ICIR

International Center for
Insurance Regulation

HOUSE OF FINANCE
Goethe-Universität Frankfurt

ICIR Working Paper Series No. 16/14

Edited by Helmut Gründl and Manfred Wandt

# "And Lead Us Not Into Temptation": Presentation Formats and the Choice of Risky Alternatives*

Franca Glenzer, Helmut Gründl, Christian Wilde†

June 17, 2014

**Abstract**

This paper uses laboratory experiments to provide a systematic analysis of how different presentation formats affect individuals' investment decisions. The results indicate that the type of presentation as well as personal characteristics influence both, the consistency of decisions and the riskiness of investment choices. However, while personal characteristics have a larger impact on consistency, the chosen risk level is determined more by framing effects. On the level of personal characteristics, participants' decisions show that better financial literacy and a better understanding of the presentation format enhance consistency and thus decision quality. Moreover, female participants on average make less consistent decisions and tend to prefer less risky alternatives. On the level of framing dimensions, subjects choose riskier investments when possible outcomes are shown in absolute values rather than rates of return and when the loss potential is less obvious. In particular, reducing the emphasis on downside risk and upside potential simultaneously leads to a substantial increase in risk taking.

**Keywords:** Behavioral finance; Decision under risk; Framing effects

*We are grateful to Mike Adams, Matthias Beenken, M. Martin Boyer, Glenn W. Harrison, Andre Liebenberg, Joan Schmit, Federica Teppa, and the participants at the CEAR/MRIC Behavioral Insurance Workshop (München, December 2012), the annual meeting of the German Insurance Science Association (Berlin, March 2013), the seminar at the University of Bath (May 2013), the International Workshop on Pension, Insurance and Saving (Paris, June 2013), the annual meeting of the American Risk and Insurance Association (Washington D.C., August 2013), the annual meeting of the European Economic Association (Göteborg, August 2013) as well as the annual meeting of the European Group of Risk and Insurance Economists (Paris, September 2013) for valuable comments and suggestions.

†All authors are affiliated with the House of Finance, Goethe University Frankfurt. Contact address: Goethe Universität Frankfurt am Main, Faculty of Economics and Business Administration, House of Finance, Grüneburgplatz 1, 60323 Frankfurt; e-mail: glenzer@finance.uni-frankfurt.de, gruendl@finance.uni-frankfurt.de, wilde@finance.uni-frankfurt.de.

## 1 Introduction

One important determinant of the decision-making process is the format in which options are framed, as first and most prominently demonstrated by Tversky and Kahneman (1981), Kahneman and Tversky (1984), and Levin et al. (1998). Behavioral finance research shows that investors' beliefs and choices are influenced by the format in which information about financial products is conveyed. Examples of these framing effects in decision making are reference points (Kahneman and Tversky, 1979), the time horizon (Benartzi and Thaler, 1999) and presenting potential terminal values as opposed to rates of return (Diacon and Hasseldine, 2007). Durbach and Stewart (2011) provide a comparison of decisions among risky alternatives when the presentation format is varied. They conclude that how the uncertain outcome of an investment is presented has an impact on the difficulty of decision-making and the quality of decisions. To our knowledge, however, the question of how these framing effects interact in influencing an individual's investment decision has not yet been addressed.

The issue of how product information should be communicated to retail investors has received a great deal of attention ever since the financial crisis revealed that many retail investors were not aware of the risks inherent in their portfolios. A comprehensive and understandable disclosure of necessary information by product sellers is particularly important since these portfolios held by retail investors often constitute a great share of their old age provision. In many countries, efforts are made to protect retail investors. In the United States, the Consumer Financial Protection Bureau (CFPB) was formed in 2011 as federal agency to regulate consumer protection regarding financial products and services. Also in Europe, policy makers are concerned with improving consumer protection. The European Commission developed a proposal for a key information document for investment products to address the problem of insufficient or incomprehensible product information (see European Commission, 2012). This proposal is based on a number of studies that deal with how different presentation formats influence retail investors' comprehension of investment product information (see e.g. IFF Research and YouGov, 2009). Similarly, a recent report from Germany discusses appropriate language and design for a standardized product fact sheet (Tiffe et al., 2012).

In this analysis, we want to take this a step further by determining exactly how different presentation formats affect individuals' risk perception and investment decisions. This is an important contribution not only to the literature on decision-making but also to the discussion how product information should be conveyed to retail investors taking into account the effect of the presentation format itself on asset allocation. The latter should help to improve decision quality, measured by the degree to which subjects' investment decisions match their preferences.

We draw on results from a number of empirical studies as for instance by Diacon and Hasseldine (2007) and Durbach and Stewart (2011) that identify drivers of decision making, and we conduct a comprehensive experiment in order to quantify the impact of framing effects on the chosen risk level in individuals' portfolios. Here, framing refers to different presentations of identical investment alternatives, i.e., alternatives with the same payoff distribution. The alternatives will be perceived to be the same across settings if one correctly draws inferences from the data presented. We consider settings in which forward-looking contract information is provided as, for example, in life insurance contracts.

We use laboratory experiments to investigate how different presentation formats influence both, the consistency and the riskiness of individuals' investment decisions. In the analysis, we include various dimensions of framing risky alternatives, such as absolute values versus rates of return, different confidence intervals for potential gains and losses, and graphical versus numerical presentation.

## 2 Related Literature and Hypotheses

Framing refers to the phenomenon that "two logically equivalent (but not *transparently* equivalent) statements of a problem lead decision makers to choose different options" (Rabin, 1998, p. 36). In their analysis of framing effects, Tversky and Kahneman (1981) laid the groundwork for extensive research in this field. Here, we are concerned with attribute framing in the sense of Levin et al. (1998) which involves changes in item evaluation when the item's attributes are framed differently. We define framing as different presentations of identical alternatives.

Our three hypotheses are based on the assumption of a rational individual who has certain preferences over risky investment alternatives with different risk-return profiles and is able to assign a preference order to given alternatives. This assumption implies that individuals should make the same decisions across settings if the alternatives presented are the same, even if the framing of the decision is varied.

One dimension of framing is presenting information in absolute or relative terms. Diacon and Hasseldine (2007) find framing effects that are induced by reporting either absolute fund values or rates of return. In particular, individuals chose the riskier investment fund when the past performance of the funds at choice was shown in terms of absolute fund values rather than in yield charts. Showing yield charts instead of absolute values thus seems to induce less risky choices. Another study that deals with the impact of framing in absolute and relative terms comes from the field of health economics. Schmitz and Ziebarth (2013) provide evidence stemming from a natural experiment: Since 2009, German public health insurers have had to state price differences in absolute values rather than in percentage point payroll tax differences. This resulted in a six-fold increase in an individual's switching probability and a four-fold price demand elasticity increase in the two years following the reform. Thus, this evidence, too, suggests that it is important for consumers whether information is presented in absolute or relative terms.

In our analysis, we therefore test the following hypothesis:

**H 1** *Decisions should not be influenced by whether absolute values or rates of return are shown to participants.*

In an experiment, Durbach and Stewart (2011) vary the amount of information about a gamble communicated to participants. They find that individuals' choice of risky alternatives is influenced by the presentation format. Specifically, participants' risk taking increased when the 95% and 5%

quantiles were shown instead of the maximum and minimum of the outcome distribution. We conjecture that individuals tend to take more risk the less prominently the downside potential of an investment is emphasized. We hypothesize:

**H 2** *Decisions should not be influenced by the extent of information explicitly provided about the tails of the outcome distribution.*

Another aspect of framing is presentation of information in graphical or tabular form. A number of studies find a difference in decisions made after receiving graphically as opposed to tabularly presented information (see, e.g., Remus, 1984; Vessey, 1991, 1994). This is due to the different nature of information conveyed by both formats. As Vessey (1994, p. 105) puts it, "Graphs are spatial problem representations [...]. Graphs emphasize relationships in the data. [...] Tables are symbolic problem representations since they present symbolic information.[...] They do not present data relationships directly." However, most of these studies analyze decision performance, which can only be measured when there is a benchmark decision against which to evaluate the participants' decisions. To our knowledge, there is no study of the graphs versus tables issue in the field of financial decision making. We seek to fill this gap in our experiment, thus hypothesizing:

**H 3** *Individuals' decisions should not be altered when information about investment alternatives is presented in graphic form rather than in tables.*

# 3 Experiments

## 3.1 Experiment Design

In the main decision block of the experiment, there is a total of 13 settings in which subjects are required to make decisions on investments. Each setting consists of four investment alternatives, three of them with normally distributed rates of return and one risk-free investment. Each alternative has a maturity of one period. The settings are based on two parameter sets for the investment alternatives, as shown in Table 1. Note that the parameters are chosen such that no return distribution is dominated by another in terms of mean-variance combinations. In fact, the Sharpe ratio is the same for all three risky investments within one parameter set. That way, participants' preference orders solely reflect their inclination towards absolute levels of risk and return and not towards the risk-return tradeoff. The two parameter sets exhibit equal means, but different standard deviations. Using two parameter sets enables us to compare decision making at different risk levels.

