On the Interaction between Investment and Emotions: an Experimental Study

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Abstract:

This paper investigates the influence of experienced and anticipated emotions on investment decisions. Data are obtained from an experiment where subjects have to allocate real money to a safe and a risky project, while their emotions are measured. The impact of two factors are considered: (i) the amount of money that is at stake, and (ii) the presence of a global risk, that is, a risk that cannot be avoided. Anticipated regret and rejoicing appear to be important determinants of investment, across all experimental treatments. Experienced emotions differ in their specific influence, with hope being particularly important if risk is controllable and irritation if global risk is present.

1 Introduction

Economic theories trying to explain the decision making of producers and consumers, typically rely on the ability of these agents to anticipate outcomes and situations in the future and to act accordingly in a consistent and predetermined way. This assumption of the ability to stick to a once made plan, is especially essential to theories involving backward induction. But, as has been observed in economic experiments, players are much less consistent in their behavior than such theories imply.

One possible factor influencing agents decisions concerns emotions. Emotions may influence decision making through (1) the anticipation of future emotional states, and (2) the actual experience of emotions (Loewenstein et al., 2001).

Already in some theories of risky choice, the anticipation of emotions is assumed to influence the behavior of the decision makers. These theories refer to regret (Bell, 1982; Loomes and Sugden, 1982), disappointment (Bell, 1985; Loomes and Sugden, 1986), or anxiety (Wu, 1999; Caplin and Leahy, 2001). Agents are supposed to act in a way to optimize this anticipated emotional experience.

The empirical question to be answered is whether indeed emotions are anticipated and taken into account and if the answer is yes, whether the anticipation is correct. Regarding the first question we suspect that agents are certainly not perfect in anticipating future emotional states (Zeelenberg, 1999). Loewenstein and Schkade (1999) consider three reasons for such errors. First, errors might be caused by erroneous theories about feelings. Second, they may result from unexpected shifts in the salience of events in the future. And third, errors might be due to problems in predicting the impact of visceral factors caused by the so called hot-cold empathy gap. This gap may lead to the underestimation of future visceral factors but may also lead humans to overestimate their future feelings (Gilbert and Wilson, 2000). Due to these errors it is to be expected that the precision with which emotions are anticipated will depend on the arousal level of a situation.

There is also some evidence of the immediate impact of experienced emotions on decision making under risk. Especially it has been noted that good and bad moods influence risk behavior in laboratories (Isen, 2001) and in the real world (Kliger and Levy, 2003). Furthermore, it has been observed that induced anxiety appears to increase individuals preferences for low-risk, low-reward options (Raghunathan and Pham, 1999). If indeed the anticipation of emotional states is not perfect, a deviating experience of emotions, might influence behavior in a way that could not have been foreseen by the decision maker. To get to know these effects, a thorough analysis of both anticipated

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and experienced emotions related to decision making under risk and uncertainty is needed.

In this paper we will present an experiment designed to systematically investigate the interaction between anticipated emotions, behavior, and experienced emotions, in a setting involving decision making under risk. To simplify emotional experience we will consider a simple one-person and one-shot investment game. Decisions concern the allocation of real money to two projects, one of which is safe while the other is risky. Changes in investment behavior are studied, when a 'global risk', that is, a risk threatening any investment, is included. In addition, we will study the impact of a higher amount of money being at stake. Investment behavior is especially interesting in this context, since emotions are frequently claimed to influence investors (see e.g. Sacco et al. (2003) on the emotional impact of global terrorism on investment). However, these claims are typically grounded on anecdotal evidence.

2 Experiment

2.1 Design

In the experiment, we will compare four treatments. In the *baseline-low* treatment, each subject is endowed with 15 euro of working money (approximately 17 US dollars), which is to be allocated (in steps of 50 cent) to two options, one of which is risky (project B) while the other one is safe (project A). The probability of winning in the risky option is $p = 1/2$ and subjects earn in that case 2.5 times their investment in this option. In case of a bad outcome, everything invested in this option is lost. The safe option returns the invested money with certainty (no gain, no loss). For simplicity we will from now on only speak of investment if the money is allocated to the risky option.

In our *global-risk-low* treatment, we included a global risk in our model, which means that subjects loose all their earnings with probability $q = 1/3$ independent of their investment decision. This 'global risk' is resolved independently for each participant, after the outcome of the risky project is known[1].

The third and fourth treatment were the same as the above, with the sole difference that subjects receive twice as much money (30 euro instead of 15 euro) and are asked to split it in amounts of one euro over the two options. We will refer to these treatments as *baseline-high* and *global-risk-high*. In all treatments only one round of this game was played.

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[1]In this we follow the procedures of the global risk experiment of Bosman and van Winden (2001).

It is common to frame these kind of situations as a choice problem between (a): (15 Euro) and (b): (37.5 Euro, 0.5). Clearly (b) has a higher expected value. Predictions are that subjects should (dependent on their level of risk aversion) opt for either of the two choices. As we will see in the following, the choice problem we are presenting was obviously not considered as a binary choice by subjects.

If global risk is included in the above choice problem, the problem is theoretically changed to a choice between: (a'): (15 Euro, 2/3) and (b'): (37.5 Euro, 1/3). Expected utility theory would predict no differences in behavior. On the other hand, (cumulative) prospect theory would predict a higher proportion of subjects choosing the risky option (b') (for a detailed discussion we refer to Bosman and van Winden (2001)) and this is also what experimental observations of binary choice problems have shown (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992; Cubitt et al., 1998).

The impact of regret on decision making has been modeled by regret theory, which was initially presented as an alternative to prospect theory (Bell, 1982; Loomes and Sugden, 1982). These theories are based on the assumption that regret is a negative emotion, which agents try to avoid by counterfactual comparison. Therefore the prospect of regret is assumed to decrease the utility for an agent.

Regret is defined as the situation where 'after making a decision a person might learn that another alternative would have been preferable' and regret is assumed to be represented by the 'difference in value between the assets actually received and the highest level of assets produced by other alternatives' (Bell, 1982). This definition implies that positive as well as negative levels of regret can be experienced. In Bell (1982) it is assumed that decision makers act according to the van Neuman and Morgenstern axioms and base their decision on their final asset and the foregone asset.

In laboratory and field experiments it has been shown that outcomes and what 'could have been' indeed elicit regret and disappointment (Mellers and McGraw, 2001; Camille et al., 2004). The interesting question is how the anticipation of regret is influencing decisions.

Similar to regret, anxiety has been modeled by including its negative hedonic value in the utility function (Wu, 1999; Caplin and Leahy, 2001). For example Caplin and Leahy (2001) expand the standard prize space to include anticipatory emotions like anxiety, assuming that anxiety is a negative emotion that subjects try to avoid.

