An Experimental Examination of Hedging and Portfolio Selection

Lucy F. Ackert*
Department of Economics and Finance
Michael J. Coles College of Business
Kennesaw State University
1000 Chastain Road
Kennesaw, Georgia 30144
(770) 423-6111
lackert@kennesaw.edu
and
Research Department
Federal Reserve Bank of Atlanta
1000 Peachtree Street NE
Atlanta, Georgia 30309-4470

Bryan K. Church
College of Management
Georgia Tech
Atlanta, Georgia 30332
(404) 894-3907
bryan.church@mgt.gatech.edu

Li Qi
Department of Economics
Agnes Scott College
141 E. College Avenue
Decatur, Georgia 30030
(404) 471-5182
lqi@agnesscott.edu

October 2010

* Corresponding author. The views expressed here are those of the authors and not necessarily those of the Federal Reserve Bank of Atlanta or the Federal Reserve System. Financial support of Agnes Scott College, the Coles College of Business, and the Federal Reserve Bank of Atlanta is gratefully acknowledged. The authors thank Yujia Wang for research assistance, Kevin Ackaramongkolrotn and Todd Swarthout for technical assistance, and Brian Kluger for helpful comments. The authors also thank Jim Cox and the EXperimental Economics CENter (EXCEN) at the Andrew Young School of Policy Studies at Georgia State University for use of their experimental laboratory.

An Experimental Examination of Hedging and Portfolio Selection

Abstract

Investors simply do not hold portfolios of assets that appear to be optimal. This paper reports the results of three experiments designed to inform us about how individuals make portfolio allocation decisions. Across all three experiments, we use a very simple experimental design with two risky assets that have payoffs that are perfectly negatively correlated so that participants can eliminate all risk. Participants make investment allocation decisions over a series of periods. Each period, portfolios can be rebalanced at no cost because the assets are traded at a fixed price set equal to the expected payoff. Hence, all risk can be eliminated by simply holding the stocks in equal numbers. We find that participants, in general, do not hold a balanced portfolio, except under very specific conditions. In particular, participants tend to hold a balanced portfolio only when no outcome feedback is provided and their payout is contingent on a single period. Absent these specific conditions, we find that individuals make decisions that are consistent with cognitive bias, including an endowment effect and gambler's fallacy.

Keywords: Asset markets, laboratory experiments, portfolio choice

JEL: C92, G15

An Experimental Examination of Hedging and Portfolio Selection

Many experimental economics studies have examined trading behavior and pricing in laboratory asset markets (e.g., Plott and Sunder, 1988; Forsythe and Lundholm, 1990). Typically the research investigates whether asset prices converge to theoretical predictions and efficiently reflect information. While pricing and market efficiency have received signficant attention, there are few examinations of individual's portfolio choices: exceptions include Kroll, Levy, and Rapoport (1988a) and Bossaerts, Plott, and Zame (2007). These researchers report that while pricing theories are supported by the evidence, portfolio choice theory receives little or no support. Individuals simply do not hold portfolios of assets that appear to be optimal, either ex ante or ex post. Empirical studies of individual portolio choices in naturally-occuring envirmonments also indicate that people do not form optimal portfolios. For example, researchers have reported that individuals fail to adequately diversify (Blume and Friend, 1975).

Our goal is to provide new insight into how individuals form investment portfolios. A better understanding of how people make these investment decisions is crucial for the appropriate development of theory and policy. Using a very simple design with two risky assets along with risk-free borrowing and lending, we examine the portfolio choices of experimental participants. Importantly, the two risky assets have payoffs that are perfectly negatively correlated so that experimental participants can eliminate all risk. Furthermore, participants can rebalance portfolios at no cost because the assets are traded at a fixed price set equal to the expected payoff. With this design, we can examine whether portfolio separation, a cornerstone of modern finance, is observed. All traders *should* hold the same portfolio of risky assets.

Despite costless rebalancing, the majority of our participants fails to diversify. We conduct a second experiment in which we vary the level of participants' exposure to risk if they do not diversify. In this experiment the assets' payoffs are negative in one-half of the possible outcomes. Prior evidence suggests that people feel a loss more strongly than a gain of equivalent magnitude (Tversky and Kahneman, 1985). In other words, individuals tend to be loss averse. We again find that many people do not eliminate risk, even though they could do so at no cost. Importantly, in the second experiment, not only do participants take unnecessary risks when they hold an undiversified portfolio, they also expose themselves to large, real losses.

Our third experiment allows us to examine whether participants fail to diversify within a period because they suffer from cognitive bias. For example, psychologists have recognized that people fall prey to gambler's fallacy, or the tendency to believe that a sample, even if very small, will share the features of the population from which it is drawn (Kahneman and Tversky, 1972). For example, suppose a fair coin is tossed a few times and heads is observed each time. A gambler with this bias would expect things to even out, thereby betting that the next flip will result in tails. On the other hand, researchers have also documented that investors can make very different decisions based on past performance. In some cases, investors chase trends, leaning toward stocks that have performed well (Goetzmann and Kumar, 2008). In our third experiment participants are given no feedback over time so that we can observe whether cognitive bias can explain the results of experiments one and two. In the experiment, outcomes each period are determined randomly and independently with no feedback. Thus, decisions across time should not be correlated. Unlike the first two experiments, the majority of participants holds a diversified portfolio. Our analysis suggests that participants in experiments one and two fell prey to gambler's fallacy.

The experimental investigation most closely related to ours is Rietz (2003). As in our design, participants were endowed with two assets and the payoffs were structured so that risk-neutral agents would want to hold the assets in equal quantity to elimate all risk. Unlike our design, Rietz's assets were priced in a market. Our assets have fixed prices because our goal is to take a step back and focus strictly on the asset allocation decision. Rietz found that the assets in his markets were often over-priced so that profitable arbitrage opportunities were apparent and unexploited. His evidence suggested that an endowment effect played a role in that participants' final holdings were impacted by their initial endowments. Researchers have reported that individuals seem to value an object more once they own it (Kahneman, Knetsch, and Thaler, 1990). We also find evidence that a participant's final holdings depend on the initial endowment.

To provide additional insight into portfolio allocation decisions, we measure participants' level of confidence and their risk tolerance. Psychologists recognize that people are frequently overconfident and asset pricing theorists have incorporated overconfident traders to model the impact on market outcomes.[1] In addition, though risk tolerance should not impact an individual's decisions regarding portfolio composition in our environment, we examine whether a consistent relationship is evident.

The remainder of the paper is organized as follows. Section I provides a framework. Section II describes the design and results of the first experiment. Sections III and IV present the results for two additional experiments. Section V reports tests of behavioral hypotheses using data from all three experiments. Section VI concludes the paper.

I. Framework

Portfolio separation is a cornerstone of modern finance. In a world with a risk-free asset, all investors hold the same portfolio of risky assets. In traditional mean-variance portfolio theory investors are risk averse and recognize the trade-off between risk and return. Optimal diversification is determined by comparing the cost and benefit of rebalancing. If the benefit, in terms of risk reduction exceeds the cost of adding an asset to the portfolio, the asset is added.

Our experimental environment is very simple and allows clear predictions, regardless of participants' risk tolerance. In our design, participants are endowed with cash and shares of two stocks (A and B), and then given the opportunity to rebalance their portfolio by transacting with the experimenter. The two stocks have payoffs that are perfectly negatively correlated so a risk-free portfolio can easily be formed by holding stocks A and B in equal numbers.

We fix the transaction price to the expected payoff of the stocks because we want to focus strictly on portfolio selection, in isolation from asset pricing. As Rietz (2003) points out, relative and absolute market prices would be independent of the level of risk aversion in this environment. There is no aggregate risk, so no aggregate risk premium would arise if the assets were priced in a market. Importantly, there are no transactions or holding costs when rebalancing in our experiments. Participants can buy and sell to rebalance their portfolio at the expected payoff of the stocks. Bossaerts and Plott (2002) argue that a small number of traders in a market can make it difficult for agents to identify trading partners with whom to transact.

---

[1] On the psychological evidence see Fischoff, Lichtenstein, and Slovic (1977) and for an example of a model with overconfident traders see Odean (1998).

Because participants are free to trade with the experimenter, market thinness cannot explain a failure to balance asset holdings in our experiment.

To further examine portfolio behavior, we include instruments to measure participants' overconfidence and risk tolerance in our design. Poor financial decisions are sometimes attributed to overconfidence (Barber and Odean, 2001). Goetzmann and Kumar (2008) report that over-confident investors are less likely to adequately diversify. We examine whether overconfidence predicts portfolio choices using a simple calibration test in which participants provide confidence intervals. Overconfident people report confidence intervals that are too narrow so that, for example, more than 10 percent of their answers fall outside of their 90 percent confidence intervals. Miscalibration tests have been shown to be useful in understanding performance in experiments (Biais, Hilton, Mazurier, and Pouget, 2005). Our measure of calibration is the number of confidence intervals that contain the true value of the variable. In addition, though risk tolerance should not impact participants' decisions regarding portfolio composition in our environment, other researchers have argued that risk preferences differ in predictable ways and can explain behavior.[2] To measure risk tolerance we use a simple procedure proposed by Charness and Gneezy (2007, 2010). Participants are given an endowment of $10 and make a single choice regarding how much to invest in a risky asset. The measure of risk tolerance is the amount invested.

II. Experiment One

Overview and participants

---

[2] For example, Charness and Gneezy (2007) report that women are more risk averse than men.