< Insert Table 1 about here >

For both parameter sets, participants are shown different presentation formats: tables with the 95%/5% and 75%/25% quantiles (plus median) for terminal values (Table 2), graphical presentations of the 95%/5% and 75%/25% quantiles for terminal values (Figure 1) and for rates of return (Figure 2), as well as rates of return framed as probability density functions (Figure 3). Normally distributed rates of return lead to log-normally distributed terminal values, exhibiting right-skewness. Note that in Settings 6 and 10, when comparing quantiles, investment alternatives A through C look as if they are strictly dominated by alternative D. Also note that this is not true for Settings 4 and 8, although the parameters are the same.

< Insert Table 2 about here >

< Insert Figure 1 about here >

< Insert Figure 2 about here >

< Insert Figure 3 about here >

The settings that are based on identical parameter sets only differ with respect to framing. This is done to elicit whether or not participants are consistent in their preferences as the framing of otherwise identical alternatives is altered. While all participants had full information about the risk-return characteristics of the alternatives, the fact that the alternatives are the same across settings was, of course, not communicated to them.

Table 3 provides an overview of all 13 settings with the dimensions in which the framing is altered.

< Insert Table 3 about here >

In the experiment, the settings are shown to participants one by one. After having completed the decision in one setting, the next setting is shown to participants. In each setting, subjects are asked to indicate their preferences for four investment alternatives with different risk-return profiles by assigning ranks from 1 (highest preference) to 4 (lowest preference). The ranking determines how the endowed capital will be invested on their behalf after one of the 13 settings has been randomly chosen to determine the real payoff to participants. The alternative which is given the first preference has the best odds of being chosen (with a probability of 1/2), followed by the second preference (with a probability of 1/3), and the third preference (with a probability of 1/6). This procedure was communicated to the participants. It is chosen in order to make sure that the participants rank the investment alternatives carefully in consideration of all possible ranks. Also, it provides a richer data set on individual decisions than just allowing participants to pick one alternative. In addition, to provide an incentive for a thoughtful decision and to avoid biases that may arise in purely hypothetical decision situations, the real payoff awarded to the participants is tied to their decisions in the experiment.

## 3.2 Experiment Sessions and Sample

The experiment was programmed and conducted with the experiment software z-Tree (Fischbacher, 2007). All experiments took place at the Frankfurt Laboratory for Experimental Research (FLEX) at Goethe University Frankfurt. The laboratory invited the individuals registered in its data base to participate in this experiment. A total of 200 participants, most of them students, participated in eight sessions of 25 participants each. The duration of a session was approximately 90 minutes. With 200 participants and four responses (ranks) in 13 settings, we observe a total of 2,600 4-tuples.

The experiment proceeded as follows. First, the participants read the instructions, which explained the set-up and some statistical concepts used in the experiment. Next, they answered a short quiz containing basic financial literacy questions based on van Rooij et al. (2011) as well as questions regarding the statistical concepts explained in the instructions. This allows us to control for the degree of comprehension when analyzing the decisions made and thus obtain a less noisy estimate of individuals' risk perception. After all decisions were made in the main part of the experiment, one of the 13 settings was played. The setting was randomly chosen by drawing from a deck of cards. To determine according to which preference the money was invested and correspondingly, which alternative would be relevant for the payout of a particular participant, a die was rolled. Finally, the performance of the investment was determined by a random draw reflecting the statistical properties of the investment as communicated to the participants. After having answered a questionnaire covering characteristics such as age, gender and field of study, each participant was paid the amount of money resulting from his or her decisions. On average, the payout was 13.70 Euro per participant. Table 4 summarizes the characteristics of the 200 participants in the experiment.

< Insert Table 4 about here >

# 4 Methodology and Results

## 4.1 Methodology

The aim of the analysis is twofold. We investigate whether and to which extent different presentation formats influence the consistency of decisions as well as the riskiness of investment choices. The hypotheses are examined in several ways. We first provide descriptive statistics to give an overview of investment decisions on an aggregate level. This allows us to compare the consistency and average riskiness of investment decisions in the different settings and to identify deviations. Subsequently, we conduct a formal hypothesis test to detect the impact of different presentation formats on the consistency and the riskiness of decisions. For this, we regress measures of the consistency and riskiness of individuals' decisions in all settings on variables capturing various dimensions of framing.

Several measures are applied to capture the riskiness of investments. The first measure for the riskiness of a choice is the weighted standard deviation of the four investment alternatives for an individual's preference order. The probabilities assigned to the different preferences in the experiment are used as weights. With these weights, we calculate the weighted standard deviations for each of the 13 settings and for every participant:

$$\sigma_{ij} = x_1\sigma_{1,ij} + x_{2,ij}\sigma_2 + x_3\sigma_{3,ij},$$

where $\sigma_{1,ij}$, $\sigma_{2,ij}$, and $\sigma_{3,ij}$ correspond to the return standard deviation of the first, second, and third asset choice, of subject $i \in [1, 200]$ in setting $j \in [1, 13]$, respectively, and $(x_1, x_2, x_3) = \left(\frac{1}{2}, \frac{1}{3}, \frac{1}{6}\right)$. This measure will be referred to as "Sigma". It allows us to compare the risk level that individuals are willing to accept in each setting. However, the risk level depends on the parameter set of the respective situation, since the standard deviations differ between the two parameter sets. In particular, the standard deviations are higher for the second parameter set.

Therefore, we introduce a second measure as standardized weighted sigma:

$$\sigma_{ij}^R = \frac{\sigma_{ij} - \sigma_{min,j}}{\sigma_{max,j} - \sigma_{min,j}}$$

where $\sigma_{min,j}$ and $\sigma_{max,j}$ denote the lowest and highest standard deviation, respectively, that are possible in setting $j \in [1, 13]$. This second measure will be referred to as "Relative Sigma". It ranges between 0 and 1 and allows us to compare the relative riskiness of a subject's choice between all situations.

The third measure for the riskiness of investment decisions is based on the order of the preference ranks. In all settings, the least risky choice is to rank the alternatives (A, B, C, D) as (1, 2, 3, 4), since A is risk-free and the standard deviation increases constantly over B and C to D. It is therefore possible to count how many times a certain preference order needs to be rearranged pairwise until the least risky order (1, 2, 3, 4) is achieved. This number, which will be referred to as the "Risk Score", ranges from 0 for the (1, 2, 3, 4) choice to 6 for the (4, 3, 2, 1) choice. The Risk Score is an attractive way of comparing risk taking between all settings.

## 4.2 Descriptive Analysis

Table 5 provides an overview of all decisions made in the experiment. The numbers show that preference orders differ substantially within each setting, since each investment alternative was assigned each preference rank by some subjects. In addition, aggregated preference orders differ across settings. In Settings 6 and 10, as well as in Settings 9 and 13, the decisions appear very similar. Settings 6 and 10 induced the riskiest choices, as the riskiest alternative D was assigned the first preference in most cases and the risk-free alternative A was mostly assigned the last preference rank. Decisions made in Settings 9 and 13 are the least risky, as the risk-free alternative A was chosen more often than in other settings and the riskiest alternative D was mostly assigned the last preference rank. Settings 6 and 10 have in common that the 75%/25% quantiles are presented, the less risky parameter set 1 with a generally lower standard deviation is applied, and the riskier investment alternative seem to dominate the less risky alternatives in terms of the risk-return profile. Settings 9 and 13 have in common that the more risky parameter set 2 with a generally higher standard deviation is applied, rates of return are shown instead of terminal values, and the tails of the distribution are more visible than in those settings in which 75%/25% quantiles are presented. These observations already suggest that not explicitly showing the tails of the distribution, presenting absolute values rather than rates of return, and settings in which riskier alternatives seem to dominate others lead to more risky decisions.

< Insert Table 5 about here >

Table 6 displays summary statistics for the three applied risk measures, i.e. Risk Score, Sigma, and Relative Sigma, for each setting and averaged over individuals. The numbers show that the Relative Sigma and the Risk Score lead to a similar ranking of the riskiness of decisions. Since the Sigma is an absolute risk measure, the values of Sigma depend on the general riskiness of the alternatives. They are systematically lower in settings based on the less risky parameter set 1 (Settings 1, 4, 6, 8, 10, 12). On average, the Risk Score is higher in settings based on the less risky parameter set 1. This indicates a tendency of participants to compensate for the lower risk involved in the investment alternatives. For all risk measures, the riskiness of decisions varies substantially, both across settings and across individuals. It can be seen that Settings 6 and 10 involve most risk-taking with mean Risk-Score values of 5.12 and 5.33, and Settings 9 and 13 involve the least risk-taking with mean Risk-Score values of 2.54 and 2.47. Particularly high Risk Scores are thus obtained in settings in which the tails of the distribution are not explicitly shown, absolute values rather than rates of return are presented, and in settings in which riskier alternatives seem to dominate others.

