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Investment Decisions and Negative Interest Rates

Anat Bracha

Abstract:

While the current European Central Bank deposit rate and 2-year German government bond yields are negative, the U.S. 2-year government bond and deposit rates are positive. Insights from Prospect Theory suggest that this situation may lead to an excess flow of funds into the United States. Yet the environment of negative interest rates is different from the environment considered in Prospect Theory and subsequent literature, since decisions are framed in terms of rates of return rather than absolute amounts and the task involves the allocation of funds rather than a choice or a pricing task as is often used in the literature. Moreover, parking money in the United States as a foreign investor may lead to a mixed lottery due to exchange rate risk, while the literature mostly studies non-mixed lotteries. We therefore explore investors' behavior in a mixed-return lottery, using a series of lab experiments where the task is to allocate money between two portfolios with either a sure return or a risky return. We use a between-subject design such that, while the investment decisions are the same, those in the negative frame allocate funds between a sure negative return and a lottery, and those in the positive frame allocate funds between a sure positive return and a lottery. Surprisingly, we find no framing effect on investment, a result that holds for a large range of stakes, no matter whether the money to invest is literally on the table, regardless of the language used to describe the problem (abstract or not), and no matter whether the lottery is a two-state or a three-state lottery. We find that this result is not driven by whether the task is continuous rather than discrete or because the risky portfolio is a mixed lottery. Not only do we find no effect of the frame on the investment decision, we also find no evidence of risk-seeking in the loss domain, and that the behavior is mostly risk-neutral.

JEL Classifications: D03, D81, G11

Keywords: investment decision, framing effect, Prospect Theory, lab experiment

Anat Bracha is a senior economist in the research department of the Federal Reserve Bank of Boston. Her email address is anat.bracha@bos.frb.org.

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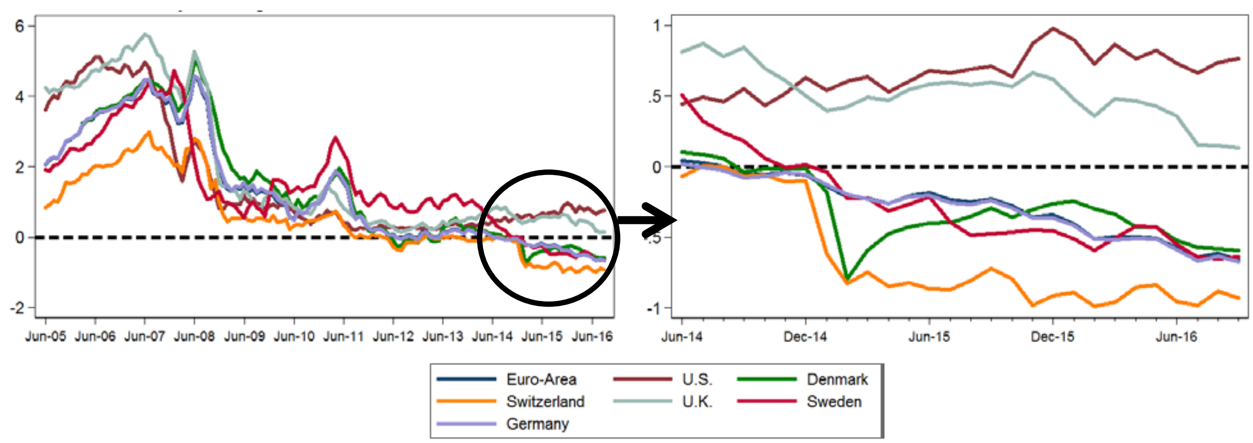
1. Introduction

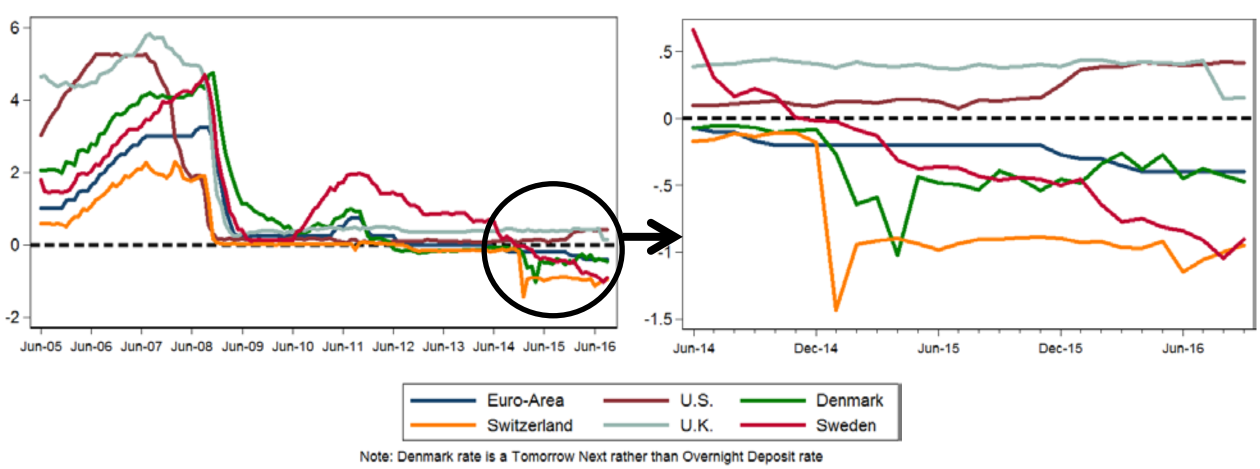
The European Central Bank deposit rate and several European government bond yields, such as the yield on 2-year German government bonds, are currently negative. At the same time, U.S. rates are low, but are positive and expected to increase. Figures 1 and 2 illustrate this recent development.

Figure 1: Monthly Average Government Bond Yield



Source: European Central Bank / Reuters / Haver Analytics .

Figure 2: Monthly Average Deposit Rates



Source: European Central Bank / Reuters / Haver Analytics .

Discrepancies in rates across countries are very common; however, having negative rates in some countries and positive rates in others is a novelty. Given the insight from Prospect Theory (PT) (Kahneman and Tversky 1979) that individuals exhibit risk-seeking in the loss domain and risk-aversion in the gain domain,[1] the question arises whether negative interest rates will induce investors and large institutions to drive excessive flows of funds into the U.S. market.

Prospect Theory's prediction of risk-aversion in the gain domain and risk-seeking in the loss domain is clear. However, PT or its enhanced version, Cumulative Prospect Theory (CPT) (Tversky and Kahneman 1992), is based on choice tasks, with lotteries over final amounts that are often non-mixed lotteries (with either only non-negative outcomes or only non-positive outcomes, but not both). Investment decisions, in contrast, are about allocating funds across portfolios, where lotteries are over rates of return and are usually mixed lotteries (with potential positive or negative returns); due to the low yields and the exchange rate risk faced by foreign investors considering parking their money in the United States, the possibility of mixed lotteries is especially relevant.

In this study, we therefore test experimentally whether decisions with properties similar to those of investment decisions exhibit the risk attitudes predicted by Prospect Theory, which implies excessive investment in the risky portfolio when in the loss domain.

The results of this experimental investigation contribute not only to the understanding of investment decisions under the current conditions of negative interest rates, but also more generally to the literature on decision-making under risk. By considering both mixed and non-mixed lotteries, using lotteries over yields, and using a fund-allocation decision framework rather than a choice task or pricing task, we contribute to the understanding of how the decision environment affects behavior. Differences in the decision environment, even subtle ones, such as in the status quo preference-elicitation mechanism and the magnitude of the payoffs, have been shown to generate different results (see, for example, Holt and Laury 2002, Harbaugh et al. 2010, Ert and Erev 2013, and references therein).

Why would the investment decision be different? There is evidence in the literature that risk attitudes are sensitive to the task: Harbaugh et al. (2010) suggests that the risk pattern as suggested by CPT emerges only when willingness to pay to play a lottery (or avoid it in the loss

[1] For instance, Kahneman and Tversky (1979) show that while individuals prefer a sure $3000 over a gamble of an 80 percent chance of winning $4000, they prefer a gamble of losing $4000 with an 80 percent chance to a sure loss of $3000.

domain) is elicited, but not when using a choice task. In the latter case, risk-neutrality emerges. A fund-allocation task is an entirely different task and may therefore lead to different attitudes toward risk than expected by PT (or CPT). Second, Holt and Laury (2002) have shown that measures of risk-aversion increase dramatically with payoffs, and Ert and Erev (2013) find that risk-aversion emerges only with large nominal payoffs (even if in real terms payoffs are the same). For investment decisions this is potentially important, since decisions are over the rates of return, which are currently in the magnitude of 1 percent and may therefore register with investors as a small payoff.

Moreover, it seems that one cannot generalize from decisions involving non-mixed lotteries to decisions involving mixed lotteries due to loss-aversion, that is, because losses loom larger than gains. This major insight of PT (loss-aversion) implies that individuals would be most risk-averse in mixed lotteries. Hence, even if an investor's decisions in the gain and loss domains are known, it is unclear what the investor's decision would be when faced with a sure loss and a mixed lottery. It is even more complicated than this, since the evidence for the existence of loss-aversion is mixed; Ert and Erev (2013), using a series of choice-task experiments with mixed lotteries, show that evidence of loss-aversion emerges only with high stakes and that overall decisions are more consistent with risk-neutrality.

To investigate the question of whether there would be excess investment in the risky portfolio in the loss domain compared with the gain domain, and whether investors exhibit loss-aversion, we ran several lab experiments where participants were asked to invest money across two available portfolios. The portfolios were presented in terms of rates of return, and participants were free to allocate their money across the two portfolios as they wished. We used a between-subject design, where subjects were randomly assigned to either a positive or a negative frame (gain or loss domain).[2] Whether in the positive or the negative frame, the allocation is always across a sure return ("domestic") portfolio and a risky ("foreign") portfolio with a few possible rates of return. In the positive frame, the domestic portfolio with the sure

[2] While there is intriguing evidence for heterogeneity in decision-making under risk, with over 50 percent of individuals best described by PT and the rest as expected-value maximizers (see, for example, Harrison and Rustrom 2009, Bruhin et al. 2010, and Santos-Pinto et al. 2015), in this study, we are interested in average behavior. This is driven by the question: should the United States expect an excess inflow of funds, given the recent negative returns in Europe?

return yields a positive return, while in the negative frame the domestic portfolio yields a sure negative return. However, by using different amounts of funds to invest, the portfolios were in fact the same across the two treatments.