The experiment was conducted at two large state universities in the same metropolitan area. In all, we report on three experiments comprised of a total of eleven sessions (in addition to two pre-tests).[3] The experimental design is summarized in Panel A of Table 1. We will first describe our initial experiment, referred to as the benchmark experiment, which was designed to provide a basis for comparison. This experiment includes three sessions with twelve participants each for a total of 36 participants. Participants were undergraduate and graduate students across a variety of majors and all were inexperienced in that none participated in an earlier session. Students earned from $21.00 to $69.34 for approximately 2 hours of time, with an average payout of $54.11.[4]

Procedures

At the beginning of each session participants received a set of instructions, which an experimenter read aloud.[5] The experimenter then addressed any procedural or technical questions. Though the data of primary interest consists of participants' asset allocation choices, we first asked them to complete two questionnaires. To provide a measure of calibration, participants completed a 10-question survey in which they indicated upper and lower values resulting in 90 percent confidence intervals. The survey questions followed closely those used by Biais, Hilton, Mazurier, and Pouget (2005) with minor adjustment.[6] Participants were

---

[3] The pre-tests allowed us to refine the experimental procedures, including the procedures regarding bankruptcy. Because significant design changes were made, the pre-tests are not included in our analyses reported subsequently.
[4] Participants' total compensation included a $2 bonus for being on time and $2 for completion of the post-experiment questionnaire, in addition to their other earnings described later in this section of the paper.
[5] The instructions for the benchmark experiment are included in the Appendix to this paper.
[6] The first question in Biais, Hilton, Mazurier, and Pouget (2005) asked Martin Luther King's age at death. As our participants are predominantly young, southern Americans the vast majority would know the correct answer was 39. This was confirmed in pre-tests, so we changed the question to ask the year that George Washington was born. The other questions were unchanged.

instructed that their responses were important for our research and paid $2 for carefully completing the task.

The second questionnaire elicited individual risk preferences. Participants made a single choice regarding the investment of cash. Each was given an endowment of $10 and asked to choose how much to invest in a risky asset that had a 50 percent chance of success.[7] A randomly chosen participant flipped a coin at the end of the session to determine the success of the investment. If the coin toss resulted in heads, the investment was successful and the amount invested increased in value by 2.5 (or 250 percent). If the coin toss was tails, then the investment was unsuccessful and participants would lose the amount invested in the risky asset.

Next the participants turned to the primary task. This task was administered in a computerized environment with the software, Z-tree (Zurich Toolbox for Readymade Economic Experiments) software (Fischbacher, 2007), which has been used extensively.[8] All transactions were in francs, the experimental currency, which were converted into dollars at a specified rate. Each session included 10 two-minute periods in which participants could trade shares of stocks A and B with the experimenter at a fixed price of 150.

At the beginning of each period, participants were endowed with shares of A and B as well as cash to finance the purchase of shares. Initial endowments are detailed in Panel A of Table 1. Participants could buy or sell as many shares as they wished with certain restrictions. The maximum number of shares of either A or B that could be purchased was 60.[9] Participants could not short sell, but they were permitted to borrow from the experimenter with the stipulation

[7] This risk measure follows from Charness and Gneezy (2007, 2010).
[8] For more detail on the software, see http://www.iew.unizh.ch/ztree/index.php.

that any francs borrowed had to be repaid at the end of the period. If a participant had insufficient funds to repay a loan, the participant was bankrupt and no longer included in the data.

Each stock had a single-period life. At the end of a period, each stock paid a randomly determined dividend using the distributions reported in Panel B of Table 1. Participants were reminded that the expected payoff for the two stocks is identical at 150 francs per period. At the end of a period, the observed state was publicly announced and a summary screen reported dividends earned, as well as period and cumulative earnings in dollars. The next period then began with constant endowments for each participant across all 10 periods.

At the end of the experiment, the final cash balance was displayed on each participant's computer screen. Participants were asked to complete a post-experiment questionnaire that included demographic questions as well as reactions to the experiment. They received additional compensation of $2 for completing the questionnaire in an effort to elicit conscientious responses. Finally, participants were paid privately in cash.

Results

Figure 1 shows frequencies for average absolute imbalance per participant for the first experiment which included 36 participants. The absolute asset imbalance is calculated as |#Stock A - #Stock B|. From the figure, we see that many participants held imbalanced portfolios. Table 2 reports asset imbalances in final stock positions where Panel A provides information on the number of participants in each imbalance interval for periods 1-10, 1-5, and

---

[9] The limit on purchases was added to the design after a participant in a pre-test bought a large number of shares in

6-10, as well as the mean and median absolute imbalance across participants. “No shares held” indicates how many participants held only cash in their portfolio at period end, whereas the frequencies reported when the imbalance is zero include those with exactly balanced stock holdings. The mean imbalance over all periods is almost six shares. Ackert, Mazzotta, and Qi (2010) also report that traders in their markets fail to eliminate risk. We conducted binomial tests to assess the probability that the number of participants who balance their portfolio exceeds 50 percent, where balancing is conservatively defined as an imbalance of 3 or less. We reject the null hypothesis that the majority of participants balances their holdings of stocks A and B. The majority of participants fails to balance ($p < 0.03$).

Panel B of Table 2 reports the signed imbalance, which preserves the direction of the imbalance, #Stock A - #Stock B. Panel B reports how many participants have positive, zero, and negative signed imbalance, along with the mean and median imbalance. We observe that more participants overweight stock B. Later in the paper we report on additional analysis to provide insight into the direction of the imbalance.

III. Experiment Two

Framework

In the benchmark experiment the majority of participants fails to diversify. In our second experiment we examine whether partipants are more likely to balance their holdings of the two risky assets when real losses are possible. In the benchmark experiment, payoffs were strictly

---

one stock and we realized that a series of lucky dividend draws, though unlikely but still possible, would bankrupt non-negative. Though the expected values of the two assets are identical here as in the first experiment, the distribution of payoffs is wider and spreads to the loss domain. With negative payoffs possible, losses may loom large. In our experiment, the easiest way to avoid losses is to balance holdings of stocks A and B. As mentioned previously, though risk tolerence should not impact the composition of the portfolio of risky assets, much research has shown the people react strongly to a possible loss (Tversky and Kahneman, 1985). In addition, Weber, Keppe, and Meyer-Delius (2000) report that loss aversion has important effects on pricing in an experimental market. Our second experiment allows us to examine whether loss aversion is a spur to more optimal portfolio allocation.

Overview and Procedures

The second experiment includes four sessions with twelve participants each for a total of 48 participants. Participants were recruited from the same subject pool as described above for experiment one and all were inexperienced in that none participated in an earlier session. Students earned from $6.40 to $90.80 for approximately 2 hours of time, with an average payout of $37.16.

As in the first experiment, we first measured calibration and risk tolerance. Also as in the first experiment, sessions were conducted in a computerized environment with the software, Z-tree. Transactions were in francs and each session included 10 two-minute periods in which participants could trade shares of assets A and B with the experimenter at a fixed price of 150. The significant difference between experiments one and two is the payoff distribution, reported

---

the experimenters.

in Panel C of Table 1. The expected payoffs for the two stocks remain identical at 150 francs per period, but the spread of payoffs is wider and includes the possibility of a loss of 150 francs.

Results

Figure 2 shows the frequency of average absolute imbalance per participant for the second experiment. As before, the absolute asset imbalance is calculated as |#Stock A - #Stock B|. We continue to observe imbalanced portfolios, even when payoffs can fall in the domain of losses. Table 2 table reports asset imbalances in final stock positions with absolute imbalance in Panel A and signed imbalance in Panel B. The mean imbalance over all periods is approximately six shares. With feedback on outcomes, even participants prone to imbalance might learn to balance over time to reduce risk. We actually observe an increase in average absolute imbalance from 5.30 in periods 1-5 to 6.72 on periods 6-10. We again conducted binomial tests to assess the probability that the number of participants who balance their portfolio exceeds 50 percent, where balancing is conservatively defined as an imbalance of 3 or less. As in experiment 1, we reject the null hypothesis that the majority of participants balances their holdings of stocks A and B ($p < 0.001$).

IV. Experiment Three

Framework

Our third experiment allows us to investigate whether the observed outcomes in experiments one and two result from cognitive bias. Gambler's fallacy is the tendency to believe that even a small sample will look the same as the population (Kahneman and Tversky, 1972). Experimentalists have reported significant evidence of sequential dependencies among participants. Kroll, Levy, and Rapoport (1988b) report that their experimental participants switched investments to stocks that had performed poorly in prior periods, presumably because they expected the poor performance to reverse. Although their participants' behavior was consistent with gambler's fallacy, the evidence is not conclusive. For example, using a database of trades and portfolio positions of individual investors, Goetzmann and Kumar (2008) conclude that investors fail to adequately diversify and those that are more under-diversified engage in trend-chasing. The choices of these investors were contrary to gambler's fallacy because they seemed to expect trends to continue, rather than reverse. In our third experiment participants are given no feedback over time so that we can observe whether cognitive bias can explain our other results.

In addition, we examine whether a lack of feedback correlates with risk preferences to impact portfolio allocation decisions. Gneezy and Potters (1997) report that their experimental participants are more risk averse when returns are evaluated more often. As Benartzi and Thaler (1995) argue, two factors lead to this myopic loss aversion. A short evaluation period combined with loss aversion leads to increased risk aversion. In our experiment, if myopic loss aversion describes behavior, participants will be *less* risk averse with no feedback.

Overview and Procedures

The third experiment includes four sessions and 49 participants. Students were recruited from the same participant pool as described above for experiments 1 and 2 and all were inexperienced in that none participated in an earlier session. Students earned from $11.00 to $120.20 for approximately 2 hours of time, with an average payout of $52.11.

