliefs, *Journal of Economic Dynamics and Control*, **37**(12), (2013), 2623-2642,

Patel, J., Zeckhauser, R., Hendricks, D., The Rationality Struggle: Illustrations from Financial Markets, *The American Economic Review*, **81**, (1991), 232–236.

Polkovnichenko, V., Household Portfolio Diversification: a Case for Rank-dependent Preferences, *Review of Financial Studies*, **18**, (2005), 1467-1502.

Powdthavee, N., Riyanto, Y. E., Why Do People Pay for Useless Advice? Implications of Gambler's and Hot-Hand Fallacies in False-Expert Setting, IZA Discussion Paper 6557, (2012).

Rieger, M. O., Why Do Investors Buy Bad Financial Products? Probability Misestimation and Preferences in Financial Investment Decision, *The Journal of Behavioral Finance*, **13**, (2012), 108-118.

Samuelson, W., Zeckhauser, R., Status-quo Bias in Decision Making, *The Journal of Risk and Uncertainty*, **1**, (1988), 7-59

Sias, R. W., Institutional Herding, *Review of Financial Studies*, **17**(1), (2004), 165-206.

Spiwoks, M., External Triggered Herding bei Rentenmarkt-Analysten, *Finanzmarkt und Portfolio-Management*, **18**(1), (2004), 58-83.

Spiwoks, M., Bizer, K., Hein, O., Anchoring Near the Lighthouse: Bond Market Analysts' Behavior Co-ordination by External Signal, in: *European Journal of Economics, Finance and Administrative Sciences*, **13**, (2008), 169-191.

Stöckl, T., Huber, J., Kirchler, M., Lindner, F., Hot Hand and Gambler´s Fallacy in Teams: Evidence from Investment Experiments, *Journal of Economic Behavior & Organization*, **117**, (2015), 327-339.

Suetens, S., Galbo-Joergensen, C., Tyran, J.-R., Predicting Lotto Numbers: Experiment on the Gambler´s Fallacy and the Hot-Hand Fallacy, *Journal of the European Economic Association*, **14**(3), (2016), 584-607.

Tedeschi, G., Iori, G., Gallegati, M., Herding Effects in Order Driven Markets: The Rise and Fall of Gurus, *Journal of Economic Behavior & Organization*, **81**, (2012), 82-96.

Tversky, A., Kahneman, D., Judgment under Uncertainty: Heuristics and Biases, *Science*, **185**, (1974), 1124–1131.

Tversky, A., Kahneman, D., Belief in the Law of Small Numbers, *Psychological Bulletin*, **76**(2), (1971), 105–110.

Voronkova, S., Bohl, M. T., Institutional Traders' Behavior in an Emerging Stock Market: Empirical Evidence on Polishpension Fund Investors, *Journal of Business Finance & Accounting*, **32**, (2005), 1537-1560.

Walter, A., Weber, F. M., Herding in the German Mutual Fund Industry, *European Financial Management*, **12**, (2006), 375-406.

Weber, E.U., Siebenmorgen, N., Weber, M., Communication Asset Risk: How Name Recognition and the Format of Historic Volatility Information Affect Risk Perception and Investment Decisions, *Risk Analysis*, **25**(3), (2005), 597-609.

Wermers, R., Mutual Fund Herding and the Impact on Stock Prices, *Journal of Finance*, **54**, (1999), 581-622.

Yen, H. R., Chuang, S. C., The Effect of Incidental Affect on Preference for the Status Quo, *Journal of the Academy of Marketing Science*, **36**, (2008), 522-537.

Zeelenberg, M., van den Bos, K., van Dijk, E., Pieters, R., The Inaction Effect in the Psychology of Regret, *Journal of Personality and Social Psychology*, **82**(3), 2002, 314-327.