Several variants of this basic experimental design were tested: (1) the money to invest was either earned income that was literally on the table or money that was paid conditional on being selected; (2) the risky portfolio was either a two-outcome or a three-outcome portfolio, where the outcome is a possible return rate, (3) the portfolios were described as either domestic or foreign portfolios, or in abstract language, (4) investment stakes varied from $20 to $1,000. And, finally, (5) the risky lottery was either mixed, with possible negative and positive returns, or not-mixed, with all returns being negative or positive, depending on the frame.

Interestingly, across all the variants of the decision that we tested, we find no evidence for the risk-attitude pattern suggested by Prospect Theory, and we find no excessive investment in the risky portfolio when the domestic portfolio yields a sure negative return; that is, we find no framing effects. Moreover, participants in our study mostly exhibit risk-neutrality in both the loss and the gain domain, suggesting no loss-aversion.

2. Investment Decision

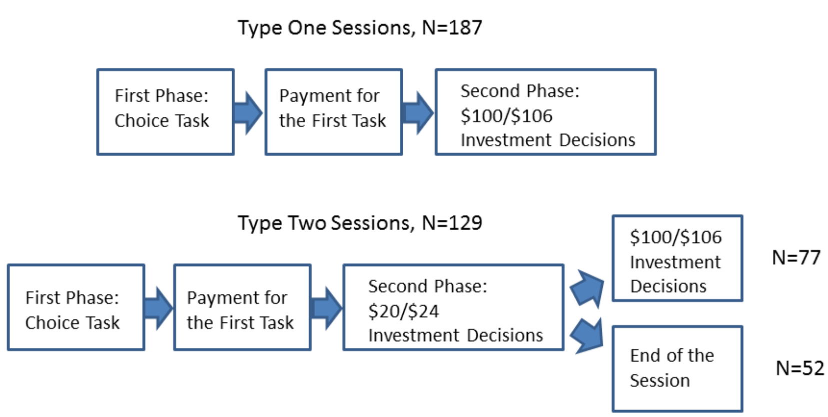
The investment decision is a simple decision to allocate funds between *Portfolio X* and *Portfolio Y*. Portfolio X yields a sure return, while Portfolio Y yields a lottery with either two or three possible returns (a two-states or a three-states lottery). Subjects were randomly assigned to either a Negative or a Positive frame:

- **Negative Frame:** Portfolio X yields *a sure negative return;* Portfolio Y is a lottery over returns.
- **Positive Frame:** Portfolio X yields *a sure positive return;* Portfolio Y is a lottery over returns.

Participants in the study were presented with a series of choices. First, participants were given a series of typical choice decisions between a lottery and a sure amount, to gauge their attitudes toward risk. Once the first stage was over, they were paid for the first stage and were then presented with a series of investment decision(s) with different stakes, depending on the session. We had two types of sessions: "Type One" sessions in which the second phase started with the baseline investment decision (described in detail below) with $100 or $106 at stake, and "Type Two" sessions in which the second phase included first investment decisions with smaller $20 or $24 stakes. These investment decisions are described in detail in Section 5 below. In order to create two frames—gains and losses—but to keep the portfolios identical across frames we used different endowments (that is, $100 and $106; $20 and $24).

The study was conducted at the Harvard Decision Science Lab in the Harvard Kennedy School, with 332 participants overall. Of the 332, 129 participated in the Type Two sessions, given (first) a series of $20/$24 investment decisions; of the 129 Type Two participants, 77 were presented with additional $100/$106 investment decisions following their $20/$24 investment decisions. Consequently, 264 of the 332 participants were presented with a series of $100/$106 investment decisions. The $100/$106 investment decision series *always* contained the baseline investment decision (described below)—hence its name—and it is therefore our main decision of interest. Within each investment decision series (the $20/$24 or the $100/$106), the order of the investment decisions that individuals faced was random. Figure 3 below illustrates the different sessions we ran:

Figure 3: "Type One" and "Type Two" Sessions



In Type One sessions, all participants were paid for their first-stage choice decisions by implementing one of their choice decisions at random. One participant in each Type One session was selected at random at the end for payment in the $100/$106 investment decisions.

For that person, one investment decision was selected at random and implemented for payment. The selected participant was announced immediately after all participants in the session completed their investment decision series. Average earnings were $35.4, including the payment for the investment decision.

In Type Two sessions, all participants were paid a fixed fee for their first-stage choice decisions—either $20 or $24, depending on the frame—which was then the basis for their $20/$24 investment decisions. Earnings from Type Two sessions excluding the $100/$106 investment decisions were $23.0 on average; average earnings in the Type Two sessions that included the $100/$106 investment decisions were approximately $35.[3]

2.1. Baseline Decision

The baseline investment decision was to allocate the endowment—either $100 or $106, depending on the frame—between a safe portfolio with a sure return and a risky portfolio with three possible rates of return; each could occur with equal probability. Below are the exact parameters of the portfolios for the baseline investment decision, by frame:

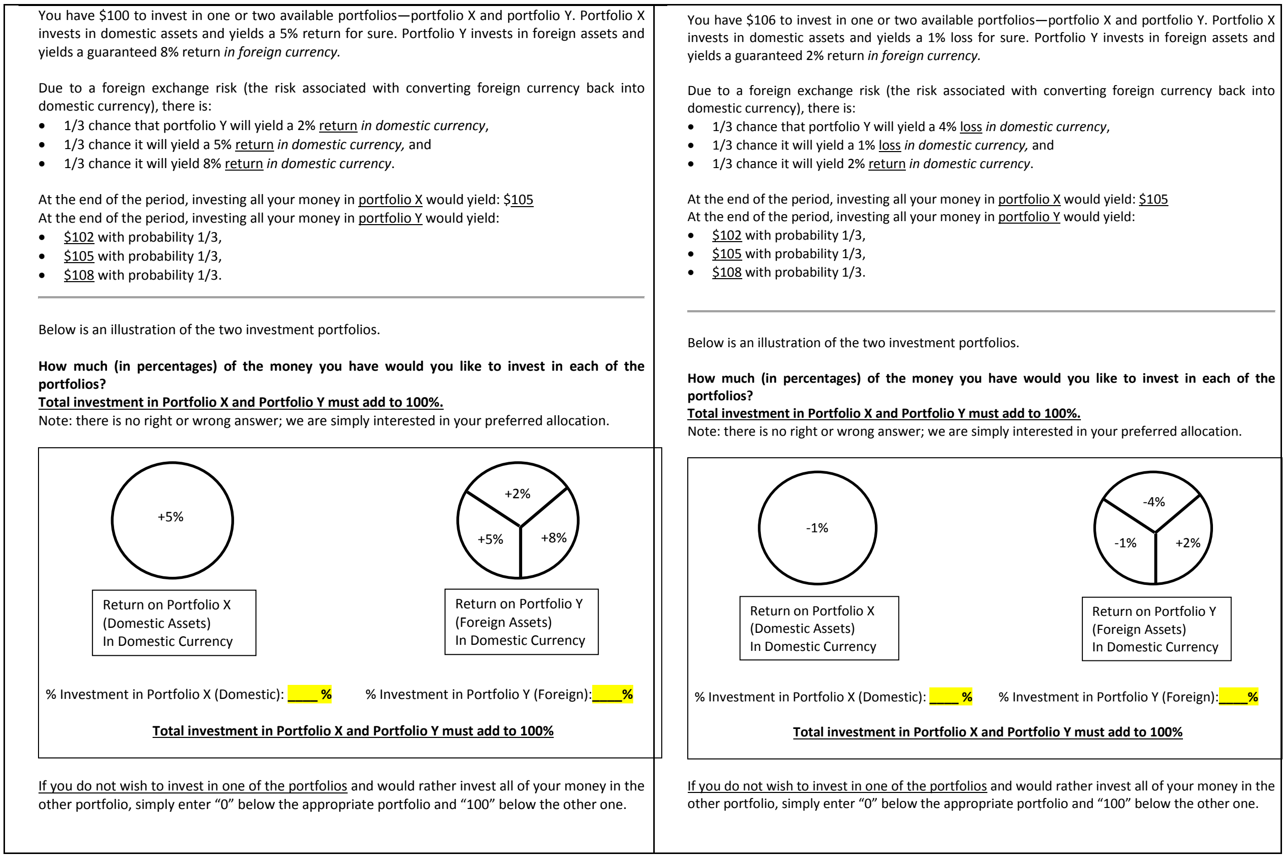
- **Negative frame:**
    - The domestic "safe" portfolio yields a sure return of -1 percent, and
    - The foreign "risky" portfolio yields (-4 percent, -1 percent, 2 percent) with equal probability.
- **Positive frame:**
    - The domestic "safe" portfolio yields a sure return of 5 percent, and
    - The foreign "risky" portfolio yields (2 percent, 5 percent, 8 percent) with equal probability.

Since those in the negative frame were given $106 to invest, and those in the positive frame were given $100 to invest, in both frames investing all the money in the safe portfolio would

[3] About half of the Type One sessions had the investment decisions made using paper-and-pencil, and the other half had the investment decisions programmed on the computer using z-tree (Fischbacher 2007). The $20/$24 investment decisions in the Type Two session were all made on the computer using z-tree (Fischbacher 2007). There was no significant difference in the $100/$106 investment decisions based on whether they were made on paper or via the computer.

yield \$105, and investing all the money in the risky portfolio would yield \$102, \$105, or \$108 with 1/3 probability. That is, in the baseline investment, the safe portfolio's return is exactly the expected return of the risky portfolio. The decision text is shown in Figure 4.

Figure 4: Investment Decisions—Positive and Negative Frames



You have \$100 to invest in one or two available portfolios—portfolio X and portfolio Y. Portfolio X invests in domestic assets and yields a 5% return for sure. Portfolio Y invests in foreign assets and yields a guaranteed 8% return *in foreign currency.*

Due to a foreign exchange risk (the risk associated with converting foreign currency back into domestic currency), there is:

- 1/3 chance that portfolio Y will yield a 2% return *in domestic currency*,
- 1/3 chance it will yield a 5% return *in domestic currency*, and
- 1/3 chance it will yield 8% return *in domestic currency*.