< Insert Table 6 about here >

Since the 13 settings include several variations of the presentation format, we now consider the descriptive statistics through the lens of the individual hypotheses and explore if and to which extent each hypothesis influences both the consistency and the riskiness of decisions. We focus on those hypotheses that can be examined based on bilateral comparisons of decisions in different settings. Descriptive statistics related to the hypotheses can conveniently be seen in Table 7. The table shows bilateral comparisons of all settings. Settings with identical alternatives that are only framed differently are represented by bold numbers, while settings based on different parameter sets are represented by non-bold numbers. If the presentation format does not matter, the responses in the two settings compared should be the same, but only for comparisons indicated by bold numbers. For comparisons indicated by non-bold numbers, decisions may well vary, since the alternatives are not identical. Thus, for analyzing the hypotheses, only comparisons indicated by bold numbers are relevant. Table 7 consists of three panels. Panel (a) displays the percentage of consistent decisions for each bilateral comparison of settings. A decision is defined to be consistent between two settings if a participant's preference order is the same in both settings. Panel (b) and (c) show how the riskiness of participants' choices changed from the setting as indicated by the row to a setting as indicated by the column. Changes in the riskiness of choices are measured by changes in the Risk Score in Panel (b) and by changes in Sigma in Panel (c).

< Insert Table 7 about here >

Economic theory prescribes that people make no inconsistent choices across different presentation formats in the sense that the choice of a risky alternative should not be influenced by the presentation format. This principle of description invariance implies that the observed level of consistency should be equal to one whenever the compared settings are based on the same underlying alternatives. The percentage of consistent decisions in our experiment is displayed in Panel (a) of Table 7. Bold figures indicate consistency of choices within a parameter set. The consistency within a parameter set ranges from 0.17 to 0.66. The mean is 0.33, indicating that subjects' choices are consistent in only 33% of the compared decisions in settings that only differ with respect to the presentation format, while in 67% of all compared decisions, individuals' choices are influenced by how the compared settings are framed.

We now look at how the deviations can be explained by the different dimensions of framing as outlined in the hypotheses. The different dimensions will be disentangled and analyzed separately. Our first hypothesis concerns the framing of investment outcomes as either absolute values or rates of return. The settings to be compared to test this hypothesis are Settings 4 and 8, 5 and 9, 6 and 10, and 7 and 11. In Table 7, the compared settings are highlighted in the form of framed boxes. Within each pair, the presentation format, the parameter set, and the quantiles presented are the same. The settings only differ in that in Settings 4 to 7, terminal values are presented while in Settings 8 to 11, rates of return are presented. Panels (b) and (c) of Table 7 show that for the settings to be compared here, i.e. settings indicated by framed boxes, risk-taking mostly decreases when rates of return are shown instead of terminal values. A Wilcoxon signed-rank test indicates that the decreases in risk-taking are significant at the one percent level, while the increase is significant at the five percent level. Overall, presenting absolute values imply higher risk taking.

To assess whether there is support for our hypothesis concerning the extent of information explicitly provided about the tails (Hypothesis 2), we first compare those pairs of settings within a parameter set that differ only with respect to the quantile that is presented to participants, i.e. 95%/5% quantiles versus 75%/25% quantiles. These settings are 2 and 3, 4 and 6, 5 and 7, 8 and 10, and 9 and 11, where the settings named first in each comparison are based on 95%/5% quantiles, and the settings named last are based on 75%/25% quantiles. In Table 7(a), these settings to be compared are represented by dark-gray boxes. The numbers show that for these pairs of settings, the percentage of consistency is not greater than 0.48, so the decisions do appear to have been influenced by the presentation format. The numbers in the dark-gray boxes in Panels (b) and (c) are positive, showing that for each pair of settings, the riskiness of individual choices was systematically, and in most cases significantly higher in the 75%/25% quantile presentation than in the 95%/5% quantile presentation. The second comparison we make to assess Hypothesis 2 is between decisions based on the full return distribution and decisions based on quantile representation. The corresponding settings are 8 and 12, 10 and 12, 9 and 13, and 11 and 13. These pairs of settings are highlighted with dark-gray boxes in Table 7. In all these settings, the rates of return are presented. However, while quantile boxes are presented in Settings 8 to 11, probability density functions are presented in Settings 12 and 13. Table 7(a) shows that the consistency is relatively low (between 21% and 32%) and Panels (b) and (c) show that the level of risk accepted by subjects is lower for the full distribution presentation as compared to quantile presentations (mostly significantly). The difference is smaller for the comparison of the 95%/5% quantiles with the full distribution than for the comparison of the 75%/25% quantiles with the full distribution. Overall, the different emphasis on downside risk induced by presenting the full distribution versus presentations of quantiles seems to have a strong negative effect on risk taking. The same holds true for quantile presentations at different levels.

According to Hypothesis 3, individuals' decisions should not be altered when information about investment alternatives is presented in graphical form rather than in tables. This hypothesis can be examined by a bilateral comparison of responses in Settings 1 and 4, 2 and 5, and 3 and 7. These settings are identical, with the exception that the information is presented in tables for Settings 1 to 3, while it is presented in graphical form in Settings 4 to 7. The settings to be compared are highlighted light-gray in Table 7. The change in risk taking can be seen in Panels (b) and (c). The numbers show that changing from a table to a graphical format does not systematically influence the extent of risk taking in one direction, since both positive and negative changes of similar magnitude are present at similar levels of significance. Thus, the low consistency observed does not seem to be associated with a bias in risk taking.

Overall, the bilateral comparisons suggest that the amount of risk taking depends on the extent to which the tails of the distribution are explicitly shown and on whether absolute values or rates of return are shown to decision makers.

Table 8 reports summary statistics on how the consistency and the riskiness of choices relate to personal characteristics. It can be seen that female participants made substantially less consistent decisions than male participants (22% compared to 45%), and that their decisions are slightly less risky on average. Moreover, the numbers show that participants who scored well in the quiz made more consistent decisions than others. However, even for the best performers, the consistency is rather low with a value of 39%. Finally, the statistics for the variables risk finance and risk general show that participants who indicated to have a high tolerance towards risk indeed took on more risk than others.

< Insert Table 8 about here >

### 4.3 Regression Analysis

Formal tests of the hypotheses are based on two sets of regressions. First, the drivers of inconsistency are analyzed by pair-wise comparisons of all investment decisions. Second, risk taking is analyzed by regressing different risk measures on variables that identify our hypotheses on framing.

#### 4.3.1 The Drivers of Inconsistency.

In the first step, we make a pair-wise comparison of all decisions for every individual to obtain a more detailed look at what drives the numbers in Table 7. The resulting matrix has 78 entries for each participant, corresponding to the comparisons made in Table 7 at the individual level. Since the consistency of decisions can only be evaluated across settings that only differ with respect to the framing, we restrict our analysis to a comparison of settings based on the same parameter set. These comparisons are indicated by bold figures in Table 7. This results in 36 comparisons per individual, and correspondingly in 7,200 observations in total. To analyze the consistency of decisions, we construct a binary variable indicating for each comparison and for each individual, whether or not the decision was consistent. We define a decision to be consistent across two compared settings if the preference order for the investment alternatives is the same in both settings. For our regression analysis, we define consistency as a binary variable that takes the value 1 for a pair of consistent decisions and 0 for a pair of inconsistent decisions.

To test for the impact of specific framing effects on the inconsistency of decisions, we then construct variables that represent our hypotheses. To test Hypothesis 1, we define *h1_absolute*, which takes the value 0 if both settings compared are the same and 1 if in one setting absolute values and in the other setting rates of return are presented. To test the second hypothesis we define three variables: The variable *h2_q75q95* takes the value 1 if one setting uses the 75%/25% and the other setting uses the 95%/5% quantile presentation, and 0 otherwise. The variables *h2_q75full* and *h2_q95full* take the value 1 if one setting uses the indicated quantile presentation and the other setting uses the full distribution, and 0 otherwise. Hypothesis 3 is tested with *h3_graphicalinfo*, a dummy variable indicating that the compared settings differ with respect to information being presented in table form or graphically.

To control for the impact of personal characteristics on decision making, we use the following variables: *female* is a binary variable indicating female respondents and *age* indicates the age of a respondent. The variable *degree* represents the highest educational degree an individual has attained. It is a categorial variable ranging from 1 to 4, where higher values indicate higher educational degree. The variable *economics* is a binary variable indicating students of economics or business administration. The variable *semester* indicates the number of semesters a respondent has attended at university. The variable *risk_general* is the respondents' self-assessed tolerance for risk in general (e.g., concerning sports or lifestyle). It is a categorial variable ranging form 0 to 10. The variable *risk_finance* is the respondents' self-assessed tolerance for risk in financial decisions. The self-assessment was done on a Likert-scale from 1 (very risk averse) to 5 (very risk-seeking). The variable *stake* represents the respondents' answer to a question of how much of a windfall gain of 100000 Euros they would like to invest in a lottery in which their money is either doubled or reduced by half with equal probabilities. The variable *incomeprospects* is the respondents' self-assessed income prospects. It is a categorial variable ranging from 1 to 5, where higher values indicate better self-assessed income prospects. The variable *quiz* captures participants' knowledge after having been trained for this experiment. In particular, it represents the percentage of correct answers to four questions concerning financial literacy and four questions relating to statistical concepts relevant for this experiment.

Table 9 reports results from the logit regressions relating consistency to hypothesis variables and personal characteristics.

< Insert Table 9 about here >

Regressions (1) to (6) differ in the set of explaining variables. Regressions (1) to (5) include hypothesis variables. Regression (2) also includes subject dummies, Regression (3) also includes personal characteristics, Regression (4) also includes the female dummy, and Regression (5) also includes the quiz score. Regression (6) only includes personal characteristics but no hypothesis variables. These models are tested to assess the relative importance of the different variables.