In the experiment emotions were measured by self-reports. Self-report measures of emotions ask subjects to rate their current or anticipated feelings on a computerized or paper and pencil scale. Self-report measures are not only easy applicable they are also considered as "the most common and potentially the best way to measure a person's
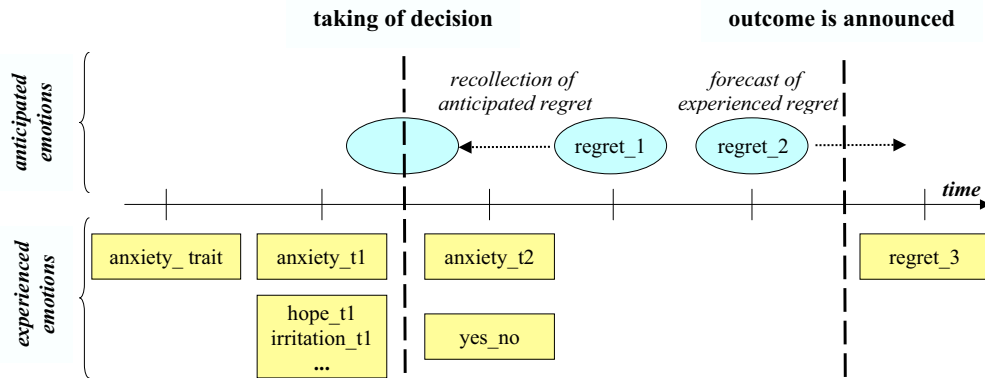
Figure 1: Time-line of emotion measures and their respective point of reference.

emotional experience" (Robinson and Clore, 2002).

Both experienced and anticipated emotions were measured. To measure anticipated emotions it is necessary to ask subjects to rate their feelings for a hypothetical future outcome. Experienced emotions can be measured by having subjects indicate how they feel at the very moment. For an overview of all the measurements see Table 1 and Figure 1.

For the measurement of anxiety we used the well known and validated Spielberger state trait anxiety inventory, in short STAI (Spielberger et al., 1970). The Spielberger scale is considered as an "excellent measure of both types [state and trait] of anxiety" (Kline, 1993) and is widely used. The scale consists of two sets of 20 questions which are answered on a four point scale (from 'almost never' to 'almost always' - see Appendix A.1.1 and A.1.2). A general score is computed from the detailed answers (a number between 20 and 80), which represents either the general disposition for anxiety (trait scale) or the anxiety at the moment when the questionnaire is filled out (state scale). Anxiety state is measured before and after the investment decision is taken and anxiety trait is measured before the start of the experiment.

Experienced and anticipated regret was measured in three different ways. First, the anticipation of regret while making the decision (regret_1) was measured. We used four questions about the importance of regret and rejoicing for the decision (see Appendix A.3.1). Second, subjects were asked to imagine a hypothetical scenario where they lose their actual investment, because of a negative outcome for the risky project. Participants had to indicate their anticipated level of regret (regret_2) and disappointment (disappointment_2) by a set of questions adopted from Zeelenberg et al. (1998) (see Appendix A.3.2). The selected items were previously found to be significantly correlated

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Table 1: Emotion measures used in the experiment.

Variable name:	Measurement scale:	Moment of measure:	Comments:
anxiety_trait	STAI trait (see Appendix A.1.1)	Before start of experiment.	General disposition to anxiety.
anxiety_t1	STAI state (see Appendix A.1.2)	Before decision was made.	Experienced anxiety prior to decision.
anxiety_t2	STAI state	After decision was made.	Experienced anxiety after taking of decision.
regret_1	Ratings of regret and rejoicing with respect to either investment option. - regret_1_1 - regret_1_2 - regret_1_3 - regret_1_4 (see Appendix A.3.1)	After decision was made.	Regret taken into account while making the decision. Regret as motivation for project B. Rejoicing as motivation for project A. Rejoicing as motivation for project B. Regret as motivation for project A.
regret_2 disappointment_2	Scale of indirect regret (disappointment) questions (see Appendix A.3.2).	After decision was made.	Estimation of regret (disappointment) for loss scenario.
regret_3 disappointment_3	Rating of: "I feel regret." "I am disappointed." (see Appendix A.3.3)	After outcome was known.	Experienced regret after outcome.
yes_no	Question about the importance of emotions (see Appendix A.2)	After decision was made.	
hope_t1	Rating of: "I feel hopeful".	Before decision was made.	Experienced hope before the decision.
irritation_t1	Rating of: "I feel irritated".	Before decision was made.	Experienced irritation before the decision.

with the two emotions. This indirect measurement was chosen to counter any effect from a quick succession of questions regarding regret. Since the two regret measures refer to different moments for the estimation of future regret (respectively, when the decision was taken, and after the decision was made), we did not want subjects to try to be consistent in their answers. Both regret_1 and regret_2 were asked after subjects had made their decision. Finally, experienced regret and disappointment (regret_3) was measured at the end of the experiment when the outcome was known. On a four-point intensity scale subjects had to answer the questions: "Are you disappointed by the outcome?" and "Do you regret your decision?".

To control for the experience of other emotions, besides regret and anxiety, we measured the experience of surprise, hope, sadness, happiness and irritation before the taking of the decision. These emotions were measured by a direct question about the feeling at that moment in time and answers were recorded on a four point scale. Because of their specific relevance for the situation at hand, we will in the following concentrate on the results from the measures of hope and irritation (hope_t1, irritation_t1).

Since our experiment consisted of only one decision situation, we will discuss the effects of emotions on behavior from an 'inter-individual' point of view. Therefore treatment effect will be observed for different groups of subjects. The limitation of this approach is that we have to assume that the emotional mechanisms are the same across subjects. This assumption seems to be justified by the general high consistency in the mechanisms of emotions. Further an 'intra-individual' comparison might involve even greater complications for analysis, due to uncontrollable spill over effects of emotions from one gaming situation to another.

2.2 Experimental Procedures

Upon entering the reception room, subjects were handed the STAI - trait scale, which they filled out in quiet. When everybody had finished, the questionnaires were collected and subjects where invited to enter the computer lab. Neither names nor any other information was recorded in combination with the questionnaire. Questionnaires were later linked through the seat number subjects had randomly chosen when entering the lab. Thus all information was confidential and anonymous.