As in the first two experiments, we first measured calibration and risk tolerance. Unlike the others, this experiment was conducted using paper and pen. In addition, in this experiment we add the risk measure developed by Holt and Laury (2002) to investigate whether the results are sensitive to the particular instrument used to measure risk. Transactions were in francs and each session included 10 two-minute periods in which participants could trade shares of assets A and B with the experimenter at a fixed price of 150. A significant difference between this experiment and the first two is that participants were not given feedback on the states observed until the conclusion of the experiment. Another important difference is that compensation was based on a single draw determining which of the 10 periods would determine payoffs. First the experimenter drew a card from a set of 10 cards numbered 1 to 10. The first card drawn indicated the period (1-10) that determines everyone's earnings. Next, a coin was flipped to determine the state. Earnings in dollars were computed for the trading task by multiplying the chosen period's earnings by a specified conversion factor.[10] As in experiment two, the expected payoffs for the two stocks remain identical at 150 francs per period, but the spread of payoffs is wider and includes the possibility of a loss of 150 francs.

Results

Figure 3 shows the frequency of average absolute imbalance per participant for the third experiment. We observe a clear leftward shift in the imbalance distribution as compared to experiments one and two. Many participants held balanced portfolios. Table 4 reports that average absolute and signed asset imbalances are much lower in this experiment. The mean

[10] The conversion rate is ten times that used earlier so that compensation for this phase of the experiment is

imbalance over all periods is now under 2 shares. We conducted binomial tests to assess the null hypothesis that the number of participants who balance their portfolio exceeds 50 percent, where balancing is conservatively defined as an imbalance of 3 or less. Unlike experiments one and two, we do not reject the null. We find that the majority of participants balances their holdings of stocks A and B when a single draw determined earnings and they receive no feedback on the outcome draws until the conclusion of the experiment ($p > 0.99$).

Our evidence does not support the notion that lack of feedback correlates with risk preferences to impact portfolio allocation decisions. Unlike Gneezy and Potters (1997) our experimental participants make chocies that are consistent with higher risk aversion when returns are evaluated less often.

V. Further Analysis

To provide insight into the choices of our participants, we report additional analysis. We examine whether an endowment effect, misunderstanding of independence, or other behavioral factors explain observed imbalances in participants' portfolios.

Endowment Effect

As we mentioned earlier, Rietz (2003) reported that profitable arbitrage opportunities were apparent and unexploited in his experiment which included two assets with negatively correlated payoffs. His experimental participants did not balance their portfolios to reduce risk

comparable across experiments.

and the evidence suggested that an endowment effect played a role. Partipants' final holdings were impacted by their initial endowments. To investigate whether a participant's final holdings depended on the initial endowment we considered imbalance in final stock holdings by initial endowment. Recall that our participants were endowed with either 0/10 or 10/0 shares of stocks A/B. While the majority did balance in the third experiment, many still held imbalanced portfolios. We wondered if participants would be more likely to balance if their initial endowment was balanced. We collected additional data to provide insight with 26 new participants who were given endowments of 5/5 using the design of experiment three.

Table 5 reports mean signed asset imbalance in final stock positions for each experiment by initial endowment, including the new data with balanced endowments. The asset imbalance is calculated as #Stock A - #Stock B. Below each mean in parentheses is the result of a t-test to indicate a significantly negative final holding for the 0/10 endowment, positive final holding for the 10/0 endowment, and different from zero for the 5/5 endowment with asterisks noting statistical significance. The results are generally consistent with the presence of an endowment effect. The final holdings for participants who are endowed with more shares of stock B (endowment 0/10) hold more shares of B, whereas those endowed with more shares of stock A (endowment 10/0) hold more shares of A with statistical significance in five of six cases. When the endowment is balanced (endowment 5/5), the difference in final holdings for the two stocks is not significantly different from zero.

Lack of Independence

In our third experiment participants were given no feedback until the conclusion of the experiment so that decisions across time should not be correlated. Unlike the first two experiments, the majority of participants holds a diversified portfolio. Figure 4 shows the average absolute imbalance per period for each of the three experiments. The imbalance is clearly lower across time for the third experiment. Interestingly, in the other two experiments, participants did not seem to learn to balance as they received feedback over time. Instead, the imbalance actually seems to increase in the final periods of both experiments one and two.

To provide insight into how partipants in the first two experiments made decsions, we examined how they reacted to past outcomes. Recall that a bettor with gambler's fallacy would expect things to even out, thereby betting that a high draw for stock A is likely followed by a high draw for stock B. Thus, decreased holdings of A (B) after A (B) experienced a high payout the previous period would support the null hypothesis of gambler's fallacy. In contrast, a trend chaser would lean toward the stock that has performed well in the previous period. Increased holdings of A (B) after A (B) paid high the previous period would support the null hypothesis of trend-chasing.

Table 6 reports tests of gambler's fallacy and trend-chasing in Panels A and B, respectively. We compute changes in holdings of each stock (#Stock A and #Stock B), as well as the relative change in holdings of the two stocks (#Stock A - #Stock B). To isolate dependence, we report averages by the outcome of the previous period(i.e., whether stock A or stock B had the high payout). We include data for experiments one and two only, as participants in experiment three were not aware of previous outcome(s). Below each mean in parentheses is the result of a t-test to indicate whether the null hypothesis of no gambler's fallacy (Panel A) or no trend-chasing (Panel B) is supported with asterisks noting statistical significance. The results in Panel A of Table 6 provide support for the hypothesis that participants fall prey to gambler's fallacy. When one stock had a good payoff, participants shifted their portfolio toward the other stock. Five of six tests of the null hypothesis that gambler's fallacy had no effect reject the null. For the results reported in Panel B, in no case can we reject the null that trend-chasing had no effect.

Confidence, Risk Tolerance, and Other Factors

To provide additional insight into portfolio allocation decisions, we estimate a regression using data for all 163 participants. The dependent variable is absolute imbalance, calculated as |#Stock A - #Stock B|. The independent variables include the number of correct responses on the calibration questionnaire (Calibration), the amount invested in the risk measure (Risk), and five dummy variables.[11] The dummy variables take the value one (and zero otherwise) in the following cases: participants given balanced endowment (Balanced endowment), the loss possible experiment (Loss possible), the no revelation, single draw experiment (No revelation), participants who are business or economics major (Business), and participants who are male (Male). Below each coefficient estimate in parentheses is the result of a t-test to indicate a difference from zero with asterisks noting statistical significance. Standard errors are corrected for clustering due to repeated sampling of participants.

The estimates reported in Table 7 indicate that the procedural change of a single draw with no revelation of information has a significant impact on imbalances. The only other significant variable is the gender dummy with men holding more imbalanced portfolios. This is consistent with the literature that documents increased risk taking among males (Barber and

[11] The risk measure used for the estimation reported is from the simple investment game of Charness and Gneezy (2007, 2010). We re-estimated the regression using the risk measure of Holt and Laury (2002) for a subset of data for which this measure was available and inferences were unchanged.

Odean, 2001). Although we found evidence consistent with an endowment effect as reported earlier, the dummy variable for the balanced endowments is not significantly different from zero.

VI. Discussion and Concluding Remarks

This paper reports the results of an experiment designed to provide insight into portfolio allocation decisions. Our evidence, as well as other experimental and anecdotal evidence, suggests that individuals do not diversity their asset holdings. But, why don't investors adequately diversify? In this paper we have provided evidence of one possible explanation, cognitive bias. Another possibility we do not investigate is an alternative to the traditional mean-variance framework proposed by Shefrin and Statman (2000) and Statman (2004). In their behavioral approach, investors do not evaluate a portfolio as a package, but rather they layer their investments as a pyramid. At the bottom are the low-risk investments that provide downside protection. At the top are riskier investments that allow the investor to reach his aspirations. An investor is willing to take great risk with a portion of his money if there is a chance, even if small, of large winnings.

Our participants may have been willing to take risk by betting on one of the stocks because if the decision paid off, their earnings would increase considerably. But which stock? We report some evidence consistent with an endowment effect. Participants favor the stock for which they had a higher initial endowment.

Another possible explanation of our results is that participants are looking at diversification from a different angle. Instead of holding a diversified portfolio at a point in time, they may be attempting to diversify across time in the first two experiments. Because each state was independently drawn and equally likely, an unbalanced portfolio (if held consistently) could be expected to result in diversification across time, at least when bankruptcy was avoided. However, in the second experiment, real losses could occur so that an imbalanced portfolio could lead to financial ruin. In fact, some participants did go bankrupt. In the benchmark experiment 3 of 36 or 8.3 percent of participants were bankrupt before the end of the experiment. In comparison, in the loss possible experiment 22 of 48 or 45.83 percent went bankrupt. Yet, the very real potential for loss did not push participants toward a balanced portfolio.

Our evidence suggests that cognitive bias is the underlying cause of a lack of diversification. Our participants are prone to hold portfolios that resembled their initial endowment. In addition, participants made decisions that were consistent with representativeness. They expected the small sample to resemble the population so that a low draw for a stock was expected to follow a high draw. Only in a very stark environment with no information revelation and in which a single draw determined their entire payout did participants focus on selecting an optimal portfolio,

In future work, we will isolate the underlying impetus for the behavior we observe. The third experiment differs from the first two in two important ways. Only a single draw determined payoff and participants received no feedback over time. Our evidence suggests that the lack of feedback is the force driving the behavioral change. We believe that the single draw is not likely to drive the results for two reasons. First, we find evidence consistent with gambler's fallacy in the first two experiments. Participants responded in a particular way to outcome information. Second, if participants attempt to diversify across time in the first two experiments, the tendency to do so should be dissipated when the potential for real loss and bankruptcy are introduced into the design, as in the second experiment. Instead, the majority of our participants continued to hold imbalanced portfolios.