The results for the hypothesis variables show the impact of our framing dimensions on the consistency of decisions. Since the hypothesis variables are dummies indicating a variation in the respective framing dimension for pairs of compared settings, negative coefficients imply that varying the respective framing reduces consistency. The statistically significant and negative coefficients for *h1_absolute*, *h2_q75full*, *h2_q95full*, and *h3_graphicalinfo* indicate that individuals' decisions are systematically less consistent when these framing dimensions are varied. The coefficient *h2_q75q95* is also negative, but not significantly different from zero. The largest coefficients are obtained for *h2_q75full* and *h2_q95full*, demonstrating that variations in the amount of information shown about the tails reduces consistency the most. The obtained coefficients for the hypothesis variables are stable across all regression models, even after controlling for individual effects in form of subject dummies and personal characteristics as done in Models (2) to (5). Overall, all analyzed framing dimensions impact the consistency of decisions.

The estimated coefficients for variables capturing different personal characteristics indicate that the gender and the quiz score matter most for the consistency of decisions. The obtained coefficients are stable across all regression models. The coefficient for *female* is negative and statistically significant, implying that female participants made systematically less consistent decisions. The coefficient for *quiz* is positive and statistically significant, implying that participants who scored higher on the quiz made systematically more consistent decisions. This shows that more financial literacy and a better understanding of the presentation format enhance consistency and thus decision quality.

A comparison of the obtained goodness of fit of each model shows the relative importance of the analyzed variables. A comparison of Model (1) and Model (6) shows that the personal characteristics explain consistency better than the framing dimensions, with a $Pseudo R^2$ of 0.069 as compared to 0.013. To see which personal characteristic has a larger effect on consistency, we include the variables *female* and *quiz* in separate regressions while controlling for framing dimensions, as reported in columns (4) and (5). The $Pseudo R^2$ shows that the gender has a bigger influence on consistency than the quiz score, with a $Pseudo R^2$ of 0.064 as compared to 0.025. However, in comparison to the hypothesis variables tested in model (1), the quiz score still has a large impact on consistency.

### 4.3.2 The Riskiness of Choices.

We conduct regressions relating the riskiness of choices to the different dimensions of framing and to personal characteristics. The risk measures applied are Sigma, Relative Sigma, and Risk Score. For each risk measure, we conduct seven regressions including hypothesis variables, subject dummies, and personal characteristics.

Regression (1) includes variables representing our hypotheses on framing. Regression (2) additionally includes subject dummies to control for any individual-specific effects on risk taking. Regressions (3) and (4) estimate Regression Model (2) for each parameter set separately. Regression (5) includes both, hypothesis variables and personal characteristics. Regression (6) includes personal characteristics, but no hypothesis variables. Regression (7) serves as a baseline model and only controls for the parameter set. These different model specifications allow us to assess the relative importance of framing and personal characteristics, and show to which extent the results are robust.

To test the impact of various dimensions of framing on risk taking, we define the following set of independent variables that identify settings with respect to these framing dimensions. The variable *absolute* is a dummy indicating that information is presented in terms of absolute values rather than in terms of rates of return. The variables *q75* and *q95* are dummies indicating whether the presentation showed the 75%/25% quantiles or the 95%/5% quantiles respectively. The variable *graphicalinfo* is a dummy indicating that the information is presented in a graphic format instead of a table. The variable *pset2* is a dummy indicating settings based on parameter set 2. It is included in all regressions to account for the fact that the risk level of the investment alternatives in settings based on parameter set 2 is generally higher.

The data set underlying the regressions contains the chosen risk level of participants in each of the 13 settings. This results in a total of 2600 observations. The regression results for Sigma and Relative Sigma as dependent variables are displayed in Tables 10 and 11.

< Insert Table 10 about here >

< Insert Table 11 about here >

The results for the regressions of Risk Score and Relative Sigma as dependent variables are not significantly different, so for the sake of clarity we omit the regression table for Risk Score. The coefficient for the variable *absolute* is significant and positive for all risk measures and all five respective regressions, revealing that subjects tend to make riskier choices among identical alternatives when absolute values are presented instead of rates of return. This implies, in line with previous findings, that Hypothesis 1 is rejected. Note that the coefficient for *absolute* is substantially larger in Regression (4) using settings based on the second parameter set compared to Regression (3) using settings based on the first parameter set. Since terminal values follow a lognormal distribution, the larger standard deviations applied in parameter set 2 induce a larger degree of asymmetry of the outcome distribution. This can be seen in Figure 1, where the shown interquantile range above the mean is relatively larger than the shown interquantile range below the mean for parameter set 2 as compared to parameter set 1. Thus, participants seem to respond to higher upside potential of riskier investment alternatives. Larger asymmetry makes individuals more susceptible to increased risk taking when absolute values are shown instead of rates of return.

The impact of the dummy variable for both the 75%/25% quantile (*q75*) and the 95%/5% quantile (*q95*) are positive and significant in all regressions for all risk measures. This implies that risk taking is larger when quantiles are presented than when the full distribution is presented.

Moreover, the coefficient of the 75%/25% dummy is always larger than the coefficient of the 95%/5% dummy, implying that choices become more risky on average when 75% and 25% quantiles are shown than when the 95% and 5% quantiles are presented. This could be due to the fact that in the 75%/25% quantile presentation, the downside risk is not as apparent as it is in the 95%/5% quantile presentation. Overall, these are strong and stable results in contradiction of Hypothesis 2, showing that the less information about the tails is shown explicitly, the more risk participants are inclined to take.

Whether investment outcomes are presented in tables or in graphical form does not seem to have an influence on investment decisions, since the coefficient for *graphicalinfo* is not statistically different from zero in any of the regressions. Therefore, Hypothesis 3 cannot be rejected.

In addition to the variables employed to test our hypotheses, we include a dummy for the second parameter set (*pset2*) in all regressions that use settings based on different parameter sets. This controls for the generally higher risk level of the investment alternatives in settings based on parameter set 2. The coefficient for *pset2* is statistically significant and negative for Risk Score and Relative Sigma as dependent variable. Subjects thus choose less risky investments in settings based on parameter set 2, in which, by construction, the alternatives are riskier than those based on parameter set 1. Participants seem to counterbalance this enhanced risk level by choosing less risky alternatives. The significant and positive coefficient estimate for *pset2* in the regression of Sigma simply shows that despite the counterbalancing effect, the absolute risk level is still higher in settings based on parameter set 2.

Finally, we turn to an analysis of the impact of personal characteristics on the riskiness of choices. The personal characteristics that impact risk taking the most are the gender and the self-assessed attitudes towards risk. In all regressions, the coefficient for *female* is negative and significant. Hence, female participants take systematically less risk than male participants. This finding is in line with previous research (see Powell and Ansic, 1997; Borghans et al., 2009; Sapienza et al., 2009). The fact that the coefficients for *risk_general* and *risk_finance* are positive and significant shows that participants' self assessment is in line with their revealed risk preferences.

To assess the relative impact of the framing dimensions and personal characteristics, we compare Model (1) which is solely based on hypothesis variables with Model (6) which is solely based on personal characteristics, while controlling for the parameter set. Both Model (1) and Model (6) have a higher $R^2$ than the baseline Model (7) which only controls for the parameter set. This indicates that both, framing effects and personal characteristics influence the chosen risk level. However, the influence of framing on risk taking is larger than that of personal characteristics, as can be seen from the higher $R^2$ of Model (1) as compared to Model (6).

#### 4.3.3 Robustness Checks.

We modify our regression analysis in various ways to check the robustness of our results. First, we use the Risk Score as dependent variable for those regressions that we have already run with the Relative Sigma and Sigma as dependent variable. The results from these regressions are very much alike the results from the regressions of the Risk Score.

Second, we run the regressions from Sections 4.3.1 and 4.3.2 for the following subsets: Participants who scored high on the quiz (with a score of 0.75 or greater), those who performed worst on the quiz, participants that were enrolled in an economics or finance study program, and participants enrolled in other programs. The results for the separate regressions for people who scored on financial literacy and comprehension questions above and below average respectively show that the influence of the hypothesis variables is robust. The same applies to the regressions run for students of finance and from other fields of study. The results for our hypothesis variables are again robust.

To test whether certain personal characteristics systematically increase individuals' susceptibility to framing, we ran Regression (3) from Table 9 employing interaction terms with the female-dummy and the quiz score. The results indicate however that these interaction terms do not have an influence on the consistency of decisions. We conclude that there are no groups in our experiments that can be identified to be especially susceptible to framing effects.

## 5 Conclusion

The purpose of this paper is to systematically analyze the impact of framing effects on the consistency of decisions and the preference for risky investment alternatives. To test our hypotheses, we conduct an experiment in which participants rank four investment alternatives in differently framed settings. We find that the presentation format has a strong influence on both the consistency and the riskiness of investment decisions.

On average, only 33% of participants' choices are consistent across different framings in the sense that the preference order for the investment alternatives is the same in settings in which identical alternatives are presented differently. It can be expected that this share of consistent decisions would be even lower for a more representative sample; half the individuals in our sample are students of economics or business administration and therefore familiar with investment decisions.