After subjects were seated in the lab, each participant received an envelope with 15 Euro (30 Euro) in coins and bills, and was informed that this would form their working money for the following experiment. Subjects were told that if they would lose money in the game, they would have to pay back the money after the session, while additional earnings would be paid out to them. After subjects had controlled the content of their

envelops, instructions were handed out and read aloud by the experimenter and any questions were answered. The instructions informed subjects about the investment decision they had to make (for a translation see Appendix B.1). They were informed that they had to allocate their working money to two projects, one of which returned the investment with certainty, while the other had a probability of $p = 1/2$ to return 2.5 times the investment and a probability of $(1 - p) = 1/2$ of returning nothing. Subjects were informed that they would have to determine the outcome of the risky project themselves, by rolling a dice after they had made their decision.

In the global risk treatments subjects were additionally informed before the general instructions were given, that they were to face a risk of $q = 1/3$ to lose all their earnings in the experiment (see Appendix B.2). Each subject would have to determine the outcome of this risk for himself by rolling a second dice in the presence of the experimenter. This second dice was rolled after the rolling of the dice determining the outcome of the risky project. When no further questions were asked, subjects were informed that they had to make their investment decision and fill in their choice in a computerized form. From this point on, subjects went individually through the questions of the experiment and were not further interrupted.

The first computerized form presented to subjects was the validated Dutch translation of the STAI-state questionnaire. After they had filled out the questionnaire, they were asked to fill in their investment decision for the two projects, which were labeled A and B. The fractions allocated to the two projects could be any multiple of 50 cent (1 euro) and had to add up to 15 euro (30 euro). Upon pushing a button to continue in the experiment, subjects were presented again with the questions of the STAI-state questionnaire. Now they were asked to record their anxiety after they had made their investment decision but still before they knew the outcome of the gamble.

After the questionnaire they were asked if they had taken their future emotions into account when they had made their decision. Subjects were asked to which extent the anticipation of regret and rejoicing influenced their decision and to predict their experienced regret if they would lose their investment in project B. Finally subjects were asked to confirm their decision and they were given the option of altering their decision if they wanted.

When all subjects had made their final decision, the experimenters went through the room to have each subject resolve the investment risk by rolling the (white) dice and to record the result. In the treatments including global risk this was followed by another round of dice rolling - in this case a red dice - to resolve the global risk. After subjects knew the outcome of their investment and of the global risk, they were asked some

general questions including the question if they felt regret or disappointment about the outcome.

Subjects were then paid out one by one. In case of a loss they were required to pay back the amount from their working money.

The experiment was conducted in the CREED-laboratory at the University of Amsterdam, during May and September of 2003. Subjects were recruited from various fields and in total 147 students participated in the experiment. Participants received 2.50 euro as show up fee. Average earnings in the low (high) *baseline* treatments were 18 (37) euro and in the low (high) *global-risk* treatments 8 (35) euro.

3 Results

In the following we will discuss and describe the results from the four treatments. We split our analysis in two parts. In part one we will present some general results concerning investment behavior. In part two we will discuss the influence of regret, anxiety and other important emotions. In section 4 we will model interactions of emotions and behavior.

3.1 General Results

In Figure 2 we present investment in all treatments. In *baseline-low* we get an average investment of 7.84 (std. dev. 3.44) and in *global-risk-low* we observe an average investment of 9.52 (std. dev. 4.13). Therefore we find a higher level of investment when global risk is present. But even more striking is the actual distribution over the range of possible investments. As we see from Figure 2 in the *baseline-low* treatment a fairly symmetric distribution of investment choices is observed, with the mode being at 5 and 7.5 (each with 6 out of 37 observations). In the *global-risk-low* case though, we see that the mode has dramatically shifted to 15 (with 11 out of 42 observations), showing a negatively skewed distribution. However the difference between these distributions is at best weakly significant (Kolmogorov-Smirnov, p=0.103, two sided).

For the treatments with high stake size, we normalized maximum investment to 15, so that investment decisions can be more easily compared to the results from the other treatments. In *baseline-high* we observe a mean normalized investment of 7.94 (std dev. 3.76) and in *global-risk-high* we observe a mean normalized investment of 8.34 (std. dev. 4.57). The distribution for *baseline-high* is not significantly different from treatment *baseline-low* (Kolmogorov-Smirnov, p=0.60, two sided). This is because we observe a shift in distributions to lower investment choices (i.e. the new mode is at 5)
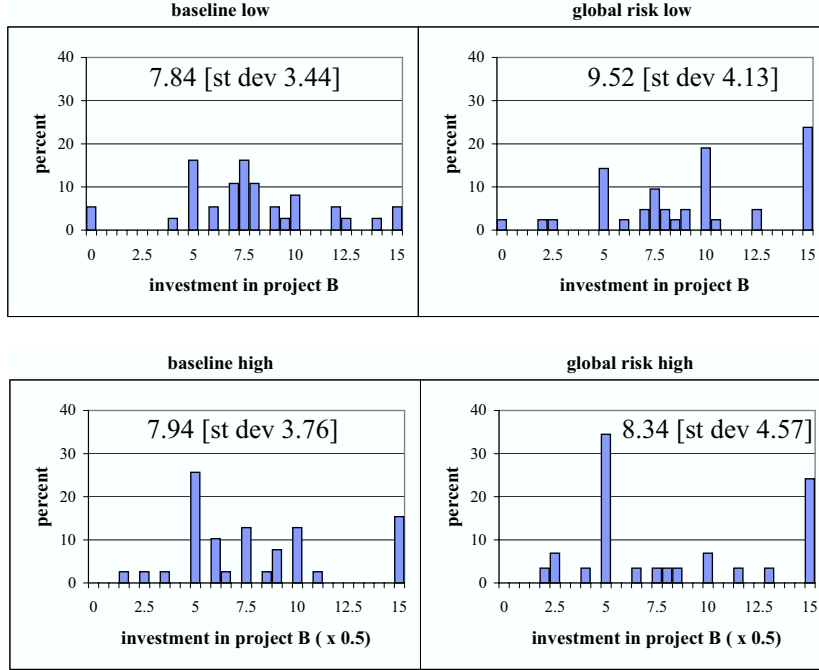
Figure 2: Investment histograms.

but also to the extreme choice of 15, while intermediate investment in the range from 5 to 15 is less often chosen. The distribution of investment in the *global-risk* treatments, shows marginally significant less investment in *global-risk-high* compared to *global-risk-low* (Kolmogorov-Smirnov, p=0.09, two sided). The distributions of *baseline-high* and *global-risk-high* do not show a significant difference (Kolmogorov-Smirnov, p=0.73, two sided), which can be explained by observing that investment shifts to both lower and higher values in the *global-risk-high* treatment.[2]

Result 1

   (a) With low stakes we observe some tendency for higher investment under global risk. The effect of higher investment is discontinuous, and leads to a high percentage of maximum investment in the global risk case.