Appendix 1: Instructions, Control Questions, Assessment of Risk Attitude

Instructions (Basic Treatment und Control Treatment 2)

The Game

By investing in stocks, you can benefit from the income return. There are two securities (stock A and stock b) to choose from. In each period of the game, the value of stock A is changed by +0 play dollars or +7 play dollars; both events occur with a probability of 50%. The same is true for stock B. Both securities have an expected value of +3.50 play dollars per period. The performances of both stocks are independent random events. 15 periods will be played in total and in each period, you have 4 units at your disposal that must be invested. The 4 units can be invested in the following portfolio combinations:

Portfolio 1: AAAA
Portfolio 2: AAAB
Portfolio 3: AABB
Portfolio 4: ABBB
Portfolio 5: BBBB

The game starts at period 0. At period 0, you have the possibility to restructure the portfolio that was randomly assigned to you. The performance of the stocks for the single periods were previously determined by 15 x two coin tosses (one toss for stock A and one toss for stock B). "Heads" signifies a good period (+7 play dollars) and "tails" signifies a weak period (+0 play dollars). You can earn up to 420 play dollars in the 15 periods.
For maximum transparency, you will be shown your results and all participants will be ranked after each period. The ranking is established according to the total earnings. You will therefore be able to compare the performance of your portfolio to the performance of the other participants' portfolios.
You can also earn up to € 3.85 in a lottery, detailed information on which you will receive in due course.

The Payout

In the 15 periods, you can earn up to 420 play dollars with the securities. 1 play dollar equals € 0.10. The maximum payout is € 42.00 (420 x 0.10). € 3.85 from the lottery are added to this sum. In total, you can earn up to € 45.85. You will receive your money at the end of the experiment.

Please note:

- Please keep quiet during the experiment!
- Please do not look at your seatmate's monitor!
- Auxiliary devices (calculators, smartphones etc.) are not allowed. All electronic devices must be switched off!
- Please note the timing given in the upper right hand corner of the monitor.

Instructions (Control Treatment 1)

The Game

By investing in stocks, you can benefit from the income return. There are two securities (stock A and stock b) to choose from. In each period of the game, the value of stock A is changed by +0 play dollars or +7 play dollars; both events occur with a probability of 50%. The same is true for stock B. Both securities have an expected value of +3.50 play dollars per period. The performances of both stocks are independent random events. 15 periods will be played in total and in each period, you have 4 units at your disposal that must be invested. The 4 units can be invested in the following portfolio combinations:

Portfolio 1: AAAA
Portfolio 2: AAAB
Portfolio 3: AABB
Portfolio 4: ABBB
Portfolio 5: BBBB

The game starts at period 0. At period 0, you have the possibility to restructure the portfolio that was randomly assigned to you. The performance of the stocks for the single periods were previously determined by 15 x two coin tosses (one toss for stock A and one toss for stock B). “Heads” signifies a good period (+7 play dollars) and “tails” signifies a weak period (+0 play dollars). You can earn up to 420 play dollars in the 15 periods.
For maximum transparency, you will be shown your results after each period.
You can also earn up to € 3.85 in a lottery, detailed information on which you will receive in due course.

The Payout

In the 15 periods, you can earn up to 420 play dollars with the securities. 1 play dollar equals € 0.10. The maximum payout is € 42.00 (420 x 0.10). € 3.85 from the lottery are added to this sum. In total, you can earn up to € 45.85. You will receive your money at the end of the experiment.

Please note:

- Please keep quiet during the experiment!
- Please do not look at your seatmate’s monitor!
- Auxiliary devices (calculators, smartphones etc.) are not allowed. All electronic devices must be switched off!
- Please note the timing given in the upper right hand corner of the monitor.

Control Questions

Control questions (tick the box):

1. What is your task in this game?
   - Solving mathematical problems.
   - Investing in stocks and taking part in a lottery. (correct)
   - Giving economic forecasts.

2. How many different securities are there to choose from and how many free stocks do you receive?
   - There are 4 different securities to choose from and I receive 2 free stocks.
   - There are 2 different securities to choose from and I receive 2 free stocks.
   - There are 2 different securities to choose from and I receive 4 free stocks. (correct)

3. On what does the payout depend in the 15 periods?
   - On the dividend payouts.
   - On the performance of the stocks. (correct)
   - On the DAX market trend.

4. How many different combinations of the portfolio are possible?
   - 2
   - 4
   - 5 (correct)

Instructions to Determine the Risk Preference

Each decision is a choice between "version A" and "version B". Each version is comparable to a lottery with different payouts and different probabilities of occurrence.