Appendix

Experimental Instructions

The computerized sessions were conducted using Z-tree. The participants were given the following written instructions for treatment 1.

INSTRUCTIONS

This experiment will include 4 activities. We will begin with a short survey and then we will ask you to make a single choice in an investment task. Next we will turn to our market trading task which includes 10 trading periods. Lastly, we will ask you to complete a post-experiment questionnaire and you will be compensated. Each of the 4 activities is a completely separate task. Your compensation for each is not dependent on any other task.

Please do not confer with other participants at any time.

[New page]

High-Low Survey

For each of the following please indicate lower and upper values which you believe will include the true value with 90% confidence. In other words, choose lower and upper values so that you are 90% sure that the actual value will fall within the range.

After you have completed this page please raise your hand and an experimenter will collect it. Your responses are important for our research and you will receive $2 for carefully completing this task.

		Low	High
1	Year George Washington was born		
2	Length of the Nile River (in miles)		
3	Number of countries that are members of OPEC		
4	Surface area of the Earth (in square miles)		
5	Maximum Takeoff Weight of a Boeing 747-8 (in pounds)		
6	Year in which J.S. Bach was born		
7	Gestation period (in days) of an Asian elephant		
8	Diameter of the moon (in miles)		
9	Air distance from London to Tokyo (in miles)		
10	Deepest known point in the oceans (in feet)		

[New page]

Instructions for Investment Task

You are asked to make a single choice. The choice concerns the investment of cash. You are endowed with $10 and can invest any portion of the $10 in a risky asset that has a 50% chance of success. If the investment is successful, the amount invested increases in value by 2.5 (or 250%). The amount you do not invest does not change in value and is yours to keep. Note that if you invest $Z in the asset there are two equally likely outcomes:

$2.5*Z + $(10 – Z) or, in words, you invest $Z and the investment is successful.

$(10 – Z) or, in words, you invest $Z and the investment is unsuccessful.

At the conclusion of the experiment today, we will actually determine the outcome of your investment choice. A participant in this room will toss a coin and if heads appears, the investment is successful and the amount you invested grows by 250%. If tails appears, you lose the amount you invested and take home $(10 - Z).

After all participants' questions have been answered, please indicate your investment below. Please hold onto this sheet until the end of the experiment when your earnings for this task will be determined. You will have 2 minutes to record your investment.

I invest $________________________ in the risky asset. Remember that you can invest any amount from $0 to $10.

Your Earnings:

[$______________	* ______________]	+	[______________]	= $ __________________
Your investment in the risky asset (Z)	2.5 or 0 determined by coin toss		The amount you do not invest ($10-Z)	Your Earnings

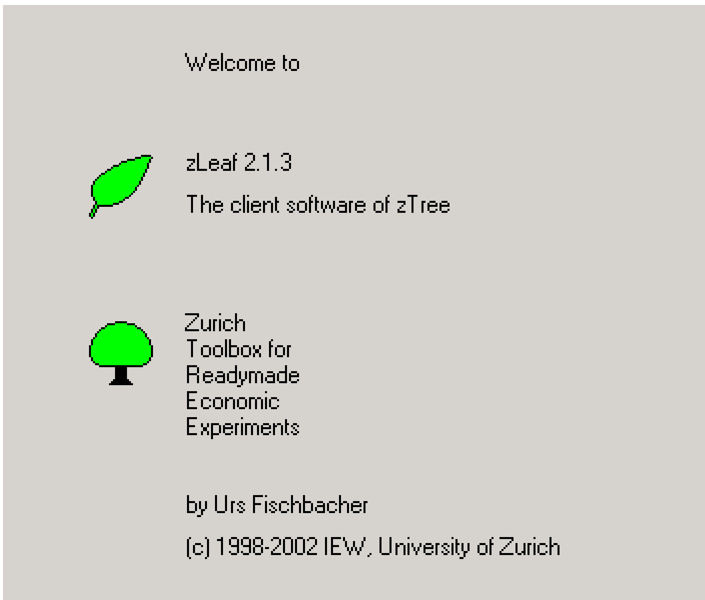
Fill in first blank now. Recall that after the experiment is completed a coin will be tossed to determine the success or not of your investment. At that time you will calculate your earnings for this task (i.e., fill in the rest of the blanks).

[New page]

INSTRUCTIONS

We are about to begin the asset trading portion of the experiment where you can trade stocks using experimental currency. The experiment is conducted in a computerized electronic market. We will describe to you how this market works and your interface with it.

Please raise your hand and let the experimenter know if you don't see the following screen on your computer:

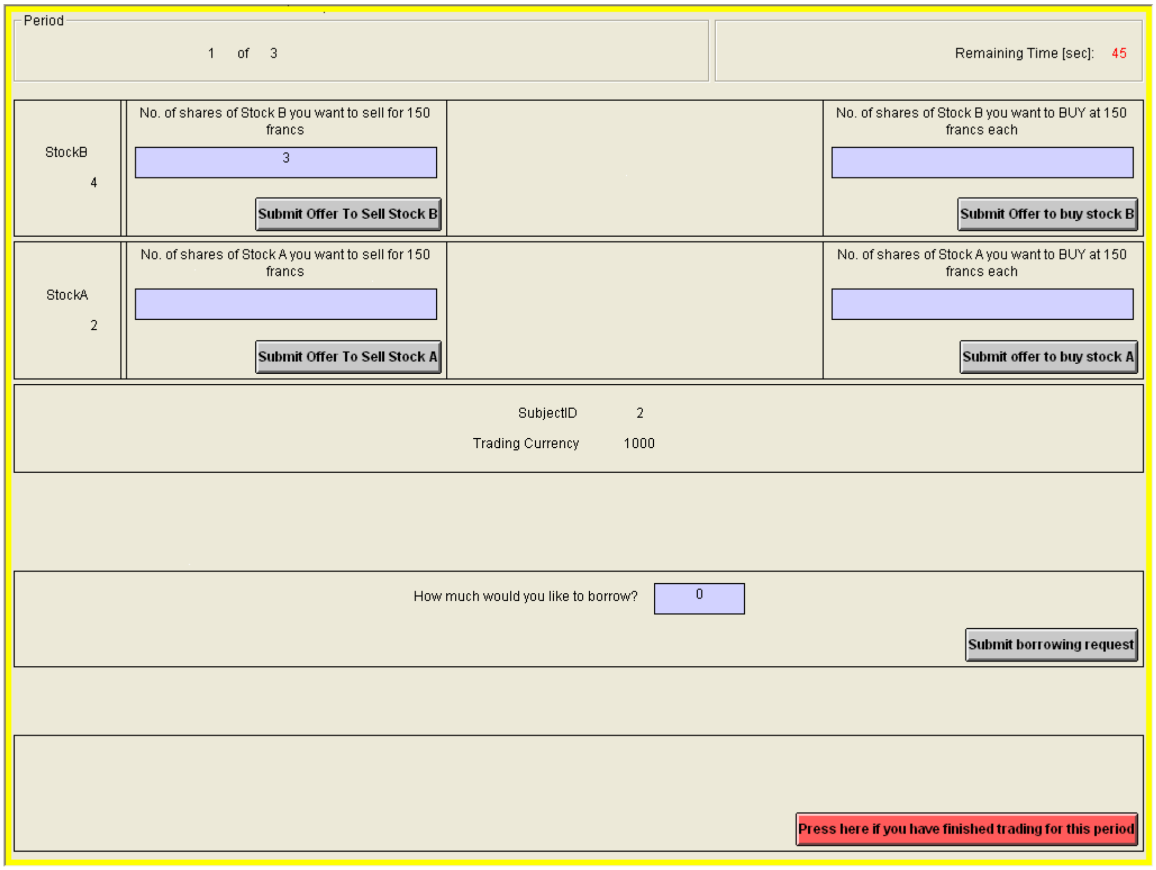


Please follow along as the experimenter reads these instructions aloud. Feel free to ask questions at any time. We will practice trading on the computer before the actual market begins.

Trading Screen:

The left upper corner of the screen shows you the current trading period and the total number of trading periods we are going to play today. The right upper corner shows the remaining seconds of the current trading period. In today's experiment, each trading period is a maximum of 2 minutes. Please press the key at the bottom to proceed at your own pace.

The middle of the screen displays your subject ID and the money you have in your trading currency account. We will call the experimental currency francs. In addition, the screen indicates the amount, in francs, that you have borrowed from the Bank. Each period you can borrow francs from the Bank but they must be repaid at the end of the trading period. If you do not have sufficient funds to repay the Bank, you are bankrupt and will no longer participate in trading. The rest of the screen is divided into two horizontal boxes, one for each specific stock.



There are two assets (stock A and stock B) in today's experiment. On the left of each box, you will see the number of units of each stock in your portfolio. The above window indicates that you have 2 units of stock A in your portfolio right now. The next column is where you indicate how many shares of stocks B and A that you want to sell at 150. The last column on the very right of the screen is where you indicate how many shares of stocks B and A that you want to buy at 150.

Today's Experiment:

Today's experiment will include 10 trading periods. There are two stocks in our experiment: A and B, which generate dividends at the end of each trading period. The trading currency is francs. At the beginning of each trading period your trading screen will indicate your endowment of A, B, and cash.

At the end of each trading period, a dividend is paid on each unit of the stocks you have in your portfolio. The dividend for each stock is determined by which state occurred at period end. There are two possible states, state I and state II. A random number draw determines the state. The probability distributions of the realization of each state in the experiment and the dividend payoff corresponding to each state are described in the following table:

	Dividend of A (in francs)	Dividend of B (in francs)
State I (probability 0.50)	0	300
State II (probability 0.50)	300	0

Notice that the expected payoff for each stock is 150 francs because half the time you will earn 0 francs and the other half of the time you will earn 300 francs. Remember that each stock lasts only 1 period so that at the beginning of each trading period your holdings begin again at your initial endowment.