   (b) We do not observe a difference between baseline-high and global-risk-high. This is caused by the fact that investment choices shift both to lower and higher values.

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[2]When investment is grouped binary, we observe a very similar investment pattern as Cubitt et al. (1998) for low stakes, but a shift if stakes are increased. For a detailed discussion of this effect see Appendix C.

(c) Average (normalized) investment in baseline-high is not different from the corresponding result in baseline-low. In the treatments with global risk, high stakes lead to weakly less investment than low stakes.

Therefore the effect of global-risk seems to be, on the one hand, to increase investment by inducing more subjects to choose the maximum level. On the other hand this effect seems to be counterbalanced by a tendency to lower investment choices by other players. The dominance of non extreme investment choices shows that binary choice procedures can be misleading.

3.2 The importance of regret, anxiety, hope, and irritation

As already mentioned, we measured a series of anticipated as well as experienced emotions in our experiment. We will focus on regret, anxiety, hope, and irritation. Regret and anxiety have both been modeled as negative emotions that rational actors try to avoid (Wu, 1999; Caplin and Leahy, 2001; Bell, 1982; Loomes and Sugden, 1982). To what extent do we observe the anticipation of emotions and how is anticipation related to decision making and to the actual experience of the emotion?

To simplify the presentation of the analysis we will frequently group the results for *baseline-low* and *baseline-high* (*baseline*, for short), as well as for *global-risk-low* and *global-risk-high* (*global-risk*, for short). In those cases, the observed effects can also be found for each treatment separately.

Due to the overall observed dominance of non-extreme investment choices, we think that a quasi continuous distribution of choices is necessary to understand the true distribution of choice patterns. I.e. that subjects should be able to choose out of any possible allocation of investment on the two projects. In the following we will, when grouping is necessary, therefore opt for a grouping of investment choices in three categories (namely: low, medium and high).

3.2.1 Regret

In total we measured three kinds of regret in our experiment: anticipated regret as motivation for investment in either the safe or the risky project[3] (regret_1), estimated regret for a 'loss' scenario (regret_2), and experienced regret once the outcome is observed (regret_3).

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[3] In treatments *baseline-low* and *global-risk-low* regret_1 was only measured for subjects responding 'yes' to the question whether they took their emotions into account when making their decision. In treatments *baseline-high* and *global-risk-high* all subjects responded to the regret_1 scale.

Since models considering the impact of regret on decision making assume the anticipation of regret, we will first investigate the relation between anticipated regret and investment behavior. In addition, we will investigate which project subjects focused on when anticipating this emotion: project A or project B. Note that only with the extreme choices of full or zero investment, subjects can exclude the experience of one of the two types of regret[4]. If subjects decide to invest intermediate amounts, they can experience regret whatever the experienced outcome is. Therefore it is of interest to find out which kind of regret particularly influences the investment decision. Rejoicing, that is, being happy with one's decision when in turns out to have been the 'right' one, can be seen as a negative level of regret. As holds for regret, rejoicing can be a motivation for more or less investment.

Anticipated regret. The four questions of the questionnaire regret_1 (presented in Appendix A.3.1), relate to the two kinds of regret and the two kinds of rejoicing discussed above. We will now show how each of these measures is related to the amount invested.

We observe that regret as motivation for project A (regret_1_4) has the highest absolute impact on the decisions taken in *baseline* (Pearson correlation coefficient: -0.523, $p = 0.000$). But also rejoicing as motivation for project A (regret_1_2) seems to play some role (Pearson correlation coefficient: -0.239, $p = 0.077$). We observe no significant correlations for regret_1_1 and regret_1_3 (Pearson correlation coefficients, respectively: -0.19, $p = 0.16$; + 0.14, $p = 0.30$).

In *global-risk* we observe again significant negative correlations for regret_1_2 and regret_1_4 (Pearson correlation coefficients, respectively: -0.506, $p = 0.000$; -0.513, $p = 0.000$). But now, in addition, significant positive correlations for regret_1_1 (regret as motivation for B) and regret_1_3 (rejoicing as motivation for B) are obtained (Pearson correlation coefficients, respectively: + 0.25, $p = 0.076$; + 0.64, $p = 0.000$). The relatively strong correlation for rejoicing as motivation for more investment can be related to the notion of 'attraction to chance' (Pope, 1998) which stands for the positive valuation of suspense. These findings suggest that the extent to which regret and rejoicing are anticipated depends on the treatment, that is, the specific decision situation.

Result 2 *Regret and rejoicing as motivation for less investment play a role in all treatments. In global-risk, in addition regret and in particular rejoicing as motivation*

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[4]This is why in theories of regret in binary choice problems, no attention is paid to this dual form of regret.

for more investment are influential.

In *baseline* only regret and rejoicing as motivation for less investment appears to play a role, suggesting that the focus of subjects is on the negative event of a loss from project B. The anticipation of regret from too risky behavior stimulates a shift in investment to project A. Interestingly in *global-risk* subjects in addition anticipate regret and rejoicing from too risk-averse behavior, that is, from observing that B wins and not having invested 'enough' into this project. Thus, in *global-risk* two counteracting forces seem to be at work.

The observation that regret (and rejoicing) can be a motivation for investment in both projects makes it interesting to look at relative measures. If one regret value outweighs the other, the higher one may determine the direction of investment. We therefore define:

Definition 1
relative_rejoicing =: (rejoicing as motivation for B - rejoicing as motivation for A)
relative_regret =: (regret as motivation for A - regret as motivation for B)

As can be seen in Figure 3 relative-rejoicing increases with investment and relative-regret decreases with investment in both *baseline* and *global-risk*. Investment is significantly correlated with relative-regret (Pearson correlation coefficients, *baseline*: -0.26, $p = 0.053$; *global-risk*: -0.57, $p = 0.000$) as well as relative-rejoicing (Pearson correlation coefficients, *baseline*: 0.28, $p = 0.034$; *global-risk*: 0.73, $p = 0.000$). Therefore, if one tendency of regret or rejoicing is clearly outweighing the other, the resulting investment decision will be defined by the higher value. When both tendencies are present this is likely to result in intermediate investment.