You have 10 decisions to make and enter. One of these decisions will be considered to determine your payout from the lottery as follows: after you entered all your decisions, a ten-sided dice is thrown to select one of the 10 decisions. Each of the decisions therefore has a 10% probability of being chosen. The selected lottery (A or B) is then played. The probability of occurrence is simulated by an urn containing table tennis balls: in an urn with 10 table tennis balls the number of orange balls determines the probability of the higher payout.

Example for decision no. 8: in an urn with 10 table tennis balls are 8 orange and 2 white balls. The probability that a randomly picked ball is orange is therefore 80%. If the picked ball is orange, you will receive € 2.00 in version A and € 3.85 in version B. If the picked ball is white, you will receive € 1.60 in version A and € 0.10 in version B. So: you make 10 decisions (either A or B), one of them is randomly selected (with a dice) and played (with an urn and 10 table tennis balls)—the result will determine your payout from the lottery. Please answer the following control questions about the lottery before making any decisions.

No.	Version A:				Version B:				Your Decision A or B
	p(€ 2.00)	Payout	p(€1.60)	Payout	p(€3.85)	Payout	p(€0.10)	Payout	
1	10%	€ 2.00	90%	€ 1.60	10%	€ 3.85	90%	€ 0.10	
2	20%	€ 2.00	80%	€ 1.60	20%	€ 3.85	80%	€ 0.10	
3	30%	€ 2.00	70%	€ 1.60	30%	€ 3.85	70%	€ 0.10	
4	40%	€ 2.00	60%	€ 1.60	40%	€ 3.85	60%	€ 0.10	
5	50%	€ 2.00	50%	€ 1.60	50%	€ 3.85	50%	€ 0.10	
6	60%	€ 2.00	40%	€ 1.60	60%	€ 3.85	40%	€ 0.10	
7	70%	€ 2.00	30%	€ 1.60	70%	€ 3.85	30%	€ 0.10	
8	80%	€ 2.00	20%	€ 1.60	80%	€ 3.85	20%	€ 0.10	
9	90%	€ 2.00	10%	€ 1.60	90%	€ 3.85	10%	€ 0.10	
10	100%	€ 2.00	0%	€ 1.60	100%	€ 3.85	0%	€ 0.10	

Control Questions to Determine the Risk Preference

Control questions (tick the box):

1. What is the minimum and the maximum payout in the lottery?
   - The minimum payout is € 0.00 and the maximum payout is € 1.60.
   - The minimum payout is € 0.10 and the maximum payout is € 3.85. (correct)
   - The minimum payout is € 0.10 and the maximum payout is € 1.60

2. If the dice selects the 7th decision and you choose version A and have drawn a white table tennis ball from the urn, what is your payout?
   - € 0.00
   - € 2.00
   - € 1.60 (correct)

3. How many white table tennis balls are in the urn if the dice chooses the tenth decision?

   - 10
   - 0 (correct)
   - 5

4. How many orange table tennis balls are in the urn if the dice chooses the fourth decision?
   - 6
   - 0
   - 4 (correct)

Appendix 2: Results of the Basic Treatment per Session

Table A-1: Percental Distribution of the Portfolios during the Game (Basic Treatment, Session 1)

	Percentage of AAAA Portfolios	Percentage of AAAB Portfolios	Percentage of AABB Portfolios	Percentage of ABBB Portfolios	Percentage of BBBB Portfolios	Most Frequently Chosen Portfolio(s) in the Previous Round	Portfolio(s) of the Leader(s) in the Previous Round
Initial Distrib.	20%	20%	20%	20%	20%	-	-
Round 1	20.0%	0.0%	60.0%	20.0%	0.0%	-	-
Round 2	10.0%	20.0%	70.0%	0.0%	0.0%	AABB	BBBA
Round 3	20.0%	10.0%	30.0%	10.0%	30.0%	AABB	AABB
Round 4	20.0%	10.0%	40.0%	20.0%	10.0%	AABB, BBBB	BBBB
Round 5	0.0%	10.0%	50.0%	10.0%	30.0%	AABB	AAAA
Round 6	0.0%	10.0%	60.0%	20.0%	10.0%	AABB	AAAB
Round 7	0.0%	10.0%	80.0%	0.0%	10.0%	AABB	AABB
Round 8	10.0%	20.0%	40.0%	10.0%	20.0%	AABB	AABB
Round 9	10.0%	0.0%	40.0%	10.0%	40.0%	AABB	BBBA
Round 10	10.0%	10.0%	30.0%	20.0%	30.0%	AABB, BBBB	BBBB, AABB
Round 11	20.0%	10.0%	50.0%	10.0%	10.0%	AABB, BBBB	BBBB
Round 12	20.0%	0.0%	50.0%	20.0%	10.0%	AABB	AAAA
Round 13	20.0%	10.0%	40.0%	20.0%	10.0%	AABB	BBBB
Round 14	30.0%	0.0%	40.0%	30.0%	0.0%	AABB	AAAA
Round 15	30.0%	10.0%	50.0%	10.0%	0.0%	AABB	AAAA

