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RATINGS AND ASSET ALLOCATION: AN EXPERIMENTAL ANALYSIS

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ABSTRACT

Financial product ratings are intended to summarize relevant information in a manner that assists in decision-making, but may be harmful. Ratings are often assigned within categories; ratings across categories may not be comparable. We assess the effect of ratings in an experiment where subjects always have complete information about the characteristics of the investments, they repeatedly make investment decisions, and there is minimial computational burden. Although ratings supply no information, categorized ratings affect investment decisions and harm performance. High-knowledge subjects make better decisions, but are also affected by categorized ratings. The effects are largely reversed when ratings no longer appear.

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1. INTRODUCTION

Personal financial decisions are critically important, with ramifications that span decades. Yet these decisions are difficult. Investors face a variety of long-term risks and are confronted with numerous assets and investment strategies. Fully optimal portfolio decisions that take into account realistic extensions to the basic model (factoring in uncertain labor income, for example) are complicated in all but the simplest cases [e.g., Merton 1971, 1973]. Moreover, investors select portfolios without high-frequency feedback; there is no safe trial-and-error learning mechanism. In addition, individuals are known to have limitations and behavioral biases in perception, attention, and cognitive ability, and they differ from one another in their ability to comprehend and act upon financial information.

To assist investors, institutions and advisers often present summary information about portfolio selection alternatives; examples include Morningstar's mutual fund ratings and bond credit ratings from Moodys, S&P, and other firms. Ratings are often given as relative rankings using simplified ordinal systems. For both fund ratings and credit ratings, investments are subdivided into categories, within which there are ordinal rankings that are generally not intended to be comparable across those categories.[1] Categories and ratings have the potential to be helpful but may undesirably focus attention on specific aspects of the investments, drawing attention away from other information relevant to the decision.[2]

In this paper we conduct an experiment designed to assess the effects of categories and ratings and to see whether financial knowledge affects performance. Subjects face four trials, with ratings playing a role in two of the four. In each trial, subjects allocate $12 across six investment alternatives. Each of the investments has a binomial payoff that is perfectly correlated across the assets. Subjects have complete information about the assets at all times: the presentation in each trial includes the high and low payoffs for each investment, along with their mean, range, and the ratio of the two. In comparing assets, therefore, subjects do not have to perform computations, think about diversification, or remember asset characteristics from one trial to the next. The goal of this design is to eliminate computational and cognitive hurdles for subjects. Payoffs are revealed at the conclusion of the experiment, so there is no learning about returns or statistical inference. Risk-averse investors should have an unambiguous preference for two of the investments, and two of the remaining four have payoffs that are strictly dominated. Diversification across the six assets is suboptimal.

Our primary treatment is categorization: Half of the subjects see investments split into two groups. In two of the trials, the investments are ranked. Categorization alters the ranking for four of the six investments, allowing us to see how the change in ranks affects investment decisions. At the end of the experiment we give subjects a test of financial knowledge, so we are able to see how their score on the test is related to their performance. A natural conjecture, for example, is that subjects with more financial knowledge would be less affected by the categorization treatments.

We have three main results:

1. Subjects generally allocate to assets in accord with theory, investing most heavily in the two preferred assets.

2. There are strong effects of heterogeneity: Subjects with greater financial knowledge invest more heavily in the preferred assets, and those who take an initial fair bet invest more in high variance assets. They have higher expected returns and Sharpe ratios and hold more concentrated portfolios with fewer dominated investments.

3. Treatments affect investment. We find little evidence, however, that knowledgeable subjects are less affected by the treatments. High knowledge subjects do tend to reallocate less between stages. Thus, they seem more likely to stick with preferred portfolios. However, there are few significant interactions between knowledge, treatments and investment levels. Thus, when they do reallocate, high knowledge subjects appear prone to the same bias as low knowledge subjects.

1 In the framework of Campbell [2006], one can view ratings as a financial product offered to investors, an example of "equilibrium household finance."

2 As an example, consider indexed mutual funds. They constitute theoretically useful investment vehicles and, in fact, are often constructed to mimic a category of investments while achieving the greatest diversification at the least cost. But, they are unlikely to be rated 5 stars due to their average (by construction) returns and risk relative to the investments within their category.

Our conclusion is thus that financial knowledge is important and helpful but that knowledgeable investors may still be influenced by standard practices such as categorization.

In interpreting these results it is important to understand that the asset allocation task is not one that subjects would have encountered, for example, in a finance class. A subject who remembered and followed a dictum such as "diversification is beneficial," would make suboptimal decisions in this experiment. Thus, although having studied finance should make it easier for a subject to perform well, it would be because the subject understood the problem, not because they had been taught how to do it. This makes it more surprising that knowledgeable investors appear to still be influenced by the treatments.

Our focus on ratings and categories is motivated by their prominence in the financial sector. Morningstar introduced their Morningstar Rating ("Star") system for mutual funds in 1985.[3] Mutual funds are subdivided into categories based on investment goal, and ranked within those categories using an ordinal system (5 stars for the best to 1 star for the worst). Standard and Poor's uses a proprietary "STock Appreciation Ranking System" (STARS) where analysts rank individual stock investments in their areas of expertise relative to appropriate market benchmarks.[4] For bonds and structured products, credit rating agencies use a familiar ordinal system (e.g., AAA, AA, etc.) to describe the credit risk of instruments. Effectively, these instruments are ranked within categories. For example, credit rating agencies use the same nomenclature to describe ordinary corporate bonds and structured products such as CDOs, while stating that the ratings across categories are non-comparable.[5]

The fact that mutual fund and credit ratings are not comparable across asset categories suggests that categorized ratings may cause a particular problem. While optimal investment allocation decisions depend on the overall investment return and risk for the entire portfolio, typical category rankings compare performance to other investments of a similar style. For example, when Morningstar introduced its fund rating system in 1985, all stock funds were ranked in a common pool. In 1996, category rankings were introduced. In 2002, smaller category groups were introduced.[6] Ratings therefore have a potential benefit in simplifying information about risk and returns, and a potential cost if they oversimplify a complicated problem and mislead investors.

We begin in Section 2 by describing the experiment. (In the Appendix we present the instructions and instruments presented to participants.) In Section 3, we explain how the experiment is related to existing empirical research. We present our empirical analysis strategy in Section 4. Section 5 discusses results, and Section 6 concludes.

2. EXPERIMENTAL DESIGN

The experiment gave subjects four opportunities, which we call "stages," to allocate $12 across six investments, or to do nothing, which we refer to as investing in "cash." The goal of the experiment was to see how the presentation of information about the six investments affected investment decisions, conditional on subject characteristics, such as

3 For a description of the original system, see Blume [1998]. For a description of how the system changed in 2002, see Morningstar [2008].

4 While categorization is not explicit, this effectively creates different categories, depending on both the analyst and choice of benchmark for each individual stock.

5 Moody's considered adopting an alternative ratings system for structured products; see Moody's Investors Services [2008]. For detailed discussions of credit ratings during the financial crisis, see Benmelech and Dlugosz [2009, 2010]. Simplified rating and ranking systems arise in many other areas as well. For example, AM Best ranks insurance companies for financial strength using ratings similar to bond ratings (see: http://www.ambest.com/ratings/guide.pdf). Outside the financial domain, NuVal collapses information about nutrition to a single number for various foods (see: http://www.nuval.com/scores).

6 Morningstar justifies these category rankings as follows:

> The rating allows investors to distinguish among funds that use similar investment strategies. The use of smaller rating groups minimizes the possibility of a "tail wind" effect boosting or hurting the ratings of funds that invest in specific areas of the market. For example, under the original methodology, persistent outperformance by the value investment style resulted in high ratings for most value funds, and relatively lower ratings for most growth-oriented funds. Morningstar [2008].

While removing one bias (the "tail wind" effect), categorization may introduce another bias: a particular category-based ratings effect. A five-star growth fund may differ drastically from a five-star value fund in risk and return characteristics. Investors may make suboptimal decisions if they focus on the star ratings of an investment without taking into account the underlying risk and return differences across investment styles.

financial knowledge. Each subject's final payoff is based on a randomly selected stage, which is not selected until the experiment is over. This design has two consequences. First, there is no learning from results because subjects never see results during the experiment. Second, results from any stage could determine the payoff, so subjects should have the same incentive each period to make their preferred choices.

We first describe the investments from which subjects could choose, then the general experimental procedure, and finally the details of the eight distinct experimental treatments.

2.1 INVESTMENT ALTERNATIVES

Table 1 describes the six investments. Unallocated funds earn a zero return, so there is always a zero-return, zero-risk seventh investment option, cash. Each of the six investments has two outcomes, high and low, with probability 1/2. At each stage of the experiment, the subject saw, at a minimum, all of the information in Table 1, although investments could have been presented in a different order, grouped into two categories, or accompanied by stars, as we describe below. By presenting investment characteristics (the average, range, and return/risk ratio) in Table 1, subjects do not have to perform these computations.

The return/risk ratio in Table 1 is the expected return of the investment divided by the range of payoffs, which is twice its standard deviation and, hence, is analogous to a Sharpe ratio.[7] At the end of the experiment, a single stage was selected at random, and a second random draw determined the state. If the state was "High," then *all* investment alternatives paid the high return. If the state was "Low," then *all* investment alternatives paid the low return. Subjects were told about this structure of payoffs at the beginning of the experiment and could not proceed without correctly answering a question about it. This design choice was driven by evidence that subjects have trouble understanding and incorporating correlation in optimal portfolio decisions (see, e.g., Kroll, et al. [1988]). Because payoffs are all high or all low, there is no benefit to diversification. This considerably simplifies the portfolio allocation problem.[8] Further, it is not altogether unrealistic. Typical correlations across the relatively diversified mutual funds available in retirement plans are very high within a class, resulting in few diversification benefits.[9]

TABLE 1: INVESTMENT ALTERNATIVES USED IN THE ALLOCATION STAGES OF THE EXPERIMENT

Alternative:	A	B	C	D	E	F
High Return:	130%	185%	125%	200%	225%	190%
Low Return:	30%	15%	-25%	-20%	-75%	-90%
Average Return:	80%	100%	50%	90%	75%	50%
Range of Returns:	100%	170%	150%	220%	300%	280%
Return/Risk Ratio:	0.8000	0.5882	0.3333	0.4091	0.2500	0.1786

Figure 1 presents two graphical depictions of the investments from Table 1. These figures were *not* presented to the subjects. The top panel presents a standard portfolio/efficient frontier graph applicable to each stage. The frontier is simple because a single random draw determines whether all investments receive the high return or low return. Note that, because there is no diversification effect, efficient portfolios are highly concentrated, consisting of at most two assets. The bottom panel displays all of the information from Table 1. In both graphs, it is apparent that investments in cash, C and F are strictly dominated by other investments.

7 The instructions tell subjects precisely how the return/risk ratio is calculated.

8 Of course, a subject who does not understand correlation may not appreciate the simplification.

9 Consider, for example, three TIAA-CREF domestic stock retirement funds: TIAA-CREF S&P 500 Index Retirement (TRSPX), TIAA-CREF Large-Cap Growth Retail (TIRTX) and TIAA-CREF Small-Cap Equity Retail (TCSEX). Monthly dividend adjusted returns from September 2007 through September 2012 had correlations of $\rho_{\text{TRSPX,TIRTX}} = 0.9621$, $\rho_{\text{TRSPX,TCSEX}} = 0.9493$ and $\rho_{\text{TIRTX,TCSEX}} = 0.9332$.

FIGURE 1

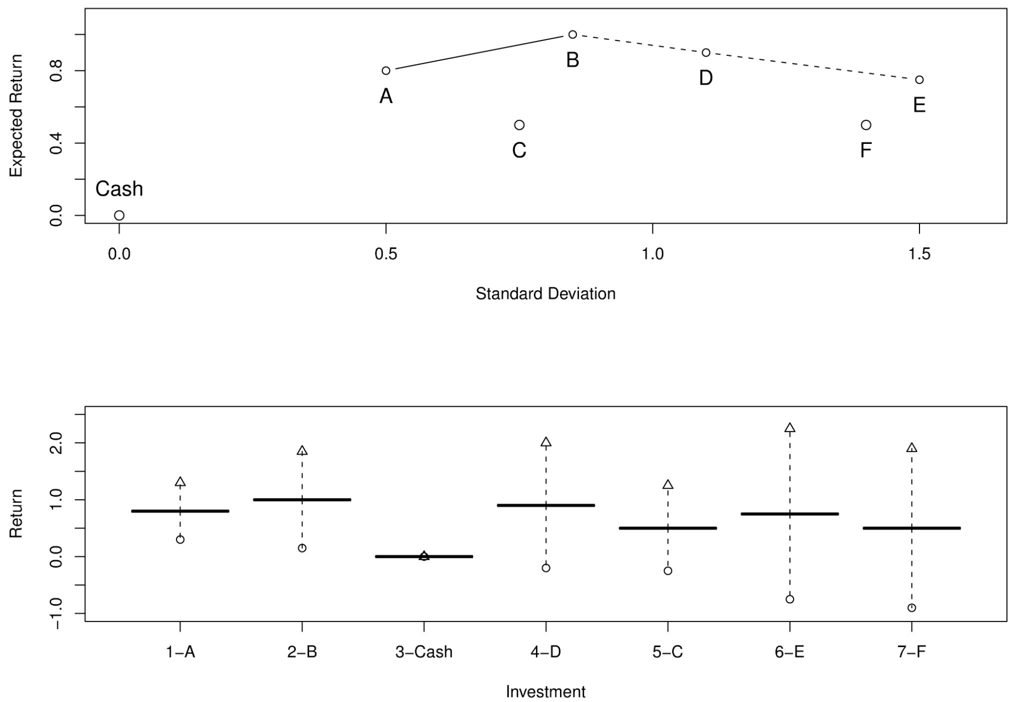

Figure 1: Top panel: Expected returns and standard deviations of investments along with the efficient frontier for risk averse investors (solid line) and risk seeking investors (dashed line). Bottom panel: Outcomes and mean return for each investment, ordered by minimum return. Investments cash, C, and F are dominated by A and B, D, and E, respectively.

2.2 OPTIMAL ALLOCATIONS

Our primary interest is in the *change* in allocations given treatments. However, given the information in Table 1, it is useful to understand what subjects should do. Rabin [2000] emphasizes that for small gambles, subjects should behave in a risk-neutral fashion. In our experiment, this implies that all subjects would select B exclusively, as it has the highest average return. As Rabin notes, however, subjects nevertheless do often behave in a risk-averse fashion in experiments. We can show that risk-averse subjects would choose at most A and B. Investment B is strictly preferred to D and E. Investments C, F, and cash are dominated and should never be selected.

We begin by showing that a risk-averse subject always prefers B to D. To demonstrate this, note that we can write the value of investing in D as

$$0.5U(D_H) + 0.5U(D_L)$$

where $U(x)$ is the utility value of existing wealth plus the payoff in the high or low outcome, D_H or D_L. Similarly, the value of investing in B is

$$0.5U(B_H) + 0.5U(B_L)$$

We can write B_H and B_L as weighted averages of the payoffs to D:

$$B_H = \lambda_1 D_H + (1-\lambda_1) D_L; \qquad \lambda_1 = \frac{285-80}{300-80} = 0.9318$$

where

$$B_L = \lambda_2 D_H + (1-\lambda_2) D_L; \qquad \lambda_2 = \frac{115-80}{300-80} = 0.1591$$

Note that $\lambda_1 + \lambda_2 > 1$. We can write the value of investing in B as

$$\begin{aligned} 0.5U(B_H) + 0.5U(B_L) &= 0.5U(\lambda_1 D_H + (1-\lambda_1)D_L) + 0.5U(\lambda_2 D_H + (1-\lambda_2)D_L) \\ &\geq 0.5\left[(\lambda_1+\lambda_2-1)U(D_H) + ((1-\lambda_1)+(1-\lambda_2))U(D_L)\right] \\ &= 0.5\left[U(D_H) + U(D_L) + (\lambda_1+\lambda_2-1)(U(D_H)-U(D_L))\right] \\ &> 0.5U(D_H) + 0.5U(D_L) \end{aligned}$$

where the first inequality follows from risk aversion and the last inequality follows because $\lambda_1 + \lambda_2 > 1$.

If we consider investment in a linear combination of B and D, the analysis follows along the same lines for the incremental portion due to D.

Considering A vs. B, we write the payoff to A as a linear combination of the high and low payoffs to B. We have $\lambda_1 = \frac{230-115}{285-115} = 0.6765$ and $\lambda_2 = \frac{130-115}{285-115} = 0.0882$. In this case, $\lambda_1 + \lambda_2 > 1$, so we cannot rule out that, for a sufficiently risk-averse investor, investment in A is optimal.

Finally, if we consider E vs. D, we can write the payoff to D as a linear combination of the payoff to E. We have $\lambda_1 = \frac{300-25}{325-25} = 0.9167$ and $\lambda_2 = \frac{80-25}{325-25} = 0.1833$. Because $\lambda_1 + \lambda_2 > 1$, a risk-averse investor will prefer investments in D to investments in E. With C, F, and cash dominated, A and B are the only two assets that a risk-neutral or risk-averse investor should select.

While rankings of investments are clear for risk-neutral and risk-averse investors, some evidence suggests that subjects may be risk seeking across small gambles [e.g., see Berg et al., 2010]. Similar arguments show that a risk seeking investor may hold B, D or E (depending on the degree of preference for risk), but not A, C or F.

2.3 THE STAGES

Here is a more detailed description of the four stages in the experiment:

Stage I: Subjects allocated investments across the six gambles based on the information in Table 1 alone.

Stage II: Investments were reordered and relabeled. Subjects were given investment information with an additional row at the bottom of the table listing star ratings (based on return/risk ratios) for the alternatives and then asked to allocate investments. Categorization affected the display: If the alternatives were categorized, there was one "3-star" alternative, one "2-star" and one "1-star" within each category, with stars assigned according to the ranking based on return/risk ratios within the category. Without categorization, two "3-star," two "2-star" and two "1-star" rankings were allocated across all of the alternatives according the overall return/risk ratios. Half of the subjects are told that the investments are ranked using the return/risk ratio.