To convert your earnings into dollars, we will multiply by 0.001. Thus, 1,000 francs in total would be equal to $1.00.

How Do You Earn Your Payoff?

Remember that your cash payoff is determined by the dividends you earned on stocks and the francs in your portfolio at the end of each trading period.

Based on the above table that determines the occurrence of the state, each unit of stock A or B will yield 150 francs on average per trading period. For example, a portfolio that only contains 150 francs will yield 150 francs per period no matter which state occurs. However, a portfolio that contains only one unit of stock A will do well half of the time, but poorly the other half of the time and, on average, you expect 150 francs per period.

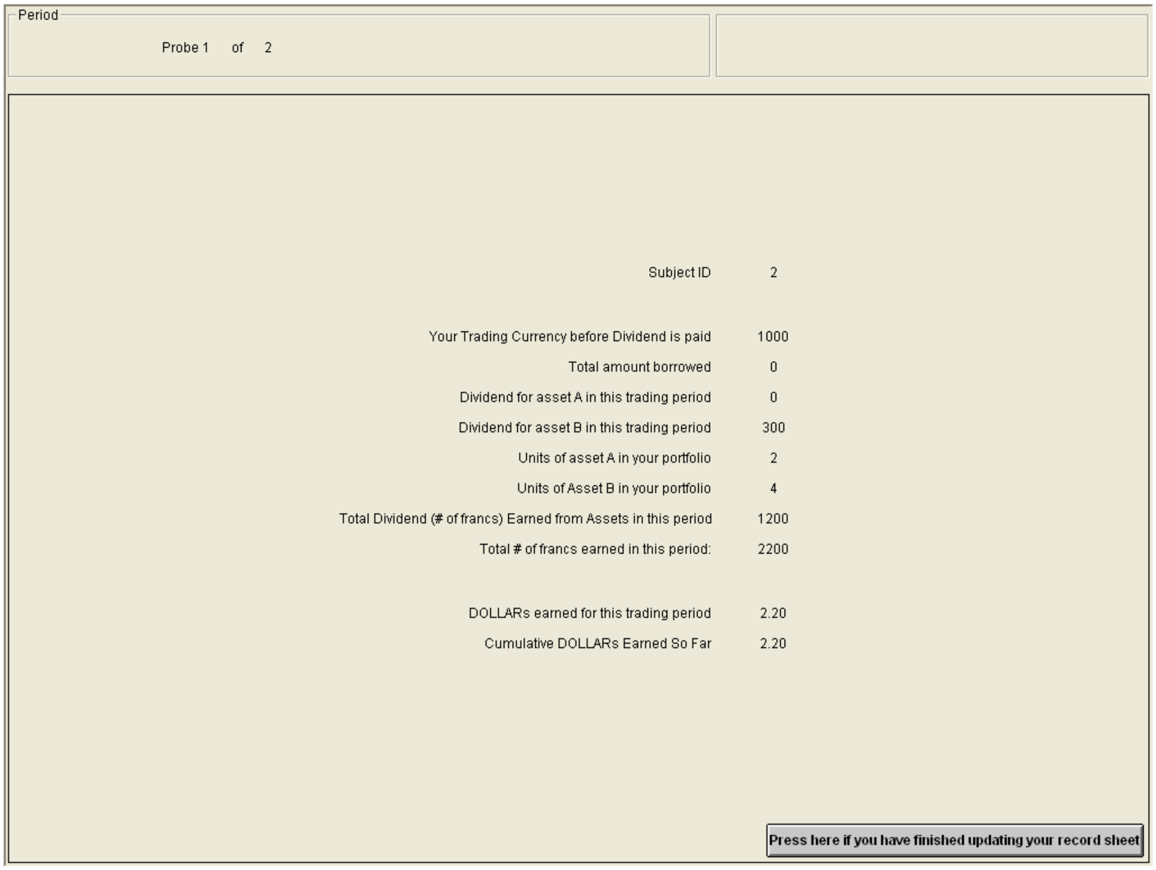
During the experiment you will trade stocks A and B with the experimenter at a price of 150 francs. You can buy or sell as many units of each stock at this price with two restrictions: (1) you cannot short sell (i.e., you cannot sell units you do not own) and (2) the maximum numbers of shares of either A or B you can purchase is 60. You will receive an error message if you try to purchase more than 60 shares.

At the beginning of each period you will be asked to record the number of shares you would like to sell of stocks A and B on the left side of your trading screen and the number of shares you would like to buy on the right.

Remember that your holding of cash can be negative, in which case you must borrow from the Bank. If you attempt to buy more shares than you have funds available to pay for and you do not borrow from the Bank, you will receive an error message indicating that you do not have enough cash. If you receive this error message you are permitted to go back to the trading screen and enter borrowings from the Bank.

Summary Screen:

At the end of each trading period, a summary screen will pop up.



On this screen, you will see the following information:

1. Francs held in your trading currency account at the end of the current trading period.
2. Dividends for each stock and number of units of each stock held in your portfolio for the current period.
3. Total dividends you earned from the stocks held in the current trading period.
4. Total income in francs for the current trading period.
5. Dollars earned for the current trading period.
6. Cumulative dollars earned so far in the experiment.
7. Total francs borrowed.

At the end of each period you will be asked to record some of the above information on a record sheet included in the folder with these instructions. After you are ready, click the “Press here” button to wait for all the other subjects to be ready to continue to the next trading period.

Summary of Important Points

Before we start our practice trading game, lets review some important points:

1.) You are allowed to trade both stocks A and B. You also receive a cash endowment that is yours to keep.

2.) You can borrow francs from the Bank during each trading period but you must repay the Bank at the end of every period. Borrowing will not carry over across periods.

3.) Recall the dividend information on the two stocks:

	Dividend of A (in francs)	Dividend of B (in francs)
State I (probability 0.50)	0	300
State II (probability 0.50)	300	0

4.) Earnings in dollars are computed by multiplying earnings in francs by the conversion rate of 0.0010.

5.) At the end of each period, record your portfolio composition and the earnings in francs on the record sheet given to you.

6.) Your starting endowments of stock A, stock B, and cash in francs are reported on your record sheet. Units of stocks A and B do not carry forward across periods. Your endowment will be the same at the beginning of each trading period.

7.) Remember that you must repay the Bank any francs you borrowed during the trading period. If you do not have sufficient funds to repay the Bank, you are bankrupt and will no longer trade. The experimenter will check your record sheet at the end of each period to ensure you have sufficient funds to continue.

Now let's practice trading.

Cumulative Record Sheet

Add $2 for completion of the high-low survey	$
Total amount earned for the investment task	$
Total amount earned in trading phase of the session	$
Add $2 if on time for the experiment.	$
Add $2 for completion of post-experiment questionnaire.	$
Your total cash earnings for participation in this session.	$

[New page]

Post-Experiment Questionnaire

This questionnaire is designed to collect general information. Such information may help us better understand differences found between participants in this experiment.

1. What university program are you in (MBA, undergrad, etc.)? __________

2. What year are you in the program (1^{st}, 2^{nd}, 3^{rd}, or 4^{th})? _________

3. What is your major or concentration (e.g., finance, economics, etc.)? ___________

4. What is your sex? male _____ female _____

5. What is your age? _____ years

6a. What are your means of financial support (check all that apply)?
_____ self supported
_____ parent or relative
_____ spouse or significant other
_____ financial aid or other loans
_____ scholarship
_____ other

6b. Referring to question 6a., what is your total household income (check one)?
_____ $0 - $25,000
_____ $25,001 - $50,000
_____ $50,001 - $75,000
_____ $75,001 - $100,000
_____ More than $100,000

6c. What is your primary means of financial support (check only one)?
_____ self supported
_____ parent or relative
_____ spouse or significant other
_____ financial aid or other loans
_____ scholarship
_____ other

7. Are you currently employed? yes _____ no _____

If you answered yes to question 7, please answer 8a -8c. If no, skip to question 9.

8a. Are you employed full or part time? full-time _____ part-time _____

8b. How long in your current employment? _____ (months) _____ (years)

8c. What is your current job title? ___________________________

9. How many years of professional work experience do you have? _________

10. How many finance and economics courses have you successfully completed at the university level? _____ courses

11. How many finance and economics courses are you currently enrolled in?
_____ courses

12. How interesting did you find this experiment? (circle the appropriate number)

Not very
Interesting
1--------2--------3--------4--------5--------6--------7--------8--------9-------10--------11

13. For the time spent, how would you characterize the amount of money earned for participating in this experiment? (circle the appropriate number)

Nominal
Amount
1--------2--------3--------4--------5--------6--------7--------8--------9-------10--------11

14. How would you characterize your financial expertise? (circle the appropriate number)

Very Little
Knowledge K
1--------2--------3--------4--------5--------6--------7--------8--------9-------10--------11

15. Have you ever traded securities for yourself or others? yes _______ no _______
If yes, please describe.

16. Have you ever participated in a market experiment where you actively trade with other participants and received financial compensation? yes _______ no _______
If yes, please describe.

17. Please describe any reflections you have on how other participants traded today.

RECORD SHEET

Period	Endowments			Period Summary							Final Earnings for the Period
	Cash	A	B	Cash before Dividends	Borrowing	Dividend A	Dividend B	Holdings A	Holdings B	Dividend Earnings	
P1											
P2											
1	1,000										
2	1,000										
3	1,000										
4	1,000										
5	1,000										
6	1,000										
7	1,000										
8	1,000										
9	1,000										
10	1,000										

Cumulative Earnings (last row on screen for period 10) ________________

FIGURE 1

Average Absolute Imbalance in Experiment One

The figure shows the frequency of average absolute imbalance per participant for the first experiment (n=36).