Table A-2: Percental Distribution of the Portfolios during the Game (Basic Treatment, Session 2)

	Percentage of AAAA Portfolios	Percentage of AAAB Portfolios	Percentage of AABB Portfolios	Percentage of ABBB Portfolios	Percentage of BBBB Portfolios	Most Frequently Chosen Portfolio(s) in the Previous Round	Portfolio(s) of the Leader(s) in the Previous Round
Initial Distribution	20%	20%	20%	20%	20%	-	-
Round 1	0.0%	22.2%	44.4%	33.3%	0.0%	-	-
Round 2	0.0%	0.0%	66.7%	33.3%	0.0%	AABB	ABBB
Round 3	0.0%	11.1%	55.6%	33.3%	0.0%	AABB	AABB, ABBB
Round 4	11.1%	11.1%	55.6%	22.2%	0.0%	AABB	ABBB
Round 5	0.0%	11.1%	55.6%	22.2%	11.1%	AABB	ABBB
Round 6	11.1%	0.0%	44.4%	44.4%	0.0%	AABB	AABB, ABBB
Round 7	11.1%	0.0%	55.6%	33.3%	0.0%	AABB, ABBB	AABB, ABBB
Round 8	11.1%	22.2%	44.4%	11.1%	11.1%	AABB	ABBB
Round 9	11.1%	22.2%	33.3%	22.2%	11.1%	AABB	AAAB
Round 10	11.1%	11.1%	44.4%	22.2%	11.1%	AABB	AABB
Round 11	22.2%	22.2%	44.4%	11.1%	0.0%	AABB	BBBB, ABBB
Round 12	0.0%	11.1%	44.4%	33.3%	11.1%	AABB	AAAA
Round 13	11.1%	11.1%	11.1%	55.6%	11.1%	AABB	BBBB
Round 14	22.2%	44.4%	22.2%	0.0%	11.1%	ABBB	BBBB, ABBB
Round 15	33.3%	33.3%	22.2%	11.1%	0.0%	AAAB	BBBB, AAAB

Table A-3: Percental Distribution of the Portfolios in the Game (Basic Treatment, Session 3)

	Percentage of AAAA Portfolios	Percentage of AAAB Portfolios	Percentage of AABB Portfolios	Percentage of ABBB Portfolios	Percentage of BBBB Portfolios	Most Frequently Chosen Portfolio(s) in the Previous Round	Portfolio(s) of the Leader(s) in the Previous Round
Initial Distribution	20%	20%	20%	20%	20%	-	-
Round 1	11.1%	33.3%	33.3%	11.1%	11.1%	-	-
Round 2	11.1%	0.0%	77.8%	11.1%	0.0%	AAAB, AABB	BBBB
Round 3	11.1%	44.4%	44.4%	0.0%	0.0%	AABB	AAAA
Round 4	0.0%	22.2%	66.7%	0.0%	11.1%	AAAB, AABB	AAAA, AAAB and AABB
Round 5	0.0%	11.1%	44.4%	22.2%	22.2%	AABB	AAAB
Round 6	0.0%	0.0%	33.3%	22.2%	44.4%	AABB	BBBB
Round 7	0.0%	22.2%	55.6%	0.0%	22.2%	BBBB	BBBB
Round 8	11.1%	0.0%	55.6%	11.1%	22.2%	AABB	AAAB, AABB and BBBB
Round 9	11.1%	11.1%	22.2%	44.4%	11.1%	AABB	AAAA
Round 10	0.0%	0.0%	33.3%	44.4%	22.2%	ABBB	BBBB
Round 11	33.3%	0.0%	33.3%	22.2%	11.1%	ABBB	BBBB
Round 12	11.1%	11.1%	66.7%	0.0%	11.1%	AABB	AAAA, BBBB
Round 13	0.0%	0.0%	55.6%	22.2%	22.2%	AABB	AAAA, BBBB
Round 14	11.1%	22.2%	55.6%	0.0%	11.1%	ABBB	BBBB
Round 15	11.1%	33.3%	44.4%	0.0%	11.1%	AAAB	AAAA, AAAB