At the end of the period, investing all your money in portfolio X would yield: \$105
At the end of the period, investing all your money in portfolio Y would yield:

- \$102 with probability 1/3,
- \$105 with probability 1/3,
- \$108 with probability 1/3.

Below is an illustration of the two investment portfolios.

How much (in percentages) of the money you have would you like to invest in each of the portfolios?
Total investment in Portfolio X and Portfolio Y must add to 100%.
Note: there is no right or wrong answer; we are simply interested in your preferred allocation.

% Investment in Portfolio X (Domestic): ____% % Investment in Portfolio Y (Foreign): ____%

Total investment in Portfolio X and Portfolio Y must add to 100%

If you do not wish to invest in one of the portfolios and would rather invest all of your money in the other portfolio, simply enter "0" below the appropriate portfolio and "100" below the other one.

You have \$106 to invest in one or two available portfolios—portfolio X and portfolio Y. Portfolio X invests in domestic assets and yields a 1% loss for sure. Portfolio Y invests in foreign assets and yields a guaranteed 2% return *in foreign currency.*

Due to a foreign exchange risk (the risk associated with converting foreign currency back into domestic currency), there is:

- 1/3 chance that portfolio Y will yield a 4% loss *in domestic currency*,
- 1/3 chance it will yield a 1% loss *in domestic currency*, and
- 1/3 chance it will yield 2% return *in domestic currency*.

At the end of the period, investing all your money in portfolio X would yield: \$105
At the end of the period, investing all your money in portfolio Y would yield:

- \$102 with probability 1/3,
- \$105 with probability 1/3,
- \$108 with probability 1/3.

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Total investment in Portfolio X and Portfolio Y must add to 100%

If you do not wish to invest in one of the portfolios and would rather invest all of your money in the other portfolio, simply enter "0" below the appropriate portfolio and "100" below the other one.

2.1.1. Results

Does Investment Differ between the Loss and the Gain Domain?

Figure 5 presents two histograms of investment in the foreign portfolio, one under each frame. Zero means investing all of the funds in the domestic "safe" portfolio; One hundred means investing all of the funds in the foreign "risky" portfolio. The average allocation to the lottery is 48.5 percent under the positive frame and 51.8 percent under the negative frame (p=0.488), and there is no evidence that the distribution of investment shares in the foreign "risky" decision across the two frames is statistically different (Mann-Whitney test p=.49). Controlling for attitudes toward risk (this is the switching point where an individual chooses a sure amount over a lottery in the first stage) and for sex and number of participants in each session, there is still no significant difference across the two frames. This result holds when grouping investment into three groups—investing "less than," "exactly," or "more than" 50 percent in the risky portfolio (Portfolio Y). Tables 1 and 2, show the results.[4]

Figure 5: Investment Distribution by Frame

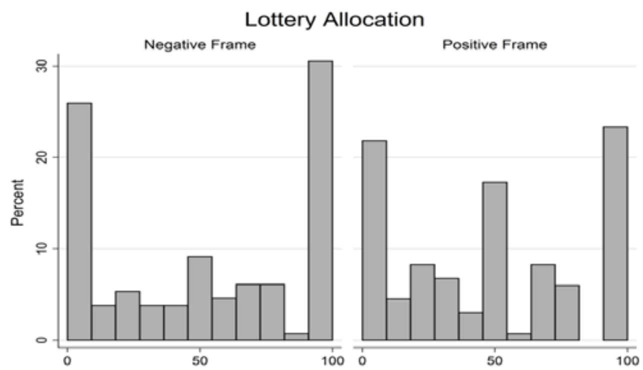


Table 1: OLS Regression of Percentage Investment in the Risky Asset

Positive Frame (=1)	-3.070
	(4.80)
Sex	-4.146
	(5.01)
Proxy for Risk Attitudes [first stage]	-0.082
	(1.18)
Number of Participants in a session	-0.074
	(0.54)
Constant	60.221***
	(16.77)
Observations	264
R-squared	0.00

Notes: Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

[4] The results are similar when we restrict attention to Type One sessions only.

Table 2: Ordered Probit Regression on Investing Less than/Exactly/More than 50 Percent in the Risky Asset

Positive Frame (=1)	-0.142
	(0.15)
Sex	-0.068
	(0.15)
Proxy for Risk Attitudes [first stage]	-0.010
	(0.04)
Number of Participants in a session	-0.006
	(0.02)
Observations	264
Pseudo R-squared	0.00

Notes: Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Examining the distribution of investment in the risky portfolio, almost 50 percent of the participants invested some fraction of their money, but not all, in the risky portfolio. In fact, the distribution seems uniform in the (0,100) range, excluding 0 and 100, and the average investment in the lottery is not statistically different from 50 percent, which suggests risk-neutrality on average (p=0.65 in the gain domain and p=0.60 in the loss domain).

Risk Attitudes

To look further into attitudes toward risk in this type of investment decision, the investment decision series that was given to 86 of the 264 participants included investment decisions with the same risky portfolios (lotteries) as the baseline lottery, but with a different sure rate of return of the safe "domestic" portfolios—from -3 to 1 percent in the negative frame, and from 3 to 7 percent in the positive frame. That is, in some decisions the sure return was higher than the expected return of the lottery, and in others it was lower. We use the results to find the switching point between investing mainly in the risky portfolio or mainly in the safe portfolio and hence to learn about attitudes toward risk in this environment.

The results are presented in Table 3 below. Before examining attitudes toward risk, it is important to note that these results confirm the "no-framing" result in investment decisions with alternative sure returns.

Turning to examine investment decisions where the sure return is either higher or lower than the expected return of the lottery, we find that the average investment in the risky portfolio increases to 75–79 percent when the sure return is lower than the expected return of the lottery, at -2 percent in the negative frame and 4 percent in the positive frame (recall that the lottery's expected return is -1 percent in the negative frame and 5 percent in the positive frame). When the return of the sure domestic portfolio is even lower, with -3 percent and 3 percent in the negative and positive frame, respectively, 91 percent of participants in the loss domain and gain domain invest all of their money in the lottery. Moreover, all but one person invested at least 50 percent in the lottery.

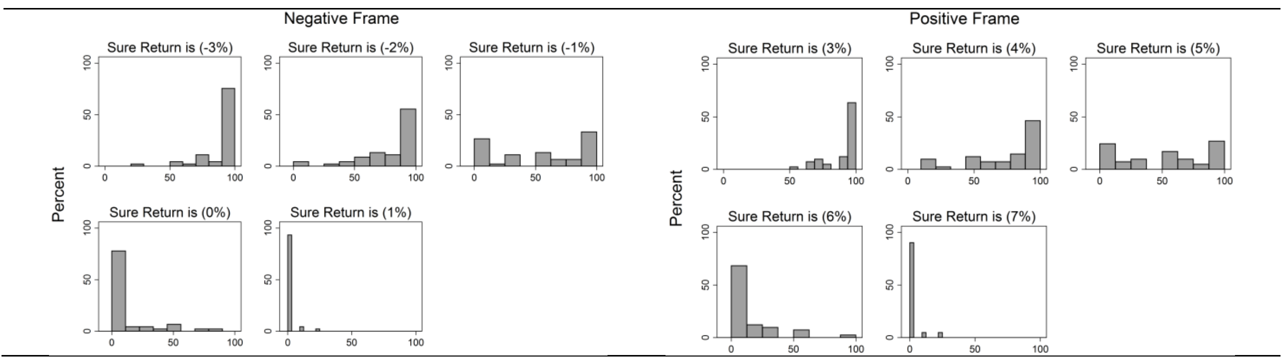
On the flip side, when the return of the sure portfolio is higher than the expected return of the risky portfolio, there is an immediate switch to withdrawing investment from the risky portfolio: when the alternative sure return is 0 percent in the negative frame and 6 percent in the positive frame, the average investment in the lottery is 11–12 percent and the median investment share in the lottery is 0. Specifically, 73 percent of participants in the negative frame and 59 percent of participants in the positive frame do not invest *at all* in the risky portfolio. When the sure return is even better, with 1 percent in the negative frame and 7 percent in the positive frame, over 90 percent of participants invest *all* their money in the sure portfolio and none in the lottery, regardless of the frame.

Table 3: Investment Share in the Risky Portfolio

Decision			**Baseline**		
Sure Return Negative Frame	(-3%)	(-2%)	(-1%)	(0%)	(+1%)
Sure Return Positive Frame	(+3%)	(+4%)	(+5%)	(+6%)	(+7%)
Negative Frame (N=45)					
Mean	90.80	79.49	54.57	10.56	1.00
Median	100	90	60	0	0
Positive Frame (N=41)					
Mean	91.02	75.32	50.15	12.07	1.71
Median	100	80	50	0	0
Ttest	P=0.4200	P=0.8744	P=0.0950	P=0.0977	P=0.3061
Mann-Whitney	P=0.2778	P=0.8468	P=0.0997	P=0.1273	P=0.2187

The results suggest that individuals follow the portfolio with the highest expected return, and hence the spread of investment when the sure return exactly equals the expected return of the lottery may be interpreted as risk-neutrality. The speed with which participants switch to the safe portfolio when its return is higher than the expected return of the lottery seems greater than the speed of the switch to the lottery when the sure alternative is worse (see Figure 6). Examining investment share in the highest-yield portfolio (that is, where 100 percent represents investing all in the highest-yielding portfolio), we can test whether the investment reaction is different depending on which portfolio—the risky or the sure return—has the higher (expected) return. Contrasting the two decisions with the sure return alternative being lower (-2 percent, 4 percent) vs. higher (0 percent, 6 percent) than the expected lottery return, we find that indeed 66 percent of individuals invest all their endowment in the sure return when it is higher than the expected lottery return (0 percent, 6 percent), while the corresponding share investing all their endowment in the lottery when the lottery has a higher expected return (-2 percent, 4 percent) is only 42 percent. Moreover, we find that the investment distributions are significantly different (Mann-Whitney, p=0.001), with the average share invested in the sure return at 89 percent when the sure return is higher (0 percent, 6 percent) and the average share invested in the lottery at 76 percent when the lottery has the higher expected return (p=0.003). This evidence supports, if anything, risk-aversion in both the gain and the loss domains.