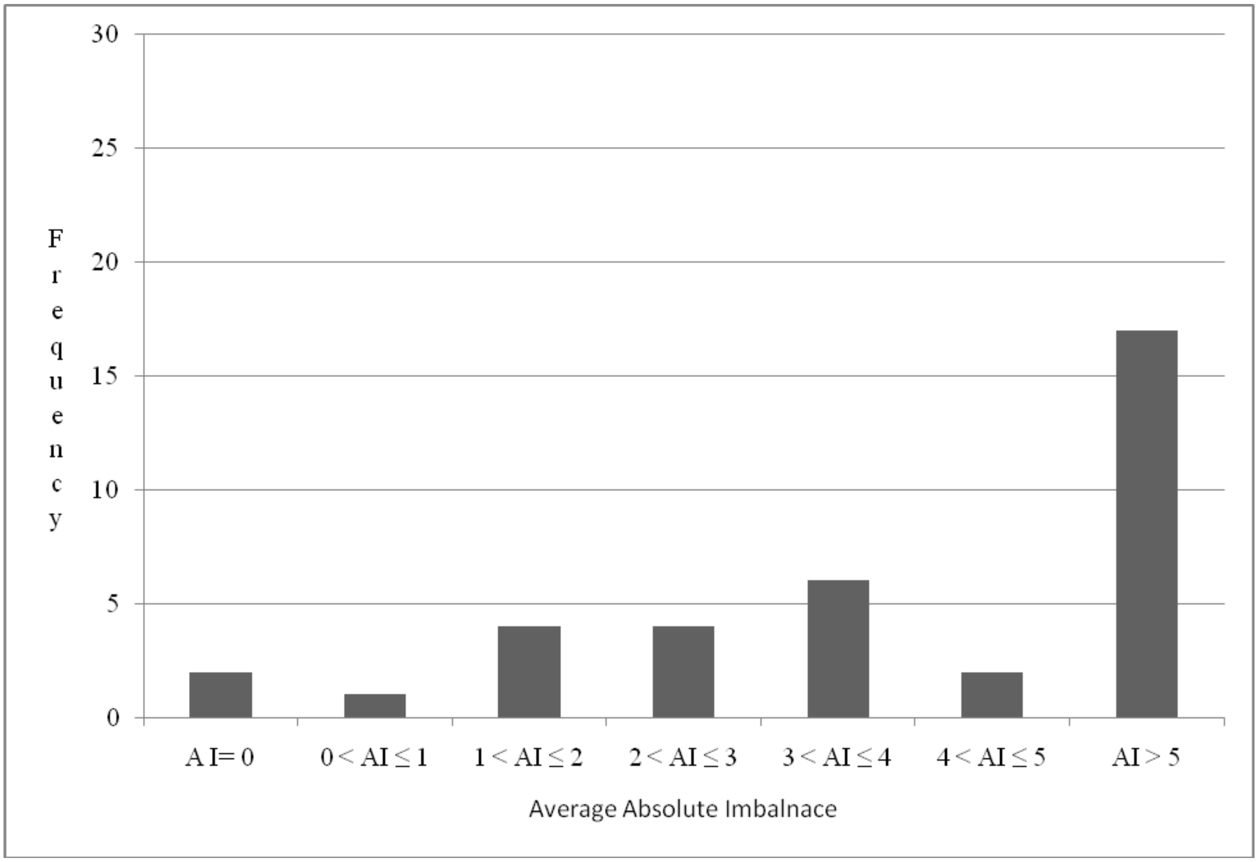


FIGURE 2

Average Absolute Imbalance in Experiment Two

The figure shows the frequency of average absolute imbalance per participant for the second experiment (n=48).

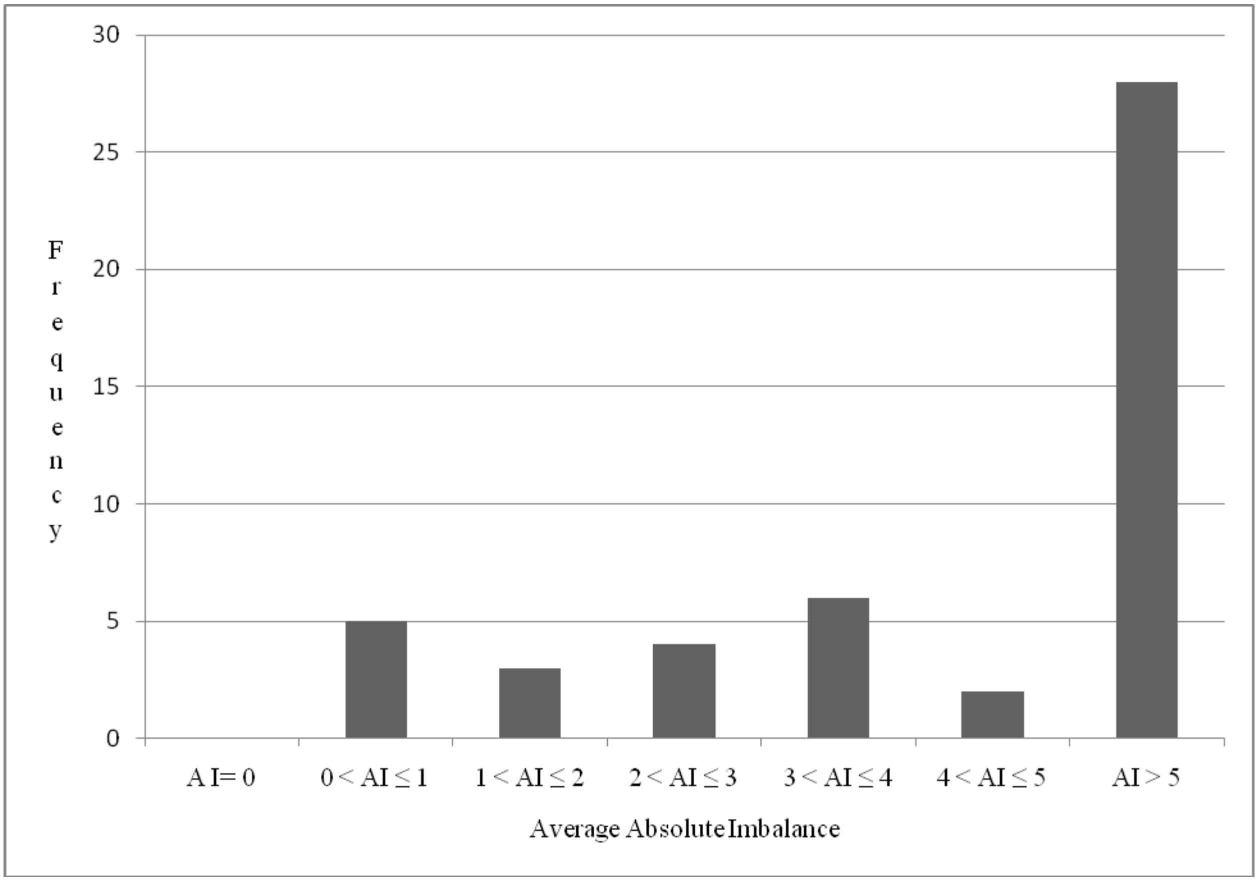


FIGURE 3

Average Absolute Imbalance in Experiment Three

The figure shows the frequency of average absolute imbalance per participant for the third experiment (n=49).