Of further interest is the finding, that relative-regret seems more important for players investing low amounts in project B, while relative-rejoicing is of higher importance for players investing high amounts in project B. The absolute values for relative-rejoicing and relative-regret differ for low and high investors in *baseline* (t-test, $p < 0.09$) as well as *global-risk* (t-test, $p < 0.008$). This leads to the next result:

Result 3 *Relative measures of regret and rejoicing are related to the amount invested, with relative-rejoicing increasing in investment and relative-regret decreasing in investment. The correlations of relative-rejoicing and relative-regret with investment are stronger for global-risk than for baseline.*

Furthermore, rejoicing is relatively more important for high investment and regret is relative more important for low investment.
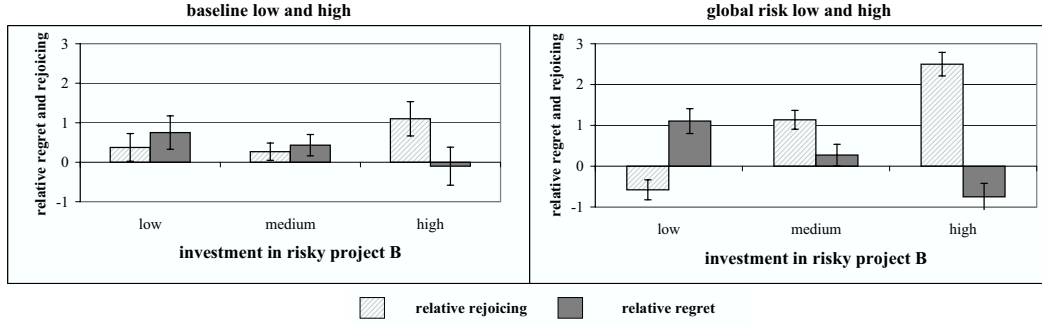
Figure 3: Relation of relative rejoicing and relative regret to investment. Error bars represent the standard error.

Anticipated versus experienced regret. Having observed that anticipated regret is related to investment, we now want to investigate whether the anticipation of regret is related to the actual experience of regret.

If we compare estimated regret_2 with experienced regret (regret_3)[5] we can test for the precision of regret estimation. We find a significant correlation for both *baseline* and *global-risk* (Pearson correlation coefficients, *baseline*: 0.588, $p = 0.000$; *global-risk*: 0.411, $p = 0.013$). In both cases the extent of experienced regret appears to be overestimated as we can see from Figure 4. Therefore estimated and experienced regret are indeed correlated and we can use in further analysis regret_2 as a good estimation for experienced regret.

Result 4 *Estimated and experienced regret are correlated. The experience of regret is overestimated.*

The assumption of minimizing anticipated regret does not specify how this might influence experienced regret. We find that regret_1_4 is neither in *baseline* nor in *global-risk* correlated with estimated regret (regret_2) (Pearson correlation coefficients, *baseline*: -0.097, $p = 0.638$; *global-risk*: -0.054, $p = 0.794$). Thus the anticipation of more 'regret as motivation for project A' seems to result in behavior which cancels out differences in experience of regret.

Further we see that regret_1_1 is positive correlated with estimated regret (regret_2) (Pearson correlation coefficient, *baseline*: 0.25, $p = 0.068$; *global-risk*: 0.51, $p = 0.000$).[6]

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[5]For regret_3 we consider only subjects for which project B actually lost. This restricts the number of observations to 70.

[6]Further: regret_1_2 shows no significant correlations, and regret_1_3 shows marginally significant positive correlations (baseline: 0.22,$p = 0.10$, global-risk: 0.34,$p = 0.013$)
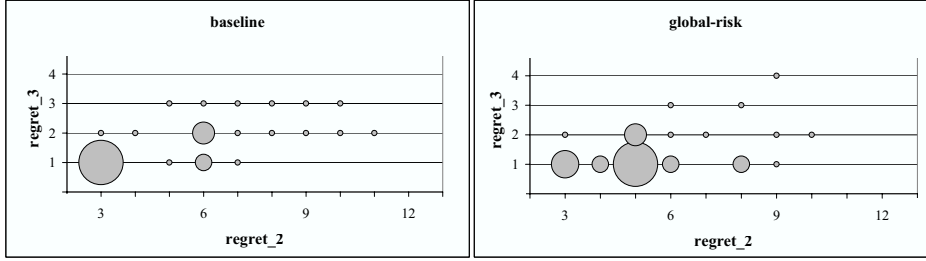
Figure 4: Scatter plots for regret_2 and regret_3 for subjects loosing their investment in project B. Width of bubble represents the number of observations.

Table 2: Correlation coefficients of the three anxiety measures.

baseline	anxiety_trait	anxiety_t1	global-risk	anxiety_trait	anxiety_t1
anxiety_t1	0.548		anxiety_t1	0.281	
	(0.000)			(0.018)	
anxiety_t2	0.653	0.792	anxiety_t2	0.355	0.842
	(0.000)	(0.000)		(0.002)	(0.000)

Note: Values in brackets are p values.

Therefore estimated and thus experienced regret from losing investment, seem to increase when, while taking the decision, the focus was on regret from too little investment.

We conclude that agents take anticipated regret into account, but that estimated and thus experienced regret might in fact not be minimized.

3.2.2 Anxiety

In the experiment, anxiety was measured at three points: before the experiment started (anxiety_trait)[7], before subjects typed in their investment decision (anxiety_t1), and after the decision was made by subjects (anxiety_t2). We observe significant correlations between these variables (see Table 2). Anxiety_t1 and anxiety_t2 are in all treatments highly correlated. The correlation of anxiety_trait with the two later measures of anxiety is higher in *baseline* than in *global-risk*.

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[7] A comparison with measures of the same variable taken during independent observations of a similar subject pool, confirm that the distribution of anxiety trait in the experiment was representative. Specifically, the observations from a sample of 493 subjects taken during a psychology experiment at the same university (mean: 35.29, sd:9.69) was very similar to our observations (mean 36.25, sd:8.08). We can reject a difference in these observations (t-test, $p = 0.27$).

Table 3: Influence of anxiety on final investment choice (invest_t2)

	N	147		N	147
	$F_{(2,144)}$	4243.71		$F_{(2,144)}$	4317.80
	R^2	0.9833		R^2	0.9836
Variable	Coef.	$P > |t|$		Coef.	$P > |t|$
invest_t1	1.001	0.000	invest_t1	1.002	0.000
anxiety_t1	-0.006	0.213	anxiety_t2	-0.009	0.046
Intercept	0.267	0.211	Intercept	0.367	0.060

Note: Pooled regression analysis for all subjects because of few observations per treatment. In total 5 subjects changed their investment.

Concerning the impact of anxiety on behavior, it is noted that we are measuring experienced anxiety before and after taking the decision and not anticipated anxiety. While the theoretical models of anxiety focus on the importance of agents trying to reduce anticipated anxiety, we hypothesize that also experienced anxiety and trait anxiety might influence decision making.

Across investment categories we find, a weak tendency for higher anxiety_trait to negatively affect investment, in *baseline* (Pearson correlation coefficient: -0.17, $p = 0.15$). Participants with higher trait anxiety chose to invest less in the risky option. In contrast, no such relationship is found for *global-risk* (Pearson correlation coefficient: 0.00, $p = 0.98$).