Figure 6: Investment Distribution by Frame and Sure Return Alternative



2.2. Using Different Lotteries

The null result of finding no framing effect and mostly risk-neutrality in investment decisions is surprising. This raises the question whether this result holds generally or whether it is an artifact of the lottery used. To test for this hypothesis, the 86 participants were also presented with investment decisions using a different lottery: (-6 percent, 1 percent, 2 percent) in the negative frame and (0 percent, 7 percent, 8 percent) in the positive frame. Table 4 presents the investment results at different alternative sure returns.

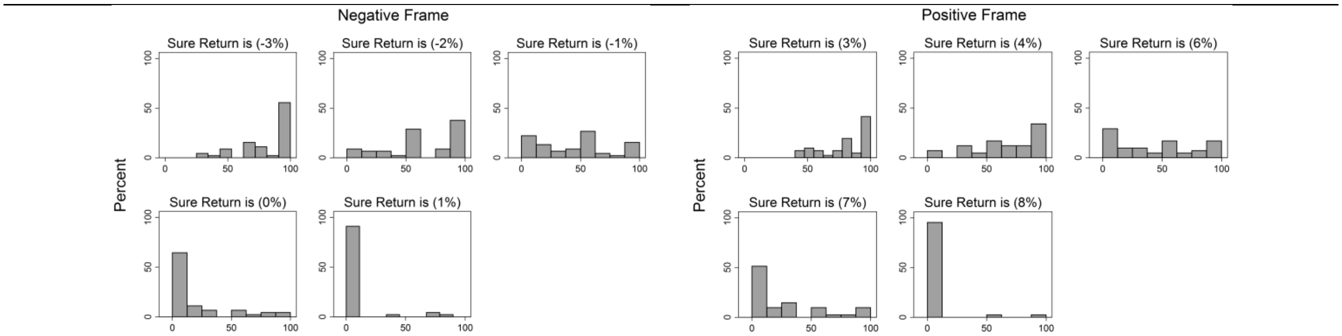
Table 4: Investment Share in the Risky Portfolio, Using an Alternative Lottery

Decision	10	9	6	7	8
Sure Return Negative Frame	(-3%)	(-2%)	(-1%)	(0%)	(+1%)
Sure Return Positive Frame	(+3%)	(+4%)	(+5%)	(+6%)	(+7%)
Negative Frame (N=45)					
Mean	83.40	64.76	42.58	17.22	6.11
Median	100	60	40	0	0
Positive Frame (N=41)					
Mean	80.51	65.39	42.15	24.78	3.78
Median	80	70	40	10	0
Ttest	P=0.5285	P=0.9270	P=0.9541	P=0.2533	P=0.5725
Mann-Whitney	P=0.4018	P=0.8916	P=0.9199	P=0.1513	P=0.7775

Again, we find no framing effect regardless of the alternative sure return, and we find evidence of risk-aversion in both the loss and the gain domains. This can be seen by examining the median and mean investments in the lottery when the sure return equals and when it is worse than the expected lottery return. While the median and mean investments in the lottery when the sure return equals the expected lottery return are insignificantly different from 50 percent, the point estimates are 40 and 42–43 percent, respectively, regardless of the frame. And when the sure return is lower than the expected return from the lottery, the mean and median investments in the lottery are statistically different from 100 percent (p=0.00, in either frame).

Testing whether investment in the highest-return portfolio is the same, whether it be the sure return (as in the case of 0 percent or 6 percent sure return) or the lottery (as in the case of -2 percent or 4 percent sure return), we find that the investment distribution in the highest-return portfolio is sensitive to whether it is the sure return that is higher or the lottery (p=0.001). The average share investing in the highest-return portfolio is 79 percent when the sure return is higher (0 percent, 6 percent), but only 65 percent when the lottery's return is higher (-2 percent, 4 percent); this difference is significant (p=0.003), and the detailed investment distributions are shown in Figure 7. In other words, we confirm the results showing no framing effect and showing attitudes toward risk that are consistent with either risk-neutrality or risk-aversion, but definitely showing no evidence of risk-seeking.

Figure 7: Investment Distribution by Frame and Sure Return Alternative, Alternative Lottery



2.3. Risk-Seeking in the Loss Domain?

In the baseline investment decision one has to allocate money between a lottery and a risk-free yield with equal expected returns. In this case, the investment shares are distributed along the entire spectrum, which suggests risk-neutrality. The additional investment decisions, keeping the baseline lotteries but using different sure returns, provide some support for risk-aversion. None of the decisions, whether in the loss or the gain domain, suggest risk-seeking. This was also shown to hold true using an alternative lottery (see Section 2.2).

However, the investment decisions in the loss domain where the sure return is negative show the sure return being either equal to or lower than the expected lottery return, as is the case of -2 percent vs. the base-line lottery of (-4 percent, -1 percent, 2 percent). Since the return of the sure amount is not better than the expected return of the lottery, positive investment in the lottery in this case cannot reveal risk-seeking and is also consistent with, for example, risk-neutrality.

In the proper test for risk-seeking, the sure return should be negative yet higher than the expected return of the lottery. If, in such an environment, individuals preferred the lottery, this would be a clear indication of risk-seeking. If they preferred the sure amount, however, this would be consistent with either risk-aversion or risk-neutrality. We construct such a decision environment by doubling the lotteries' possible returns in the loss domain (negative frame). Specifically, in the positive frame the potential lottery returns are (-2 percent, 4 percent, 10 percent), and in the negative frame they are (-8 percent, -2 percent, 4 percent). There were two sets of decisions:

- **Negative frame:** decisions between (-8 percent, -2 percent, 4 percent) and either -2 percent or -1 percent sure returns.
- **Positive frame:** decisions between (-2 percent, 4 percent, 10 percent) and either 4 percent or 5 percent sure returns.

The first decision in each set is between a lottery and its expected return, similar in structure to the baseline decision; the second is an investment decision between a lottery and a sure return that is greater than the expected lottery return, and in the loss domain the sure return is negative. The main point of interest is the latter investment in the loss domain, with the (-8 percent, -2 percent, 4 percent) lottery and the -1 percent sure return.

Two-hundred participants were presented with these investment decisions; the results are shown in Table 5 below.

Table 5: Investment Share in the Risky Portfolio, Doubled Returns

Decision	**Original Setup**	**Doubled Returns**	
Sure Return Negative Frame	(-1%)	(-2%)	(-1%)
Sure Return Positive Frame	(+5%)	(+4%)	(+5%)
Negative Frame (N=100)			
Mean	51.67	36.55	18.08
Median	50	30	0
Positive Frame (N=100)			
Mean	49.17	43.53	25.93
Median	50	50	10
Ttest	P=0.6442	P=0.1630	P=0.0658
Mann-Whitney	P=0.6978	P=0.0952	P=0.0173

Focusing on the last column of Table 5, which presents the investment share in the lottery for the main case of interest (where the sure return is better than the expected lottery return but is negative in the loss domain), we find that the median and mean shares of investment in the lottery in the loss domain are 0 and 18 percent, respectively. In the gain domain, the median and mean shares of investment in the lottery are low, but are greater than in the loss domain, at 10 and 26 percent, respectively. While the average investment in the lottery is significantly greater than zero under both frames (p=0.00), we find that 58 percent invest nothing in the lottery in the loss domain and 40 percent invest nothing in the gain domain. The difference in investment distributions across frames is significant (p=0.02), with the direction being opposite to Prospect Theory's prediction. That is, we find *less* average investment in the lottery in the loss domain than in the gain domain (p=0.066).

2.4. Mixed Lotteries

Thus far, in all the investment decisions in the loss domain the lotteries were mixed, with both positive and negative returns. Since risk-aversion is thought to be the highest when faced with mixed lotteries due to loss-aversion (Kahneman and Tversky 1979), the no-framing result and the no-risk-seeking in the loss domain may be a result of using mixed lotteries.[5] To test this hypothesis, 114 participants were presented with the following investment decisions using non-mixed lotteries only:

- **Negative Frame:** -2 percent vs. (-1 percent, -2 percent, -3 percent), and -3 percent vs. (-2 percent, -4 percent, -6 percent)
- **Positive Frame:** 4 percent vs. (3 percent, 4 percent, 5 percent), and 3 percent vs. (0 percent, 2 percent, 4 percent)

Note that in the negative domain the possible returns in one of the lotteries are exactly twice the returns in the other lottery. This allows us to test, as in Section 2.3., for risk-seeking in the loss domain, since we can ask whether individuals prefer the lottery over the sure return when the latter is better than former but is nevertheless negative. Table 6 below shows the results: examining the first set of lotteries we find no framing effect and risk-neutrality on average (two-sided *t*-test for even split of funds, p=0.33 in the loss domain, and p=0.17 in the gain domain), confirming past results. When presented with the second set of investment decisions, where the sure return alternative is greater than the expected return of the lottery, we find that while the median investment in the lottery is zero in both the negative and the positive frames, the average investment in the lottery is significant (p=0.00 for each frame) and significantly higher in the positive frame (p=0.01). Indeed, we find that while 69 percent do not invest at all in the lottery in the loss domain, only 52.5 percent do so in the gain domain. This suggests greater risk-taking in the *gain* than in the loss domain, opposite to the hypothesis based on Prospect Theory.

[5] It should be noted that this may not always be the case. Curiously, Slovic et al. (2002) and Yechiam and Hochman (2013) find that adding a loss to a gamble may actually increase its likelihood of being selected.

Table 6: Investment Share in Non-Mixed Risky Portfolio

Decision	Set I	Set II
Sure Return Negative Frame	(-2%)	(-3%)
Sure Return Positive Frame	(+4%)	(+3%)
Negative Frame (N=55)		
Mean	55.36	10.82
Median	50	0
Positive Frame (N=59)		
Mean	56.86	26.81
Median	50	0
Ttest	P=0.8382	P=0.0065
Mann-Whitney	P=1.0000	P=0.0218

Putting this result in terms of European investors thinking of investing in European and U.S. government bonds, this means that when the rate of return in Europe is negative, the share of investment in the United States would be either the same or *lower* than European investment in the United States when the returns on European bonds are positive, holding constant the rate differentials across countries.

2.5. Discussion

In this experiment we used a realistic return schedule (sure loss of 1 percent) and exchange rate risk, real money was at stake, and the design allows for a clean comparison of the effect of framing; that is, it enables us to see whether the negative returns lead to an excessive reaction above and beyond the return gap across assets.