Stage III: Investments were reordered and relabeled. Subjects were instructed to rank the alternatives themselves, and were then asked to allocate investments. When categorized, subjects had to allocate one "3-star," one "2-star" and one "1-star" rating in each category. When uncategorized, subjects had to allocate two "3-star," two "2-star" and two "1-star" ratings. In half of the treatments, subjects were asked to rank alternatives according to the return/risk ratio;

in the rest, they were not told how to rank the alternatives. To control for order effects, half of the subjects actually completed Stage III before Stage II.[10]

Stage IV: Investments were reordered and relabeled. Subjects allocate cash across the six investments. There were no star ratings provided or requested. This stage repeats Stage I.

Note that because Stage IV is identical to Stage I, we are able to see whether the treatments with in Stages II and III have persistent effects.

2.4 TREATMENTS

The experiment implements a 2 x 2 x 2 design. The three treatments are:

- Categorization: Whether the investment alternatives are categorized or not.
- Explicit Rating Rule: Whether the rating method used in Stages 2 and 3 is explicitly stated.
- Order: Whether subjects participated in Stage II then Stage III or in Stage III then Stage II.

Each treatment was selected with a probability of 1/2, so each combination of treatments was presented to 1/8 of the subjects.

TABLE 2: CATEGORIZED DISPLAY OF INVESTMENT ALTERNATIVES

		Category I				Category II		
Alternative:		**A**	**B**	**C**		**D**	**E**	**F**
High Return:		130%	185%	125%		200%	225%	190%
Low Return:		30%	15%	-25%		-20%	-75%	-90%
Average Return:		80%	100%	50%		90%	75%	50%
Range of Returns:		100%	170%	150%		220%	300%	280%
Return/Risk Ratio:		0.8000	0.5882	0.3333		0.4091	0.2500	0.1786

The main treatment variable was categorization. Categorization was based on the variability of returns, with A, B, and C always together in one category and D, E, and F in the other. In uncategorized treatments, the six investments were presented grouped in the same way, but not explicitly categorized. That is, while the ordering changed between allocation stages, investments A, B and C (not necessarily in that order) were in either the first three or the last three columns. Investments D, E and F (not necessarily in that order) were in the other three columns.[11]

In categorized treatments, a blank column separated the two groups of three and the groups were explicitly labeled as “Category I” (first group) and “Category II” (second group).[12] Subjects were told that investments were categorized using “a commonly used financial method.” In uncategorized treatments, no mention of categorization was made. Tables 1 and 2 show the non-categorized and categorized presentations.

10 That is, half of the subjects self-rated first and received ratings second. The stage names seen by subjects were always sequential. For convenience, we refer to the self-ranked stage as “Stage III” regardless of the actual order.

11 We associate the labels “A” through “F” with specific alternatives here for expositional convenience. Subjects were always shown alternatives labeled “A” through “F” in order form left to right regardless of the actual investment alternatives that appeared in each column.

12 We will use the category labels “I” and “II” to mean relatively low and high risk investments. The categorized displays in the experiment were always labeled “I” and “II” from left to right, regardless of the actual investment alternatives that appeared in each category.

TABLE 3: RATINGS OF INVESTMENT ALTERNATIVES

Alternative:	A	B	C	D	E	F
Uncategorized Rating:	***	***	**	**	*	*
Categorized Rating:	***	**	*	***	**	*

The critical aspect of categorization is that it changes the way investments are ranked. Without categorization, all investments are ranked as a single group. With categorization, investments are ranked within group. Table 3 gives the investment ratings based on return/risk ratios (or, equivalently, Sharpe ratios) for categorized and uncategorized treatments. A has the highest Sharpe ratio and, as a result, is ranked 3-star either way. F has the lowest Sharpe ratio and is ranked 1-star either way. Categorization drops B from 3-star to 2-star and C from 2-star to 1-star. It raises D from 2-star to 3-star and E from 1-star to 2 star. We are interested in the possibility that these rating changes will affect decisions even though all of the fundamental information remains constant and is displayed throughout the stages.

The other two treatment variables are primarily for control purposes. Subjects were randomly assigned to orderings for Stages II and III to control for possible order effects. Without explicit statement of the rule, subjects may assume it contains additional information. Stating that ratings are based on the reward/risk ratio controls for this, making it explicit that the ratings do not depend on any information that the subjects do not have themselves.

We base star ratings on the risk-return ratio for several reasons. As we discussed, risk-averse investors should choose only A or B; with a corner solution the investment choice does not conform to the standard portfolio choice problem or metrics. Subjects could potentially analyze the choice in different ways (e.g. comparing expected returns, range, maximum return, etc.). The return-risk ratio is a simple intuitive criterion that provides a ranking in the non-categorized treatment that is roughly consistent with optimal choices for a risk-averse investor (A and B receive the highest ratings). Conditional on categorization, the ranking is also correct for both categories (A and B are preferred to C and D is preferred to E and F). Finally, a subject who has studied finance might believe they *should* perform this kind of calculation; the presentation is intended to reduce computational load for subjects by computing what they might want to compute. The return-risk ratio of course does not show that dominated assets are dominated, but no simple metric will completely characterize this investment decision.

We emphasize that the point of the experiment is to see how treatments alter choices, not to test hypotheses about the choice of specific investment alternatives. In theory the ratings provide no new information; our interest is in whether allocations are affected by the subjects receiving a rating, receiving an explanation of the rating, and performing the rating themselves.

2.5 EXPERIMENTAL PROCEDURE

The 266 participating subjects came from a volunteer subject pool of undergraduate and MBA students in University of Iowa business classes. Subjects were asked to participate in an on-line experimental session that would last less than an hour. Subjects who agreed to participate received the web address for the study, a login ID and a random password. They could participate at their convenience. After logging in, they went through an on-line version of the instructions and exercises given in the Appendix. Participating subjects received a $5 participation fee and additional payments that depended on the allocation decisions and random draws as described in the Appendix. Here, we briefly describe the procedures.

First, subjects received instructions and general information about the experiment. The instructions discuss how investment alternatives are described. Each alternative has two possible outcomes: a high return and a low return, which are equally likely. Each alternative was described in a table containing the high return, low return, average return, range of returns and the return/risk ratio. In addition, the information may include star ratings for the alternatives depending on the investment stage as discussed below.

Second, subjects completed a short quiz on what the outcomes of gambles mean. They could not proceed until they answered all questions correctly.

TABLE 4: INITIAL INVESTMENT ALTERNATIVE

Alternative:	A
High Return:	100%
Low Return:	-100%
Average Return:	0%
Range of Returns:	200%
Return/Risk Ratio:	0.0000

Third, the subjects chose whether to allocate $1 to a single, actuarially fair investment alternative to determine their willingness to gamble. Table 4 shows the parameters of this initial investment option.

Fourth, the subjects allocated endowments of cash across investment alternatives in a series of four stages. In each stage, subjects allocated $12 across the six gambles in $1 increments. Subjects could also allocate less than $12, in which case the unallocated amount was effectively invested in a seventh investment with zero return and zero risk. We refer to this seventh investment as "cash." The gambles were the same in each stage, though their presentation order was varied.

Fifth, subjects filled out knowledge and demographic surveys, both of which are reproduced in the Appendix. The demographic survey, adapted from Oliven and Rietz [2004], asks about gender, age, marital status, education, etc. The knowledge survey, also adapted from other sources, asks subjects to self-report on their own financial market knowledge and experience (four questions) and also asks about simple definitions, basic concepts, applications of concepts to risk and return relationships and asset allocation (nine questions).

Sixth, a series of random draws determined payoffs. Subjects earned a $5 participation fee. Three random numbers then determined the additional payment based on the subject's responses in the experiment. The first determined the payoff to the preliminary bet. The second selected which portfolio allocation (from among the four stages) would be used to determine payment. The third determined whether all the investments in the selected stage paid the high or low return. The University mailed checks for the total amounts to the subjects.

Seventh, after learning their total payment, the subjects answered one final question about their satisfaction with their own decisions in the experiment.

3. RELATED RESEARCH

In this section we discuss related literature and provide some additional context.[13] A non-experimental paper asking closely-related questions is Del Guercio and Tkac [2008], who find that mutual fund flows respond to star rating changes in a study of Morngingstar-ranked equity funds. An increase from four to five stars, for example, is accompanied by an inflow of funds, even after controlling for historical return characteristics. This finding raises the possibility that investors are overly sensitive to the ratings.[14] Del Guercio and Tkac [2008] have no investor-level data and thus are unable to examine heterogeneity of investor responses. By contrast, we are able to see how subject characteristics are associated with a response to ratings. We also have the advantage of a completely controlled economic environment, in which investors know with certainty the return process and can see easily, or are explicitly told, that ratings contain only

13 Subjects in our study do not interact and do not determine market prices. Thus, our work is *not* related to the literature on experimental asset markets, e.g. see Sunder [1995].

14 Del Guercio and Tkac [2008] report that investing only in five-star funds produces a positive risk-adjusted excess return in their sample, making it difficult to rule out the possibility that Morningstar rankings do convey information. See also Blake and Morey [2000].

redundant information. Of course, this comes with the concomitant disadvantage that dollar amounts in an experimental setting are relatively small.[15]

Another related paper is Benartzi and Thaler [2001], who suggest that investors choosing funds in a retirement account naively diversify using a $1/N$ rule (investing equal amounts in offered assets).[16] Diversification is suboptimal in our setting, so we are able to see whether subject are prone to diversify inappropriately. Using a relatively small number of assets, we find that most subjects do not naively diversify.

Beyond this, our paper is related to several strands of the literature:

- Work on portfolio choice, specifically experimental studies of how individuals select and value individual risky gambles.
- Household finance, which, broadly speaking, empirically examines household financial behavior and studies determinants of heterogeneity. This literature documents effects of characteristics such as gender and knowledge as determinants of heterogeneity
- Studies examining cognitive limitations and decision-making biases

Our paper is experimental, but also related to household finance, as it studies financial decision making and the role of decision-making guides such as ratings. As a broad generalization, the experimental literature is typically more concerned with characterizing behavior on average while the household finance literature focuses on determinants of behavior. One of our contributions is performing an experiment in which we are able to measure and assess the effects of heterogeneity.

3.1 RESEARCH ON PORTFOLIO CHOICE

Much experimental research on portfolio choice mimics important aspects of real-world portfolio decision-making, studying, for example, how subjects use historical information or make theoretically correct decisions in realistic settings. In general, research has found that subjects inappropriately extrapolate from historical data [Moore et al., 1999], have difficulty forming efficient portfolios, [Kroll et al., 2003], and do not properly account for asset correlation Kroll et al. [1988].) Kroll et al. [2003] find that investors make better choices when they are offered dominating portfolios directly, instead of expecting investors to build them. These studies typically have not focused on the heterogeneity of subject responses (though they note that there is heterogeneity)[17] and they require subjects to either implicitly or explicitly estimate expected returns, standard deviations, and correlations, and to understand their use in portfolio decisions.

In our experimental design, in order to sharpen the focus of the treatments, we avoid many of the documented issues associated with optimal portfolio selection by: specifying the distribution of returns, eliminating benefits of diversifications by having returns perfectly correlated, and including assets that are dominated. Also, unlike some studies, payment for our subjects is based on the choices they make.[18]

3.2 HOUSEHOLD FINANCE AND INVESTOR HETEROGENEITY

Campbell [2006] describes household finance as studying household financial decisions, both from a positive and normative perspective, and also the determinants of the products and services that are available to investors. A goal of our experiment is to shed light on behavior in the presence of ratings, which are a real-life market-provided service. The household finance literature identifies effects associated with knowledge, cognitive ability, and gender.

15 Along related lines, Barberis and Shleifer [2003] suggest that categorization of risky assets into style categories can cause investors to follow correlated investment strategies. This in turn creates price inefficiencies and excess co-movement among assets lumped together, giving rise to profitable momentum strategies. Credit ratings may have performed a similar function in the build-up to the financial crisis.

16 But note that Huberman and Jiang [2006] find that investors are less inclined to diversify naively as the number of investments increases.

17 Kroll and Levy [1992] achieve better results than Kroll et al. [1988] using business students and better incentives. This indicates that there are differences across subjects in their abilities to select optimal portfolios.

18 Recent evidence shows that paying subjects results in more economically consistent decisions (e.g., Berg et al. [2012]).

There is evidence that both education and cognitive ability affect financial decisions. Bernheim et al. [2001] provide survey evidence that graduates from high schools with financial education programs have higher savings rates. Along similar lines, Bernheim and Garrett [2003] find that workers experiencing financial education in the workplace also have higher savings rates. Along similar lines, Lusardi and Mitchell [2007] find that individuals who plan for retirement are financially literate. In an experiment, Anderson and Settle [1996] also show significant effects of prior financial knowledge. The most direct evidence so far is from Grinblatt et al. [2011]. Using Finnish data, they find that a higher IQ is associated with greater stock market participation and a higher Sharpe ratio.

We use gender as a control variable in our multivariate analysis due to previous findings that women tend to diversify more. Using field data, Sunden and Surette [1998] suggest that gender may affect asset allocation in defined contribution retirement savings plans with the evidence suggesting that unmarried women are more likely to choose diversified portfolios than unmarried men.[19] In a related vein, Croson and Gneezy [2009] survey the experimental economics literature and conclude that women are more risk-averse.[20]

3.3 COGNITIVE LIMITATIONS AND DECISION-MAKING BIASES

Numerous studies have shown that subjects have computational limitations and exhibit various biases. As mentioned previously, we design the experiment to *minimize* the effect of such documented behavior and to maximize transparency. Although subjects should understand basic probability and the implications of distributional information for choosing a portfolio, we present the relevant information in the same format in each stage, and we do not tax the ability of subjects to compute, recall, or infer. The ratings in our study are supplemental information, and we present this information in various ways, so the question is whether these effects play a role. Subjects must interpret the effects of treatments, and try to understand whether an additional or altered element of presentation corresponds to a substantive change. As we mentioned above, the task does not precisely correspond to a rote problem studied in finance classes.

Previous studies have documented presentation effects and shown that limited attention affect the perceptions of risk or ability to understand tradeoffs. Subjects may process information differently depending upon how information is presented [Weber et al., 2005, Ibrekk and Morgan, 1987]; see also discussions in Tversky and Kahneman [1981, 1986]. In an investment context, Weber et al. [2005] show that how historic returns are presented affects the estimates of volatility for stock investments.[21] Hirshleifer and Teoh [2003] argue that investor attention is limited. As a result, how information is presented (in particular how salient it is) affects choices.[22] Anderson and Settle [1996] show that both the form and amount of information affect choices. Too much information or information in a complicated form can result in "information overload."

Experimental subjects can be affected by irrelevant information. Edgell et al. [1996] list a range of areas in psychology where irrelevant information affects behavior. Examples include sunk costs [Thaler, 1980], random information signals [Tversky and Kahneman, 1974] and extra information not pertinent to the decision [Camerer et al., 1989]. Subjects also have trouble ignoring irrelevant alternatives. The failure of the independence axiom is well documented in general contexts (e.g., see Davis and Holt [1993]). In an investment environment, Herne [1999] shows how a "decoy" gamble can affect choices across gambles.

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19 Our sample consists primarily of unmarried subjects (92% unmarried overall).

20 Grinblatt et al. [2011] have IQ data only on men, but study a woman's brother's IQ as a proxy. They find similar effects for women and men. Lusardi and Mitchell [2008] find that older women are unprepared for retirement, but attribute this to low levels of financial literacy.

21 Historical returns presented as a (smoothed) density function resulted in subjects estimating higher future volatilities than when the same historical returns are presented as a bar graph. Ibrek and Morgan [1987] study a wider range of presentations in a different context.

22 Information that is more apparent, easily processed and absorbed had more impact. As a result, investors respond differently to information presented in annual reports of companies depending on how the information is presented. Barber et al. [2005] give another real world example. Investors appear to avoid mutual funds with high front loads and are less likely to avoid funds with high operating expenses. They argue that the front loads are more apparent and, thus, more salient.

The ratings in this paper provide no new information, but do present information in a different manner than the tabular, numerical presentation of possible outcomes. The research on presentation and attention suggests that star ratings may affect choice by reducing the information processing burden faced by subjects, repackaging existing information and, possibly, by making information more salient and reducing information overload. In contrast to the research on irrelevant information or alternatives, star ratings and categorizations in our context do not present either additional information or additional choices, and the ratings are redundant, not irrelevant. The effect of ratings arises from a redundant restatement of decision-relevant information that is already known by subjects.

One way to think about the task is in terms of the subject's ability to perform the comparisons and appropriately apply the results.[23] A nuanced psychological model for thinking about this kind of computation is the elaboration likelihood model (ELM) [Petty and Cacioppo, 1981], which considers the effect of expertise on decisions. Assuming that a subject is interested in performing the task, ELM distinguishes between those who, on the one hand, have the ability to process a message (i.e., experts), or at least to think about a message, and those who do not. The latter category is persuaded by "non-issue-relevant" concerns, which in our context could be interpreted as stars. ELM thus suggests that experts in our context will compare probabilities and payoffs, while those who are not experts will look for alternative dimensions to help them make a decision.[24]

4. EMPIRICAL STRATEGY

The experiment is designed to assess the effects of star ratings on investment decisions. The null hypotheses are that investors select from between A and B and that star ratings do not affect the investment choices. The experimental literature on limited computational ability, cognitive biases, and presentation effects, coupled with a heterogeneous subject pool, suggests that star ratings could matter for at least some subjects.

Our primary statistical approach is to run one regression for each of the six investments, plus cash. We use a censored regression to account for the investment amounts being between 0 and 12.[25] Given investment in asset i by subject j in stage k, where $k \in \{1,...4\}$ in stage, the model is

$$I_{ijk} = \alpha_i + \beta_1 X_j + \beta_2 D_{k=2} X_{2,j} + \beta_3 D_{k=3} X_{3,j} + \beta_4 D_{k=4} X_{4,j} + \epsilon_{i,j} \quad (1)$$

where X_j is a vector of subject characteristics and $X_{k,j}$ is a vector of controls for different stages. $D_{k=n}$ is a dummy variable that takes the value 1 in stage n. The β_1 coefficents can be interpreted as the baseline effect of subject characteristics and, when the explanatory variables are the same for each stage, then, β_k, $k > 1$, is the incremental effect in stage k.