While all examined framing dimensions affect the consistency of decisions, three dimensions also have a strong influence on risk taking. First, showing the 75% and 25% quantiles instead of the 95% and 5% quantiles increases the riskiness of participants' preference order. A possible explanation is that some of the downside risk apparent in a wider confidence interval is not revealed in this narrower confidence interval. Second, showing the full probability distribution leads to a further decrease in risk taking, indicating that subjects react to being shown more clearly the full loss potential of riskier investments. Obviously, risk taking decreases with the extent of information that is explicitly provided about the tails of the outcome distribution. Hence we conclude that, if not explicitly shown the loss potential of investment alternatives, individuals are in fact led into temptation to invest more riskily. Third, our results indicate that when absolute values are shown to individuals, they systematically make riskier investment choices than for the rate of return presentation. Participants seem to accept higher risk in their investments when they see the upside potential that results from the asymmetric shape of the log-normal distribution of terminal values.

It seems that subjects are also led into temptation to choose more risky investments by a seemingly over-proportional upside potential.

Our results not only contribute to the decision-making literature, but also point to the importance of comparable product information. They show how difficult it is for individuals to make investment decisions independent of the way in which information is presented to them. The issue of comparability of product information thus needs to be addressed by policymakers, possibly through the introduction of mandatory standardized product fact sheets. Our findings can prevent unintended and unwelcome consequences of the design of fact sheets for the portfolios of retail investors.

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Table 1: Parameter Sets.

This table shows the two parameter sets used in the experiment. The returns for each investment alternative follow a normal distribution.

| | | | | |
|---|---|---|---|---|
| | **Parameter Set 1** | | | |
| | A | B | C | D |
| mean | 10.00% | 20.00% | 30.00% | 40.00% |
| standard deviation | 0.00% | 9.17% | 18.34% | 27.51% |
| | **Parameter Set 2** | | | |
| | A | B | C | D |
| mean | 10.00% | 20.00% | 30.00% | 40.00% |
| standard deviation | 0.00% | 22.36% | 44.72% | 67.08% |

Table 2: Settings 1 to 3.

This table displays Settings 1 to 3. In these settings, information on the terminal values of the investment alternatives is given. The information is shown in form of tables. The settings differ with respect to the underlying parameter set and the quantiles shown. The columns represent the two parameter sets and the rows represent the quantiles shown to the participants: the upper part contains the settings in which the 95%- and 5% quantile as well as the median were shown, whereas the lower part contains the settings in which the 75%- and 25% quantile as well as the median were shown.

| **Quantile** | **Parameter Set 1** | | | | **Parameter Set 2** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Setting 1** | | | | **Setting 2** | | | |
| | A | B | C | D | A | B | C | D |
| 95% | 11.05 | 14.20 | 18.25 | 23.45 | 11.05 | 17.64 | 28.17 | 44.97 |
| 50% | 11.05 | 12.21 | 13.50 | 14.92 | 11.05 | 12.21 | 13.50 | 14.92 |
| 5% | 11.05 | 10.50 | 9.98 | 9.49 | 11.05 | 8.46 | 6.47 | 4.95 |
| | | | | | **Setting 3** | | | |
| | A | B | C | D | A | B | C | D |
| 75% | 11.05 | 12.99 | 15.28 | 17.96 | 11.05 | 14.20 | 18.25 | 23.45 |
| 50% | 11.05 | 12.21 | 13.50 | 14.92 | 11.05 | 21.21 | 13.50 | 14.92 |
| 25% | 11.05 | 11.48 | 11.93 | 12.39 | 11.05 | 10.50 | 9.98 | 9.49 |

Table 3: Overview of Settings.

This table summarizes all settings included in the experiment. The columns correspond to the dimensions in which the framing is varied.

| **Setting** | **Format** | **Outcome Presentation** | **Quantiles** | **Parameter Set** |
|---|---|---|---|---|
| **1** | Table | Terminal Values | 95%/5% | 1 |
| **2** | Table | Terminal Values | 95%/5% | 2 |
| **3** | Table | Terminal Values | 75%/25% | 2 |
| **4** | Quantile box | Terminal Values | 95%/5% | 1 |
| **5** | Quantile box | Terminal Values | 95%/5% | 2 |
| **6** | Quantile box | Terminal Values | 75%/25% | 1 |
| **7** | Quantile box | Terminal Values | 75%/25% | 2 |
| **8** | Quantile box | Rates of Return | 95%/5% | 1 |
| **9** | Quantile box | Rates of Return | 95%/5% | 2 |
| **10** | Quantile box | Rates of Return | 75%/25% | 1 |
| **11** | Quantile box | Rates of Return | 75%/25% | 2 |
| **12** | Density | Rates of Return | | 1 |
| **13** | Density | Rates of Return | | 2 |

Table 4: Summary Statistics of Participants.

This table summarizes the characteristics of the 200 participants in the experiment. The numbers do not always add up to 200 because some subjects did not make a statement. "Tolerance for risk in general" denotes the subject's reported preference for risk in general, for instance, regarding sports, with 0 being the lowest risk tolerance and 10 being the highest.

| Personal Characteristic | Observations | % of the Respondents |
|---|---|---|
| **Gender** | | |
| Male | 96 | 48.5% |
| Female | 102 | 51.5% |
| **Age** | | |
| 18-22 | 91 | 46.2% |
| 23-26 | 76 | 38.6% |
| 27-30 | 31 | 10.2% |
| >31 | 10 | 5.1% |
| **Highest Degree** | | |
| High school diploma | 156 | 79.2% |
| Bachelor's degree | 24 | 12.2% |
| Master's degree (or German equivalent) | 16 | 8.1% |
| Doctorate | 1 | 0.5% |
| **Field of Study** | | |
| Business/Economics | 104 | 52% |
| Law | 18 | 9% |
| Medicine | 8 | 4% |
| Other | 70 | 35% |
| **No. of Semesters Completed** | | |
| 1-6 | 137 | 70.3% |
| 7-10 | 45 | 23.1% |
| >11 | 13 | 6.7% |
| **Tolerance for Risk in General** | | |
| 0-3 | 42 | 21.21% |
| 4-6 | 75 | 37.88% |
| 7-10 | 81 | 40.91% |
| **Tolerance for Financial Risk** | | |
| Very risk-averse | 24 | 12.1% |
| Somewhat risk-averse | 66 | 33.3% |
| Risk-neutral | 42 | 21.2% |
| Risk-seeking | 59 | 29.8% |
| Very risk-seeking | 7 | 3.5% |

Table 5: Summary Statistics of Preference Ranks.

This table summarizes the decisions made throughout the experiment. For every investment alternative A, B, C, and D, the numbers in columns 1 to 4 describe how often subjects assigned the respective preference rank to that alternative. The lines 1 to 13 stand for the 13 settings that are based on two different parameter sets. The four numbers assigned to each alternative add up to 200, i.e., the number of participants.

| **Setting** | **A** | | | | **B** | | | | **C** | | | | **D** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** |
| **1** | 18 | 17 | 26 | 139 | 18 | 20 | 136 | 26 | 22 | 140 | 20 | 18 | 142 | 23 | 18 | 17 |
| **2** | 35 | 32 | 32 | 101 | 48 | 41 | 88 | 23 | 26 | 104 | 49 | 21 | 91 | 23 | 31 | 55 |
| **3** | 15 | 25 | 24 | 136 | 22 | 33 | 124 | 21 | 30 | 123 | 34 | 13 | 133 | 19 | 18 | 30 |
| **4** | 9 | 8 | 19 | 164 | 15 | 30 | 145 | 10 | 59 | 121 | 17 | 3 | 117 | 41 | 19 | 23 |
| **5** | 30 | 19 | 28 | 123 | 24 | 41 | 115 | 20 | 48 | 104 | 34 | 14 | 98 | 36 | 23 | 43 |
| **6** | 14 | 9 | 10 | 167 | 10 | 26 | 157 | 7 | 23 | 152 | 21 | 4 | 153 | 13 | 12 | 22 |
| **7** | 23 | 19 | 18 | 140 | 27 | 43 | 121 | 9 | 61 | 99 | 33 | 7 | 89 | 39 | 28 | 44 |
| **8** | 15 | 21 | 31 | 133 | 32 | 51 | 107 | 10 | 69 | 94 | 33 | 4 | 84 | 34 | 29 | 53 |
| **9** | 71 | 36 | 21 | 72 | 50 | 81 | 57 | 12 | 36 | 63 | 89 | 12 | 43 | 20 | 33 | 104 |
| **10** | 13 | 5 | 10 | 172 | 6 | 17 | 170 | 7 | 18 | 162 | 14 | 6 | 163 | 16 | 6 | 15 |
| **11** | 21 | 25 | 32 | 122 | 42 | 49 | 101 | 8 | 72 | 82 | 37 | 9 | 65 | 44 | 30 | 61 |
| **12** | 27 | 24 | 36 | 113 | 51 | 53 | 86 | 10 | 50 | 96 | 41 | 13 | 72 | 27 | 37 | 64 |
| **13** | 51 | 45 | 35 | 69 | 85 | 58 | 48 | 9 | 29 | 76 | 84 | 11 | 35 | 21 | 33 | 111 |

Table 6: Riskiness of Choices.