Table A-4: Percental Distribution of the Portfolios in the Game (Basic Treatment, Session 4)

	Percentage of AAAA Portfolios	Percentage of AAAB Portfolios	Percentage of AABB Portfolios	Percentage of ABBB Portfolios	Percentage of BBBB Portfolios	Most Frequently Chosen Portfolio(s) in the Previous Round	Portfolio(s) of the Leader(s) in the Previous Round
Initial Distribution	20%	20%	20%	20%	20%	-	-
Round 1	0.0%	30.0%	40.0%	30.0%	0.0%	-	-
Round 2	10.0%	30.0%	50.0%	10.0%	0.0%	AABB	ABBB
Round 3	0.0%	20.0%	50.0%	30.0%	0.0%	AABB	AAAA, AABB and ABBB
Round 4	10.0%	40.0%	40.0%	10.0%	0.0%	AABB	ABBB
Round 5	0.0%	40.0%	30.0%	20.0%	10.0%	AAAB, AABB	AAAB
Round 6	0.0%	30.0%	40.0%	20.0%	10.0%	AAAB	AAAB
Round 7	10.0%	50.0%	20.0%	10.0%	10.0%	AABB	AAAB
Round 8	10.0%	20.0%	55.0%	20.0%	0.0%	AAAB	BBBB
Round 9	0.0%	30.0%	30.0%	30.0%	10.0%	AABB	AAAA
Round 10	0.0%	10.0%	40.0%	40.0%	10.0%	AAAB, AABB and ABBB	AABB
Round 11	10.0%	40.0%	40.0%	10.0%	0.0%	AABB, ABBB	AABB
Round 12	10.0%	10.0%	20.0%	40.0%	20.0%	AAAB, AABB	AAAA
Round 13	0.0%	50.0%	40.0%	0.0%	10.0%	ABBB	BBBB
Round 14	30.0%	20.0%	40.0%	0.0%	10.0%	AAAB	AABB
Round 15	30.0%	20.0%	40.0%	0.0%	10.0%	AABB	AAAA

Table A-5: Percental Distribution of the Portfolios in the Game (Basic Treatment, Session 5)

	Percentage of AAAA Portfolios	Percentage of AAAB Portfolios	Percentage of AABB Portfolios	Percentage of ABBB Portfolios	Percentage of BBBB Portfolios	Most Frequently Chosen Portfolio(s) in the Previous Round	Portfolio(s) of the Leader(s) in the Previous Round
Initial Distribution	20%	20%	20%	20%	20%	-	-
Round 1	0.0%	14.3%	71.4%	14.3%	0.0%	-	-
Round 2	0.0%	28.6%	57.1%	14.3%	0.0%	AABB	ABBB
Round 3	0.0%	28.6%	42.9%	28.6%	0.0%	AABB	AAAB
Round 4	0.0%	28.6%	42.9%	14.3%	14.3%	AABB	ABBB
Round 5	0.0%	71.4%	14.3%	14.3%	0.0%	AABB	AAAB
Round 6	0.0%	14.3%	57.1%	28.6%	0.0%	AAAB	AAAB
Round 7	0.0%	0.0%	57.1%	28.6%	14.3%	AABB	ABBB
Round 8	0.0%	14.3%	28.6%	57.1%	0.0%	AABB	ABBB
Round 9	0.0%	14.3%	42.9%	42.9%	0.0%	ABBB	AAAB
Round 10	0.0%	14.3%	28.6%	57.1%	0.0%	AABB, ABBB	AABB
Round 11	14.3%	42.9%	28.6%	0.0%	14.3%	ABBB	AAAB, ABBB
Round 12	14.3%	28.6%	0.0%	57.1%	0.0%	AAAB	AAAB
Round 13	0.0%	14.3%	42.9%	42.9%	0.0%	ABBB	AAAB, ABBB
Round 14	0.0%	14.3%	28.6%	28.6%	28.6%	AABB, ABBB	ABBB
Round 15	0.0%	42.9%	28.6%	14.3%	14.3%	AABB, ABBB and BBBB	AAAB, ABBB