Result 5 *Higher values for anxiety_trait tend to be related to lower investment in baseline. In global-risk no influence of anxiety_trait is observed.*

Thus, although there is some evidence that anxiety_trait can influence decision making, this effect appears to depend on the specific investment situation.

We further hypothesize that anxiety experienced after the investment decision (anxiety_t2), influences how subjects perceive their choice. Since subjects got the opportunity to review their decision after having recorded their emotions, we can observe if changes in decisions are related to this anticipated anxiety. Interestingly only few subjects did change their decision when they were given the opportunity to do so. This could point at a correct anticipation of this anxiety, but may also be due to a form of cognitive dissonance (admitting a wrong choice may be seen as a weakness).

Nevertheless we find that anxiety_t2 helps to explain the changes in investment

(see Table 3). Higher experienced (anticipatory) anxiety after the decision, leads to a decrease in investment in the risky option. When we compare the regression results of investment_t2 on anxiety_t1 with the regression results of investment_t2 on anxiety_t2, we observe that the effect is due to the anxiety experienced after the decision. In contrast, anxiety_t1 does not show a significant impact on final investment.[8]

Result 6 *Higher anxiety_t2 leads to a decrease in investment if the investment choice is altered.*

We conclude that trait anxiety may influence how much people intend to invest and that experienced anxiety after the decision influences subsequent behavior (final investment). This is consistent with psychological findings of a correlation between anxiety and risk aversion (Eisenberg et al., 1996). An attentional bias may be responsible for this effect according to Luu et al. (1998).

3.2.3 Hope and Irritation

In the previous sections we have discussed in detail the relationship of regret and anxiety to the investment decision. We concentrated on these emotions, since they seem to dominate in the discussion of emotional influences on risk taking. We measured a number of emotions after each of the questionnaires concerned with experienced anxiety. Particularly, subjects had to indicate on a four point scale to what extent they experienced the following five emotions: surprise, hope, sadness, happiness and irritation.

While anxiety is triggered by the threat of a future harm (Lazarus, 1991), *hope* is related to the possibility to overcome that harm while *irritation* may be generated by the apprehension of that harm. Because of this close relationship we were especially interested in hope and irritation. First of all it turns out that hope and irritation are correlated with anxiety_t1 in *baseline*, but not in *global-risk*; furthermore hope and irritation are negatively correlated in both cases (see Table 4).

Turning now to behavior, we find hope experienced prior to the taking of the decision is positively correlated with the amount invested in *baseline* (Pearson correlation coefficient, 0.376, $p = 0.001$), whereas no correlation is observed in *global-risk* (Pearson correlation coefficient, 0.101, $p = 0.404$).

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[8]Even though anxiety_t2 is related to regret_2, we do not observe the same impact of regret on investment changes. The difference between anxiety and regret at this point is though, that anxiety was actually experienced, while regret_2 was an estimation of the regret expected for a negative outcome.

Table 4: Pearson correlation coefficients

baseline	hope_t1	irritated_t1	global-risk	hope_t1	irritated_t1
irritated_t1	-0.2603		irritated_t1	-0.2739	
	(0.0231)			(0.0208)	
anxiety_t1	-0.3793	0.3775	anxiety_t1	0.0286	0.0652
	(0.0007)	(0.0008)		(0.8126)	(0.5893)

Note: Values in brackets are p values.

Result 7 *Hope is positively correlated with investment in baseline, whereas no correlation at all is found for global-risk.*

Exactly the opposite pattern is obtained for experienced irritation. No correlation of investment and irritation is found for *baseline* (Pearson correlation coefficient, -0.090, $p = 0.438$) while a positive correlation is observed in *global-risk* (Pearson correlation coefficient, 0.235, $p = 0.048$).

Result 8 *Irritation is positively correlated with investment in global-risk, whereas no correlation at all is found for baseline.*

We conclude that hope is important for decision making in *baseline* while irritation is important in *global-risk*.[9]

4 Modeling the interaction of emotions and behavior

In this section we first investigate to what extent a simple linear regression model can organize our experimental data. This is followed by a discussion of some more complicated interactions of emotions and behavior that we observe.

4.1 A linear regression model

The previous section indicates that people, when making their investment decision, take anticipated emotions into account and that the experience of anxiety, hope, and irritation affects the amount they are willing to invest. More specifically, we found that anticipated (relative) regret and rejoicing influence investment in all treatments, while, in addition, hope is related to investment in *baseline* and irritation is related to investment in *global-risk*.

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[9]For the other emotions no consistent patterns were observed.

Table 5: Influence of anticipated and experienced emotions on investment.

	baseline		global-risk	
	N	76	N	71
	$F_{(3,72)}$	9.21	$F_{(3,67)}$	11.25
	P>F	0.000	P>F	0.000
	R^2	0.277	R^2	0.335
Variable	Coef.	$P > |t|$	Coef.	$P > |t|$
rel. rejoicing	1.222	0.000	1.535	0.000
hope_t1	2.631	0.000	0.885	0.220
irritated_t1	-0.526	0.405	1.577	0.014
Intercept	0.223	0.922	2.999	0.256

Table 5 shows that similar effects can be observed in a regression model including all these variables. Relative-rejoicing shows a significant positive coefficient in *baseline* as well as *global-risk*. Furthermore a significant positive coefficient is obtained for hope in *baseline* and for irritation in *global-risk*, in line with our previous results.

Next we want to investigate whether additional effects of other emotions, like anxiety, can be observed if these are also included in the model. For that purpose, we will focus on our basic treatment, *baseline_low*. We start with a full model, including as additional variables[10]: trait anxiety (anxiety_trait), experienced anxiety before the investment choice (anxiety_t1), and anxiety, regret and disappointment after this choice (respectively, anxiety_t2, regret_2, and disappointment_2). The inclusion of the emotions experienced after the investment choice, is motivated by the idea that their experience may have been anticipated. The first column of Table 6 presents the results of the full model.

Comparing to the results from Table 5 we see that the coefficient of relative_rejoicing is stable across models, as is the sign of the coefficients for hope and irritation. Further we see in the full model a negative coefficient for trait anxiety and anxiety_t1 and a

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[10]Since regret_1 was in treatments baseline-low and global-risk-low only measured for subjects responding 'yes' to the question if they took their emotions into account, in these treatments the value for relative-rejoicing is equal to regret_1 if subjects answered 'yes' and if the answer was 'no' the value is set to 0.