This table displays for each setting the mean and standard deviation of the three risk measures across participants. The risk measures are the Risk Score, the weighted Sigma, and the Relative Sigma. The Risk Score denotes the number of pair-wise changes in the preference order that are necessary to transform a given preference order into the least risky choice. It takes values between 0 and 6. Sigma is defined as the weighted standard deviation of the investment alternatives, weighted according to a participant's preference order. The Relative Sigma is the weighted standard deviation divided by the largest possible standard deviation in a particular setting.

| **Setting** | **Risk Score** | | **Sigma** | | **Rel. Sigma** | |
|---|---|---|---|---|---|---|
| | mean | std | mean | std | mean | std |
| 1 | 4.87 | 1.73 | 0.14 | 0.05 | 0.83 | 0.30 |
| 2 | 3.74 | 2.18 | 0.29 | 0.14 | 0.62 | 0.39 |
| 3 | 4.65 | 1.81 | 0.33 | 0.12 | 0.79 | 0.32 |
| 4 | 4.94 | 1.57 | 0.14 | 0.04 | 0.83 | 0.27 |
| 5 | 4.20 | 2.04 | 0.31 | 0.13 | 0.71 | 0.36 |
| 6 | 5.12 | 1.74 | 0.14 | 0.04 | 0.86 | 0.29 |
| 7 | 4.26 | 2.00 | 0.31 | 0.13 | 0.71 | 0.35 |
| 8 | 4.21 | 1.91 | 0.13 | 0.05 | 0.70 | 0.34 |
| 9 | 2.54 | 2.25 | 0.22 | 0.15 | 0.41 | 0.40 |
| 10 | 5.33 | 1.52 | 0.15 | 0.04 | 0.90 | 0.26 |
| 11 | 3.91 | 1.96 | 0.29 | 0.13 | 0.64 | 0.35 |
| 12 | 3.70 | 2.07 | 0.12 | 0.06 | 0.61 | 0.37 |
| 13 | 2.47 | 2.04 | 0.22 | 0.14 | 0.40 | 0.37 |

## Table 7: Bilateral Comparison of Decisions.

This table displays (a) the consistency of decisions, (b) the Risk-Score changes, and (c) the Sigma changes for decisions in the experiment. The consistency is the average of a dummy variable that indicates for each pair of situations whether a subject made a consistent decision, i.e. whether the preference order for the investment alternatives is the same in both settings. A number close to 0 indicates that only a few people made consistent decisions, whereas a number close to 1 indicates a high degree of consistency. The Risk-Score changes and the Sigma changes are derived from Table 6. They show how the riskiness of participants' choices changed from the setting as indicated by the row to a setting as indicated by the column. Positive values show an increase in risk-taking while negative values represent a decrease in risk-taking. Bold figures indicate a comparison within a parameter set, i.e. identical alternatives. Framed boxes indicate relevant figures for Hypothesis 1 and shaded boxes indicate relevant figures for Hypothesis 2 (dark-gray), and Hypothesis 3 (light-gray).

(a) Consistency of Decisions

| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.42 | 0.48 | **0.42** | 0.39 | **0.51** | 0.34 | **0.34** | 0.20 | **0.56** | 0.27 | **0.30** | 0.15 |
| 2 | | **0.41** | 0.29 | **0.35** | 0.36 | **0.31** | 0.26 | **0.25** | 0.39 | **0.26** | 0.25 | **0.20** |
| 3 | | | 0.38 | **0.36** | 0.48 | **0.35** | 0.33 | **0.20** | 0.51 | **0.29** | 0.29 | **0.17** |
| 4 | | | | 0.44 | **0.48** | 0.42 | **0.41** | 0.17 | **0.49** | 0.35 | **0.28** | 0.14 |
| 5 | | | | | 0.45 | **0.36** | 0.37 | **0.24** | 0.40 | **0.35** | 0.28 | **0.17** |
| 6 | | | | | | 0.43 | **0.37** | 0.20 | **0.66** | 0.33 | **0.31** | 0.16 |
| 7 | | | | | | | 0.40 | **0.22** | 0.43 | **0.37** | 0.30 | **0.18** |
| 8 | | | | | | | | 0.20 | **0.39** | 0.40 | **0.29** | 0.20 |
| 9 | | | | | | | | | 0.21 | **0.28** | 0.24 | **0.32** |
| 10 | | | | | | | | | | 0.34 | **0.32** | 0.16 |
| 11 | | | | | | | | | | | 0.34 | **0.21** |
| 12 | | | | | | | | | | | | 0.25 |

(b) Risk-Score Changes

| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -1.13 | -0.22 | **0.08** | -0.67 | **0.26** | -0.61 | **-0.66** | -2.33 | **0.47** | -0.96 | **-1.17** | -2.40 |
| 2 | | **0.92** | 1.21 | **0.47** | 1.39 | **0.53** | 0.48 | **-1.20** | 1.60 | **0.17** | -0.04 | **-1.27** |
| 3 | | | 0.29 | **-0.45** | 0.47 | **-0.39** | -0.44 | **-2.12** | 0.68 | **-0.75** | -0.96 | **-2.19** |
| 4 | | | | -0.74 | **0.18** | -0.68 | **-0.73** | -2.41 | **0.39** | -1.04 | **-1.25** | -2.48 |
| 5 | | | | | 0.92 | **0.06** | 0.01 | **-1.67** | 1.13 | **-0.30** | -0.51 | **-1.74** |
| 6 | | | | | | -0.86 | **-0.91** | -2.59 | **0.21** | -1.22 | **-1.43** | -2.66 |
| 7 | | | | | | | -0.05 | **-1.73** | 1.07 | **-0.36** | -0.57 | **-1.80** |
| 8 | | | | | | | | -1.68 | **1.12** | -0.31 | **-0.52** | -1.75 |
| 9 | | | | | | | | | 2.80 | **1.37** | 1.16 | **-0.07** |
| 10 | | | | | | | | | | -1.43 | **-1.64** | -2.87 |
| 11 | | | | | | | | | | | -0.21 | **-1.44** |
| 12 | | | | | | | | | | | | -1.23 |

(c) Sigma Changes

| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.19 | 0.25 | **0.00** | 0.23 | **0.01** | 0.23 | **-0.02** | 0.12 | **0.01** | 0.21 | **-0.03** | 0.11 |
| 2 | | **0.06** | -0.19 | **0.03** | -0.19 | **0.04** | -0.21 | **-0.08** | -0.18 | **0.01** | -0.22 | **-0.08** |
| 3 | | | -0.25 | **-0.03** | -0.25 | **-0.02** | -0.27 | **-0.14** | -0.24 | **-0.05** | -0.28 | **-0.14** |
| 4 | | | | 0.22 | **0.00** | 0.23 | **-0.02** | 0.11 | **0.01** | 0.20 | **-0.03** | 0.11 |
| 5 | | | | | -0.22 | **0.01** | -0.24 | **-0.11** | -0.21 | **-0.02** | -0.26 | **-0.11** |
| 6 | | | | | | 0.22 | **-0.02** | 0.11 | **0.01** | 0.20 | **-0.04** | 0.11 |
| 7 | | | | | | | -0.25 | **-0.11** | -0.22 | **-0.03** | -0.26 | **-0.12** |
| 8 | | | | | | | | 0.13 | **0.03** | 0.22 | **-0.01** | 0.13 |
| 9 | | | | | | | | | -0.10 | **0.09** | -0.15 | **-0.00** |
| 10 | | | | | | | | | | 0.19 | **-0.04** | 0.10 |
| 11 | | | | | | | | | | | -0.24 | **-0.09** |
| 12 | | | | | | | | | | | | 0.14 |

Table 8: Summary Statistics by Personal Characteristics.

This table displays mean consistency and riskiness of choices split up by gender, quiz score and risk tolerance. The variable *quiz score* represents the percentage of correct answers to four questions concerning financial literacy and four questions relating to statistical concepts relevant for this experiment. The variable *risk general* is the respondents' self-assessed tolerance for risk in general (e.g., concerning sports or lifestyle). It is a categorial variable ranging form 0 to 10. The variable *risk finance* is the respondents' self-assessed tolerance for risk in financial decisions. The self-assessment was done on a Likert-scale from 1 (very risk averse) to 5 (very risk-seeking). The last column denotes the number of observations for each category and adds up to 200 within each of the personal characteristics.

| | | **Consistency** | **Sigma** | **Rel. Sigma** | **Score** | **Obs** |
|---|---|---|---|---|---|---|
| **Gender** | **male** | 0.45 | 0.30 | 0.75 | 4.49 | 96 |
| | **female** | 0.22 | 0.27 | 0.64 | 3.82 | 102 |
| | . | 0.26 | 0.29 | 0.71 | 4.31 | 2 |
| **Quiz score** | **0.125** | 0.28 | 0.32 | 0.78 | 4.85 | 1 |
| | **0.25** | 0.18 | 0.27 | 0.62 | 3.64 | 6 |
| | **0.375** | 0.23 | 0.29 | 0.67 | 3.94 | 12 |
| | **0.5** | 0.27 | 0.28 | 0.67 | 4.04 | 26 |
| | **0.625** | 0.27 | 0.28 | 0.65 | 3.89 | 31 |
| | **0.75** | 0.36 | 0.29 | 0.71 | 4.24 | 49 |
| | **0.875** | 0.38 | 0.29 | 0.72 | 4.30 | 42 |
| | **1** | 0.39 | 0.29 | 0.71 | 4.28 | 33 |
| **Risk finance** | **1-2** | 0.27 | 0.26 | 0.62 | 3.70 | 90 |
| | **3** | 0.29 | 0.28 | 0.68 | 4.09 | 42 |
| | **4-5** | 0.48 | 0.32 | 0.81 | 4.87 | 66 |
| | . | 0.26 | 0.29 | 0.71 | 4.31 | 2 |
| **Risk general** | **0-3** | 0.24 | 0.25 | 0.58 | 3.53 | 42 |
| | **4-6** | 0.31 | 0.28 | 0.67 | 4.00 | 75 |
| | **7-10** | 0.48 | 0.32 | 0.79 | 4.69 | 81 |
| | . | 0.26 | 0.29 | 0.71 | 4.31 | 2 |

Table 9: Regression Results for Consistency.