We now discuss some of the specific control variables, our handling of different treatemnts, and what we expect to see.

4.1 THE EFFECT OF STARS AND CATEGORIZATION

Our null hypothesis is that subject allocations are unaffected by the treatments, specifically:

- Portfolio allocations should be unaffected by the introduction of ratings, whether given to the subject (Stage II) or self-assigned (Stage III).

23 Subjects may be unable to perform calculations necessary to analyze a problem or they may find they are overwhelmed by the information in a given setting (e.g., Agnew and Szykman [2005]). Star ratings do not give subjects less information to process (as the information overload hypothesis suggests would help), but instead gives subjects an additional presentation of the same information. Thus, in our setting, such subjects may use ratings as a shortcut in selecting investments. Well-constructed and individually-appropriate ratings can help subjects who are otherwise unable to process the existing information effectively. However, inappropriate or unnecessary ratings can harm subjects who could have processed the available information but who choose to rely on ratings when available.

24 Hong and Sternthal [2010] provide an illustration of ELM used in the marketing literature.

25 Because investments in each alternative range from \$0 to \$12 in one dollar increments, we also estimated ordered probit models as a robustness check and got essentially identical results. We present the censored regression models because they are easier to interpret.

- Portfolio allocations should also be unaffected by categorization, which causes differences in ratings relative to the uncategorized treatment.

The alternative hypothesis is that subjects are influenced by star ratings, in which case the precise effect of the ratings should depend upon whether or not investments are categorized. Equation (1) permits us to assess the significance of *differences* in investment levels stemming from treatments. For some of the assets, investment should be low initially, and our prior would then be no effect of a treatments that lowered the rating. With this caveat in mind, we expect that, for at least some subjects:

1. When ratings are introduced, investment levels will rise for alternatives with increased ratings and low initial investment levels. Similarly, investment levels will fall for alternatives with reduced ratings and high initial investment levels. Put differently, we should see rating effects when the ratings conflict with initial preferences over alternatives as revealed by initial investment levels.

2. Changes in star ratings across categorized and uncategorized treatments will affect investment levels according to the direction of the changes. Categorization changes star ratings for B, C, D, and E and is expected to alter investment in those stages, with investment changes positively correlated with stars changes across categorization treatments. The ratings for A and F do not change; we have no expectations for these alternatives.

4.2 SELF-RATING

In Stage III, participants are asked to rank assets themselves before making an investment decision. Half of the subjects are told to rank according to the return/risk ratio. The other half are free to assign ratings as they choose so long as the appropriate numbers of different ratings are assigned. The question here is whether forcing subjects to pay close attention will change allocations, perhaps leading subjects to override star ratings.

4.3 EFFECTS OF FINANCIAL KNOWLEDGE

The knowledge survey, discussed in Section 2, allows us to study the effects of and control for prior knowledge. We anticipate that higher prior knowledge subjects would hold more efficient and less diversified portfolios. They may also be less prone to biases introduced by ratings and categorization.

The knowledge survey has four experience and nine knowledge questions. A factor analysis on the nine knowledge questions reveals one factor with an Eigenvalue above one; there are also high correlations among the answers. As a result, we use the summed score on the nine questions (questions 5 throught 13) as our measure of (actual as opposed to self-reported) prior financial knowledge. We also ask questions about experience, but our measures of experience and knowledge are also highly correlated.[26] Thus, we rely primarily on the observed knowledge score.

5. RESULTS

We study the following determinants of investment:

- Effects of categorization and star rating
- Effects of self-rating
- Effects of knowledge

We begin by summarizing the data, and then examining how investments vary across rounds and across treatments. We use regressions with dummy variables to control for treatments.

26 The answers to the four experience questions are also highly correlated; a factor analysis reveals only one factor with an Eigenvalue greater than one.

In reporting results, we use the allocations in round 1 as a baseline, and then examine changes from those allocations. The first question is how to measure the effect. We can examine either dollar amounts or percentage amounts. Because subjects select an integer dollar amount, we focus on dollar amounts. Each $1 change reflects $1/$12 = 8.33% of the subject's $12 endowment each period.

We expect that subjects exhibiting more knowledge will perform better, in the sense of allocating more to investments with high Sharpe ratios and avoiding dominated assets. The primary question is whether categorization, which changes star ratings, will alter investment decisions.

5.1 DATA SUMMARY

The Experience Index is the scaled average response on questions 1-4 on the Knowledge Survey in the Appendix, where the response values for each question are 1 through 4 in the order of the answers. The Knowledge Score is the mean score for answering questions 5-13 in the Knowledge Survey. Seconds Spent in Decision Stages is total time spent selecting allocations for all four stages. It does not count time reading instructions or answering other questions. This variable was not recorded in the early stages of the experiment, so it is available only for: 18, 22, 22, 23, 33, 33, 33 and 33 observations in treatments 1 through 8, respectively. We also add medians to this row because, sometimes, this variable was highly skewed.

TABLE 5: SUMMARY INFORMATION BY TREATMENT

	Treatment:	1	2	3	4	5	6	7	8	Overall
	Categorized?	Yes	Yes	Yes	Yes	No	No	No	No	N/A
	Rating Rule Given?	No	Yes	No	Yes	No	Yes	No	Yes	N/A
	Stage II or III First?	II	II	III	III	II	II	III	III	N/A
	Obs.	34	34	33	33	33	33	33	33	266
	% Female	32%	35%	42%	42%	33%	44%	36%	44%	39%
	% Married	18%	3%	9%	6%	12%	6%	0%	9%	8%
	% Making Preliminary Bet	53%	50%	52%	39%	45%	45%	36%	42%	45%
Experience Index	Mean	0.34	0.30	0.27	0.29	0.36	0.31	0.32	0.31	0.31
	Std. Dev.	0.20	0.24	0.17	0.21	0.21	0.20	0.24	0.22	0.21
Knowledge Score	Mean	6.79	6.35	6.15	6.67	6.82	6.03	6.39	6.61	6.48
	Std. Dev.	1.84	1.52	1.91	1.49	1.40	2.17	2.05	1.48	1.75
Seconds Spent in Decision Stages*	Mean	581	447	427	608	373	478	399	517	470
	Median	373	354	431	502	342	380	350	437	384
	Std. Dev.	482	226	130	404	262	302	161	267	292
Total Payment	Mean.	$ 27.36	$ 28.56	$ 28.04	$ 28.22	$ 25.72	$ 29.99	$ 28.18	$ 30.78	$ 28.35
	Std. Dev.	$ 10.58	$ 10.70	$ 10.18	$ 9.36	$ 9.95	$ 9.81	$ 9.96	$ 10.12	$ 10.06

Table 5 summarizes the treatments, the number of subjects, and the gender composition in each treatment. Also reported is the Experience Index, Knowledge Score, how much time the subjects spend in the asset allocation portions of the experiment (on average, roughly two minutes per round), and their total payment. Either 33 or 34 subjects participated in each treatment. On average, 39% were women. The overall average total payoff was $28.35 with a standard deviation of $10.06, a high of $44.00 and a low of $8.50 (including the $5 show up fee).[27] There was no significant difference in average payoffs across treatments. Forty-five percent of the subjects bet on the initial gamble, consistent with the median subject exhibiting risk aversion.[28]

Table 6 presents summary statistics for the investment levels in the different assets, averaged across stages and treatments. Subjects primarily invest in A and B — investments that are efficient for risk-averse investors — with less investment in D, and substantially less in C, E, F, and cash. There is some investment in assets that would appeal to risk-seekers (D and E). The last row in Table 6 shows that investors on average do not naively diversify — investment levels differ significantly from 1/7 for each asset (albeit weakly different for D).

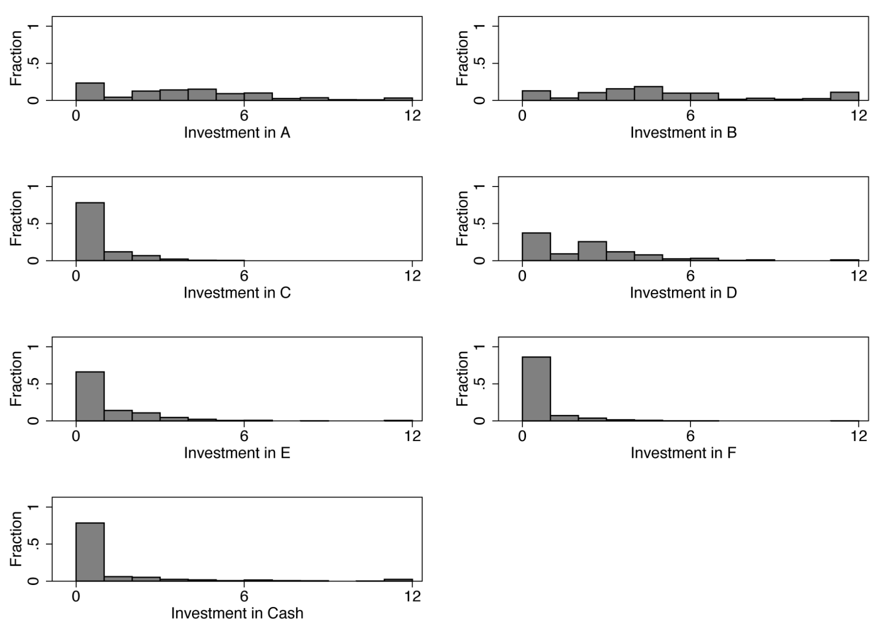
TABLE 6: AVERAGE INVESTMENT LEVELS IN ALL ALTERNATIVES

	A	B	C	D	E	F	Cash
Mean Investment	$ 3.41	$ 4.57	$ 0.36	$ 1.82	$ 0.75	$ 0.26	$ 0.83
Standard Deviation	$ 2.88	$ 3.46	$ 0.81	$ 2.05	$ 1.47	$ 0.83	$ 2.26
t-test vs Naïve Diversification	19.12***	26.94***	-54.08***	1.69*	-21.48***	-57.35***	-12.77***

T-tests are versus a naive null of 1/7 of the total available cash in each asset.
"*," "**" and "***" designate significant at the 90%, 95% and 99% level of confidence.

Figure 2 presents histograms for the 7 investments (including cash), with every trial and treatment recorded as a separate observation. It is apparent that most investment is in assets A, B, and D, although several investors invest heavily in cash, which is a dominated asset.

FIGURE 2: AVERAGE DOLLAR INVESTMENTS ACROSS ALL TRIALS IN INVESTMENTS A THROUGH F, PLUS CASH

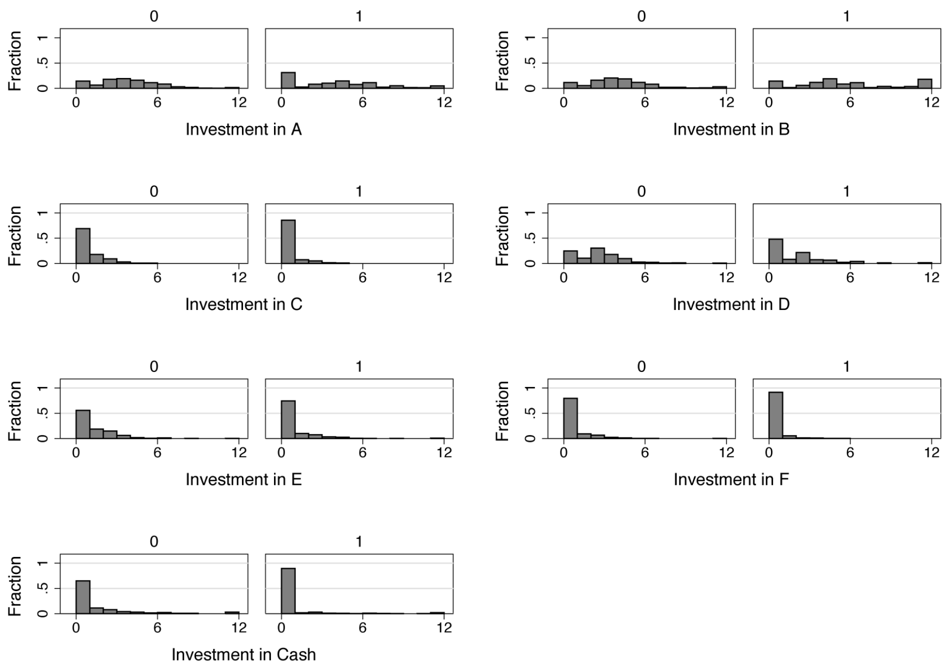


27 The maximum possible payment was $46.00, earned if a participant invested $1 in the initial bet, invested $12 in Alternative E and the high payoff state occurred for both. The payoff would then be $5+$1x(1+1)+$12x(1+2.25)=$46.

28 Researchers often find experimental subjects to be risk averse. See Harrison and Cox [2008]. Others, e.g. Berg et al. [2010], observe risk seeking.

Figure 3 repeats the plots of Figure 2 but broken down by the knowledge score of participants. Observations from participants with below-mean knowledge scores are on the left of each panel. It is clear from Figure 3 that knowledge score is related to investment behavior. Knowledgeable investors are less likely to invest in C, D, E, F, and cash. Knowledgeable investors are also more likely to invest in B, and more likely to invest heavily in B.

FIGURE 3: AVERAGE DOLLAR INVESTMENTS ACROSS ALL TRIALS IN INVESTMENTS A THROUGH F, PLUS CASH. IN THE PANELS WITH A SUBTITLE OF "0", THE INVESTOR HAS A BELOW-MEAN KNOWLEDGE SCORE



We now consider the extent to which knowledgable investors hold more concentrated portfolios. Let s_i be the fraction of the portfolio invested in asset i. The normalized Herfindahl index is defined as $H = \frac{\hat{H}-1/N}{1-1/N}$ where $\hat{H} = \sum_{i\in\{A,B,C,D,E,F,\text{Cash}\}} s_i^2$ is the Herfindahl index. An index of $H = 1$ (the maximum) means that the subject has invested entirely in one asset. An index of $H = 0.4167$ means that the subject has invested equally in two assets; this is the lowest index we should observe for an efficient portfolio. The minimum index observed in the sample is 0.0278, attained when the subject invests \$2 in each of 6 assets.[29]

We transform the normalized Herfindahl index to make it easier to interpret. The "diversification index" is

$$m = \frac{n}{(n-1)H+1}. \qquad (2)$$

The value m is monotonically decreasing in H, and has the convenient interpretation that if a subject invests an equal amount in each of p assets, equation (2) will give $m = p$.[30]

The evidence to this point is consistent with more knowledgeable investors holding more concentrated portfolios. This is verified in Figure 4, which shows the diversification index by stage, separately for low and high-knowledge score

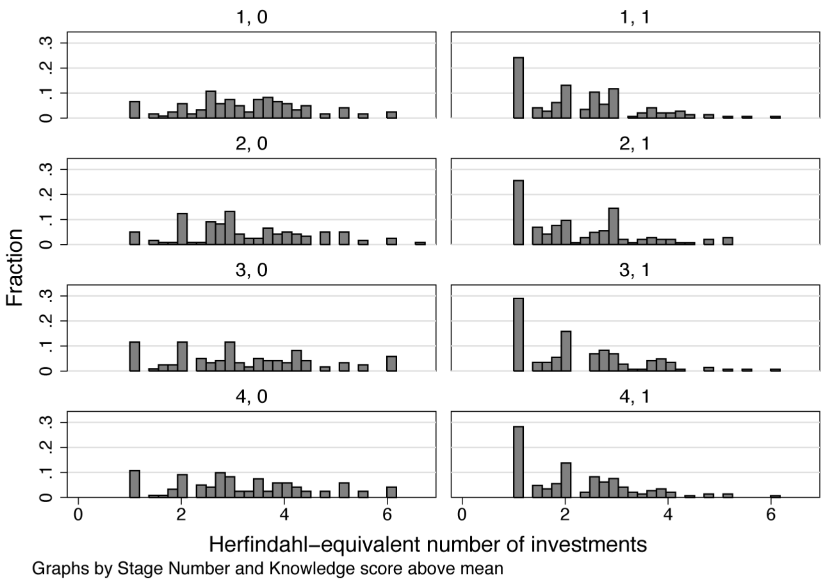
29 We restrict investment levels to be integer dollar amounts, so with 7 investments, the normalized Herfindahl ranges from 0.0115 (where the subject invests \$1 in each of 2 investments and \$2 in each of the other five) to 1 (where the subject invests all in one investment). As a benchmark, if the subject splits the \$12 equally across two investments, we have H=0.4167. Theoretically optimal concentrations thus range from 0.4167 to 1. Unsurprisingly, no subject included cash in an even allocation.

30 With an equal investment in assets, the normalized Herfindahl index is $H_p = \frac{n\sum_{i=1}^{p}\frac{1}{p^2}-1}{n-1} = \frac{n/p-1}{n-1}$

The diversification index is then $\frac{n}{(n-1)H_p+1} = p.$

investors. For all stages, the diversification index averages about 2.24 for high knowledge subjects and 3.17 for low knowledge subjects; this is consistent across stages. Almost 1/3 of the high-knowledge investors invest in only one asset at each stage compared to 10% of the low knowledge investors. Approximately one-half of the high-knowledge investors have a diversification index of 2 or less for each stage. Perhaps more importantly, high-knowledge investors are less likely to engage in naive diversification strategies. It is clear from the histograms that fewer high knowledge investors have a diversification index greater than 4.

FIGURE 4: DIVERSIFICATION INDEX BY STAGE



The panels on the left show the distribution of the diversification index for subjects with a below-mean knowledge score, while those on the right are for subjects with a mean or above knowledge score.

5.2 UNIVARIATE ANALYSIS

Table 7 examines in more detail how investments vary by stage, categorization, and whether the investment ratings are given to the subject or assigned by the subject. Wilcoxon rank-sum tests are used to measure the significance of the shifts in the distributions of allocations across categorization treatments.