Table 6: Estimation results for: invest_t2 in *baseline_low*

	N	37	N	37	N	37
	$F_{(8,28)}$	7.930	$F_{(7,29)}$	4.310	$F_{(5,31)}$	5.040
	Prob > F	0.000	Prob > F	0.002	Prob > F	0.002
	R^2	0.694	R^2	0.510	R^2	0.448
Variable	Coef.	$P > |t|$	Coef.	$P > |t|$	Coef.	$P > |t|$
anxiety_trait	-0.21	0.002	-0.08	0.260	-0.06	0.400
anxiety_t1	-0.21	0.020	0.04	0.623	0.06	0.475
hope_t1	4.26	0.000	3.31	0.000	3.28	0.000
irritated_t1	-1.52	0.020	-1.43	0.071	-1.44	0.070
relative_rejoicing	1.20	0.002	1.30	0.005	1.37	0.004
regret_2	0.20	0.294	0.40	0.091	–	–
disappointment_2	-0.16	0.360	-0.14	0.513	–	–
anxiety_t2	0.38	0.000	–	–	–	–
Constant	-1.51	0.637	-0.16	0.968	0.03	0.994

positive coefficient for anxiety_t2.

In columns two and three we present, respectively, models excluding anxiety_t2 and regret_2 and disappointment_2. Even though we observe a drop in the R^2 compared to the full model, the two reduced models seem to explain behavior to an equal extent. There seems to be no or at most a very weak effect of regret_2 and disappointment_2, which supports earlier findings that these are not anticipated.

While mostly in line with our previous findings, a point that still needs explanation is the observed positive coefficient for anxiety_t2. Indeed it is not strange that anxiety_t2 is related to investment. For example, if the marginal disutility of anxiety is increasing in investment, while the marginal utility derived from an extra monetary unit invested is more or less constant, then anxiety_t2 can be taken as a proxy for the size of the marginal disutility of anxiety (if this disutility if anticipated). In that case, the larger the marginal disutility, the less will be invested and the smaller the anxiety

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Table 7: Estimation results for: anxiety_t2

	baseline-low		baseline-high	
	N	37	N	39
	$F_{(5,31)}$	40.58	$F_{(5,33)}$	15.434
	R^2	0.867	R^2	0.700
Variable	Coef.	$P > \lvert t \rvert$	Coef.	$P > \lvert t \rvert$
investment in project B	0.813	0.000	-0.112	0.702
anxiety_trait	0.419	0.000	0.222	0.150
anxiety_t1	0.630	0.000	0.531	0.001
hope_t1	-5.063	0.000	-2.724	0.217
irritated_t1	1.127	0.236	2.525	0.302
Intercept	5.516	0.253	14.233	0.192

experienced after the choice. Unfortunately, the same relationship may also induce a reverse causality, that is, investment may in its turn influence anxiety_t2 (see Table 7). The interesting problem is how these two effects, i.e. the effect of the anticipation of anxiety_t2 and the effect of investment on anxiety, can be disentangled. For this we need a richer model, plus a better measure of anticipated anxiety (like for regret and rejoicing on which we focused in our study).

Further it turns out, that the issue might be even more complicated, since the effect of investment on anxiety does not necessarily show up in all situations: as can be seen for *baseline-high* in Table 7.

4.2 Non-linear interactions of emotions and behavior

One limitation of a linear regression model is the assumption of a linear relationship between emotions and behavior, which need not hold. We will discuss this issue focusing on anxiety experienced after the investment choice.

In Figure 5 we present average experienced anxiety_t2 for different investment levels[11]. We will discuss the interactions for each treatment separately and try to outline which mechanisms could account for the differences.

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[11]We will in the following compare low, medium and high investment, where we define the categories for investment as follows: low if ($0 \leq$ investment ≤ 5), medium if ($5 <$ investment ≤ 10) and high if ($10 <$ investment ≤ 15).
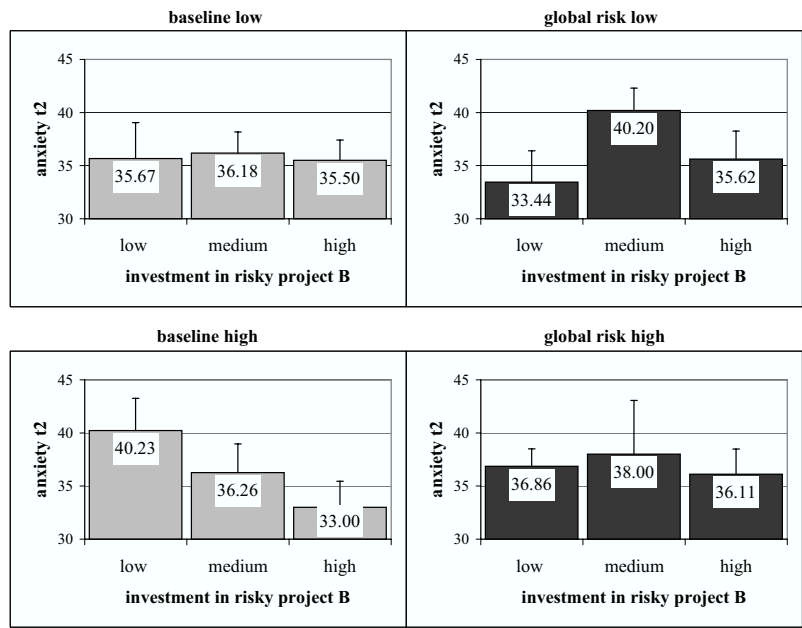
Figure 5: Anxiety_t2 dependent on categorized investment. Error bars represent standard error.
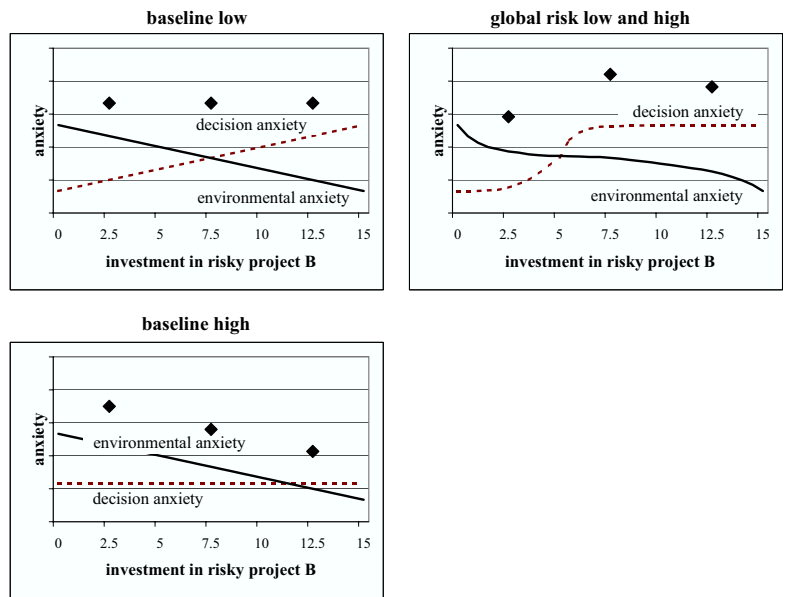

Figure 6: Hypothetical interaction of environmental and decision anxiety across treatments. Dots show the sum of both types of anxiety for low, medium and high investment.