Table A-6: Percental Distribution of the Portfolios in the Game (Basic Treatment, Session 6)

	Percentage of AAAA Portfolios	Percentage of AAAB Portfolios	Percentage of AABB Portfolios	Percentage of ABBB Portfolios	Percentage of BBBB Portfolios	Most Frequently Chosen Portfolio(s) in the Previous Round	Portfolio(s) of the Leader(s) in the Previous Round
Initial Distribution	20%	20%	20%	20%	20%	-	-
Round 1	12.5%	12.5%	25.0%	37.5%	12.5%	-	-
Round 2	25.0%	25.0%	12.5%	25.0%	12.5%	AABB	BBBB
Round 3	25.0%	37.5%	37.5%	0.0%	0.0%	AAAA, AAAB and ABBB	ABBB
Round 4	25.0%	62.5%	12.5%	0.0%	0.0%	AAAB, AABB	AABB
Round 5	25.0%	25.0%	25.0%	25.0%	0.0%	AAAB	AAAB
Round 6	25.0%	12.5%	12.5%	37.5%	12.5%	AAAA, AAAB, AABB, ABBB	AAAA
Round 7	12.5%	0.0%	12.5%	37.5%	37.5%	ABBB	ABBB
Round 8	37.5%	0.0%	25.0%	37.5%	0.0%	ABBB, BBBB	BBBB
Round 9	12.5%	25.0%	25.0%	12.5%	25.0%	AAAA, ABBB	AABB
Round 10	25.0%	12.5%	50.0%	0.0%	12.5%	AAAB, AABB and BBBB	BBBB
Round 11	37.5%	25.0%	25.0%	0.0%	12.5%	AABB	BBBB
Round 12	25.0%	0.0%	12.5%	25.0%	37.5%	AAAA	AAAA
Round 13	37.5%	25.0%	0.0%	12.5%	25.0%	BBBB	BBBB
Round 14	37.5%	37.5%	12.5%	0.0%	12.5%	AAAA	BBBB
Round 15	37.5%	25.0%	0.0%	12.5%	25.0%	AAAA, AAAB	AAAA

Appendix 3: Percental Distribution of the Portfolios in the Game

Table A-7: Percental Distribution of the Portfolios in the Game (Basic Treatment)

	Percentage of AAAA Portfolios	Percentage of AAAB Portfolios	Percentage of AABB Portfolios	Percentage of ABBB Portfolios	Percentage of BBBB Portfolios
Initial Distribution	20%	20%	20%	20%	20%
Round 1	7.5%	18.9%	45.3%	24.5%	3.8%
Round 2	9.4%	17.0%	56.6%	15.1%	1.9%
Round 3	9.4%	24.5%	43.4%	17.0%	5.7%
Round 4	11.3%	28.3%	43.4%	11.3%	5.7%
Round 5	3.8%	26.4%	37.7%	18.9%	13.2%
Round 6	5.7%	11.3%	41.5%	28.3%	13.2%
Round 7	5.7%	15.1%	47.2%	17.0%	15.1%
Round 8	13.2%	13.2%	41.5%	22.6%	9.4%
Round 9	7.5%	17.0%	32.1%	26.4%	17.0%
Round 10	7.5%	9.4%	37.7%	30.2%	15.1%
Round 11	22.6%	22.6%	37.7%	9.4%	7.5%
Round 12	13.2%	9.4%	34.0%	28.3%	15.1%
Round 13	11.3%	18.9%	32.1%	24.5%	13.2%
Round 14	22.6%	22.6%	34.0%	9.4%	11.3%
Round 15	24.5%	26.4%	32.1%	7.5%	9.4%