This table reports results from the regression analysis with consistency as dependent variable. The regressions are based on a pair-wise comparison of settings from one parameter set (i.e., the bold figures from Table 7). A logit model is used for consistency which is a binary variable indicating for each pair of situations whether a subject made a consistent decision, i.e. whether the preference order for the investment alternatives is the same in both settings. The variable *h1_absolute* takes the value 0 if both settings compared are the same and 1 if in one setting absolute values and in the other setting rates of return are presented. The variable *h2_q75q95* takes the value 1 if one setting uses the 75%/25% and the other setting uses the 95%/5% quantile presentation, and 0 otherwise. The variables *h2_q75full* and *h2_q95full* take the value 1 if one setting uses the indicated quantile presentation and the other setting uses the full distribution, and 0 otherwise. The variable *h3_graphicalinfo* is a dummy indicating whether the compared settings differ with respect to presenting information in table form or graphically. Regressions (1) to (5) include hypothesis variables. Regression (2) also includes subject dummies, Regression (3) also includes personal characteristics, Regression (4) also includes the female dummy, and Regression (5) also includes the quiz score. Regression (6) only includes personal characteristics but no hypothesis variables.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| h1_absolute | -0.1740*** | -0.2635*** | -0.1842*** | -0.1815*** | -0.1764*** | |
| | (-3.33) | (-4.11) | (-3.32) | (-3.35) | (-3.35) | |
| h2_q75q95 | -0.0715 | -0.1093 | -0.0829 | -0.0722 | -0.0725 | |
| | (-1.15) | (-1.44) | (-1.25) | (-1.11) | (-1.15) | |
| h2_q95full | -0.5548*** | -0.8441*** | -0.6063*** | -0.5804*** | -0.5625*** | |
| | (-6.74) | (-8.22) | (-6.97) | (-6.81) | (-6.79) | |
| h2_q75full | -0.7191*** | -1.1025*** | -0.7763*** | -0.7503*** | -0.7290*** | |
| | (-7.90) | (-9.60) | (-8.09) | (-7.98) | (-7.96) | |
| h3_graphicalinfo | -0.1735** | -0.2629*** | -0.1977*** | -0.1863*** | -0.1760** | |
| | (-3.25) | (-4.01) | (-3.49) | (-3.36) | (-3.27) | |
| female | | | -0.9539*** | -1.1198*** | | -0.9363*** |
| | | | (-16.29) | (-21.03) | | (-16.16) |
| age | | | 0.0096 | | | 0.0094 |
| | | | (1.39) | | | (1.37) |
| degree | | | 0.1063* | | | 0.1046* |
| | | | (1.98) | | | (1.96) |
| economics | | | -0.0550 | | | -0.0543 |
| | | | (-0.83) | | | (-0.83) |
| semester | | | 0.0362*** | | | 0.0355*** |
| | | | (3.59) | | | (3.56) |
| risk_general | | | 0.0726*** | | | 0.0714*** |
| | | | (4.35) | | | (4.32) |
| risk_finance | | | 0.1015*** | | | 0.0995*** |
| | | | (3.48) | | | (3.44) |
| stake | | | 0.0000 | | | 0.0000 |
| | | | (1.08) | | | (1.07) |
| incomeprospects | | | 0.1438*** | | | 0.1412*** |
| | | | (3.79) | | | (3.76) |
| quiz | | | 0.6889*** | | 1.2992*** | 0.6769*** |
| | | | (4.79) | | (10.03) | (4.75) |
| Subject dummies | | yes | | | | |
| Observations | 7200 | 6660 | 6984 | 7128 | 7200 | 6984 |
| Pseudo $R^2$ | 0.013 | 0.205 | 0.083 | 0.064 | 0.025 | 0.069 |

$t$ statistics in parentheses

$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

Table 10: Regression Results for Sigma.

This table reports results from the least-squares regression analysis with Sigma as dependent variable. It contains seven model specifications including hypothesis variables, subject dummies, and personal characteristics. The variable *absolute* is a dummy indicating that information is presented in terms of absolute values rather than in terms of rates of return. The variables *q75* and *q95* are dummies indicating whether the presentation showed the 75% and 25% quantiles or the 95% and 5% quantiles respectively. The variable *graphicalinfo* is a dummy indicating that the information is presented in a graphic format instead of a table. The variable *pset2* is a dummy indicating settings based on parameter set 2. The models are based on all settings, with the exception of Model (3) which is based on settings applying parameter set 1 and Model (4) which is based on settings applying parameter set 2.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| absolute | 0.0376*** | 0.0376*** | 0.0077** | 0.0675*** | 0.0382*** | | |
| | (7.08) | (8.07) | (2.60) | (8.53) | (7.32) | | |
| q75 | 0.0574*** | 0.0574*** | 0.0359*** | 0.0732*** | 0.0566*** | | |
| | (8.32) | (9.49) | (9.19) | (7.17) | (8.34) | | |
| q95 | 0.0179** | 0.0179** | 0.0199*** | 0.0216* | 0.0171* | | |
| | (2.59) | (2.96) | (5.10) | (2.12) | (2.52) | | |
| graphicalinfo | -0.0078 | -0.0078 | -0.0030 | 0.0045 | -0.0065 | | |
| | (-1.34) | (-1.53) | (-0.76) | (0.57) | (-1.14) | | |
| pset2 | 0.1876*** | 0.1876*** | | | 0.1893*** | 0.1970*** | 0.1955*** |
| | (44.19) | (50.36) | | | (45.28) | (45.66) | (44.72) |
| female | | | | | -0.0228*** | -0.0228*** | |
| | | | | | (-5.05) | (-4.82) | |
| age | | | | | 0.0005 | 0.0005 | |
| | | | | | (0.91) | (0.87) | |
| degree | | | | | -0.0033 | -0.0033 | |
| | | | | | (-0.80) | (-0.76) | |
| economics | | | | | 0.0022 | 0.0022 | |
| | | | | | (0.43) | (0.41) | |
| semester | | | | | 0.0014 | 0.0014 | |
| | | | | | (1.78) | (1.69) | |
| risk_general | | | | | 0.0044*** | 0.0044*** | |
| | | | | | (3.56) | (3.39) | |
| risk_finance | | | | | 0.0101*** | 0.0101*** | |
| | | | | | (4.47) | (4.26) | |
| stake | | | | | 0.0000 | 0.0000 | |
| | | | | | (1.10) | (1.05) | |
| incomeprospects | | | | | 0.0058* | 0.0058 | |
| | | | | | (2.05) | (1.95) | |
| quiz | | | | | -0.0006 | -0.0006 | |
| | | | | | (-0.06) | (-0.06) | |
| Subject dummies | | yes | yes | yes | | | |
| Observations | 2600 | 2600 | 1200 | 1400 | 2522 | 2522 | 2600 |
| $R^2$ | 0.485 | 0.634 | 0.399 | 0.487 | 0.520 | 0.470 | 0.435 |

$t$ statistics in parentheses

$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

Table 11: Regression Results for the Relative Sigma.