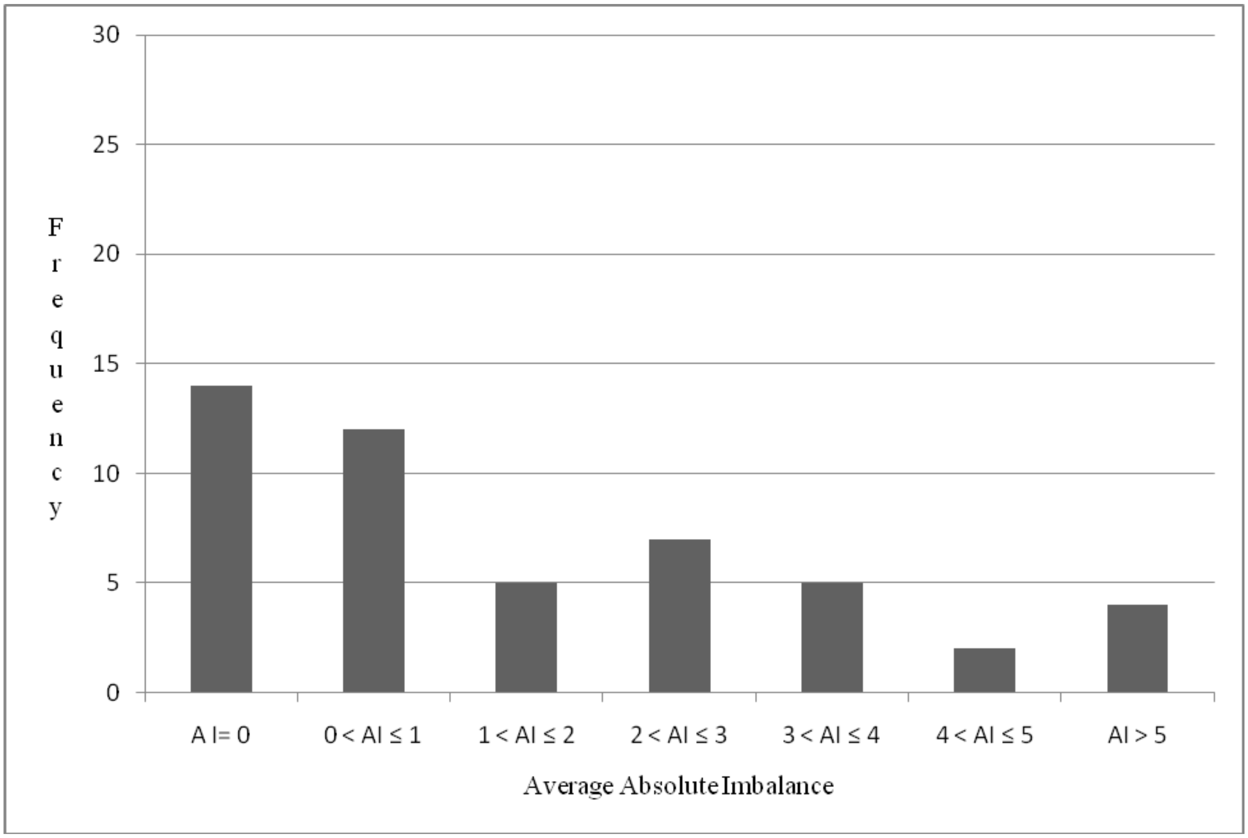


FIGURE 4

Average Absolute Imbalance over Time

The figure shows the average absolute imbalance per period for each of the three experiments.

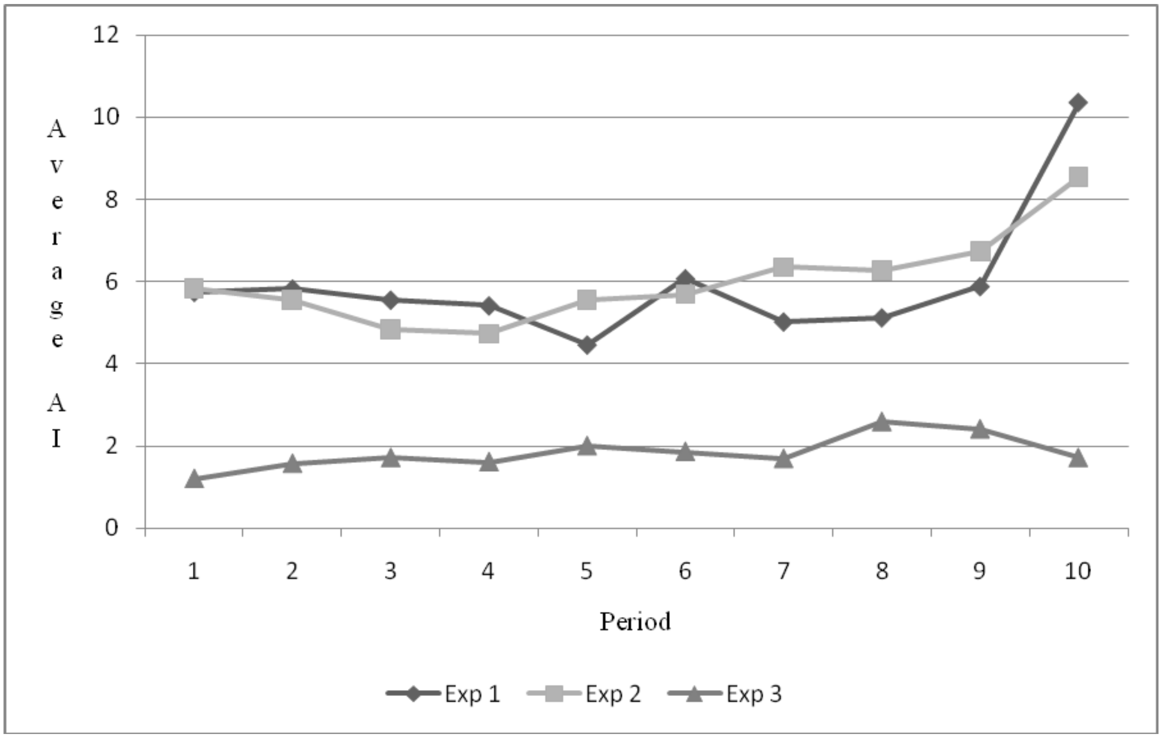


TABLE 1
Outline of Experiments

Panel A: Experimental design

Session	Experiment	Number of participants	Feedback	Endowment		
				Stock A	Stock B	Cash
B1, B2, B3	(1) Benchmark	18	Yes	10	0	1,000
		18		0	10	1,000
HV1, HV2, HV3, HV4	(2) Loss Possible	24	Yes	10	0	1,000
		24		0	10	1,000
NR1, NR2, NR3, NR4	(3) No revelation, Single draw, Loss Possible	26	No	10	0	1,000
		23		0	10	1,000

Panel B: Distribution of dividends for the Benchmark Experiment

Asset Dividend Distributions			Expected Value
State	I	II	150
Probability	0.50	0.50	
Stock A's Dividends	0	300	
Stock B's dividends	300	0	

Panel C: Distribution of dividends for the Loss Possible and No Revelation Experiments

Asset Dividend Distributions			Expected Value
State	I	II	150
Probability	0.50	0.50	
Stock A's dividends	-150	450	
Stock B's dividends	450	-150	

Notes: All sessions include 10 periods and all participants are endowed with 1,000 francs, in addition to shares of stocks A and B.

TABLE 2
Summary Statistics on Holdings Imbalance for Benchmark Experiment

The table reports asset imbalances in final stock positions for the first experiment which included 36 participants. The absolute asset imbalance is calculated as |#Stock A - #Stock B|, whereas the signed imbalance preserves the direction of the imbalance, #Stock A - #Stock B. Panel A provides information on the number of participants in each imbalance interval for periods 1-10, 1-5, and 6-10, as well as the mean and median absolute imbalance across participants. "No shares held" indicates how many participants held only cash in their portfolio at period end, whereas the frequencies reported when the imbalance is zero include those with stock holdings. Panel B reports how many participants have positive, zero, and negative signed imbalance, along with the mean and median.

Panel A: Absolute Imbalance

	Periods 1-10	Periods 1-5	Periods 6-10
No shares held	0	0	0
#Stock A - #Stock B = 0	2	4	2
0 < |#Stock A - #Stock B| ≤ 1	1	0	2
1 < |#Stock A - #Stock B| ≤ 2	4	6	6
2 < |#Stock A - #Stock B| ≤ 3	4	6	1
3 < |#Stock A - #Stock B| ≤ 4	6	4	4
4 < |#Stock A - #Stock B| ≤ 5	2	3	1
5 < |#Stock A - #Stock B| ≤ 10	12	10	14
|#Stock A - #Stock B| > 10	5	3	6
Mean	5.95	5.41	6.50
Median	6.20	3.00	9.40

Panel B: Signed Imbalance

	Periods 1-10	Periods 1-5	Periods 6-10
#Stock A - #Stock B > 0	12	14	9
#Stock A - #Stock B = 0	2	6	3
#Stock A - #Stock B < 0	22	16	24
Mean	-1.02	0.59	-2.63
Median	-2.60	0.60	-5.80

TABLE 3
Summary Statistics on Holdings Imbalance for Loss Possible Experiment

The table reports asset imbalances in final stock positions for the second experiment which included 48 participants. The absolute asset imbalance is calculated as |#Stock A - #Stock B|, whereas the signed imbalance preserves the direction of the imbalance, #Stock A - #Stock B. Panel A provides information on the number of participants in each imbalance interval for periods 1-10, 1-5, and 6-10, as well as the mean and median absolute imbalance across participants. “No shares held” indicates how many participants held only cash in their portfolio at period end, whereas the frequencies reported when the imbalance is zero include those with stock holdings. Panel B reports how many participants have positive, zero, and negative signed imbalance, along with the mean and median.

Panel A: Absolute Imbalance

<table>
<tr><th></th><th>Periods 1-10</th><th>Periods 1-5</th><th>Periods 6-10</th></tr>
<tr><td>No shares held</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>#Stock A - #Stock B = 0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>0 < |#Stock A - #Stock B| ≤ 1</td><td>5</td><td>7</td><td>7</td></tr>
<tr><td>1 < |#Stock A - #Stock B| ≤ 2</td><td>3</td><td>3</td><td>5</td></tr>
<tr><td>2 < |#Stock A - #Stock B| ≤ 3</td><td>4</td><td>5</td><td>1</td></tr>
<tr><td>3 < |#Stock A - #Stock B| ≤ 4</td><td>6</td><td>8</td><td>3</td></tr>
<tr><td>4 < |#Stock A - #Stock B| ≤ 5</td><td>2</td><td>3</td><td>3</td></tr>
<tr><td>5 < |#Stock A - #Stock B| ≤ 10</td><td>23</td><td>16</td><td>24</td></tr>
<tr><td>|#Stock A - #Stock B| > 10</td><td>5</td><td>5</td><td>5</td></tr>
<tr><td>Mean</td><td>6.01</td><td>5.30</td><td>6.72</td></tr>
<tr><td>Median</td><td>2.85</td><td>2.90</td><td>3.61</td></tr>
</table>

Panel B: Signed Imbalance

	Periods 1-10	Periods 1-5	Periods 6-10
#Stock A - #Stock B > 0	21	23	18
#Stock A - #Stock B = 0	0	1	0
#Stock A - #Stock B < 0	27	24	30
Mean	-0.62	-0.02	-1.22
Median	-2.50	-2.30	-2.70

TABLE 4
Summary Statistics on Holdings Imbalance for No Revelation Experiment

The table reports asset imbalances in final stock positions for the third experiment which included 49 participants. The absolute asset imbalance is calculated as |#Stock A - #Stock B|, whereas the signed imbalance preserves the direction of the imbalance, #Stock A - #Stock B. Panel A provides information on the number of participants in each imbalance interval for periods 1-10, 1-5, and 6-10, as well as the mean and median absolute imbalance across participants. "No shares held" indicates how many participants held only cash in their portfolio at period end, whereas the frequencies reported when the imbalance is zero include those with stock holdings. Panel B reports how many participants have positive, zero, and negative signed imbalance, along with the mean and median.