Table A-8: Percental Distribution of the Portfolios in the Game (Control Treatment 1)

	Percentage of AAAA Portfolios	Percentage of AAAB Portfolios	Percentage of AABB Portfolios	Percentage of ABBB Portfolios	Percentage of BBBB Portfolios
Initial Distribution	20%	20%	20%	20%	20%
Round 1	2.2%	15.2%	52.2%	21.7%	8.7%
Round 2	8.7%	30.4%	17.4%	34.8%	8.7%
Round 3	4.3%	28.3%	32.6%	21.7%	13.0%
Round 4	10.9%	34.8%	15.2%	19.6%	19.6%
Round 5	8.7%	13.0%	50.0%	13.0%	15.2%
Round 6	15.2%	13.0%	39.1%	17.4%	15.2%
Round 7	13.0%	19.6%	30.4%	28.3%	8.7%
Round 8	4.3%	39.1%	28.3%	10.9%	17.4%
Round 9	8.7%	21.7%	21.7%	21.7%	26.1%
Round 10	4.3%	13.0%	37.0%	26.1%	19.6%
Round 11	15.2%	26.1%	26.1%	17.4%	15.2%
Round 12	0.0%	10.9%	39.1%	32.6%	17.4%
Round 13	4.3%	19.6%	28.3%	32.6%	15.2%
Round 14	15.2%	30.4%	26.1%	21.7%	6.5%
Round 15	15.2%	21.7%	34.8%	17.4%	10.9%

Table A-9: Percental Distribution of the Portfolios in the Game (Control Treatment 2)

	Percentage of AAAA Portfolios	Percentage of AAAB Portfolios	Percentage of AABB Portfolios	Percentage of ABBB Portfolios	Percentage of BBBB Portfolios
Initial Distribution	20%	20%	20%	20%	20%
Round 1	5.9%	19.6%	60.8%	7.8%	5.9%
Round 2	5.9%	29.4%	43.1%	11.8%	9.8%
Round 3	9.8%	17.6%	43.1%	21.6%	7.8%
Round 4	11.8%	25.5%	21.6%	23.5%	17.6%
Round 5	5.9%	13.7%	51.0%	15.7%	13.7%
Round 6	9.8%	25.5%	37.3%	17.6%	9.8%
Round 7	5.9%	25.5%	41.2%	19.6%	7.8%
Round 8	7.8%	35.3%	33.3%	17.6%	5.9%
Round 9	0.0%	13.7%	47.1%	33.3%	5.9%
Round 10	3.9%	9.8%	47.1%	27.5%	11.8%
Round 11	17.6%	15.7%	41.2%	17.6%	7.8%
Round 12	3.9%	21.6%	39.2%	21.6%	13.7%
Round 13	5.9%	23.5%	27.5%	23.5%	19.6%
Round 14	13.7%	25.5%	39.2%	13.7%	7.8%
Round 15	17.6%	23.5%	41.2%	2.0%	15.7%

Appendix 4: Further Results

Table A-10: Variances und Standard Deviations of the Five Portfolios Considering the Actual Events for Stock A and Stock B in Play Dollars

Round	Events		Performance of Portfolios				
	Stock A	Stock B	AAAA	AAAB	AABB	ABBB	BBBB
1	±0	+7	±0	+7	+14	+21	+28
2	+7	+7	+28	+28	+28	+28	+28
3	±0	+7	±0	+7	+14	+21	+28
4	+7	±0	+28	+21	+14	+7	±0
5	+7	+7	+28	+28	+28	+28	+28
6	±0	±0	±0	±0	±0	±0	±0
7	±0	+7	±0	+7	+14	+21	+28
8	+7	±0	+28	+21	+14	+7	±0
9	±0	±0	±0	±0	±0	±0	±0
10	±0	+7	±0	+7	+14	+21	+28
11	+7	±0	+28	+21	+14	+7	±0
12	+7	+7	+28	+28	+28	+28	+28
13	±0	+7	±0	+7	+14	+21	+28
14	±0	±0	±0	±0	±0	±0	±0
15	+7	±0	+28	+21	+14	+7	±0
		Variance	209.07	115.27	84.00	115.27	209.07
		Stand. Dev.	14.46	10.74	9.17	10.74	14.46