TABLE 7: AVERAGE ALLOCATIONS TO INVESTMENTS BY STAGE AND CATEGORIZATION TREATMENT

Panel A: Stage I (Unranked)							
	A	B	C	D	E	F	Cash
Uncategorized	$ 3.00	$ 4.74	$ 0.39	$ 1.95	$ 1.02	$ 0.29	$ 0.61
Categorized	$ 3.25	$ 4.83	$ 0.37	$ 1.75	$ 0.87	$ 0.16	$ 0.75
Difference:	$ (0.25)	$ (0.09)	$ 0.02	$ 0.19	$ 0.14	$ 0.12	$ (0.14)
Wilcoxon Test Stat.	-0.536	-0.381	0.309	0.324	1.577	1.674*	-0.428
Panel B: Stage II (Rankings Given)							
	A	B	C	D	E	F	Cash
Uncategorized	$ 3.22	$ 5.06	$ 0.48	$ 1.65	$ 0.59	$ 0.27	$ 0.72
Categorized	$ 3.67	$ 4.13	$ 0.30	$ 2.18	$ 0.78	$ 0.31	$ 0.63
Difference:	$ (0.45)	$ 0.93	$ 0.19	$ (0.53)	$ (0.19)	$ (0.03)	$ 0.09
Wilcoxon Test Stat.	-1.111	2.544**	2.373**	-2.158**	-0.632	0.630	0.138
Panel C: Stage III (Self-Ranked)							
	A	B	C	D	E	F	Cash
Uncategorized	$ 3.44	$ 4.49	$ 0.45	$ 1.62	$ 0.58	$ 0.21	$ 1.20
Categorized	$ 3.70	$ 3.84	$ 0.33	$ 1.91	$ 0.55	$ 0.27	$ 1.40
Difference:	$ (0.26)	$ 0.65	$ 0.13	$ (0.29)	$ 0.02	$ (0.06)	$ (0.19)
Wilcoxon Test Stat.	-0.426	1.848*	2.184**	-1.211	0.930	0.468	0.447
Panel D: Stage IV (Unranked)							
	A	B	C	D	E	F	Cash
Uncategorized	$ 3.32	$ 5.09	$ 0.38	$ 1.62	$ 0.67	$ 0.30	$ 0.62
Categorized	$ 3.63	$ 4.40	$ 0.21	$ 1.87	$ 0.91	$ 0.27	$ 0.71
Difference:	$ (0.31)	$ 0.69	$ 0.17	$ (0.25)	$ (0.24)	$ 0.03	$ (0.09)
Wilcoxon Test Stat.	-0.456	1.880*	2.081**	-0.962	-0.510	0.780	0.775

Wilcoxon statistics are for differences in the distributions across the categorization treatments according to rank-sum tests (Mann-Whitney two-sample statistics). ** and * designate significance at the 95% and 90% level of confidence, respectively.

Recall that categorization is a simple assignment of the investments into two groups. Categorization alone may have an effect if it changes the decision frames of subjects. For example, it may affect allocations if subjects (1) evaluate allocations across categories first and then (2) decide on investments within categories. Categories enable this process. However, we do not have strong priors on how this will affect allocations to specific investments. The only significant difference in Stage I is for Alternative F, where investment is higher in uncategorized data ($0.29 on average) than categorized ($0.16).

What is the effect of categorization on investment levels? Categorization lowers the star rank of investments B and C and raises the rank of D and E (Table 3). Table 7 shows that, when ratings are given to subjects, the effects for B, C, D and E are all in the predicted direction and are significant for B, C and D. With categorization, investment in B declines by $0.93 (18%), investment in C declines by $0.19 (38%) and investment in D increases by $0.53 (32%), in accordance with the change in star ratings. In Stage III, the effects remain large in relative terms and statistically significant for B and C.

Table 8 shows how subjects reallocate funds across stages. It differs from Table 7 in measuring the significance of changes in investment across stages. Subjects are given ratings in Stage II and asked to rank investments in Stage III. Thus, Stage II and Stage III changes assess effects associated with ratings. The change in Stage IV is a control, providing a measure of the cumulative treatment effects across all stages.

TABLE 8: STAGE I ALLOCATIONS TO INVESTMENTS AND DEVIATIONS FROM STAGE I TO OTHER STAGES

Panel A: Average Allocation in Stage 1								
Stage 1		**A**	**B**	**C**	**D**	**E**	**F**	**Cash**
Avg. Allocation		$ 3.13	$ 4.79	$ 0.38	$ 1.85	$ 0.94	$ 0.23	$ 0.68
Std. Dev.		$ 2.65	$ 3.33	$ 0.79	$ 2.16	$ 1.75	$ 0.66	$ 1.81
Panel B: Overall Changes from Stage 1								
Change from Stage 1 to:		**A**	**B**	**C**	**D**	**E**	**F**	**Cash**
Stage 2	Avg. Change	$ 0.32	$ (0.19)	$ 0.01	$ 0.07	$ (0.26)	$ 0.06	$ (0.01)
	Wilcoxon Stat.	1.07	-1.34	-0.26	1.12	-2.12**	0.71	-0.03
Stage 3	Avg. Change	$ 0.44	$ (0.62)	$ 0.01	$ (0.08)	$ (0.38)	$ 0.02	$ 0.62
	Wilcoxon Stat.	2.25**	-3.36***	-0.52	-0.82	-3.48***	-0.14	2.18**
Stage 4	Avg. Change	$ 0.35	$ (0.04)	$ (0.09)	$ (0.10)	$ (0.15)	$ 0.06	$ (0.02)
	Wilcoxon Stat.	1.30	-0.43	-1.53	-0.04	-1.29	0.47	-0.14
Panel C: Changes from Stage 1 in Categorized Treatments								
Change from Stage 1 to:		**A**	**B**	**C**	**D**	**E**	**F**	**Cash**
Stage 2	Avg. Change	$ 0.42	$ (0.69)	$ (0.07)	$ 0.43	$ (0.09)	$ 0.14	$ (0.13)
	Wilcoxon Stat.	0.90	-2.97***	-1.98**	2.67***	0.42	1.19	-0.34
Stage 3	Avg. Change	$ 0.45	$ (0.99)	$ (0.04)	$ 0.16	$ (0.32)	$ 0.10	$ 0.64
	Wilcoxon Stat.	1.63	-3.45***	-1.88*	0.96	-2.28**	0.97	0.61
Stage 4	Avg. Change	$ 0.37	$ (0.43)	$ (0.16)	$ 0.12	$ 0.04	$ 0.10	$ (0.04)
	Wilcoxon Stat.	0.80	-1.62	-2.45**	1.05	0.46	1.07	-1.22
Panel D: Changes from Stage in in Uncategorized Treatments								
Change from Stage 1 to:		**A**	**B**	**C**	**D**	**E**	**F**	**Cash**
Stage 2	Avg. Change	$ 0.22	$ 0.32	$ 0.09	$ (0.30)	$ (0.42)	$ (0.02)	$ 0.11
	Wilcoxon Stat.	0.61	1.37	1.61	-1.25	-3.52***	-0.23	0.30
Stage 3	Avg. Change	$ 0.44	$ (0.25)	$ 0.06	$ (0.33)	$ (0.44)	$ (0.08)	$ 0.59
	Wilcoxon Stat.	1.57	-1.11	0.97	-2.38**	-2.65***	-1.10	2.53**
Stage 4	Avg. Change	$ 0.32	$ 0.35	$ (0.02)	$ (0.33)	$ (0.35)	$ 0.02	$ 0.01
	Wilcoxon Stat.	1.11	1.20	0.30	-1.22	-2.24**	-0.47	0.98

Wilcoxon statistics are for differences in the distributions across the stages according to rank-sum tests (Mann-Whitney two-sample statistics).
***, ** and * designate significance at the 99%, 95% and 90% levels of confidence, respectively.

In Stage II, subjects are given rankings. Overall, this resulted in a significant decrease in investment in E. This drop is driven by the uncategorized data, where E is ranked 1 star. In the categorized data, there were significant decreases in B (2 star) and C (1 star) and an increase in D (3 star).

In Stage III, subjects are asked to rank the alternatives themselves. This led to significant reductions in B and E overall and an increase in cash held. The reductions in B and E are driven by categorized data where there is also a significant reduction in C. In the uncategorized data, self rankings led to a significant drop in D and E and an increase in cash held.

Overall, no significant effects remain in Stage 4. In the categorized data, there remains a significant drop in C and, in the uncategorized data, a significant drop in E. We note that, in the respective data sets, both are ranked 1 star investments. Thus, by and large, the effects we observe are temporary. Other than the residual effects of low ranked assets in subsets of data, all significant effects disappear when the rankings are removed.

As a final univariate exercise, we can examine the effect of star ratings on the expected returns and Sharpe ratios of our subjects' portfolios. As a measure of this effect, we compare the change in expected portfolio returns, risks and Sharpe ratios between Stage I and Stage II with and without categorization. Expected returns do not differ significantly between Stage I and II whether the data is categorized or not. However, there is a significant reduction in risk in the uncategorized data which leads to a significant increase in the Sharpe Ratio (from an average of 1.04 in Stage I to 1.09 in Stage II, Wilcoxon signed rank statistic=3.45, p-value=0.0006).[31] There is no significant difference in the categorized data.

Comparing Stage I to Stage III, we can see the effects of self-ranking. Expected returns fall significantly in both categorized and uncategorized data, but so do risks. In both cases, subjects shift to lower return, but lower risk portfolios. The net effect on the Sharpe ratio is significantly positive in the categorized data (from an average of 1.05 in Stage I to 1.11 in Stage III, Wilcoxon signed rank statistic = 3.466, p-value=0.0005).[32] Again, the net effect is not significant in the categorized data.

Thus, categorization creates a differential impact of ratings. Sharpe ratios only increase when the ratings reflect the overall risk return tradeoffs of the investments (uncategorized treatments).

5.3 REGRESSION ANALYSIS

We now use multivariate regression to parse more carefully the effects of treatments and to examine the role of subject characteristics. We have already seen that prior knowledge may matter and self-rating can mitigate the effects. Here, we study the effects of categorization, star ratings, prior knowledge, gender and other treatment variables on asset allocation.

Table 9 presents regressions of the investment levels in each alternative. Here, we include the main treatment variables: rankings and the changes in rankings across categorization treatments. In Appendix I, we conduct further analysis of our control variables: the ordering of Stages II and III and whether the ranking rule is explicitly given to subjects. Censoring accounts for the fact that investment levels can only range from $0 (no short selling) to $12 (no buying on margin). To account for repeated observations by subject, we use robust standard errors clustered by subject. Category and stage variables are dummy variables. The variables labelled "rank" are the number of stars given an investment minus 2. (This normalizes the rank so that 0 is the median ranking across alternatives.)

31 Recall that the Sharpe ratio is twice the Return/Risk ratio in Table 1. To understand the economic magnitude of these changes, $1 reallocated from asset A to cash reduces the portfolio Sharpe ratio by 2x0.8/12=0.133. Reallocating $1 from B to C (which is dominated) reduces the Sharpe ratio by 2x(0.5822-0.3333)/12=0.0425..

32 The average in Stage I differs slightly because several subjects who had well defined Sharpe ratios in Stages I and II held no risk in Stage III and, as a result, have undefined Sharpe ratios in Stage III and are not included in tests comparing Stage I to Stage III.

Table 10 presents similar regressions on portfolio level allocation characteristics: the amounts not allocated and, therefore, left in cash; the allocations to dominated assets (C, F and Cash), risk return efficiency of portfolios measured by the Sharpe ratio, and the diversification index. Larger numbers of this indicate more diversification (i.e., the subjects distribute investment across more alternatives). Here, the dependent variables do not have individual rankings associated with them, so we use combinations of stage and categorization variables as explanatory variables. Again, the appendix contains a discussion of order and ranking rule variables.

TABLE 9: REGRESSION RESULTS ON INVESTMENT LEVELS

Knowledge Score is the number correct on the Knowledge Survey (given in the appendix) minus the mean score. Rankings are -1 for alternatives ranked 1-star, 0 for alternatives ranked 2-stars and 1 for alternatives ranked 3 stars. Dummy variables account for gender, whether the subject made the initial bet and stage. For investment levels, observations are left censored at $0 and right censored at $12. Robust standard errors clustered by subject appear in parentheses.

TABLE 9

	Alternative					
	A	B	C	D	E	F
Constant	2.594***	5.428***	-2.114***	1.031***	-1.498***	-4.664***
	(0.302)	(0.339)	(0.331)	(0.264)	(0.433)	(0.731)
Knowledge	-0.413**	1.000***	-0.475***	-0.383**	-0.655***	-0.634**
Score	(0.182)	(0.239)	(0.160)	(0.174)	(0.180)	(0.305)
Gender	0.444	-0.413	0.683**	-0.092	0.256	0.739
	(0.391)	(0.422)	(0.331)	(0.305)	(0.385)	(0.541)
Gender x	0.247	-0.175	-0.006	0.080	-0.053	-0.101
Knowledge Score	(0.226)	(0.247)	(0.180)	(0.162)	(0.217)	(0.286)
Initial Bet	-0.131	-1.275***	0.305	0.422	1.203***	1.204**
Amount	(0.405)	(0.440)	(0.349)	(0.329)	(0.464)	(0.542)
Initial Bet x	0.421*	-0.640**	0.259	0.288	0.437*	0.525*
Knowledge Score	(0.240)	(0.264)	(0.182)	(0.184)	(0.240)	(0.284)
Stage 2	0.456**	-0.833**	0.384	-0.307	-0.439	0.192
	(0.208)	(0.368)	(0.250)	(0.266)	(0.351)	(0.297)
Stage 2 x	0.083	-0.042	0.009	0.021	0.280	-0.146
Knowledge Score	(0.124)	(0.234)	(0.126)	0.140	0.180	0.161
Stage 2 Rank	N/A	1.129**	1.229***	0.644*	0.426	N/A
		(0.535)	(0.441)	(0.385)	(0.494)	
Stage 2 Rank x	N/A	-0.013	0.321	-0.379*	0.257	N/A
Knowledge Score		(0.306)	(0.250)	(0.218)	(0.260)	
Stage 3	-0.582*	-1.691***	0.551**	-0.204	-0.837***	1.020**
	(0.354)	(0.381)	(0.244)	(0.233)	(0.321)	(0.518)
Stage 3 x	0.061	-0.214	0.292**	-0.003	0.296*	0.258
Knowledge Score	(0.177)	(0.195)	(0.145)	(0.149)	(0.164)	(0.243)

Stage 3 Rank	1.759***	1.247***	1.567***	0.091	0.497	1.316**
	(0.376)	(0.473)	(0.328)	(0.323)	(0.437)	(0.518)
Stage 3 Rank x	0.033	0.491**	0.167	0.002	-0.071	0.025
Knowledge Score	(0.190)	(0.244)	(0.162)	(0.212)	(0.253)	(0.200)
Stage 4	0.435*	-0.585	0.037	-0.308	-0.401	0.072
	(0.248)	(0.395)	(0.278)	(0.276)	(0.362)	(0.311)
Stage 4 x	0.080	0.083	0.208	0.046	-0.068	-0.267
Knowledge Score	(0.139)	(0.252)	(0.146)	(0.164)	(0.200)	(0.195)
Stage 4 Rank	N/A	0.903*	1.091**	0.244	0.369	N/A
		(0.547)	(0.446)	(0.396)	(0.504)	
Stage 4 Rank x	N/A	0.070	0.351	0.010	0.029	N/A
Knowledge Score		(0.310)	(0.228)	(0.216)	(0.278)	
Obs.	1052	1052	1052	1052	1052	1052
Uncensored Obs./Estimate	55.1	44.4	12.9	36.0	19.4	10.4
% Censor left	23.5%	12.8%	77.9%	37.5%	66.3%	86.1%
% No censor	73.3%	76.0%	22.1%	61.6%	33.2%	13.8%
% Censor right	3.2%	11.1%	0.0%	1.0%	0.6%	0.1%
Clusters	263	263	263	263	263	263

***, ** and * designate significance at the 99%, 95% and 90% levels of confidence, respectively.

TABLE 10: REGRESSION RESULTS ON PORTFOLIO CHARACTERISTICS

Knowledge Score is the number correct on the Knowledge Survey (given in the appendix) minus the mean score. Dummy variables account for gender, categorization and stages. The first two regressions are censored, the last two are estimated via OLS. Robust standard errors clustered by subject appear in parentheses.