In spite of having real money at stake, it is possible that individuals view the investment money as "house money" (Thaler and Johnson 1990) and would therefore have reacted differently if they were making a decision to allocate their own money—amounts that they had already earned. Another possibility is that, in spite of using relatively large stakes of over $100, these amounts may not be enough. Perhaps with higher stakes, the framing effect would emerge and individuals would take more risks in the loss domain.

There are other issues that may drive these results and the departure from the standard results in the literature. For example, the investment decision is an allocation decision with a continuous decision variable, while in most past studies the decision is a choice decision of picking either the sure amount or the lottery. The question is: if we were to present individuals with a discrete choice, would framing effects emerge?

Furthermore, it is possible that the foreign versus domestic assets labels had an effect and that the three-state lottery is too complex. Although these aspects of the investment decision are definitely relevant to actual investments, we nevertheless test whether the null result stems from these properties or whether it applies more generally to investment decisions that we consider. We test these various concerns in Sections 3–5, next.

3. Continuous vs. Discrete Choice

To test the sensitivity of our results to having continuous rather than discrete decision settings, 45 of our participants were presented with a discrete version of a subset of the investment decisions they were given in the same session; in the discrete version, the order in which they saw the decisions was randomized. In these discrete decisions, subjects were simply asked to choose the lottery *or* the sure amount, by checking a box below the choice they preferred. We limit the analysis in this section to participants who were facing both a continuous and a discrete version of the same investment decisions to test whether the continuous nature of the investment decisions plays a role in the null result. Below are the three sets of investment decisions for which we also created a discrete decision analogy:

- Set I: **Positive frame**: 4 percent vs. (-2 percent, 4 percent, 10 percent); **Negative frame**: -2 percent vs. (-8 percent, -2 percent, 4 percent)
- Set II: **Positive frame**: 5 percent vs. (-2 percent, 4 percent, 10 percent); **Negative frame**: -1 percent vs. (-8 percent, -2 percent, 4 percent)
- Set III: **Positive frame**: 5 percent vs. (2 percent, 5 percent, 8 percent); **Negative frame**: -1 percent vs. (-4 percent, -1 percent, 2 percent)

Table 7: Investment Share in the Risky Portfolio, Continuous vs. Discrete Choice

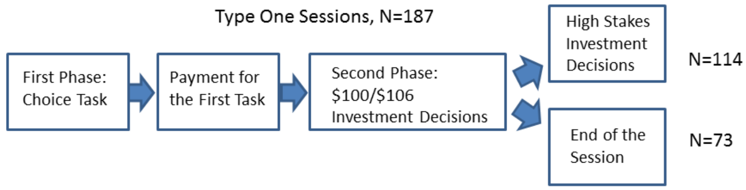
Decision	**Set I**		**Set II**		**Set III**	
Continuous (C) or Discrete (D)	C	D	C	D	C	D
Negative Frame (N=23)						
Mean	16.30	34.78	6.87	4.35	41.04	39.13
Median	0	0	0	0	34	0
Positive Frame (N=22)						
Mean	33.27	50	17.05	9.09	50.09	45.45
Median	35	50	0	0	50	0
Ttest (P-value)	0.0419	0.3124	0.1018	0.5345	0.4475	0.6762
Mann-Whitney (P-value)	0.0767	0.3070	0.2106	0.5284	0.4086	0.6712

We find that using the continuous rather than the discrete allocation decision cannot be the reason for the null effect, as even the weak evidence of a framing effect (found in the continuous decisions of Set I), was eliminated in the discrete choice. Regression analysis (not reported) confirms this result and shows that it also holds if we categorize the continuous investment decision into two groups, such that investing more than 50 percent in the lottery is classified as "picking the lottery" and investing less than 50 percent is classified as "picking the sure return," and regardless of whether investing exactly 50 percent is coded in the top or the bottom group.

4. High Stakes

To test whether the results hold with even higher stakes, 114 Type One participants were given a variant of the baseline investment decision with a non-mixed lottery and with large sum of money at stake—either $1,000 or $1,060, depending on the frame. The investment decision was identical to an investment decision these participants had been given with the lower stakes of $100 or $106, only with a minor adjustment due to the stakes (0.1 percent difference): 4 percent vs. (3 percent, 4 percent, 5 percent) in the positive frame, and -1.9 percent vs. (-2.9 percent, -1.9 percent, -1 percent) in the negative frame. This high-stakes investment decision appeared at the end, after concluding all other investment decisions (see Figure 8 for an illustration).

Figure 8: Session Flow, High-Stakes Investment Decisions



The reason for having these high-stake decisions at the end was to avoid contaminating the other investment decisions, so that they would be comparable to the investment decisions completed by participants in the other sessions. Moreover, payment for the high-stakes investment decision was separate and different from the payment for the other investment decisions: each participant in the high-stakes sessions received a business card (Bracha's) with a unique random number marked on it. Once all the high-stakes sessions were over, one participant of all the 114 participants was randomly selected by drawing a number from all the numbers distributed; this number was announced by email and the selected person came back to the lab with the card to cash in his earnings. This procedure was clearly explained before engaging in the high-stakes decision, after all the other decisions had been made.

The high-stakes investment decision was virtually the same as one of the investment decisions each of the 114 participants had encountered before, only with different stakes (and a minor adjustment). We can therefore directly compare the effect of stakes on investments. Table 8 below presents the investment decision by frame and by stakes.

Table 8: Investment Share in the Risky Portfolio, Medium and High Stakes

Decision	**$100**	**$1,000**
Sure Return Negative Frame	(-2%)	(-1.9%)
Sure Return Positive Frame	(+4%)	(+4%)
Negative Frame (N=55)		
Mean	55.36	48.73
Median	50	50
Positive Frame (N=59)		
Mean	56.86	59.58
Median	50	50
Ttest	P=0.8382	P=0.1321
Mann-Whitney	P=1.0000	P=0.1578

The results indicate no significant difference in investment behavior across frames even when the stakes are high (two-sided *t*-test for differences in average investment share, p=0.132). While insignificant, it is interesting nonetheless to examine the average investment in the risky portfolio (lottery): when stakes are high, the investment in the risky portfolio is 49 percent in the loss domain and 60 percent in the gain domain; when stakes are lower ($100/$106), the average investment among the same group of people in the loss and in the gain domain is 56 and 57 percent, respectively. That is, the gap seems to widen with higher stakes, reducing the average investment in the lottery in the loss domain and increasing the investment in the risky portfolio in the gain domain.

Examining the individual investment decision by stakes, approximately 49 percent of the people are changing their lottery investment between these two decisions ($100/$106 vs. $1,000/$1,060) under both frames. Under the positive frame, 19 percent *decrease* and 31 percent *increase* their investment in the lottery when stakes are high(er). Under the negative frame, the investment change is the opposite: 31 percent *decrease* and 18 percent *increase* their investment in the lottery when the stakes are high. Testing the average *change* in investment by frame, we find it is not significant (*t*-test, p=.1739), but the distribution of the investment *change* is (p=.0843).

The results also hold in a random-effect OLS regression analysis (Table 9) that takes into account the two investment decisions that differ only in the stakes. That is, we find: (1) no significant effect of the positive frame on lottery allocation when the stakes are $100/$106, and (2) a marginally significant positive effect of the positive frame when the stakes are high (joint test of main effect and interaction, p=0.075).

Table 9: Random Effects OLS on Lottery Allocation in Non-Mixed Decisions Medium ($100) vs. High Stakes ($1,000)

Positive Frame (=1)	3.45
	(7.18)
Sex	-5.52
	(6.67)
Proxy for Risk Attitudes	3.69**
	(1.72)
Number of Participants	0.55
	(0.90)
High Stakes ($1,000)	-6.64
	(4.91)
High Stakes ($1,000) * Positive Frame	9.35
	(6.83)
Constant	21.80
	(24.61)
Number of Subjects	114
Observations	228

Standard errors in parentheses. Models are OLS with random effects, on the lottery allocation. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5. Money on the Table

An additional important concern is that the results may be driven by individuals who were investing money that was not theirs *yet*; it is possible that the null effect of framing and no risk-seeking in the loss domain are artifacts of investing someone else's money, aka the "House Money" effect (Thaler and Johnson 1990). To test this, we use the Type Two sessions, where, following Holt and Laury's (2002) suggestion, participants earn their money. Specifically, in these Type Two sessions participants are paid a flat fee of either $20 or $24 (depending on the frame to which they were assigned) for completing the first stage with the choice tasks. Once the first stage concluded, participants were given their payment for it ($20/$24), and their payment was placed on the table in their station. Only then were participants presented with the investment decisions and asked to invest the money they had just earned—the $20 or $24—in two portfolios similar to the baseline investment decision discussed before (see the appendix for screenshots of the full experiment). There were two $20/$24 investment decisions—one with a three-state lottery and one with a simpler, two-state lottery—and in both we avoided using the portfolios' labels of foreign vs. domestic and used abstract language instead. The positive/negative decision frame was randomized at the session level, meaning that all participants in a session faced the same frame—either the positive or the negative frame.

One of the $20/$24 investment decisions was randomly selected for *each* participant and was implemented to determine the participant's pay. In the negative frame, participants were explicitly told that they could lose money; most did in fact lose money, which was then collected by the experimenter.

Since participants in these Type Two sessions invested their own money (this was literally money on the table), the stakes and yields considered in these investment decisions had to be adjusted. Specifically, the stakes were either $20 or $24 and the sure return portfolio was either a 15 percent return in the positive frame ($3 gain) or a 4.2 percent loss in the negative frame ($1 loss). The risky portfolio was either:

- **A three-state lottery:** (0 percent, 15 percent, 30 percent) returns with equal probability in the gain domain
  and (-16.7 percent, -4.2 percent, 8.3 percent) returns with equal probability in the loss domain.
  or
- **A two-state lottery:** (0 percent, 30 percent) returns with equal probability in the gain domain
  and (-16.7 percent, 8.3 percent) returns with equal probability in the loss domain.

The order of the two decisions (two-state or three-state lottery) was randomized. One-hundred-twenty-nine Harvard students participated in these Type Two sessions.

5.1. Results

Figures 9 and 10 below present the distribution of investment in the two- and three-state lottery, respectively, each for both the positive and the negative frames. Table 10 summarizes the average and median investments in the lottery and the tests for equality of investments across frames.