Panel A: Absolute Imbalance

	Periods 1-10	Periods 1-5	Periods 6-10
No shares held	9	11	10
#Stock A - #Stock B = 0	5	8	6
0 < |#Stock A - #Stock B| ≤ 1	12	8	8
1 < |#Stock A - #Stock B| ≤ 2	5	8	7
2 < |#Stock A - #Stock B| ≤ 3	7	4	5
3 < |#Stock A - #Stock B| ≤ 4	5	5	5
4 < |#Stock A - #Stock B| ≤ 5	2	1	4
5 < |#Stock A - #Stock B| ≤ 10	4	4	4
|#Stock A - #Stock B| > 10	0	0	0
Mean	1.84	1.62	2.05
Median	0.00	0.00	0.00

Panel B: Signed Imbalance

	Periods 1-10	Periods 1-5	Periods 6-10
#Stock A - #Stock B > 0	20	18	14
#Stock A - #Stock B = 0	16	20	20
#Stock A - #Stock B < 0	13	11	15
Mean	-0.14	-0.16	-0.12
Median	0.00	0.00	0.00

Table 5
Distribution of Imbalance across Endowments

The table reports mean signed asset imbalance in final stock positions for each experiment by initial endowment. The asset imbalance is calculated as #Stock A - #Stock B. Below each mean in parentheses is the result of a t-test to indicate a significantly negative final holding for the 0/10 endowment, positive final holding for the 10/0 endowment, and different from zero for the 5/5 endowment difference from zero with asterisks noting statistical significance.

Endowment (A/B)	Benchmark	Loss Possible	No revelation
0/10	-2.64 (-4.13)***	-4.68 (-12.86)***	-0.56 (-2.28)**
5/5	N/A N/A	N/A N/A	0.05 (0.21)
10/0	0.61 (0.75)	3.45 (6.40)***	0.34 (1.64)*

Note: Asterisks (*, **, *) denote significant differences from zero at the 10%, 5%, and 1% level, one-tailed tests.**

Table 6
Tests of Gambler's Fallacy and Trend-Chasing

The table reports tests of gambler's fallacy and trend-chasing in Panels A and B. Decreased holdings of A (B) after A (B) paid high the previous period would support the null hypothesis of gambler's fallacy. Increased holdings of A (B) after A (B) paid high the previous period would support the null hypothesis of trend-chasing. Below each mean in parentheses is the result of t-tests of the null hypothesis of no gambler's fallacy (Panel A) and no trend-chasing (Panel B) with asterisks noting statistical significance.

Panel A: Tests of Gambler's Fallacy

Change in holdings	Stock paying high previous period	Mean (t-statistic)	Hypothesized direction
#Stock A	A	-0.50 (-1.39)*	-
	B	0.52 (1.28)	+
#Stock B	A	1.01 (3.69)***	+
	B	-0.59 (-1.53)*	-
#Stock A - #Stock B	A	-1.51 (-3.19)***	-
	B	1.11 (2.06)**	+

Panel B: Tests of Trend-Chasing

Change in holdings	Stock paying high previous period	Mean (t-statistic)	Hypothesized direction
#Stock A	A	-0.50 (-1.39)	+
	B	0.52 (1.28)	-
#Stock B	A	1.01 (3.69)	-
	B	-0.59 (-1.53)	+
#Stock A - #Stock B	A	-1.51 (-3.19)	+
	B	1.11 (2.06)	-

Note: Asterisks (*, **, *) denote significant differences from zero at the 10%, 5%, and 1% level, one-tailed tests.**

Table 7
Absolute Imbalance Regression

The table reports the results of a regression in which the dependent variable is absolute imbalance, calculated as |#Stock A - #Stock B|. The data includes the choices made by all 163 participants. The independent variables include the number of correct responses on the calibration questionnaire (Calibration), the amount invested in the risk measure (Risk), and five dummy variables. The dummy variables take the value one (and zero otherwise) in the following cases: participants given balanced endowment (Balanced endowment), the high variance experiment (High variance), the no revelation, single draw experiment (No revelation), participants who are business or economics major (Business), and participants who are male (Male). Below each coefficient estimate in parentheses is the result of a t-test to indicate a difference from zero with asterisks noting statistical significance. Standard errors are corrected for clustering due to repeated sampling of participants.

Independent variable	Estimated Coefficient
Constant	3.99 (4.09)***
Calibration	0.20 (0.96)
Risk	0.17 (1.66)
Balanced endowment	-0.35 (-0.52)
Loss Possible	0.28 (0.39)
No revelation	-3.96 (-6.21)***
Business	-0.44 (-1.01)
Male	0.91 (2.67)***

Note: Asterisks (*, **, *) denote significant differences from zero at the 10%, 5%, and 1% level, two-tailed tests.**

REFERENCES

Ackert, Lucy F., Stefano Mazzotta, and Li Qi. 2010. An experimental investigation of asset pricing in segmented markets, *Southern Economic Journal*, forthcoming.

Barber, Brad. M., and Terrancce Odean. 2001. Boys will be boys: Gender, overconfidence,and common stock investment, *Quarterly Journal of Economics* 116(1), 261-292.

Benartzi, Shlomo, and Richard H. Thaler. 1995. Myopic loss aversiona nd the equity premium puzzle, *Quarterly Journal of Economics* 110(1), 73-92.

Biais, Bruno, Denis Hilton, Karine Mazurier, and Sebastien Pouget. 2005. Judgemental overconfidence, self-monitoring, and trading performance in an experimental financial market, *Review of Economic Studies* 72, 287-312.

Blume, Marshall E., and Irwin Friend. 1975. The asset structure of individual portfolios and some implications for utility functions, *Journal of Finance* 30(2), 585-603.

Bossaerts, Peter, and Charles Plott. 2002. The CAPM in thin experimental financial markets. *Journal of Economic Dynamics & Control* 26, 1093-1112.

Bossaerts, Peter, Charles Plott, and William R. Zame. 2007. Prices and portfolio choices in financial markets: Theory, econometrics, experiments. *Econometrica* 75(4), 993-1038.

Charness, Gary, and Uri Gneezy. 2007. Strong evidence for gender differences in investment. SSRN Working Paper 648735.

Charness, Gary, and Uri Gneezy. 2010. Portfolio choice and risk attitudes: An experiment. *Economic Inquiry* 48(1), 133-146.

Fischbacher, Urs. 2007. z-tree: Zurich toolbox for ready-made experiments. *Experimental Economics* 10(2), 171-178.

Fischhoff, Baruch, Sarah Lichtenstein, and Paul Slovic. 1977. Knowing with certainty: The appropriateness of extreme confidence. *Journal of Experimental Psychology* 3(4), 552-564.

Forsythe, Robert, and Russell Lundholm. 1990. Information aggregation in an experimental market. *Econometrica* 58(2), 309-347.

Gneezy, Uri, Arie Kapteyn, and Jan Potters. 2003. Evaluation periods and asset prices in a market experiment. *Journal of Finance* 73(2), 821-837.

Goetzmann, William N., and Alok Kumar. 2008. Equity portfolio diversification. *Review of Finance* 12, 433-463.

Holt, Charles A., and Susan K. Laury. 2002. Risk aversion and incentive effects. *American Economic Review* 92(5), 1644-1655.

Kahneman, Amos, Jack L. Knetsch, and Richard H. Thaler. 1990. Experimental tests of the endowment effect and the Coase theorem, *Journal of Political Economy* 98(6), 1325-1348.

Kahneman, Amos, and Daniel Tversky. 1972. Subjective probability: A judgment of representativeness. *Cognitive Psychology* 3, 430-454.

Kroll, Yoram, Haim Levy, and Amnon Rapoport. 1988a. Experimental tests of the separation theorem and the capital asset pricing model. *American Economic Review* 78(3), 500-519.

Kroll, Yoram, Haim Levy, and Amnon Rapoport. 1988b. Experimental tests of the mean-variance model for portfolio selection, *Organizational Behavior and Human Decision Processes* 42, 388-410.

Odean, Terrance. 1998. Volume, volatility, price, and profit when all traders are above average. *Journal of Finance* 53(6), 1887-1934.

Plott, Charles R., and Shyam Sunder. 1988. Rational expectations and the aggregation of diverse information in laboratory security markets. *Econometrica* 56(5), 1085-1118.

Rietz, Thomas A. 2003. Trader behavior, arbitrage, and efficiency in experimental asset markets. Working paper, University of Iowa.

Shefrin, Hersh, and Meir Statman. 2000. Behavioral portfolio theory. *Journal of Financial and Quantitative Analysis* 35(2), 127-151.

Statman, Meir. 2004. The diversification puzzle. *Financial Analysts Journal* 60(4), 44-53.

Tversky, Amos, and Daniel Kahneman. 1985. Rational choice and the framing of decisions. *Journal of Business* 59(4), pt. 2, S251-S278.

Weber, Martin, Hans-Jurgen Keppe, and Gabriela Meyer-Delius. 2000. The impact of endwoment framing on market prices – an experimental analysis. *Journal of Economic Behavior and Organization* 41, 159-176.