	Investment in		Sharpe	Diversification
	Cash	C, F & Cash	Ratio	Index
Constant	-8.032***	-2.466***	1.068***	2.682***
	(1.454)	(0.654)	(0.021)	(0.115)
Knowledge Score	-1.535***	-1.121***	0.033***	-0.324***
	(0.563)	(0.327)	(0.012)	(0.063)
Gender (1=Female)	1.763	1.509**	0.000	0.290**
	(1.169)	(0.702)	(0.024)	(0.139)
Gender x	0.844	0.267	0.015	0.058
Knowledge Score	(0.567)	(0.360)	(0.016)	(0.078)
Amount bet in	1.161	1.150*	-0.066***	0.171
Preliminary Stage	(1.074)	(0.643)	(0.024)	(0.136)

Initial Bet x	0.080	0.339	-0.008	0.104
Knowledge Score	(0.561)	(0.335)	(0.015)	(0.075)
Categories	0.130	-0.486	0.047*	-0.232*
	(1.313)	(0.717)	(0.025)	(0.140)
Categories x	-0.345	-0.233	-0.009	0.055
Knowledge Score	(0.691)	(0.416)	(0.016)	(0.080)
Stage 2	0.376	0.342	0.049***	-0.100
	(0.861)	(0.369)	(0.016)	(0.073)
Stage 2 x	0.110	0.115	-0.014*	-0.037
Knowledge Score	(0.447)	(0.196)	(0.008)	(0.041)
Stage 2 x Categories	-0.265	-0.600	-0.054**	0.132
	(1.168)	(0.552)	(0.023)	(0.104)
Stage 2 x Categories	0.522	0.013	0.028**	0.032
x Knowledge Score	(0.642)	(0.335)	(0.013)	(0.057)
Stage 3	1.898**	1.181**	0.065***	-0.050
	(0.896)	(0.504)	(0.019)	(0.093)
Stage 3 x	-1.011	-0.369	-0.022**	0.075
Knowledge Score	(0.649)	(0.319)	(0.011)	(0.075)
Stage 3 x Categories	-0.169	-0.243	-0.042	-0.073
	(1.418)	(0.815)	(0.027)	(0.126)
Stage 3 x Categories	0.461	-0.013	0.021	-0.041
x Knowledge Score	(0.904)	(0.514)	(0.017)	(0.090)
Stage 4	0.339	0.017	0.058***	-0.124
	(0.870)	(0.441)	(0.018)	(0.092)
Stage 4 x	-0.676	-0.358	-0.001	-0.010
Knowledge Score	(0.492)	(0.257)	(0.011)	(0.057)
Stage 4 x Categories	-0.565	-0.591	-0.047*	0.031
	(1.154)	(0.629)	(0.025)	(0.129)
Stage 4 x Categories	0.722	0.117	0.008	-0.013
x Knowledge Score	(0.724)	(0.424)	(0.016)	(0.075)
Obs.	1052	1052	1026	1052
Uncensored Obs./Estimate	10.1	10.1	51.3	52.6
% Censor left	78.3%	59.5%	N/A	N/A
% No censor	19.2%	37.7%	N/A	N/A
% Censor right	2.5%	2.8%	N/A	N/A
Clusters	263	263	262	263

***, ** and * designate significance at the 99%, 95% and 90% levels of confidence, respectively.

The constants in Tables 9 and 10 represent averages for male investors with average knowledge in Stage I. They confirm that, in general, subjects invest significant amounts in A and B, and to a lesser extent in D. They would like to short the three dominated investments C, F, and cash as well as investment E, but are prevented from doing so by the design of the experiment.

Financial knowledge has statistically and economically significant effects. In Table 9, higher measured knowledge increases investment in B and reduces investment in each other asset. Answering one additional question correct on the test of financial knowledge raises investment in B by more than $1.00 (>18% relative to the average subject) and reduces investment in other assets by 14% to 23%.[33] Table 10 shows that higher knowledge reduces investment in Cash and overall in dominated assets (C, F and Cash) while increasing the Sharpe Ratio and increasing concentration of portfolios.

There are also gender effects in Tables 9 and 10. Women invest significantly more in the dominated asset C and more in dominated assets overall. In total, women invest an average of $1.50 more in dominated assets. Gender is also associated with more diversification.[34] All of these effects are consistent with women engaging in more diversification. Prior research suggests that women may diversify more than men (Sunden and Surette [1998]) in a context where diversification is beneficial. Here, diversification across all assets is sub-optimal, so a naive diversification strategy harms performance.

Subjects who are less risk averse (more risk seeking) according to the amount bet in the initial alternative invest significantly less in B, more in high risk investments E (undominated) and F (dominated) and more in dominated investments overall. These effects are even larger for higher knowledge risk seeking subjects. Thus, risk seeking subjects invest more into high risk investments as expected, but also harm themselves by moving into dominated investments.

Finally, Tables 9 and 10 clearly demonstrate the effects of ratings and differences in ratings driven by categorization. First, consider Stage II. There the Sharpe-Ratio-based ratings are given to subjects. Categorization results in higher ratings for D and E and lower ratings for B and C. Investment in high Sharpe Ratio assets falls when categorization lowers their star rankings. Moving to Stage II, increases investment in A overall (the low risk investment that is always ranked 3 stars). It reduces investment in B when B is ranked 2-stars (categorized data). However, investment in B is significantly higher when B is ranked 3-stars (uncategorized data) than 2-stars (categorized). Similarly, investment in C is higher when it is ranked 2-stars (uncategorized) instead of 1-star (categorized). Investment in D is also affected, with higher investment when it is ranked 3-stars (categorized) than when it is ranked 2-stars (uncategorized). However this effect is mitigated for high knowledge investors.[35]

For Stage II, Table 10 shows that rankings improve Sharpe ratios when they are consistent with Sharpe ratios (uncategorized data), but this effect is reversed when there are inconsistencies (categorized data).

For Stage III analysis, we use the subjects' own self-declared rankings for alternatives. Table 9 shows that, overall, investment in A, B and F fall (though the number of uncensored observations in F is small in any case). Subjects who ranked A, B, C and F higher invested significantly more in these alternatives. Thus, stated preferences (through rankings) and revealed preferences (through investment levels) accord with each other. As in Stage II, investment in B falls significantly overall, but this effect is offset when it is ranked higher. This is consistent with subjects liking B, but in some treatments, being forced to rank it lower and responding to these rankings. Investment in C also increases when it is ranked higher, but has a baseline increase as well. This is consistent with subjects not liking C, but in some treatments, being forced to rank it higher and responding to these rankings. Here, there are significant effects resulting from whether the ranking rule is given. These effects (discussed in Appendix I) are generally consistent with subjects investing more

33 Recall that these are censored normal regressions, thus, the individual coefficients on dominated assets do not necessarily add up to the coefficient on the sum of dominated assets.

34 he average male investor in Stage 1 (uncategorized) has a diversification index of 2.7 (the constant). The average female investor's diversification index is 3.0.

35 Analysis in Appendix I shows no significant differences between treatments when subjects are given the ranking rule and when they are not. There are also no significant order effects for alternatives where there are enough uncensored observations for reasonable estimation of the parameters.

consistently with their freely stated rankings than with rankings where they use a set rule. Finally, there is one significant order effect in B: subjects respond more strongly to their own rankings in Stage II when Stage III follows Stage II.

For Stage III, Table 10 shows that self-rankings actually increase investment in Cash and dominated assets. This effect is driven mostly by subjects who are not given the ranking rule and subjects who go through Stage III before going through Stage II. In contrast, Sharpe ratios increase overall, driven primarily by subjects who go through Stage II first and by subjects who are given the ranking rule.

In Stage IV, there are no rankings given, but subjects have seen rankings in Stage II and had to rank alternatives in Stage III. We use the rankings given in Stage II to characterize alternatives. The baseline effects all go away except for a marginal increase in investment in A. There remains a marginally significant ranking effect for B and a significant ranking effect for C. All other effects for individual investments are insignificant. However, there is a significant residual effect of improved Sharpe ratios in Stage IV. This occurs only in uncategorized data (there is an offsetting significant reduction in Sharpe ratios for categorized data). Interestingly, it is driven by data where the ranking rule is not given and where subjects go through Stage II first.

5.4 PERFORMANCE AND INVESTOR ATTRIBUTES

Subjects differ on a number of dimensions. We have discussed the role of knowledge score; we now explore investor characteristics as determinants of portfolio characteristics: portfolio efficiency, portfolio diversification, and response to star ratings.

Tables 11 and 12 illustrate how portfolio characteristics are related to subject characteristics or treatment variables. We divide the subject sample into quintiles according to several measures of portfolio efficiency and whether subjects are prone to reallocation across stages:

1. average (across stages) expected return
2. average standard deviation
3. average Sharpe Ratios
4. average portfolio concentration levels
5. the average amounts invested in dominated assets (C, F, and Cash)
6. the average reallocation rate between across all combinations of two stages.

These measures are reported in the columns. The rows in Table 11 can be broadly characterized as subject characteristics (gender, marital status, etc.). The rows in Table 12 are treatment variables in the experiment (categorization, order of stages, and whether the subject was given the rating rule).

The purpose of the tables is to see which characteristics (if any) distinguish subjects in the high and low quintiles across each portfolio efficiency measure. Both tables show the average characteristics of subjects overall, as well as the average

characteristics of subjects that fall into the high and low quintiles of various measures of portfolio performance. The table also shows differences in the means across the high and low quintiles and t-tests for significance of differences.

For example, the second row in Table 11 shows that 7.92% of the subjects are married ("overall mean"). Of those subjects with average expected return in the top quintile, 15.69% are married, nearly twice the group's proportionate representation. In the bottom quintile, 1.85% are married, less than a quarter of the married group's proportionate representation. The difference between the percentages in the quintiles is statistically different at the 95% level of confidence. With respect to portfolio concentration, the percentage in the top quintile is 21.15%, while that in the bottom is 7.27%. also differing statistically at the 95% level of confidence. We conclude from the second row in Table 11 that married subjects are overrepresented among those who hold high return, high concentration portfolios with low investment in dominated assets.

TABLE 11: AVERAGE CHARACTERISTICS OF SUBJECTS WITHIN QUANTILES OF VARIOUS MEASURES OF PORTFOLIO PERFORMANCE

Each test is based on the mean value of the subject characteristic in the left column by data sorted into the top and bottom quintiles according to the portfolio characteristic in the top row.

		Average Portfolio Expected Return	Average Portfolio Standard Deviation	Average Sharpe Ratio	Average Diversi-fication Index	Average Investment in Dominated Assets (C, F & Cash)	Average Reallocation Between Stages
Gender	Overall Mean	0.3864	0.3864	0.3864	0.3864	0.3864	0.3864
(1=Female)	Top Quintile	0.2115	0.4423	0.4255	0.5472	0.5333	0.3846
	Bottom Quintile	0.5185	0.4259	0.4792	0.2000	0.2636	0.2143
	Difference	-0.3070	0.0164	-0.0536	0.3472	0.2697	0.1703
	t-Statistic	-3.42***	0.17	-0.52	3.97***	3.30***	1.95*
Marital Status	Overall Mean	0.0792	0.0792	0.0792	0.0792	0.0792	0.0792
Dummy	Top Quintile	0.1569	0.0566	0.0833	0.0566	0.0000	0.0755
(1=Married)	Bottom Quintile	0.0185	0.0741	0.0204	0.2037	0.1364	0.1786
	Difference	0.1383	-0.0175	0.0629	-0.1471	-0.1364	-0.1031
	t-Statistic	2.59**	-0.36	1.40	-2.29**	-2.65***	-1.61
Amount Bet in	Overall Mean	0.4549	0.4549	0.4549	0.4549	0.4549	0.4549
Initial Bet	Top Quintile	0.2885	0.6038	0.3333	0.6038	0.6667	0.6604
	Bottom Quintile	0.6667	0.4630	0.6327	0.3818	0.3604	0.3333
	Difference	-0.3782	0.1408	-0.2993	0.2220	0.3063	0.3270
	t-Statistic	-4.17***	1.46	-3.06***	2.34**	3.61***	3.59***
Self-Reported	Overall Mean	0.3134	0.3134	0.3134	0.3134	0.3134	0.3134
Experience	Top Quintile	0.4038	0.2938	0.3482	0.2291	0.2444	0.2898
Index	Bottom Quintile	0.2315	0.3201	0.2332	0.4026	0.3784	0.4348
	Difference	0.1724	-0.0263	0.1150	-0.1735	-0.1339	-0.1451
	t-Statistic	4.60***	-0.65	3.00***	-4.45***	-3.76***	-3.62***
Knowledge	Overall Mean	6.4774	6.4774	6.4774	6.4774	6.4774	6.4774
Score	Top Quintile	7.7115	6.3774	7.1042	5.6792	5.4667	6.0189
	Bottom Quintile	5.4815	6.3889	5.7143	7.6000	7.3243	7.3860
	Difference	2.2301	-0.0356	1.3899	-1.9208	-1.8577	-1.3671
	t-Statistic	7.89***	-0.13	4.21***	-6.82***	-6.86***	-4.03***

***, ** and * denote significance at the 99%, 95% and 90% levels of confidence, respectively.

TABLE 12: AVERAGE TREATMENT VARIABLES FOR SUBJECTS WITHIN QUANTILES OF VARIOUS MEASURES OF PORTFOLIO PERFORMANCE

Each test is based on the mean value of the treatment variable in the left column by data sorted into the top and bottom quintiles according to the portfolio characteristic in the top row.

		Average Portfolio Expected Return	Average Portfolio Standard Deviation	Average Sharpe Ratio	Average Diversi-fication Index	Average Investment in Dominated Assets (C, F & Cash)	Average Reallocation Between Stages
Categorization	Overall Mean	0.5038	0.5038	0.5038	0.5038	0.5038	0.5038
Dummy	Top Quintile	0.4808	0.5283	0.4583	0.5283	0.5111	0.6038
(1=Categorized)	Bottom Quintile	0.5370	0.5370	0.5918	0.4545	0.5405	0.3860
	Difference	-0.0563	-0.0087	-0.1335	0.0738	-0.0294	0.2178
	t-Statistic	-0.57	-0.09	-1.31	0.76	-0.33	2.32**
Order	Overall Mean	0.4962	0.4962	0.4962	0.4962	0.4962	0.4962
Dummy	Top Quintile	0.4423	0.5849	0.5208	0.3396	0.5556	0.4528
(1=Stage III first)	Bottom Quintile	0.5741	0.5556	0.6327	0.5636	0.4505	0.4737
	Difference	-1.3556	0.0294	-0.1118	-0.2240	0.1051	-0.0209
	t-Statistic	-1.28	0.30	-1.11	-2.38**	1.19	-0.22
Ranking Rule	Overall Mean	0.5009	0.5009	0.5009	0.5009	0.5009	0.5009
Dummy	Top Quintile	0.5000	0.5283	0.5208	0.4340	0.3778	0.3962
(1=Rule Given)	Bottom Quintile	0.3889	0.4815	0.4490	0.5636	0.5315	0.5439
	Difference	0.1111	0.0468	0.0719	-0.1297	-0.1538	-0.1476
	t-Statistic	1.15	0.48	0.70	-1.35	-1.747*	-1.553*

***, ** and * denote significance at the 99%, 95% and 90% levels of confidence, respectively.

5.4.2 INVESTMENT EFFICIENCY

We consider a subject an efficient investor if his or her asset selections exhibit high expected returns (given low risks here), high Sharpe ratios, high concentration, and low investment in dominated assets. (We will look at susceptibility to the ranking effect through measured reallocation rates in the next section.) To determine which characteristics are associated with investment efficiency, we look for cases where the characteristic is disproportionately present in the top quintile of those portfolio characteristics.

Married subjects disproportionately adopt high return, concentrated portfolios and avoid dominated assets. In addition to marriage, subjects with self-reported experience and a high knowledge score also have more efficient portfolios. Such subjects are disproportionately represented among investors with high expected return, high Sharpe ratio, high concentration portfolios, and a low percentage of dominated assets.

Risk-seeking subjects, as measured by the amount bet in the initial allocation task, are overrepresented in low Sharpe ratio portfolios as would be expected. However, the Sharpe ratio effect is not driven by the risk these subjects hold, but that they invest in low return portfolios with high investments in dominated assets. These subjects also hold less concentrated portfolios.

Women are overrepresented in low concentration, low expected return portfolios, because of high levels of investment in dominated assets. While women account for 39% of the overall sample, they account for 52% and 53% of the subjects in the lowest quintile expected return and concentration portfolios respectively. More than half of the subjects who hold the highest quintile of portfolios in dominated assets are women as well. All of this is consistent with more diversification even though, in this case, diversification into dominated assets harms performance.

Table 12 shows controls for treatment variables including categorization, order (whether Stage II was presented before or after Stage III) and whether the rating rule was given to subjects. There are two significant differences between the high quintile and low quintile portfolios across the dimensions of portfolio efficiency given in Table 12. Half of the subjects received Stage III (self rankings) before State II (rankings given). Those who did tended to hold low concentration portfolios. Those who were told the ranking rule tended (weakly) to hold lower investments in dominated assets. Both effects reflect the tendency (also shown in the regressions) for subjects to hold more cash when they self ranked first without the guidance of a given ranking rule.

5.4.3 PORTFOLIO REALLOCATION RATES

We divide the sample into quintiles according to the average amount investors reallocate between each period. Reallocation is measured as the average percentage of the portfolio reallocated across every combination of two stages. Because each stage has the same investment alternatives, this measure serves as a proxy for susceptibility to the ratings effect.[36] Then, we ask what characteristics (if any) distinguish subjects in the high and low quintiles. The last column in Table 11 shows that high experience and high knowledge subjects are overrepresented in the low reallocation quintile (relative to the high reallocation quintile).[37] While women and risk seeking subjects are overrepresented in the high reallocation quintile. This suggests that knowledge and experience can reduce susceptibility to the bias.

Interestingly, subjects in the categorized treatments tend to do more reallocation than those in the uncategorized treatments. This reflects the reallocation of subjects from B and E to A in the categorized treatments shown in Table 9. Finally, knowing the ranking rule tends to reduce reallocations between stages.

6. CONCLUSION

To assess the effects of ratings, we create an experiment in which subjects at all times have full information about the characteristics of investments, some of which are dominated. Ratings should be irrelevant in this setting. However, we find that ratings do affect subject behavior. Specifically:

- We document mean shifts in asset allocations as a result of Star ratings. These shifts appear due to both levels of ratings and changes in ratings due to categorization.
- The shifts appear to be mostly temporary. In repeated observations of allocations across the same investments by the same investors, investments shift when ratings appear. These shifts largely disappear when ratings do.
- In our environment, diversification is not beneficial. Investors most frequently concentrate their portfolios and avoid d ominated assets. In particular, most do not follow a naive “1/N” diversification strategy.
- There is heterogeneity: Some subjects pick “better” portfolios (according to objective measures of optimal choice) and are less affected by ratings. Women tend to diversify more; as a result, their portfolios tend to suffer by objective measures. More financially experienced and knowledgeable subjects tend to do better by these measures. (We also find that married subjects and those with children tend to hold better performing portfolios, but the sample size is small.)

36 We note that the other factor is the rearrangement of investment alternatives between stages. So, this may also indicate susceptibility to a “rearrangement effect.” However, the relatively small differences between Stage I and Stage 4 shown in the univariate and regression analyses above suggest the primary determinate of reallocation rates is the ratings effect.

37 The marital status dummy is nearly significant with a p-value of 0.1098.

- Greater financial knowledge is generally associated with more efficient portfolios. Low knowledge score subjects are most influenced by ratings, with the result that they are helped by ratings when they are based on the overall rankings of assets and hurt by the shifts induced by categorized rankings.