This table reports results from the least-squares regression analysis with Relative Sigma as dependent variable. It contains seven model specifications including hypothesis variables, subject dummies, and personal characteristics. The variable *absolute* is a dummy indicating that information is presented in terms of absolute values rather than in terms of rates of return. The variables *q75* and *q95* are dummies indicating whether the presentation showed the 75% and 25% quantiles or the 95% and 5% quantiles respectively. The variable *graphicalinfo* is a dummy indicating that the information is presented in a graphic format instead of a table. The variable *pset2* is a dummy indicating settings based on parameter set 2. The models are based on all settings, with the exception of Model (3) which is based on settings applying parameter set 1 and Model (4) which is based on settings applying parameter set 2.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| absolute | 0.1156*** | 0.1156*** | 0.0503** | 0.1810*** | 0.1182*** | | |
| | (6.78) | (7.94) | (2.60) | (8.53) | (7.07) | | |
| q75 | 0.2188*** | 0.2188*** | 0.2351*** | 0.1965*** | 0.2155*** | | |
| | (9.87) | (11.56) | (9.19) | (7.17) | (9.92) | | |
| q95 | 0.0912*** | 0.0912*** | 0.1304*** | 0.0580* | 0.0876*** | | |
| | (4.11) | (4.82) | (5.10) | (2.12) | (4.03) | | |
| graphicalinfo | -0.0126 | -0.0126 | -0.0194 | 0.0120 | -0.0079 | | |
| | (-0.67) | (-0.79) | (-0.76) | (0.57) | (-0.43) | | |
| pset2 | -0.2004*** | -0.2004*** | | | -0.1964*** | -0.1728*** | -0.1763*** |
| | (-14.69) | (-17.20) | | | (-14.69) | (-12.46) | (-12.50) |
| female | | | | | -0.0741*** | -0.0741*** | |
| | | | | | (-5.13) | (-4.87) | |
| age | | | | | 0.0018 | 0.0018 | |
| | | | | | (1.01) | (0.96) | |
| degree | | | | | -0.0108 | -0.0108 | |
| | | | | | (-0.81) | (-0.77) | |
| economics | | | | | 0.0077 | 0.0077 | |
| | | | | | (0.48) | (0.46) | |
| semester | | | | | 0.0057* | 0.0057* | |
| | | | | | (2.31) | (2.19) | |
| risk_general | | | | | 0.0151*** | 0.0151*** | |
| | | | | | (3.79) | (3.60) | |
| risk_finance | | | | | 0.0348*** | 0.0348*** | |
| | | | | | (4.84) | (4.59) | |
| stake | | | | | 0.0000 | 0.0000 | |
| | | | | | (1.05) | (0.99) | |
| incomeprospects | | | | | 0.0202* | 0.0202* | |
| | | | | | (2.22) | (2.11) | |
| quiz | | | | | 0.0536 | 0.0536 | |
| | | | | | (1.56) | (1.48) | |
| Subject dummies | | yes | yes | yes | | | |
| Observations | 2600 | 2600 | 1200 | 1400 | 2522 | 2522 | 2600 |
| $R^2$ | 0.147 | 0.426 | 0.399 | 0.487 | 0.204 | 0.114 | 0.057 |

$t$ statistics in parentheses

$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

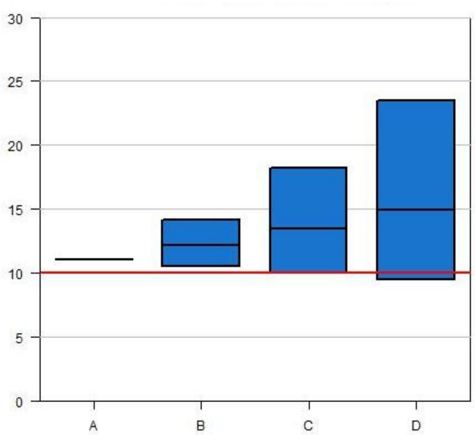
Figure 1: Terminal Values - Settings 4 to 7

This figure displays Settings 4 to 7. In these settings, information on the terminal values of the investment alternatives are given. The information is shown in form of rectangular quantile representations. The settings differ with respect to the underlying parameter set and the quantiles shown. The columns represent the two parameter sets and the rows represent the quantiles shown to the participants: the upper part contains the settings in which the 95%- and 5% quantile as well as the median were shown, whereas the lower part contains the settings in which the 75%- and 25% quantile as well as the median were shown.

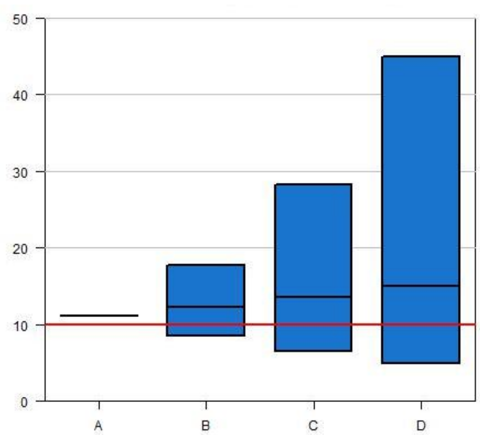
| Quantile | **Parameter Set 1** | **Parameter Set 2** |
|---|---|---|
| 95%/5% | Setting 4 | Setting 5 |
| 75%/25% | Setting 6 | Setting 7 |

**95%/5%**

Setting 4

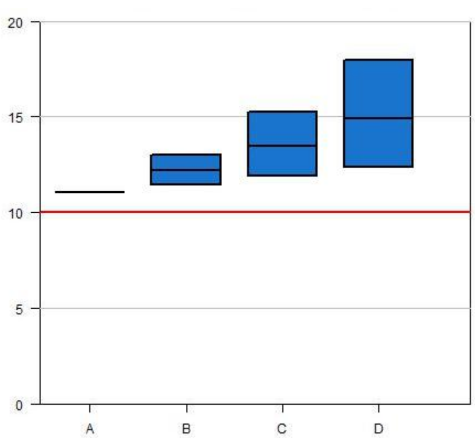



Setting 5




**75%/25%**

Setting 6




Setting 7

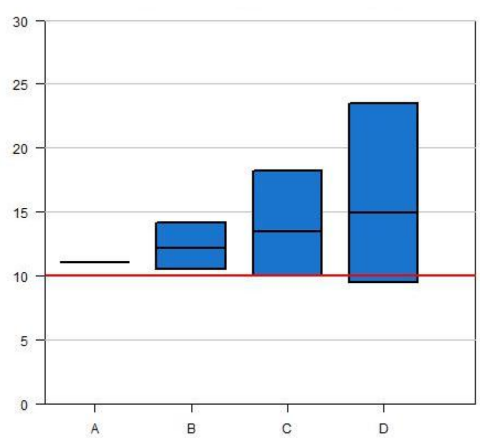


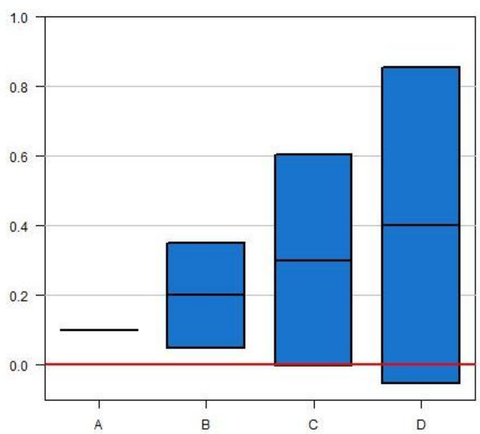
Figure 2: Total Rates of Return - Settings 8 to 11

This figure displays Settings 8 to 11. In these settings, information on the rates of return of the investment alternatives are given. The information is shown in form of rectangular quantile representations. The settings differ with respect to the underlying parameter set and the quantiles shown. The columns represent the two parameter sets and the rows represent the quantiles shown to the participants: the upper part contains the settings in which the 95%- and 5% quantile as well as the median were shown, whereas the lower part contains the settings in which the 75%- and 25% quantile as well as the median were shown.

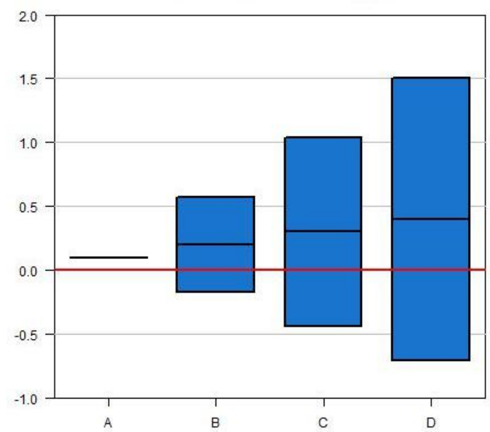
| Quantile | **Parameter Set 1** | **Parameter Set 2** |
|---|---|---|

95%/5%

Setting 8

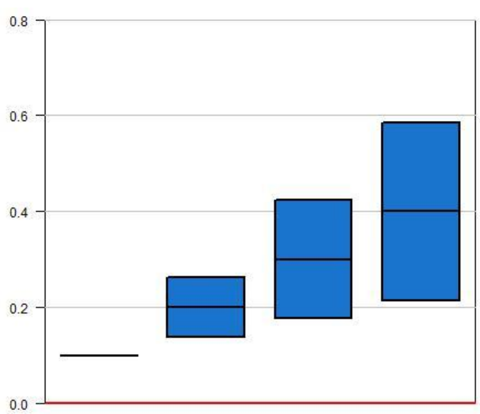



Setting 9




75%/25%

Setting 10




Setting 11

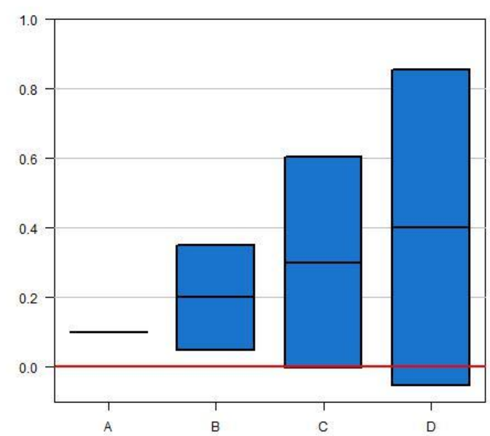


Figure 3: Total Rates of Return - Settings 12 and 13

This figure displays Settings 12 and 13. In these settings, information on the rates of return of the investment alternatives are given. The information is shown in form of probability density functions. The settings differ with respect to the underlying parameter set.

| **Parameter Set 1** | **Parameter Set 2** |
|---|---|
| Setting 12 | Setting 13 |