Figure 9: Investment Distribution by Frame, Two-State Lottery

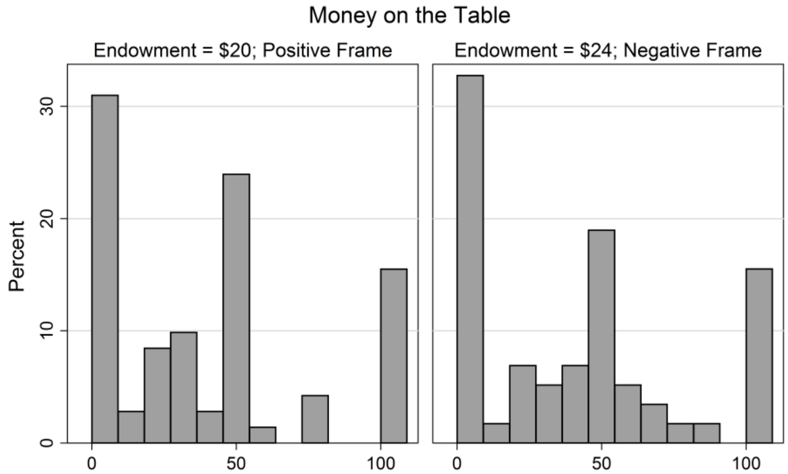


Figure 10: Investment Distribution by Frame, Three-State Lottery

Table 10: Investment Share in the Two-State and Three-State Risky Portfolios, Money on the Table

Decision	Two-State Lottery	Three-State Lottery
Sure Return Negative Frame	-4.2% vs. (-16.7/8.3%)	-4.2% vs. (-16.7/-4.2/8.3%)
Sure Return Positive Frame	+15% vs. (0/30%)	+15% vs. (0/15/30%)
Negative Frame (N=58)		
Mean	39.52	45.19
Median	40	50
Positive Frame (N=71)		
Mean	37.96	48.03
Median	35	50
Ttest	P=0.8021	P=0.6675
Mann-Whitney	P=0.8331	P=0.6519

As before, we find no significant difference in the distributions (Mann-Whitney test, p>0.65) or in the average investment in the lottery (two-sided *t*-test, p>0.66). The average investment in the lottery under the positive frame is 38–48 percent, and under the negative frame it is 40–45 percent, depending on whether the lottery is a two-state or a three-state lottery. While we find that the average investment in the risky portfolio is higher in three-state lottery investment decisions than in two-state lottery decisions, this increase is significant in the gain domain (p=0.03) but not in the loss domain (p=0.30). Combining the two frames, the average share invested in the lottery is 46.75 percent in a three-state lottery decision and 38.66 percent in a two-state lottery decision; this overall average investment share is significantly different across the two vs. three-state lotteries (p=0.02). That is, the evidence supports a higher share of investment in the more-complex lottery than in the simpler (two-state) lottery. In fact, while the results support risk-neutrality on average when investing in the three-state lottery, there is evidence for risk-aversion on average in the two-state lottery investment.[6]

However, whether there is evidence for risk-neutrality or risk-aversion, considering decisions with a two-state or three-state lottery, we consistently find no evidence for framing effects or risk-seeking.

6. Summary and Conclusions

We test the effect of gains and losses in an investment decision environment, where money is allocated across risky and risk-free portfolios and outcomes are marked in terms of rates of return. Surprisingly, we find no framing effect, meaning that the average investment share in the risky portfolio (lottery) is similar across the gain and the loss domains. This holds for investing one's own earnings, for a large range of stakes (from $20 to $1000), in both continuous and discrete versions of the decision, and whether the risky portfolio is a simple two-state lottery or a more-complex three-state lottery. We also find this null framing result whether we use mixed or non-mixed lotteries, whether the lotteries are labeled "foreign" vs. "domestic" or are labelled with abstract language instead.

[6] Testing whether the average investment share in the three-state lottery is equal to 50, p=0.30-p=0.66, depending on the frame. Testing whether the average investment share in the two-state lottery is equal to 50, p=0.00-p=0.03, depending on the frame.

Furthermore, we find no evidence for risk-seeking in the loss domain (or in the gain domain). In most instances that we analyzed investment is consistent with risk-neutrality, and in some we find evidence for risk-aversion. In fact, we mostly find risk-aversion in the loss rather than the gain domain, adding to similar recent evidence (see, for instance, Laury and Holt (2008) and Ert and Erev (2013)).

Before concluding that the predictions of Prospect Theory do not hold in the investment decision that we have considered, it is important to test the framing effect and risk-seeking in the loss domain using a typical PT question. We therefore asked a variant of Tversky and Kahneman's (1981) famous "Asian Disease" question,[7] framed in terms of employment. We asked that question to 114 of our participants and find results consistent with KT's. That is, the likelihood of choosing the lottery was higher in the loss domain, 20 percent on average compared with only 8.5 percent in the gain domain; this difference is marginally significant (p=0.078.)

We therefore conclude that in an investment decision in which outcomes are represented by a rate of return, we find no evidence of a framing effect: participants act mostly in a risk-neutral manner, and, if anything, there is some evidence of risk-aversion in the loss domain. This study therefore adds to the recent evidence on the sensitivity of attitudes toward risk to the decision environment and provides another example of a decision in which attitudes toward risk do not

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[7] KT's original question is: "Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimate of the consequences of the programs is as follows: If Program A is adopted, 200 people will be saved. If Program B is adopted, there is a 1/3 probability that 600 people will be saved, and a 2/3 probability that no people will be saved. Which of the two programs would you favor?" In the negative frame, the programs were "C" and "D" and were: "If Program C is adopted 400 people will die. If Program D is adopted, there is a 1/3 probability that nobody will die, and a 2/3 probability that 600 people will die."

Our question was framed in terms of employment: "Suppose that a firm employing 1,000 workers is facing the risk of closing down. By court order, the firm needs to adopt one of two recovery programs—Program A or Program B. If program A is adopted, 400 workers will remain employed. If Program B is adopted, there is a 33.3 percent chance that all 1,000 workers will remain employed, and a 66.6 percent chance that no worker will remain employed. Which investment would you prefer—A or B?" In the negative frame, the programs were framed as follows: "If program A is adopted, 600 workers will get laid off. If Program B is adopted, there is a 33.3 percent chance that no worker will get laid off, and a 66.6 percent chance that all the workers will get laid off. Which investment would you prefer—A or B?"

follow the pattern suggested by PT. The implication of this result is that investors may not overreact to discrepancies in rates just because some rates are negative and others are positive.

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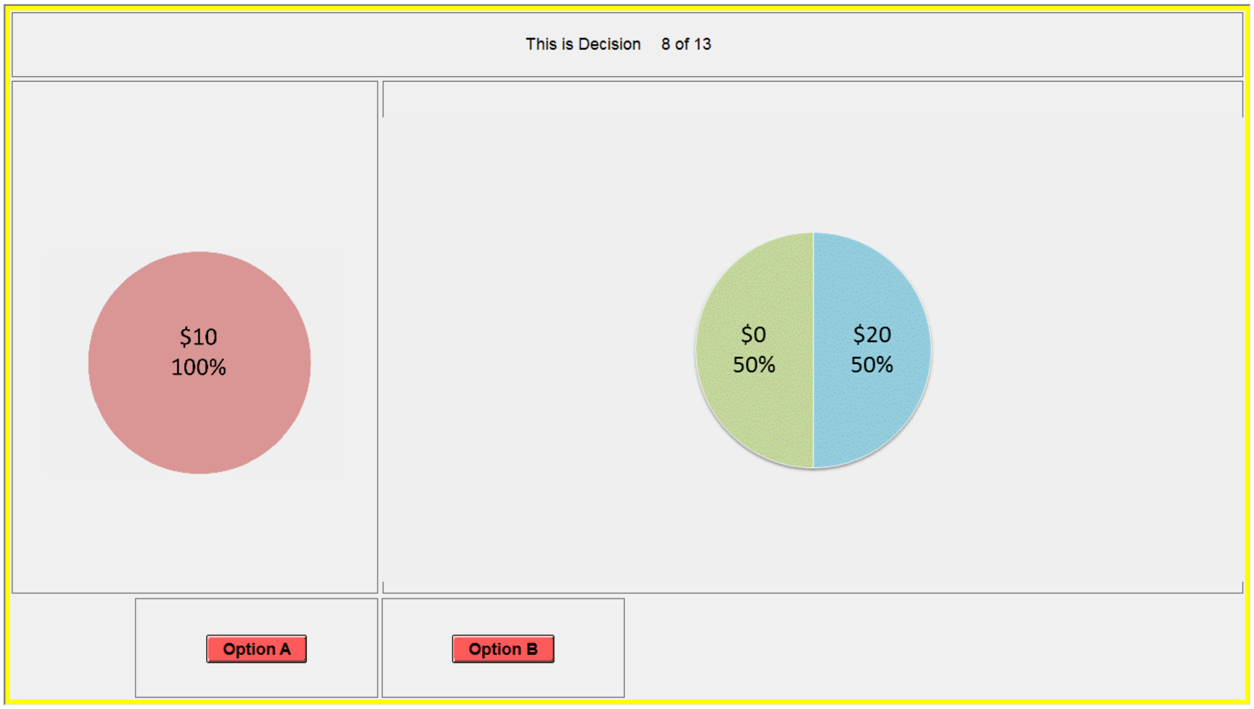
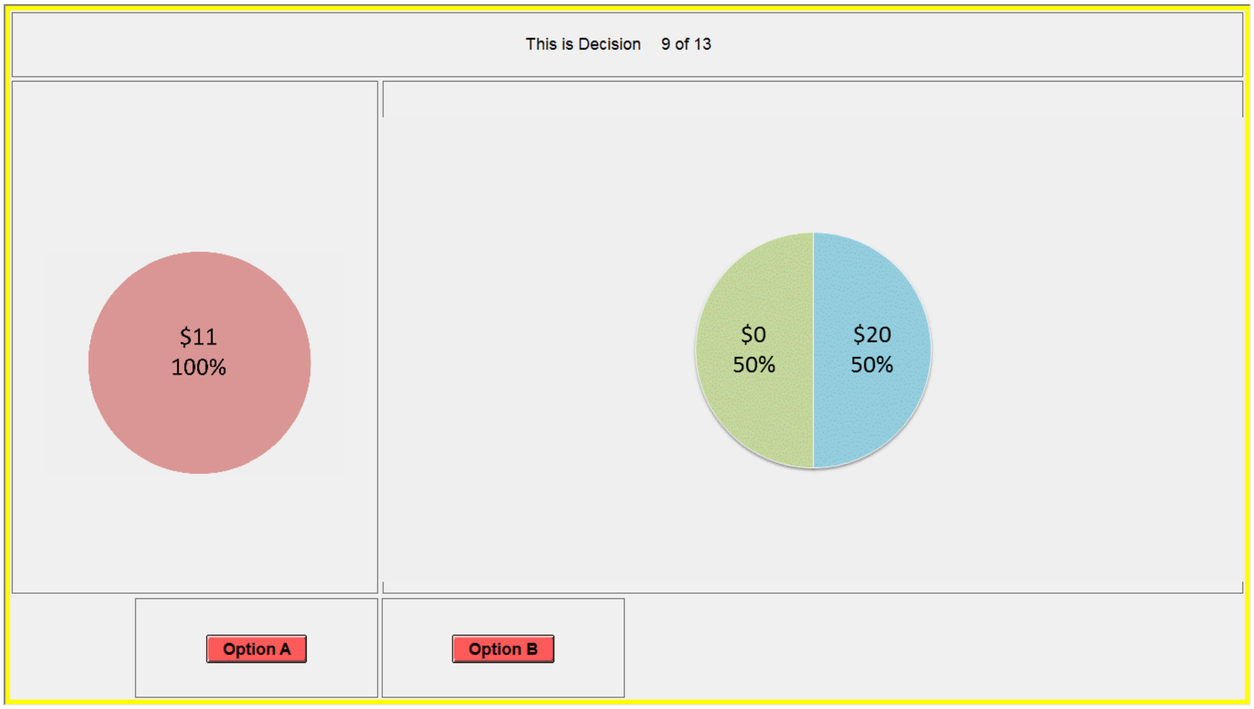
8. Appendix