Of course our results have no direct bearing on the important question of whether specific real-world ratings are helpful or harmful. They do suggest that ratings can be influential and that there may be a complicated relationship between how ratings are implemented and whether they have net benefits.

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7. APPENDIX I: ADDITIONAL REGRESSION ANALYSIS

Here, we study the effects of experimental control treatments by analyzing samples split according to two controls: (1) whether the ranking rule was given to subjects and (2) the order of stages II and III. When we split the sample, the number of uncensored observations can become very small for some treatments which can lead to overfitting and unreliable estimates. The problem is bad enough that the estimation does not converge for investments in F by subjects who are given the ranking rule. There is considerable debate in the literature about minimum sample sizes to avoid overfitting of models (see, for example, Green [1991]). Perhaps the oldest and most common rule of thumb is to require 10 (uncensored) observations per estimated parameter. We do not take a stand on what the minimum should be. Instead, we list the number of uncensored observations per estimate, emphasize regressions where we are well above this limit and caution the reader in interpreting regressions where the uncensored sample size is small.

Table 9 shows how subjects change investment levels in alternatives in response to ratings and categorization effects on ratings overall. Table 13 runs similar regressions breaking the data set into two parts: subjects for whom the ranking rule was specified and subjects for whom it was not. Coefficients that differ across treatments at the 95% level of confidence are bolded and italicized. Subjects in both treatments invest heavily in A and B, to a lesser extent in D and would short the other investments. Risk seekers invest less in B and more in D and E. The latter effect is driven primarily by data when the ranking rule is given. There are no significant differences between treatments in Stage II, except for C, where the number of uncensored observations is very small. There are no significant differences in treatments in Stage IV. The majority of the significant differences are in Stage III and are consistent with subjects investing more in accordance with their own unrestricted rankings than when the ranking rule is given to them.

Table 14 shows regressions similar to Table 9 breaking the data set into two parts: subjects for whom Stage II was first and those for whom Stage II was first. With one exception, significant differences all arise when uncensored sample sizes are very small and, as a result, parameter estimates are likely to be unstable because of overfitting. The exception is for Investment B in Stage III: subjects appear to invest more heavily in B when they rank it more highly in Stage III when Stage III follows Stage II.

Tables 15 and 16 conduct regressions on split data that are similar to Table 10. There are what appear to be significant differences in investments in dominated assets depending on whether the ranking rule was given. However, the effects may be driven by small numbers of uncensored observations. The only other significant difference due to the ranking rule treatment is for diversification: subjects appear to be more diversified (which is suboptimal), when the ranking rule is given to subjects in Stage III. There do appear to be order effects on Sharpe Ratios and diversification. High knowledge, risk seeking subjects are more diversified when Stage III comes first than when Stage II comes first. This leads to higher Sharpe ratios for these investors. However, for both measures, there is a significant offsetting effect in categorized data. In Stage IV, subjects who saw Stage II first continue to have higher Sharpe ratios.

TABLE 13: REGRESSION RESULTS ON INVESTMENT LEVELS BY WHETHER THE RANKING RULE WAS GIVEN. SEE TABLE 9 FOR DETAILS ON VARIABLES

	Panel A: Ranking Rule Not Given Alternative						Panel B: Ranking Rule Given Alternative					
	A	B	C	D	E	F	A	B	C	D	E	F
Constant	2.679***	5.511***	-2.175***	0.911**	-0.796*	-4.688***	2.458***	5.416***	-2.014***	1.190***	-2.038***	No
	(0.432)	(0.480)	(0.477)	(0.392)	(0.460)	(0.961)	(0.425)	(0.475)	(0.443)	(0.358)	(0.688)	Conver
Knowledge	-0.411*	0.934***	-0.537***	-0.440*	-0.973***	-0.553*	-0.438	1.097***	-0.311	-0.309	0.285	-gence
Score	(0.24)	(0.345)	(0.199)	(0.257)	(0.237)	(0.294)	(0.276)	(0.325)	(0.232)	(0.250)	-(1.000)	
Gender	-0.341	0.122	0.693	0.377	0.032	0.413	1.031**	-0.861*	0.831*	-0.401	0.388	
	(0.583)	(0.722)	(0.489)	(0.514)	(0.557)	(0.782)	(0.505)	(0.499)	(0.430)	(0.365)	(0.529)	
Gender x	-0.171	0.109	0.032	0.263	0.226	-0.064	0.660**	-0.476	-0.185	-0.104	-0.254	
Knowledge Score	(0.351)	(0.405)	(0.266)	(0.255)	(0.283)	(0.365)	(0.326)	(0.310)	(0.232)	(0.224)	(0.372)	
Initial Bet	-0.028	-1.599**	-0.214	0.004	0.679	1.848**	-0.167	-0.959*	0.707	0.716*	1.784**	
Amount	(0.604)	(0.682)	(0.507)	(0.541)	(0.522)	(0.723)	(0.499)	(0.546)	(0.450)	(0.377)	(0.755)	
Initial Bet x	0.585	-0.772*	0.448*	0.248	0.321	0.641**	0.356	-0.529	-0.008	0.307	0.542	
Knowledge Score	(0.362)	(0.396)	(0.240)	(0.270)	(0.249)	(0.287)	(0.321)	(0.337)	(0.262)	(0.246)	(0.420)	
Stage 2	0.463	-0.796	0.863**	-0.372	-0.939*	0.067	0.449	-0.855*	-0.207	-0.236	-0.018	
	(0.302)	(0.546)	(0.345)	(0.415)	(0.485)	(0.439)	(0.288)	(0.495)	(0.351)	(0.333)	(0.505)	
Stage 2 x	0.089	0.061	0.094	-0.136	0.116	-0.202	0.074	-0.188	-0.050	0.185	0.589*	
Knowledge Score	(0.161)	(0.304)	(0.150)	(0.304)	(0.205)	(0.231)	(0.192)	(0.364)	(0.200)	(0.177)	(0.346)	
Stage 2 Rank	N/A	0.982	1.132*	0.899	0.157	N/A	N/A	1.237*	1.208**	0.407	0.595	
		(0.828)	(0.621)	(0.595)	(0.623)			(0.672)	(0.598)	(0.486)	(0.727)	
Stage 2 Rank x	N/A	-0.003	0.351	-0.231	-0.071	N/A	N/A	0.017	0.508	-0.543	0.821*	
Knowledge Score		(0.451)	(0.290)	(0.287)	(0.319)			(0.419)	(0.477)	(0.342)	(0.484)	
Stage 3	-1.276**	-2.454***	1.141***	-0.494	-0.876*	1.829***	0.456	-1.212***	-0.035	-0.021	-0.879**	
	(0.524)	(0.650)	(0.362)	(0.368)	(0.449)	(0.618)	(0.383)	(0.445)	(0.305)	(0.292)	(0.449)	
Stage 3 x	0.248	-0.470*	0.227	0.139	0.455**	0.130	-0.035	-0.016	0.305	-0.126	0.091	
Knowledge Score	(0.268)	(0.266)	(0.193)	(0.201)	(0.187)	(0.261)	(0.230)	(0.287)	(0.198)	(0.223)	(0.295)	
Stage 3 Rank	2.319***	1.888***	2.208***	0.623	1.522**	3.205***	0.876**	0.826	0.781*	-0.290	-0.371	
	(0.593)	(0.731)	(0.416)	(0.505)	(0.638)	(0.683)	(0.364)	(0.576)	(0.427)	(0.389)	(0.572)	
Stage 3 Rank x	-0.079	0.834***	0.018	0.003	-0.097	0.093	0.039	0.175	0.327*	-0.172	0.041	
Knowledge Score	(0.319)	(0.319)	(0.223)	(0.346)	(0.334)	(0.258)	(0.196)	(0.339)	(0.179)	(0.257)	(0.391)	
Stage 4	0.529	-0.468	0.033	0.040	-0.840	0.169	0.329	-0.680	-0.049	-0.656*	0.004	
	(0.376)	(0.579)	(0.448)	(0.429)	(0.510)	(0.454)	(0.324)	(0.535)	(0.334)	(0.355)	(0.521)	
Stage 4 x	0.196	0.333	0.319	0.001	-0.176	-0.492*	-0.078	-0.248	0.208	0.072	0.104	
Knowledge Score	(0.199)	(0.324)	(0.209)	(0.221)	(0.217)	(0.255)	(0.196)	(0.385)	(0.199)	(0.237)	(0.437)	
Stage 4 Rank	N/A	0.320	0.655	0.132	0.703	N/A	N/A	1.501**	1.282**	0.385	0.051	
		(0.816)	(0.677)	(0.594)	(0.684)			(0.718)	(0.560)	(0.512)	(0.692)	
Stage 4 Rank x	N/A	-0.402	0.615**	-0.113	-0.513	N/A	N/A	0.658	0.150	0.241	0.659	
Knowledge Score		(0.434)	(0.299)	(0.274)	(0.336)			(0.437)	(0.293)	(0.354)	(0.514)	
Obs.	532	532	532	532	532	532	520	520	520	520	520	520
Uncensored Obs./Estimate	26.8	21.6	6.3	17.4	9.5	5.6	28.3	24.2	6.9	19.6	10.5	5
% Censor left	25.8%	13.7%	78.6%	39.8%	67.5%	85.2%	21.2%	11.9%	77.3%	35.0%	65.0%	87.1%
% No censor	70.5%	73.1%	21.4%	59.0%	32.1%	14.7%	76.2%	79.0%	22.7%	64.2%	34.2%	12.9%
% Censor right	3.8%	13.2%	0.0%	1.1%	0.4%	0.2%	2.7%	9.0%	0.0%	0.8%	0.8%	0.0%
Clusters	133	133	133	133	133	133	130	130	130	130	130	130

***, ** and * designate significance at the 99%, 95% and 90% levels of confidence, respectively.Bold and italicized text indicate significant (95% level of confidence) differences in coefficients between panels.

TABLE 14: REGRESSION RESULTS ON INVESTMENT LEVELS BY ORDERING OF STAGES II AND III. SEE TABLE 9 FOR DETAILS ON VARIABLES

	Panel A: Stage 2 First Alternative						Panel B: Stage 3 First Alternative					
	A	B	C	D	E	F	A	B	C	D	E	F
Constant	2.351***	5.738***	-1.944***	**_0.527_**	-1.908**	-4.336***	2.814***	5.173***	-2.192***	**_1.445***_**	-1.069**	-4.780***
	(0.476)	(0.552)	(0.431)	**_(0.411)_**	(0.750)	(0.821)	(0.383)	(0.396)	(0.487)	**_(0.313)_**	(0.422)	(1.069)
Knowledge	-0.465	0.748*	-0.172	0.066	-0.647*	-0.526	-0.353	1.164***	-0.628**	-0.666***	-0.611***	-0.543
Score	(0.296)	(0.406)	(0.214)	(0.315)	(0.333)	(0.343)	(0.230)	(0.290)	(0.253)	(0.188)	(0.192)	(0.450)
Gender	-0.177	0.271	0.866*	0.499	0.413	1.081	0.844*	-0.807*	0.456	-0.613	0.185	0.308
	(0.586)	(0.705)	(0.466)	(0.462)	(0.647)	(0.739)	(0.501)	(0.484)	(0.453)	(0.417)	(0.437)	(0.715)
Gender x	-0.139	0.118	0.110	0.227	0.080	0.160	0.400	-0.244	-0.168	-0.030	-0.043	-0.410
Knowledge Score	(0.356)	(0.409)	(0.212)	(0.278)	(0.376)	(0.328)	(0.280)	(0.263)	(0.259)	(0.223)	(0.240)	(0.392)
Initial Bet	-0.398	-1.755**	0.157	0.668	1.661**	1.044	0.176	-0.960*	0.521	0.324	0.798*	1.557**
Amount	(0.620)	(0.704)	(0.464)	(0.459)	(0.788)	(0.755)	(0.501)	(0.509)	(0.484)	(0.481)	(0.447)	(0.730)
Initial Bet x	0.490	-0.344	**_-0.310_**	**_-0.201_**	0.382	0.071	0.419	-0.941***	**_0.775***_**	**_0.624**_**	0.390*	0.886**
Knowledge Score	(0.385)	(0.455)	**_(0.227)_**	**_(0.327)_**	(0.418)	(0.364)	(0.279)	(0.267)	**_(0.235)_**	**_(0.259)_**	(0.234)	(0.349)
Stage 2	0.668**	-0.353	0.169	-0.523	-0.776	-0.165	0.265	-1.272***	0.537	-0.121	-0.351	0.553
	(0.286)	(0.584)	(0.324)	(0.392)	(0.564)	(0.440)	(0.303)	(0.448)	(0.372)	(0.359)	(0.443)	(0.370)
Stage 2 x	-0.087	-0.172	-0.122	-0.055	**_0.810**_**	0.121	0.215	0.045	0.140	0.089	**_-0.131_**	-0.344*
Knowledge Score	(0.186)	(0.360)	(0.137)	0.223	**_0.369_**	0.239	(0.173)	(0.287)	(0.200)	0.186	**_0.202_**	0.208
Stage 2 Rank	N/A	0.855	1.175**	0.612	1.296	N/A	N/A	1.427**	1.211*	0.717	-0.193	N/A
		(0.888)	(0.579)	(0.600)	(0.867)			(0.599)	(0.622)	(0.487)	(0.541)	
Stage 2 Rank x	N/A	0.542	-0.006	-0.467	**_1.462***_**	N/A	N/A	-0.422	0.623	-0.277	**_-0.461*_**	N/A
Knowledge Score		(0.509)	(0.275)	(0.383)	**_(0.518)_**			(0.327)	(0.397)	(0.255)	**_(0.273)_**	
Stage 3	-0.729	-2.355***	0.344	-0.374	**_-1.861***_**	0.831**	-0.681	-1.219***	0.731**	-0.109	**_-0.094_**	1.218**
	(0.643)	(0.682)	(0.369)	(0.416)	**_(0.557)_**	(0.974)	(0.419)	(0.404)	(0.320)	(0.254)	**_(0.362)_**	(0.617)
Stage 3 x	0.167	-0.234	0.280	-0.072	0.527*	0.364	-0.026	-0.202	0.322	0.101	0.147	0.221
Knowledge Score	(0.303)	(0.400)	(0.210)	(0.280)	(0.306)	(0.466)	(0.209)	(0.175)	(0.210)	(0.142)	(0.174)	(0.289)
Stage 3 Rank	2.490***	**_2.407***_**	1.814***	0.390	0.154	2.010	1.326***	**_0.342_**	1.216***	-0.064	0.641	0.840
	(0.685)	**_(0.851)_**	(0.520)	(0.544)	(0.709)	(0.998)	(0.414)	**_(0.513)_**	(0.437)	(0.377)	(0.480)	(0.630)
Stage 3 Rank x	0.102	0.852	0.213	-0.197	0.377	0.438	-0.057	0.240	0.136	0.126	-0.259	-0.146
Knowledge Score	(0.339)	(0.520)	(0.252)	(0.341)	(0.444)	(0.410)	(0.213)	(0.234)	(0.209)	(0.226)	(0.261)	(0.243)
Stage 4	0.784**	-0.599	-0.297	-0.396	-0.406	**_-0.590_**	0.099	-0.599	0.257	-0.236	-0.609	**_0.660_**
	(0.364)	(0.666)	(0.382)	(0.437)	(0.565)	**_(0.431)_**	(0.337)	(0.457)	(0.408)	(0.336)	(0.484)	**_(0.436)_**
Stage 4 x	-0.177	0.205	-0.020	-0.163	**_0.422_**	-0.068	0.289	-0.011	0.480**	0.233	**_-0.492**_**	-0.411
Knowledge Score	(0.210)	(0.429)	(0.166)	(0.293)	**_(0.373)_**	(0.247)	(0.189)	(0.289)	(0.218)	(0.182)	**_(0.238)_**	(0.278)
Stage 4 Rank	N/A	1.134	1.048*	-0.083	**_1.529*_**	N/A	N/A	0.783	1.082*	0.501	**_-0.571_**	N/A
		(0.893)	(0.607)	(0.595)	**_(0.883)_**			(0.648)	(0.633)	(0.503)	**_(0.578)_**	
Stage 4 Rank x	N/A	0.415	**_-0.222_**	0.398	**_1.062**_**	N/A	N/A	-0.190	**_0.875***_**	-0.298	**_-0.648**_**	N/A
Knowledge Score		(0.549)	**_(0.243)_**	(0.358)	**_(0.495)_**			(0.320)	**_(0.284)_**	(0.262)	**_(0.329)_**	
Obs.	528	528	528	528	528	528	524	524	524	524	524	524
Uncensored Obs./Estimate	25.8	22.1	6.4	17.9	9.3	4.4	29.3	24.9	7.3	20.2	11.2	6.0
% Censor left	27.8%	14.2%	79.5%	41.5%	69.1%	88.4%	19.1%	11.5%	76.3%	33.4%	63.4%	83.8%
% No censor	68.4%	71.2%	20.5%	57.6%	29.9%	11.6%	78.2%	80.9%	23.7%	65.6%	36.5%	16.0%
% Censor right	3.8%	14.6%	0.0%	0.9%	0.9%	0.0%	2.7%	7.6%	0.0%	1.0%	0.2%	0.2%
Clusters	132	132	132	132	132	132	131	131	131	131	131	131

***, ** and * designate significance at the 99%, 95% and 90% levels of confidence, respectively. Bold and italicized text indicate significant (95% level of confidence) differences in coefficients between panels.

TABLE 15: REGRESSION RESULTS ON PORTFOLIO CHARACTERISTICS BY WHETHER THE RANKING RULE WAS GIVEN TO SUBJECTS. SEE TABLE 10 FOR DETAILS ON VARIABLES

	Panel A: Ranking Rule Not Given				Panel B: Ranking Rule Given			
	Investment in		Sharpe	Diversification	Investment in		Sharpe	Diversification
	Cash	C, F & Cash	Ratio	Index	Cash	C, F & Cash	Ratio	Index
Constant	-9.297***	-3.293***	1.059***	2.691***	-6.621***	-1.717**	1.075***	2.660***
	(2.022)	(0.931)	(0.031)	(0.159)	(1.983)	(0.899)	(0.029)	(0.177)
Knowledge Score	-0.634	-0.555	0.030**	-0.337***	-2.453***	-1.567***	0.037*	-0.300***
	(0.784)	(0.444)	(0.014)	(0.087)	(0.727)	(0.445)	(0.020)	(0.102)
Gender (1=Female)	1.321	0.872	-0.024	0.279	2.214	2.105**	0.016	0.340*
	(1.404)	(0.970)	(0.035)	(0.230)	(1.686)	(0.973)	(0.032)	(0.179)
Gender x	0.502	0.096	-0.005	0.109	1.541*	0.447	0.038*	-0.019
Knowledge Score	(0.813)	(0.516)	(0.021)	(0.121)	(0.914)	(0.510)	(0.023)	(0.114)
Amount bet in	2.303	1.754*	-0.038	-0.025	-0.252	0.344	-0.087***	0.359*
Preliminary Stage	(1.435)	(0.904)	(0.035)	(0.197)	(1.491)	(0.839)	(0.033)	(0.183)
Initial Bet x	0.084	0.644	-0.007	0.115	0.171	-0.011	-0.010	0.099
Knowledge Score	(0.828)	(0.458)	(0.020)	(0.105)	(0.744)	(0.462)	(0.022)	(0.108)
Categories	1.668	0.492	0.040	0.022	-1.468	-1.306	0.047	-0.457**
	(1.834)	(1.039)	(0.037)	(0.208)	(1.744)	(0.914)	(0.034)	(0.187)
Categories x	-0.822	-0.765	0.012	0.000	-0.114	-0.013	-0.035	0.108
Knowledge Score	(0.921)	(0.536)	(0.017)	(0.108)	(1.035)	(0.599)	(0.027)	(0.114)
Stage 2	1.354*	1.484***	0.048*	-0.010	-0.455	-0.670	0.049**	-0.192
	(0.755)	(0.430)	(0.026)	(0.068)	(1.638)	(0.622)	(0.019)	(0.131)
Stage 2 x	-0.212	-0.208	-0.012	-0.053	0.242	0.269	-0.017	-0.026
Knowledge Score	(0.386)	(0.242)	(0.010)	(0.037)	(0.853)	(0.326)	(0.013)	(0.075)
Stage 2 x Categories	-1.558	-1.715**	-0.051	-0.008	1.001	0.506	-0.057*	0.272*
	(1.389)	(0.708)	(0.035)	(0.136)	(1.840)	(0.849)	(0.030)	(0.159)
Stage 2 x Categories	0.182	0.043	0.025	0.026	1.542	0.435	0.032	0.054
x Knowledge Score	(0.672)	(0.422)	(0.017)	(0.062)	(1.206)	(0.565)	(0.020)	(0.100)
Stage 3	3.588***	2.451***	0.053*	-0.004	0.399	0.121	0.077***	-0.101
	(1.492)	(0.806)	(0.030)	(0.130)	(0.907)	(0.532)	(0.022)	(0.130)
Stage 3 x	-1.683	-1.066***	-0.017	0.086	-0.533	0.183	-0.028	0.060
Knowledge Score	(0.774)	(0.411)	(0.012)	(0.069)	(1.092)	(0.500)	(0.017)	(0.139)
Stage 3 x Categories	-0.745	-0.414	-0.044	-0.320*	0.081	-0.305	-0.042	0.181
	(2.264)	(1.293)	(0.042)	(0.183)	(1.075)	(0.834)	(0.035)	(0.166)
Stage 3 x Categories	1.066	0.539	0.011	0.034	0.144	-0.269	0.037	-0.164
x Knowledge Score	(1.122)	(0.665)	(0.021)	(0.092)	(1.373)	(0.814)	(0.028)	(0.155)
Stage 4	1.605	0.766	0.077***	-0.169	-0.816	-0.512	0.037	-0.088
	(1.334)	(0.691)	(0.027)	(0.142)	(1.155)	(0.495)	(0.023)	(0.121)
Stage 4 x	-1.152	-0.908**	-0.003	0.040	-0.434	0.069	0.003	-0.062
Knowledge Score	(0.738)	(0.374)	(0.013)	(0.086)	(0.699)	(0.278)	(0.016)	(0.077)
Stage 4 x Categories	-1.903	-1.235	-0.078**	0.136	0.845	-0.035	-0.012	-0.067
	(1.766)	(0.915)	(0.038)	(0.198)	(1.363)	(0.803)	(0.032)	(0.169)
Stage 4 x Categories	0.959	0.344	0.025	-0.106	1.027	0.344	-0.020	0.109
x Knowledge Score	(0.936)	(0.504)	(0.021)	(0.107)	(1.293)	(0.789)	(0.022)	(0.101)
Obs.	532	532	516	532	520	520	510	520
Uncensored Obs./Estimate	5.4	10.3	25.8	26.6	4.7	9.6	25.5	26.0
% Censor left	76.7%	58.1%	N/A	N/A	80.0%	61.0%	N/A	N/A
% No censor	20.3%	38.5%	N/A	N/A	18.1%	36.9%	N/A	N/A
% Censor right	3.0%	3.4%	N/A	N/A	1.9%	2.1%	N/A	N/A
Clusters	133	133	133	133	130	130	129	130

***, ** and * designate significance at the 99%, 95% and 90% levels of confidence, respectively. Bold and italicized text indicate significant (95% level of confidence) differences in coefficients between panels.

TABLE 16: REGRESSION RESULTS ON PORTFOLIO CHARACTERISTICS BY WHETHER ORDERING OF STAGES II AND III. SEE TABLE 10 FOR DETAILS ON VARIABLES.

	Panel A: Stage 2 First				Panel B: Stage 3 First			
	Investment in		Sharpe	Diversification	Investment in		Sharpe	Diversification
	Cash	C, F & Cash	Ratio	Index	Cash	C, F & Cash	Ratio	Index
Constant	-7.591***	-1.829**	1.071***	2.581***	-8.142***	-2.962***	1.065***	2.782***
	(1.954)	(0.867)	(0.030)	(0.170)	(2.027)	(0.943)	(0.028)	(0.150)
Knowledge Score	-1.972***	-1.254***	0.029	-0.339***	-1.211	-0.900*	0.033**	-0.297***
	(0.705)	(0.411)	(0.018)	(0.090)	(0.804)	(0.470)	(0.013)	(0.081)
Gender (1=Female)	0.879	1.054	-0.025	0.374*	1.691	1.526	0.026	0.134
	(1.597)	(0.953)	(0.031)	(0.195)	(1.520)	(0.943)	(0.034)	(0.194)
Gender x	-0.217	0.003	-0.005	0.055	1.403*	0.264	0.027	0.022
Knowledge Score	(0.767)	(0.490)	(0.018)	(0.106)	(0.730)	(0.423)	(0.021)	(0.102)
Amount bet in	2.011	1.364	-0.095***	0.198	0.809	1.024	-0.040	0.205
Preliminary Stage	(1.534)	(0.945)	(0.032)	(0.177)	(1.378)	(0.837)	(0.036)	(0.209)
Initial Bet x	1.176	0.102	***0.025***	***-0.084***	-0.604	0.643	***-0.034***	***0.306****
Knowledge Score	(0.745)	(0.476)	***(0.018)***	***(0.096)***	(0.700)	(0.395)	***(0.021)***	***(0.103)***
Categories	-2.132	-1.463	0.063*	-0.259	1.985	0.583	0.033	-0.188
	(2.160)	(1.011)	(0.036)	(0.198)	(1.672)	(1.010)	(0.034)	(0.198)
Categories x	-0.730	0.187	***-0.042****	***0.239*****	-0.165	-0.632	***0.023***	***-0.110***
Knowledge Score	(1.097)	(0.553)	***(0.021)***	***(0.109)***	(0.871)	(0.572)	***(0.020)***	***(0.100)***
Stage 2	0.495	-0.047	0.069***	-0.181*	-0.151	0.712	0.029	-0.020
	(1.417)	(0.529)	(0.023)	(0.107)	(1.134)	(0.550)	(0.023)	(0.102)
Stage 2 x	-0.285	0.040	-0.023	-0.021	0.602	0.173	-0.006	-0.052
Knowledge Score	(0.744)	(0.267)	(0.015)	(0.061)	(0.659)	(0.338)	(0.008)	(0.053)
Stage 2 x Categories	-0.661	-0.942	-0.050	0.090	0.344	-0.416	-0.058*	0.178
	(2.274)	(0.886)	(0.032)	(0.151)	(1.359)	(0.692)	(0.033)	(0.145)
Stage 2 x Categories	1.102	0.409	0.025	0.018	-0.144	-0.258	0.030*	0.051
x Knowledge Score	(1.216)	(0.530)	(0.022)	(0.093)	(0.817)	(0.465)	(0.016)	(0.068)
Stage 3	1.251	***0.071***	0.098***	-0.186	2.299*	***2.108******	0.029	0.085
	(1.315)	***(0.674)***	(0.023)	(0.146)	(1.227)	***(0.747)***	(0.028)	(0.113)
Stage 3 x	-1.506	-0.773	-0.030*	0.156	-0.677	-0.177	-0.012	0.002
Knowledge Score	(1.059)	(0.513)	(0.017)	(0.117)	(0.825)	(0.439)	(0.010)	(0.081)
Stage 3 x Categories	-0.611	-0.392	-0.029	-0.052	-0.078	-0.148	-0.059	-0.093
	(2.528)	(1.172)	(0.038)	(0.199)	(1.766)	(1.116)	(0.038)	(0.153)
Stage 3 x Categories	0.533	0.106	0.046*	-0.102	0.293	0.058	-0.010	0.018
x Knowledge Score	(1.587)	(0.801)	(0.027)	(0.137)	(1.118)	(0.695)	(0.018)	(0.108)
Stage 4	0.232	***-0.860***	***0.098******	-0.192	0.279	***0.858***	***0.018***	-0.058
	(1.173)	***(0.586)***	***(0.024)***	(0.119)	(1.330)	***(0.647)***	***(0.026)***	(0.143)
Stage 4 x	-0.727	-0.456	-0.003	-0.030	-(0.728)	-0.359	0.002	0.008
Knowledge Score	(0.704)	(0.337)	(0.018)	(0.065)	0.786	(0.400)	(0.013)	(0.092)
Stage 4 x Categories	-1.619	-0.693	-0.067*	-0.096	-(0.160)	-0.691	-0.024	0.148
	(2.238)	(0.995)	(0.036)	(0.179)	(1.508)	(0.792)	(0.035)	(0.185)
Stage 4 x Categories	0.083	0.060	-0.007	0.121	1.095	0.269	0.020	-0.133
x Knowledge Score	(1.317)	(0.666)	(0.025)	(0.090)	(0.968)	(0.573)	(0.020)	(0.113)
Obs.	528	528	515	528	524	524	511	524
Uncensored Obs./Estimate	4.7	9.1	25.8	26.4	5.5	10.8	25.6	26.2
% Censor left	79.9%	62.9%	N/A	N/A	76.7%	56.1%	N/A	N/A
% No censor	17.6%	34.3%	N/A	N/A	20.8%	41.2%	N/A	N/A
% Censor right	2.5%	2.8%	N/A	N/A	2.5%	2.7%	N/A	N/A
Clusters	132	132	132	132	131	131	130	131

***, ** and * designate significance at the 99%, 95% and 90% levels of confidence, respectively.Bold and italicized text indicate significant (95% level of confidence) differences in coefficients between panels

8. APPENDIX II: EXPERIMENTAL INSTRUCTIONS

Here, we give the text of the webpages used for this experiment. Web formatting differed slightly from the formatting below and the webpages were interactive. Subjects used drop-down boxes to make allocation decisions and radio buttons to answer survey questions.

GENERAL INSTRUCTIONS

This is an experiment in the economics of decision making. The instructions are simple. If you follow them carefully and make good decisions, you might earn a considerable amount of money which will be mailed to you at the end of the experiment.

In stages of this experiment, you will be given cash that you can keep or you can invest all of it or portions of it in one or more investment alternatives. The amounts you invest in each alternative and some random draws will determine your payoffs from participating in this experiment. We will also ask you a series of questions about your preferences, knowledge and demographics.

DESCRIPTIONS OF INVESTMENT ALTERNATIVES

At different stages in this experiment you will be given cash that you can (a) keep or (b) can invest all of it or portions of it in one or more investment alternatives. This is called an allocation decision. The amounts you invest will be in $1 increments. Each investment alternative will result in either a high return or a low return. A random draw will determine which occurs. Half of the time, the high return will occur and half of the time the low return will occur. The cash you keep always earns a zero return.

For each $1 invested in an alternative, you will be paid $1 times 1 plus the return that occurs. Returns will be expressed in percentage terms. So, for example, if the return that occurs is 80%, you will be paid $1x(1+0.80) = $1.80 for each dollar invested in that alternative. That is, you get the original $1 back plus 80% of a dollar, or 80 cents in additional return. If the return that occurs is -30%, then you will be paid $1x(1+(-0.30)) = $0.70. That is, you lose 30%, or 30 cents, of the original dollar invested. If you had invested $2, you would have been paid $2x(1+0.80) = $3.60 or $2x(1+(0.30)) = $1.40 if the high or low return had occurred, respectively.

Each investment alternative will be described to you by giving the high return, the low return, the average return and the range of returns in a table. Finally, you will be given a "Return/Risk" ratio which is the expected return divided by the range. For example, an investment alternative, say, "Alternative X" that has a high return of high return of 150% and a low return of -50% would be described as:

Alternative:	**X**
High Return:	150%
Low Return:	-50%
Average Return:	50%
Range of Returns:	200%
Return/Risk Ratio:	0.2500

If you received the high return in this case, you would be paid $1x(1+1.5) = $2.50 for each $1 invested. If you received the low return in this case, you would be paid $1x(1+(-0.50)) = $0.50 for each $1 invested. Recall, that the high return will occur half of the time and the low return will occur half of the time. Which actually occurs is determined by a random draw. In any given stage, you may be asked to allocate cash across several investments.

In a stage, if the high return occurs for one investment, the high return will occur for all investments in that stage. If the low return occurs for one investment, the low return will occur for all investments in that stage.

DESCRIPTIONS OF INVESTMENT ALTERNATIVES (CONTINUED)

To see if you understand an investment alternative, please answer the following three questions about the investment alternative "Y" described by:

Alternative:	**Y**
High Return:	210%
Low Return:	-80%
Average Return:	65%
Range of Returns:	290%
Return/Risk Ratio:	0.2241

1. If the high return occurs for "Y", what return will occur for other investments in that stage?

   a. All other investments in that stage will return their respective "low" returns. *Feedback if selected: "Recall that, in a given stage, either ALL investments return their respective 'high' returns or ALL investments return their respective 'low' returns. Please try a different answer."*

   b. All other investments will return their respective "low" returns. *Feedback if selected: "Correct. Proceed to question 2."*

   c. The returns to other investments at that stage may be mixed with some "high" and some "low" returns. *Feedback if selected: "Recall that, in a given stage, either ALL investments return their respective 'high' returns or ALL investments return their respective 'low' returns. Please try a different answer."*

2. If you invest $3 in this alternative and the high return occurs, how much will you be paid?

   a. $2.10 *Feedback if selected: "This is the gain on a $1 investment, not the total amount paid to you. Please try a different answer."*

   b. $3.10 *Feedback if selected: "This is the payment for a $1 investment. Recall you are investing $3. Please try a different answer."*

   c. $6.30 *Feedback if selected: "This is the gain on the $3 investment, not the total amount paid to you. P lease try a different answer."*

   d. $9.30 *Feedback if selected: "Correct. Please continue to Question 3."*

3. If you invest $2 in this alternative, and the low return occurs, how much will you be paid?

   a. -$0.80 *Feedback if selected: "This is the loss on a $1 investment, not the total amount paid to you. Please try a different answer."*

   b. $0.20 *Feedback if selected: "This is the payment for a $1 investment. Recall you are investing $2. Please try a different answer."*

   c. -$1.60 *Feedback if selected: "This is the loss on the $2 investment, not the total amount paid. Please try a different answer."*

   d. $0.40 *Feedback if selected: "Correct. Please continue to the next part of the experiment."*

The continue button only becomes active after the answers are correct.

PRELIMINARY STAGE

In this stage you have $1 to allocate. You can either keep it or invest it in the following investment alternative:

Alternative:	**A**		
High Return:	100%		
Low Return:	-100%		
Average Return:	0%		
Range of Returns:	200%		
Return/Risk Ratio:	0..0000		Amount Kept
Amount you Invest:			=$1-Invested

When you are finished with your choice, click the "continue" button below. At the end of the experiment, a random draw will determine your payoff to this stage. This will become part of your earnings for the experiment.

ADDITIONAL INSTRUCTIONS

In the rest of the experiment, you will make several investment decisions. Each decision is a "stage" in the experiment.

In each stage, you will have $12 to keep or invest. You can keep the $12 or invest some or all of it in any of 6 investment alternatives in $1 increments. You can invest the $12 in whatever combination of investments and in whatever amounts you wish so long as the total investment is less than or equal to $12. Any amount you do not invest will be kept for that stage and earn a zero return. The outcomes of any given stage will not affect the amount you have to invest in the next stage. You will always start each stage with a new $12.

At the end of the experiment, ***we will randomly select one stage***. Then, we will make a SINGLE random draw that will determine whether the gambles in that stage pay the high return or the low return. That is, either ALL investments in that stage will give you a high return or ALL of the investments will give the low return.

Earnings from this stage and random draw, together with earnings from the preliminary stage and the $5 participation fee, will contribute to your earnings for the experiment.

Between stages and at the end of the experiment, you will be asked questions that will help us categorize your responses.

STAGE I

Treatments with Categories:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments. These alternatives have been categorized using a commonly used financial method.