A Full Description of Type Two Sessions

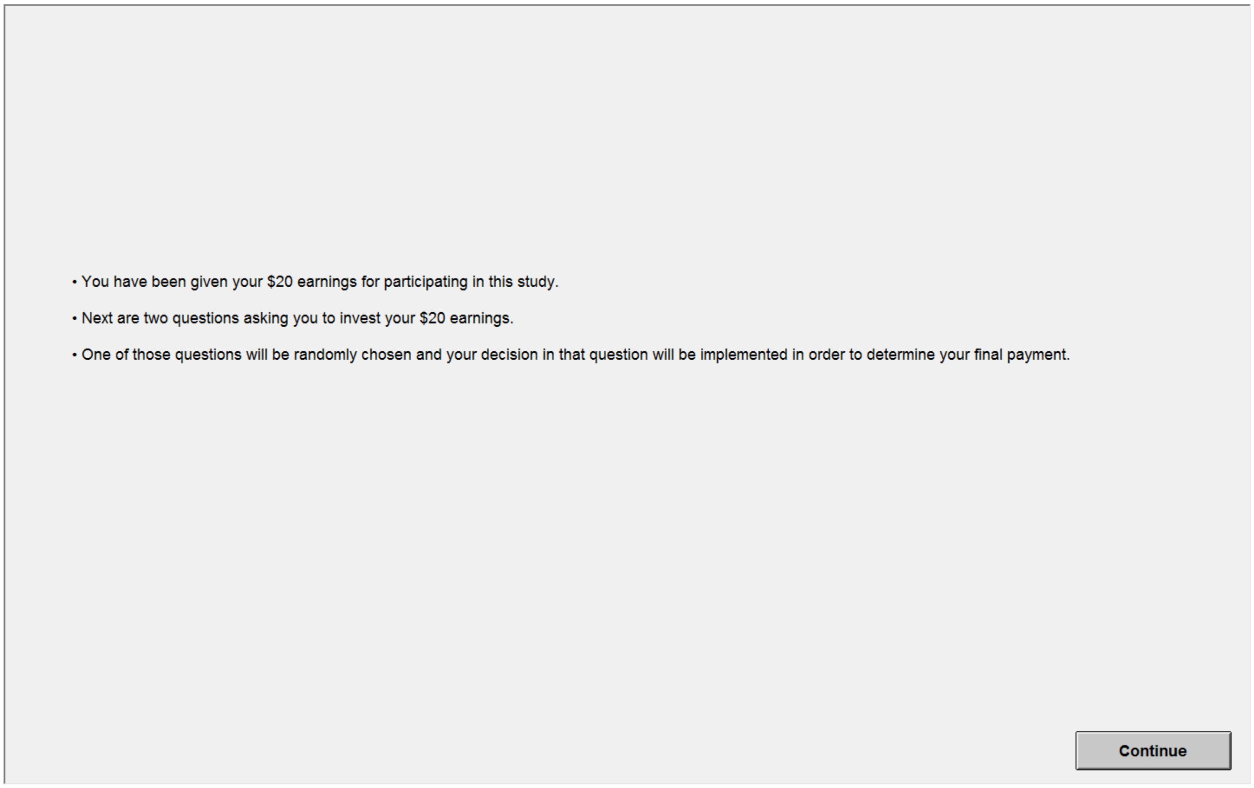
First phase–Choice Decisions





Following the first phase, we distributed the earnings for the first phase, and then launched the second phase—the investment decisions.

Positive Frame

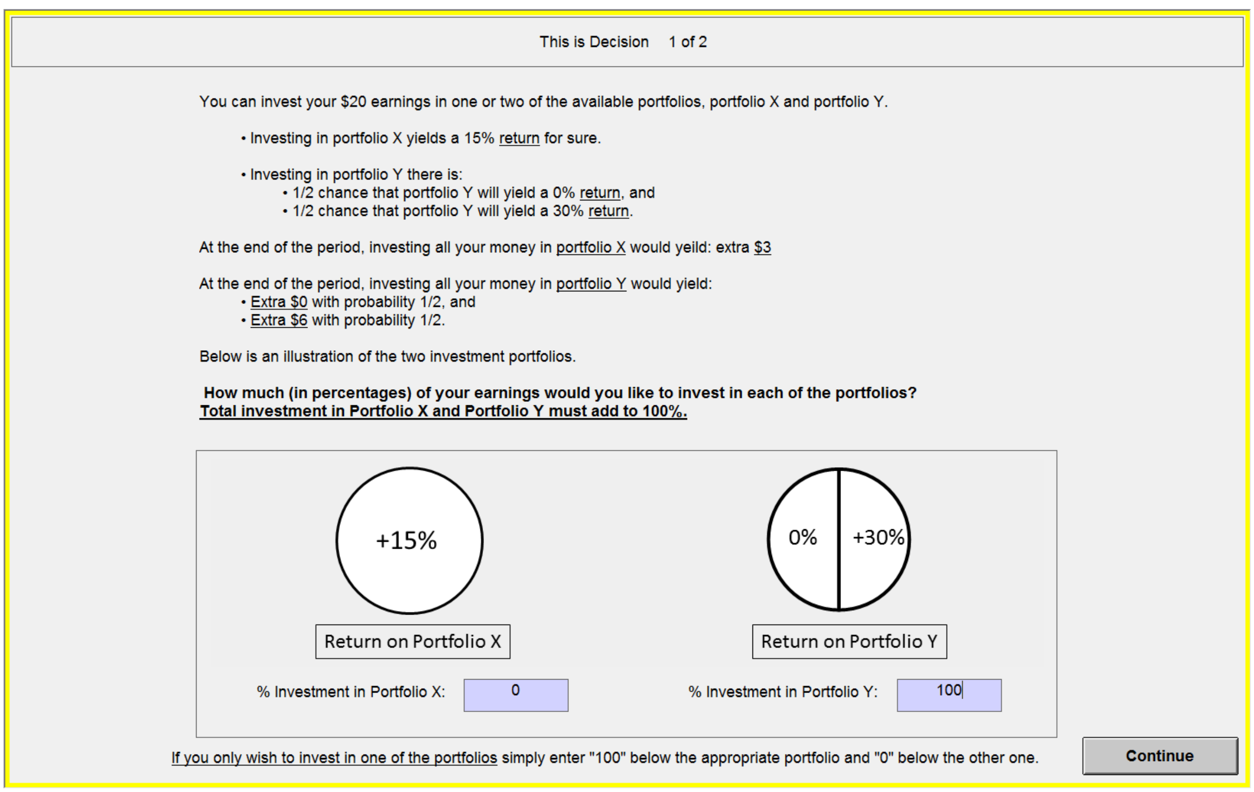


• You have been given your $20 earnings for participating in this study.

• Next are two questions asking you to invest your $20 earnings.

• One of those questions will be randomly chosen and your decision in that question will be implemented in order to determine your final payment.

Continue



This is Decision 1 of 2

You can invest your $20 earnings in one or two of the available portfolios, portfolio X and portfolio Y.

• Investing in portfolio X yields a 15% return for sure.

• Investing in portfolio Y there is:
  • 1/2 chance that portfolio Y will yield a 0% return, and
  • 1/2 chance that portfolio Y will yield a 30% return.

At the end of the period, investing all your money in portfolio X would yeild: extra $3

At the end of the period, investing all your money in portfolio Y would yield:
• Extra $0 with probability 1/2, and
• Extra $6 with probability 1/2.

Below is an illustration of the two investment portfolios.

How much (in percentages) of your earnings would you like to invest in each of the portfolios?
Total investment in Portfolio X and Portfolio Y must add to 100%.

+15%

Return on Portfolio X

% Investment in Portfolio X: 0

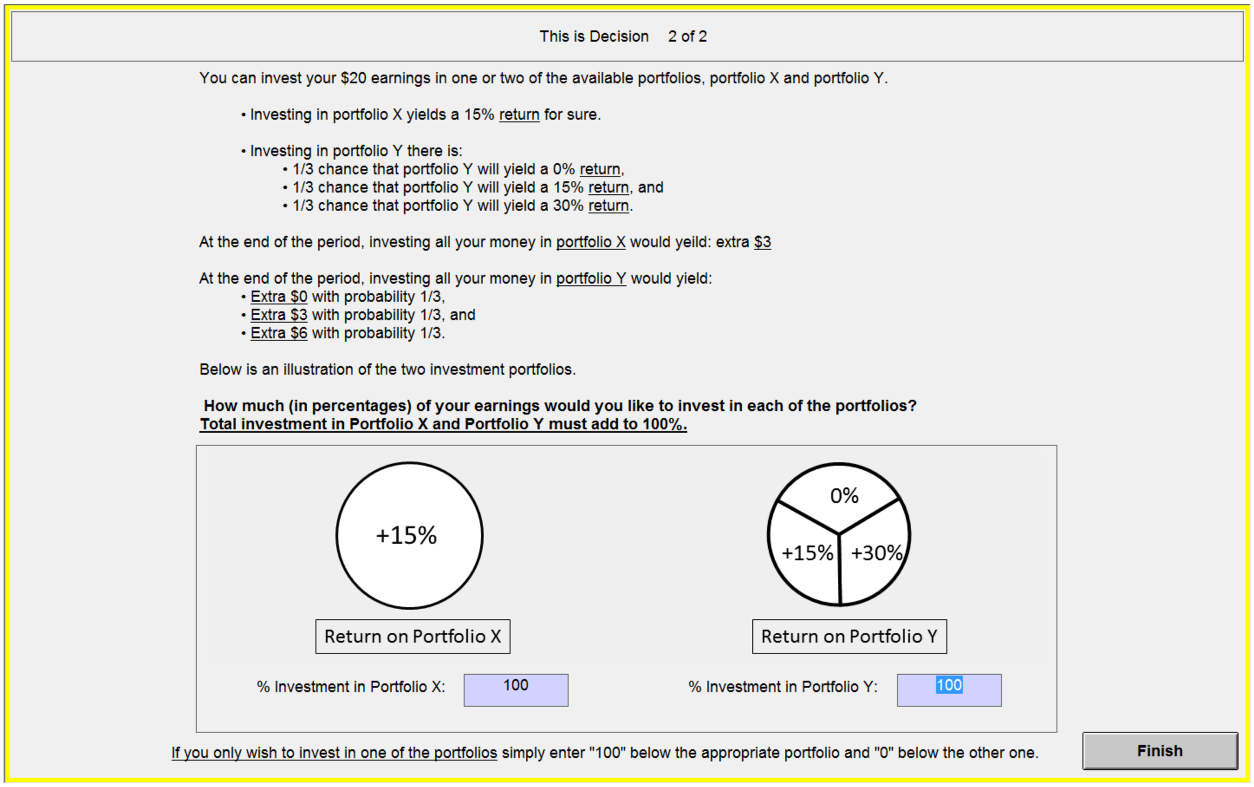
0% | +30%

Return on Portfolio Y

% Investment in Portfolio Y: 100

If you only wish to invest in one of the portfolios simply enter "100" below the appropriate portfolio and "0" below the other one.

Continue


This is Decision 2 of 2

You can invest your $20 earnings in one or two of the available portfolios, portfolio X and portfolio Y.

• Investing in portfolio X yields a 15% return for sure.

• Investing in portfolio Y there is:
  • 1/3 chance that portfolio Y will yield a 0% return,
  • 1/3 chance that portfolio Y will yield a 15% return, and
  • 1/3 chance that portfolio Y will yield a 30% return.

At the end of the period, investing all your money in portfolio X would yeild: extra $3

At the end of the period, investing all your money in portfolio Y would yield:
• Extra $0 with probability 1/3,
• Extra $3 with probability 1/3, and
• Extra $6 with probability 1/3.

Below is an illustration of the two investment portfolios.

How much (in percentages) of your earnings would you like to invest in each of the portfolios?
Total investment in Portfolio X and Portfolio Y must add to 100%.

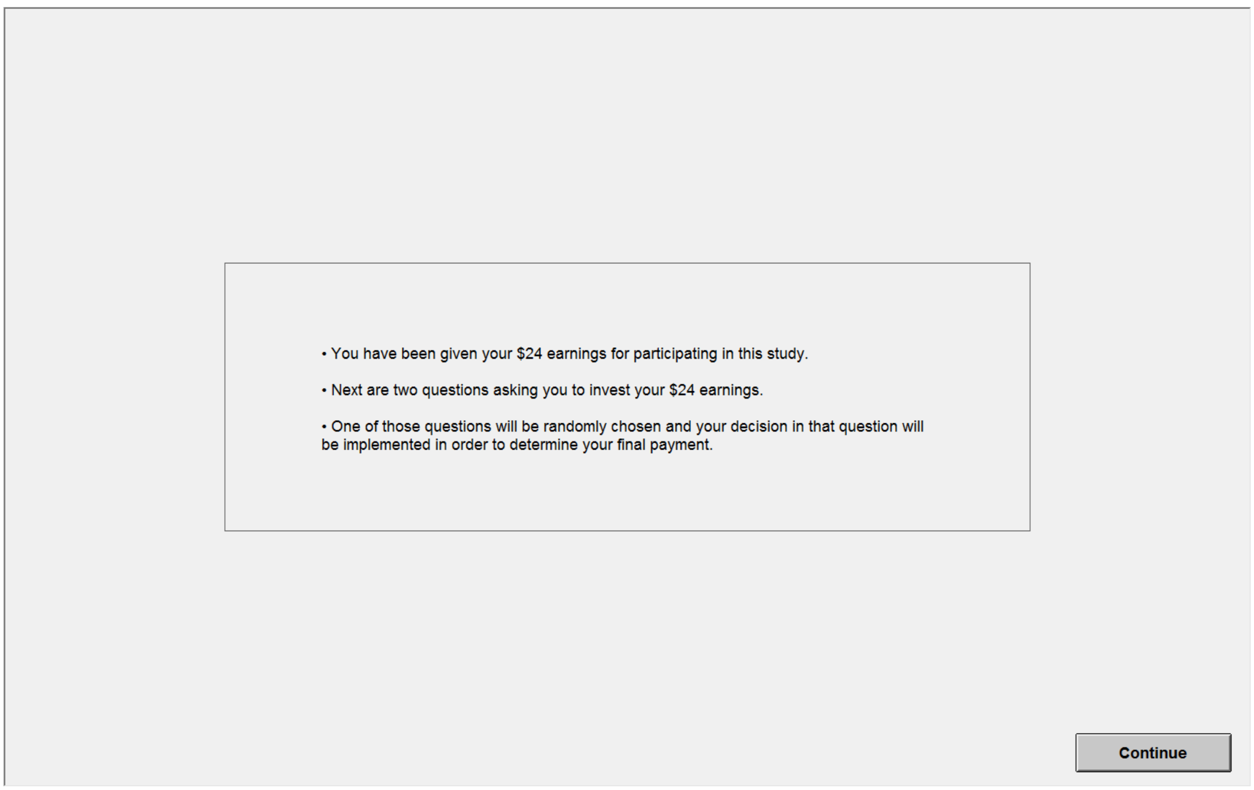
% Investment in Portfolio X: 100

% Investment in Portfolio Y: 100

If you only wish to invest in one of the portfolios simply enter "100" below the appropriate portfolio and "0" below the other one.

Finish

Negative Frame


• You have been given your $24 earnings for participating in this study.

• Next are two questions asking you to invest your $24 earnings.

• One of those questions will be randomly chosen and your decision in that question will be implemented in order to determine your final payment.

Continue

This is Decision 1 of 2

You can invest your $24 earnings in one or two of the available portfolios, portfolio X and portfolio Y.

- Investing in portfolio X yields a 4.2% loss for sure.

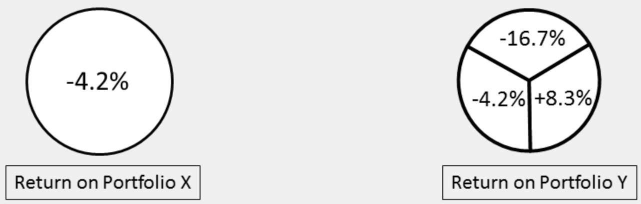
- Investing in portfolio Y there is:
  - 1/3 chance that portfolio Y will yield a 16.7% loss,
  - 1/3 chance that portfolio Y will yield a 4.2% loss, and
  - 1/3 chance that portfolio Y will yield a 8.3% return.

At the end of the period, investing all your money in portfolio X would yeild: loss of $1

At the end of the period, investing all your money in portfolio Y would yield:
- Loss of $4 with probability 1/3,
- Loss of $1 with probability 1/3, and
- Extra $2 with probability 1/3.

Below is an illustration of the two investment portfolios.

How much (in percentages) of your earnings would you like to invest in each of the portfolios?
Total investment in Portfolio X and Portfolio Y must add to 100%.



% Investment in Portfolio X: 20 % Investment in Portfolio Y: 80

If you only wish to invest in one of the portfolios simply enter "100" below the appropriate portfolio and "0" below the other one. **Continue**

This is Decision 2 of 2

You can invest your $24 earnings in one or two of the available portfolios, portfolio X and portfolio Y.

- Investing in portfolio X yields a 4.2% loss for sure.

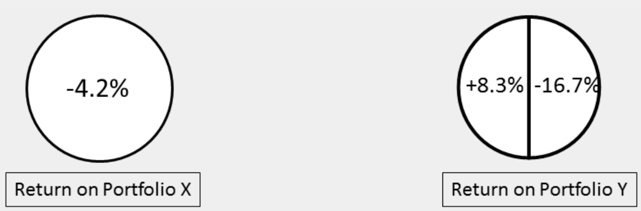
- Investing in portfolio Y there is:
  - 1/2 chance that portfolio Y will yield a 16.7% loss, and
  - 1/2 chance that portfolio Y will yield a 8.3% return.

At the end of the period, investing all your money in portfolio X would yeild: loss of $1

At the end of the period, investing all your money in portfolio Y would yield:
- Loss of $4 with probability 1/2, and
- Extra $2 with probability 1/2.

Below is an illustration of the two investment portfolios.

How much (in percentages) of your earnings would you like to invest in each of the portfolios?
Total investment in Portfolio X and Portfolio Y must add to 100%.



% Investment in Portfolio X: 100 % Investment in Portfolio Y: 0

If you only wish to invest in one of the portfolios simply enter "100" below the appropriate portfolio and "0" below the other one. **Finish**

Final Earnings Screen

Decision randomly selected for payment: **1**

Your investment in Portfolio X in that decision: **20.00%**

Your investment in Portfolio Y in that decision: **80.00%**

Return on Portfolio X in that decision: **-4.2%**

Return on Portfolio Y in that decision: **-16.7%**

YOUR TOTAL EARNINGS ARE: **$21**