		Category I				Category II				
Alternative:		**A**	**B**	**C**		**D**	**E**	**F**		
High Return:		130%	185%	125%		200%	225%	190%		
Low Return:		30%	15%	-25%		-20%	-75%	-90%		
Average Return:		80%	100%	50%		90%	75%	50%		
Range of Returns:		100%	170%	150%		220%	300%	280%		
Return/Risk Ratio:		0.8000	0.5882	0.3333		0.4091	0.2500	0.1786		Amount Kept
Amount you Invest:										=$12-Invested

Treatments without Categories:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments:

Alternative:		**A**	**B**	**C**	**D**	**E**	**F**		
High Return:		130%	185%	125%	200%	225%	190%		
Low Return:		30%	15%	-25%	-20%	-75%	-90%		
Average Return:		80%	100%	50%	90%	75%	50%		
Range of Returns:		100%	170%	150%	220%	300%	280%		
Return/Risk Ratio:		0.8000	0.5882	0.3333	0.4091	0.2500	0.1786		Amount Kept
Amount you Invest:									=$12-Invested

All treatments:

Please confirm your allocation before pressing continue.

When you are finished with your choice, click the "continue" button below. At the end of the experiment, we will randomly select one of these stages to play out. If this stage is chosen, a single random draw will determine the returns to ALL of the investment in this stage and, as a result, your payoff to this stage. This will become part of your earnings for the experiment.

STAGE I QUESTIONS

Please answer the following questions. Click the "Submit" button below to continue on to the next stage.

1. How satisfied are you with your allocation decision in this stage?

Very Dissatisfied			Neutral			Very Satisfied
1	2	3	4	5	6	7

2. Do you wish you could go back and change your decision?

   a. Yes

   b. No

3. How confused did you feel while making the allocation decision?

Very Confused			Neutral			Not Confused At All
1	2	3	4	5	6	7

STAGE II

Treatments with Categories without the ranking rule defined:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments. These alternatives have been categorized using a commonly used financial method. In this stage, we have ranked the investments according to a common method of ranking investments within categories. Investments with more *'s in the ranking line are ranked higher according to this criterion.

		Category I				Category II				
Alternative:		**A**	**B**	**C**		**D**	**E**	**F**		
High Return:		200%	190%	225%		125%	130%	185%		
Low Return:		-20%	-90%	-75%		-25%	30%	15%		
Average Return:		90%	50%	75%		50%	80%	100%		
Range of Returns:		220%	280%	300%		150%	100%	170%		
Return/Risk Ratio:		0.4091	0.1786	0.2500		0.3333	0.8000	0.5882		
Ranking:		***	*	**		*	***	**		Amount Kept
Amount you Invest:										=$12-Invested

Treatments with Categories with the ranking rule defined:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments. These alternatives have been categorized using a commonly used financial method. In this stage, we have ranked the investments according to the Return/Risk ratio, which is a common method of ranking investments within categories. Investments with more *'s in the ranking line are ranked higher according to this criterion.

		Category I				Category II				
Alternative:		**A**	**B**	**C**		**D**	**E**	**F**		
High Return:		200%	190%	225%		125%	130%	185%		
Low Return:		-20%	-90%	-75%		-25%	30%	15%		
Average Return:		90%	50%	75%		50%	80%	100%		
Range of Returns:		220%	280%	300%		150%	100%	170%		
Return/Risk Ratio:		0.4091	0.1786	0.2500		0.3333	0.8000	0.5882		
Ranking:		***	*	**		*	***	**		Amount Kept
Amount you Invest:										=$12-Invested

Treatments without Categories without the ranking rule defined:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments. In this stage, we have ranked the investments according to a common method of ranking investments. Investments with more *'s in the ranking line are ranked higher according to this criterion.

Alternative:		**A**	**B**	**C**	**D**	**E**	**F**		
High Return:		200%	190%	225%	125%	130%	185%		
Low Return:		-20%	-90%	-75%	-25%	30%	15%		
Average Return:		90%	50%	75%	50%	80%	100%		
Range of Returns:		220%	280%	300%	150%	100%	170%		
Return/Risk Ratio:		0.4091	0.1786	0.2500	0.3333	0.8000	0.5882		
Ranking:		***	*	**	*	***	**		Amount Kept
Amount you Invest:									=$12-Invested

Treatments without Categories with the ranking rule defined:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments. In this stage, we have ranked the investments according to the Return/Risk ratio, which is a common method of ranking investments. Investments with more *'s in the ranking line are ranked higher according to this criterion.

Alternative:		**A**	**B**	**C**	**D**	**E**	**F**		
High Return:		200%	190%	225%	125%	130%	185%		
Low Return:		-20%	-90%	-75%	-25%	30%	15%		
Average Return:		90%	50%	75%	50%	80%	100%		
Range of Returns:		220%	280%	300%	150%	100%	170%		
Return/Risk Ratio:		0.4091	0.1786	0.2500	0.3333	0.8000	0.5882		
Ranking:		***	*	**	*	***	**		Amount Kept
Amount you Invest:									=$12-Invested

All Treatments:

Please confirm your allocation before pressing continue.

When you are finished with your allocation, click the "continue" button below. As a reminder, at the end of the experiment, we will randomly select one of these stages to play out. If this stage is chosen, a single random draw will determine the returns to ALL of the investments in this stage and, as a result, your payoff to this stage.

STAGE II QUESTIONS

Please answer the following questions. Click the "Submit" button below to continue on to the next stage.

1. How satisfied are you with your allocation decision in this stage?

Very Dissatisfied			Neutral			Very Satisfied
1	2	3	4	5	6	7

2. Do you wish you could go back and change your decision?

    a. Yes

    b. No

3. How confused did you feel while making the allocation decision?

Very Confused			Neutral			Not Confused At All
1	2	3	4	5	6	7

STAGE III

Treatmets with Categories without the ranking rule defined:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments. These alternatives have been categorized using a commonly used financial method.

In this stage, we ask you to first rank the investments. Use the drop down boxes to assign 1, 2 or 3 stars to investments. 3-star investments are the investments with the highest rank, 1-star investments are the investments with the lowest rank and 2-star investments are in between. You are asked to assign one 3-star, one 2-star and one 1-star rating within each category of investments.

		Category I				**Category II**				
Alternative:		**A**	**B**	**C**		**D**	**E**	**F**		
High Return:		185%	125%	130%		225%	200%	190%		
Low Return:		15%	-25%	30%		-75%	-20%	-90%		
Average Return:		100%	50%	80%		75%	90%	50%		
Range of Returns:		170%	150%	100%		300%	220%	280%		
Return/Risk Ratio:		0.5882	0.3333	0.8000		0.2500	0.4091	0.1786		
Ranking:										Amount Kept
Amount you Invest:										=$12-Invested

Treatments with Categories with the ranking rule defined:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments. These alternatives have been categorized using a commonly used financial method.

In this stage, we ask you to first rank the investments according to the return/risk ratio. Use the drop down boxes to assign 1, 2 or 3 stars to investments. 3-star investments should be the investments with the highest return/risk ratio, 1-star investments should be the investments with the lowest return/risk ratio and 2-star investments should be in between. You are asked to assign one 3-star, one 2-star and one 1-star rating within each category of investments.

		Category I				Category II				
Alternative:		**A**	**B**	**C**		**D**	**E**	**F**		
High Return:		185%	125%	130%		225%	200%	190%		
Low Return:		15%	-25%	30%		-75%	-20%	-90%		
Average Return:		100%	50%	80%		75%	90%	50%		
Range of Returns:		170%	150%	100%		300%	220%	280%		
Return/Risk Ratio:		0.5882	0.3333	0.8000		0.2500	0.4091	0.1786		
Ranking:										Amount Kept
Amount you Invest:										=$12-Invested

Treatments without Categories without the ranking rule defined:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments. In this stage, we ask you to first rank the investments. Use the drop down boxes to assign 1, 2 or 3 stars to investments. 3-star investments should be the investments with the highest rank, 1-star investments should be the investments with the lowest rank and 2-star investments should be in between. You are asked to assign two 3-star, two 2-star and two 1-star ratings.

Alternative:		**A**	**B**	**C**	**D**	**E**	**F**		
High Return:		185%	125%	130%	225%	200%	190%		
Low Return:		15%	-25%	30%	-75%	-20%	-90%		
Average Return:		100%	50%	80%	75%	90%	50%		
Range of Returns:		170%	150%	100%	300%	220%	280%		
Return/Risk Ratio:		0.5882	0.3333	0.8000	0.2500	0.4091	0.1786		
Ranking:									Amount Kept
Amount you Invest:									=$12-Invested

Treatments without Categories with the ranking rule defined:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments. In this stage, we ask you to first rank the investments according to the return/risk ratio. Use the drop down boxes to assign 1, 2 or 3 stars to investments. 3-star investments should be the investments with the highest return/risk ratio, 1-star investments should be the investments with the lowest return/risk ratio and 2-star investments should be in between. You are asked to assign two 3-star, two 2-star and two 1-star ratings.

Alternative:		**A**	**B**	**C**	**D**	**E**	**F**		
High Return:		185%	125%	130%	225%	200%	190%		
Low Return:		15%	-25%	30%	-75%	-20%	-90%		
Average Return:		100%	50%	80%	75%	90%	50%		
Range of Returns:		170%	150%	100%	300%	220%	280%		
Return/Risk Ratio:		0.5882	0.3333	0.8000	0.2500	0.4091	0.1786		
Ranking:									Amount Kept
Amount you Invest:									=$12-Invested

All Treatments:

When you are finished with your allocation, click the "submit rankings" button below. Then, you will be allowed to allocate cash.

Please confirm your allocation before pressing continue.

When you are finished with your allocation, click the "continue" button below. As a reminder, at the end of the experiment, we will randomly select one of these stages to play out. If this stage is chosen, a single random draw will determine the returns to ALL of the investments in this stage and, as a result, your payoff to this stage.

STAGE III QUESTIONS

Please answer the following questions. Click the "Submit" button below to continue on to the next stage.

1. How satisfied are you with your allocation decision in this stage?

Very Dissatisfied			Neutral			Very Satisfied
1	2	3	4	5	6	7

2. Do you wish you could go back and change your decision?

   a. Yes

   b. No

3. How confused did you feel while making the allocation decision?

Very Confused			Neutral			Not Confused At All
1	2	3	4	5	6	7

STAGE IV

Treatments with Categories:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments. These alternatives have been categorized using a commonly used financial method.

		Category I				Category II				
Alternative:		**A**	**B**	**C**		**D**	**E**	**F**		
High Return:		190%	225%	200%		125%	185%	130%		
Low Return:		-90%	-75%	-20%		-25%	15%	30%		
Average Return:		50%	75%	90%		50%	100%	80%		
Range of Returns:		280%	300%	220%		150%	170%	100%		
Return/Risk Ratio:		0.1786	0.2500	0.4091		0.3333	0.5882	0.8000		Amount Kept
Amount you Invest:										=$12-Invested

Treatments without Categories:

In this stage you have $12 to allocate. You can either keep it or invest it in the following investment alternatives in $1 increments:

Alternative:		**A**	**B**	**C**	**D**	**E**	**F**		
High Return:		190%	225%	200%	125%	185%	130%		
Low Return:		-90%	-75%	-20%	-25%	15%	30%		
Average Return:		50%	75%	90%	50%	100%	80%		
Range of Returns:		280%	300%	220%	150%	170%	100%		
Return/Risk Ratio:		0.1786	0.2500	0.4091	0.3333	0.5882	0.8000		Amount Kept
Amount you Invest:									=$12-Invested

All Treatments:

Please confirm your allocation before pressing continue.

When you are finished with your allocation, click the "continue" button below. As a reminder, at the end of the experiment, we will randomly select one of these stages to play out. If this stage is chosen, a single random draw will determine the returns to ALL of the investments in this stage and, as a result, your payoff to this stage.

STAGE IV QUESTIONS

Please answer the following questions. Click the "Submit" button below to continue on to the next stage.

1. How satisfied are you with your allocation decision in this stage?

Very Dissatisfied			Neutral			Very Satisfied
1	2	3	4	5	6	7

2. Do you wish you could go back and change your decision?

    a. Yes

    b. No

3. How confused did you feel while making the allocation decision?

Very Confused			Neutral			Not Confused At All
1	2	3	4	5	6	7

KNOWLEDGE AND DEMOGRAPHIC SURVEYS

Next, we would like you to fill out brief demographic and knowledge surveys to help us classify the data. Your responses will be kept in a data file that does not include any identifying information. We will keep your participation in this research study confidential to the extent permitted by law.

Taking part in the surveys is completely voluntary. Leave blank any questions you prefer not to answer. You won't be penalized or lose any benefits for which you otherwise qualify.

At the end of the surveys, we will randomly select one of stages 1 through 4 that you have completed and use your allocation decision from this stage and a random draw to determine your payoffs for this experiment.

Earnings from this stage and random draw, together with earnings from the preliminary stage and the $5 participation fee, will contribute to your earnings for the experiment.

Press the "continue" button below to go on to the Knowledge Survey.

KNOWLEDGE SURVEY

1. How would you classify your knowledge of financial markets?

    a. No knowledge whatsoever

    b. Beginner level

    c. Intermediate level

    d. Advanced level

Source: Variant (added the "know knowledge whatsoever" option) of IEM financial knowledge survey question from Oliven and Rietz [2004].

2. How much experience have you had with trading on organized financial markets?

    a. Novice (Have never traded.)

    b. Limited (Have, for example, made some trades on my own account.)

    c. Experienced Amateur (Have traded a good deal for myself, friends or family.)

    d. Professional (Have been paid for trading.)

Source: IEM financial knowledge survey question from Oliven and Rietz [2004].

3. How many hours in a typical week do you spend following or trading on organized financial markets?

  a. None
  b. An hour or less
  c. Between 1 and 5 hours
  d. Between 5 and 10 hours
  e. More than 10 hours

Source: Variant (made into multiple choice question) of IEM financial knowledge survey question from Oliven and Rietz [2004].

4. How do you rate your knowledge of investments relative to other people?

  a. Much less knowledgeable
  b. Somewhat less knowledgeable
  c. About as knowledgeable
  d. Somewhat more knowledgeable
  e. Much more knowledgeable

Source: New.

5. What is compound interest?

  a. Earning money on your principal and your interest.
  b. a complicated form of interest.
  c. A long term investment.
  d. A risk/return scenario.

Source: InvestNative Project Investment Quiz, question 4. http://www.investnative.org/test.html, accessed 08/19/2010.

6. What is an example of a low risk investment?

  a. Small cap stock.
  b. High yield "junk" bond.
  c. FDIC insured savings account.
  d. An international mutual fund focused on small Latin American airline companies.

Source: InvestNative Project Investment Quiz, question 21. http://www.investnative.org/test.html, accessed 08/19/2010.

7. If the value of your investment declines by 60%, what subsequent percentage increase is needed to return to your original investment amount?

  a. 60%.
  b. 120%.
  c. 150%.
  d. 180%.

Source: Pacific Life Investment Knowledge Quiz, question 4: http://www.pacificlife.com/Channel/Educational+Information/Calculators/Investment+Knowledge+Quiz, accessed 08/19/2010.

8. In general, stock mutual funds that are riskier tend to provide higher returns over time than stock mutual funds with less risk.

a. True.

b. False.

c. Don't know/Not sure.

Source: Financial Industry Regulatory Authority Investor Knowledge Quiz, question 7: http://apps.finra.org/Quiz/1/investorquiz.aspx, accessed 08/19/2010.

9. Which of these investments have a risk of losing value?

a. Mutual funds

b. Blue chip stocks

c. High-yield bonds

d. They all have risk of losing value

Source: Pacific Life Investment Knowledge Quiz, question 5: http://www.pacificlife.com/Channel/Educational+Information/Calculators/Investment+Knowledge+Quiz, accessed 08/19/2010.

10. What is diversification?

a. A way to reduce risk.

b. Investing in different things, such as stocks, bonds, savings, property, etc.

c. Having an asset allocation that spreads your investment among different asset classes.

d. All of the above.

Source: InvestNative Project Investment Quiz, question 11. http://www.investnative.org/test.html, accessed 08/19/2010.

11. Common stocks always provide higher returns than bonds or money market investments.

a. True.

b. False.

c. Don't know.

Source: Vanguard Investment Knowledge Quiz, question 3: https://personal.vanguard.com/us/InvestmentKnowledge, accessed 08/19/2010.

12. Asset allocation is a form of:

a. Repayment.

b. Diversification.

c. Capital.

Source: InvestNative Project Investment Quiz, question 14. http://www.investnative.org/test.html, accessed 08/19/2010.

13. Generally, a portfolio that has 80% of its assets invested in stocks would be best suited for:

a. An 18-year-old using the assets to pay for college expenses over the next 4 years.
b. A 35-year-old investing for retirement.
c. A 75-year-old investing for income and capital preservation.
d. None of the above.
e. Don't know.

Source: Vanguard Investment Knowledge Quiz, question 19: https://personal.vanguard.com/us/InvestmentKnowledge, accessed 08/19/2010.

DEMOGRAPHIC SURVEY

1. What is your gender?

a. Female
b. Male

2. What is your age?

a. Under 30 Years Old.
b. 30–39 Years Old.
c. 40–49 Years Old.
d. 50 Year Old and Older.

3. What is your current marital status?

a. Married.
b. Not Married.

4. Do you have children?

a. Yes.
b. No.

5. What is your current annual income?

a. $0–$19,999.
b. $20,000-$29,999.
c. $30,000-$39,999.
d. $40,000-$69,999.
e. Greater that $60,000.
f. Would rather not say.

6. What is the highest educational degree you have achieved?
    a. High School
    b. Bachelor's.
    c. Master's
    d. Doctorate.
    e. Other.

7. What is or was your college major (most recent degree if you are not currently a student)?
    a. Business.
    b. Social Science.
    c. Humanities.
    d. Natural Science.
    e. Mathematics or Engineering.
    f. Other.
    g. None.

FINAL QUESTION

After outcomes and payments have been determined, subjects answer the following final question:

1. How satisfied are you with your allocation decision in the stage that was selected to determine your payoffs?

Very Dissatisfied			Neutral			Very Satisfied
1	2	3	4	5	6	7