For *baseline-low* we observe no significant variation in anxiety levels across investment categories. According to Bosman and van Winden (2001) this could be due to the interaction of environmental anxiety and decision anxiety. Environmental anxiety refers to the anxiety elicited by the specific situation that the subject is exposed to and decision anxiety to the additional anxiety the subjects experiences due to the amount of money it decided to invest. Decision anxiety *can* be anticipated by agents when making their decision, but it is not clear if this is the case.

In Figure 6 we present a hypothetical model of the underlying environmental and decision anxiety. It seems reasonable that investment is decreasing in environmental anxiety, which means that subjects with higher anxiety tend to invest less. Decision anxiety in contrast should be increasing in investment. Due to these two counteracting forces, we see that indeed we should observe in treatment *baseline-low* approximately the same level of anxiety across investment decisions.

For *baseline-high* anxiety is decreasing in investment. This might be because in *baseline-high*, the valence of the situation was so low that decision anxiety was more or less constant for any investment chosen. This would, as shown in Figure 6, explain the downward slope of anxiety.

More puzzling seem the observations for anxiety in treatment *global-risk*. We observe a non-linear relationship of anxiety across investment. This being more pronounced in treatment *global-risk-low* than in *global-risk-high*. We can speculate, that especially for a situation of high arousal, environmental anxiety might have a critical value, above which only very low investment is chosen. Further for decision anxiety we can imagine the inverted S shape presented in Figure 6. The assumptions behind this shape is that starting from a critical value of investment, decision anxiety is at it's maximum, which leaves no room to increase for even higher levels of investment. From a combination of these two anxiety functions, we would then indeed observe the highest anxiety for medium investment and slightly lower levels for high and low investors.

5   Conclusion

In this paper we have analyzed and discussed, how emotions influence behavior in an investment experiment. The results confirm that experienced as well as anticipated emotions influence behavior and further that emotions after the game are influenced by investment. We think that for a complete model of the impact of emotions on behavior it is necessary to consider these different kinds of interactions. This experiment was a first attempt to combine multiple measures of emotions to facilitate the analysis of the

interactions at hand.

One limitation of our design is that we could not go as deeply into the anticipation of anxiety as we did for regret. To measure and analyze anticipated anxiety and to compare it with experienced anxiety might prove helpful in explaining the differences in the impact of anxiety across treatments. A further step would be to also consider repeated investment games, to study the emotional spill-over effects from one game to the next. The interactions of emotions and behavior in such repeated situations will be quite complex. However we think that theories ignoring the dynamics of emotions will fail to arrive at a satisfactory explanation of investment behavior.

A Appendix: Emotion measures

A.1 Anxiety

A.1.1 anxiety_trait: STAI-trait (Spielberger et al., 1970)

A number of statements which people have used to describe themselves are given below. Read each statement and then choose the appropriate number to the right of the statement to indicate how you *generally* feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

		almost never			almost always
1.	I feel pleasant	(1)	(2)	(3)	(4)
2.	I tire quickly	(1)	(2)	(3)	(4)
3.	I feel like crying	(1)	(2)	(3)	(4)
4.	I wish I could be as happy as others seem to be	(1)	(2)	(3)	(4)
5.	I am losing out on things because I can't make up my mind soon enough	(1)	(2)	(3)	(4)
6.	I feel rested	(1)	(2)	(3)	(4)
7.	I am 'calm, cool and collected '	(1)	(2)	(3)	(4)
8.	I feel that difficulties are piling up so that I cannot overcome them	(1)	(2)	(3)	(4)
9.	I worry too much over something that really doesn't matter	(1)	(2)	(3)	(4)
10.	I am happy	(1)	(2)	(3)	(4)
11.	I am inclined to take things hard	(1)	(2)	(3)	(4)
12.	I lack self-confidence	(1)	(2)	(3)	(4)
13.	I feel secure	(1)	(2)	(3)	(4)
14.	I try to avoid facing a crisis or difficulty	(1)	(2)	(3)	(4)
15.	I feel blue	(1)	(2)	(3)	(4)
16.	I am content	(1)	(2)	(3)	(4)
17.	Some unimportant thought runs through my mind and bothers me	(1)	(2)	(3)	(4)
18.	I take disappointments so keenly that I can't put them out of my mind	(1)	(2)	(3)	(4)
19.	I am a steady person	(1)	(2)	(3)	(4)
20.	I get in a state of tension or turmoil as I think over my recent concerns and interests	(1)	(2)	(3)	(4)

A.1.2 anxiety_t1 (anxiety_t2): STAI-state (Spielberger et al., 1970)

A number of statements which people have used to describe themselves are given below. Read each statement and then choose the appropriate number to the right of the statement to indicate how you *feel* right now, that is, *at this moment.* There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

		not at all			very much so
1.	I feel calm	(1)	(2)	(3)	(4)
2.	I feel secure	(1)	(2)	(3)	(4)
3.	I am tense	(1)	(2)	(3)	(4)
4.	I am regretful	(1)	(2)	(3)	(4)
5.	I feel at ease	(1)	(2)	(3)	(4)
6.	I feel upset	(1)	(2)	(3)	(4)
7.	I am presently worrying over possible misfortunes	(1)	(2)	(3)	(4)
8.	I feel rested	(1)	(2)	(3)	(4)
9.	I feel anxious	(1)	(2)	(3)	(4)
10.	I feel comfortable	(1)	(2)	(3)	(4)
11.	I feel self-confident	(1)	(2)	(3)	(4)
12.	I feel nervous	(1)	(2)	(3)	(4)
13.	I am jittery	(1)	(2)	(3)	(4)
14.	I feel 'high strung'	(1)	(2)	(3)	(4)
15.	I am relaxed	(1)	(2)	(3)	(4)
16.	I feel content	(1)	(2)	(3)	(4)
17.	I am worried	(1)	(2)	(3)	(4)
18.	I feel over-excited and 'rattled'	(1)	(2)	(3)	(4)
19.	I feel joyful	(1)	(2)	(3)	(4)
20.	I feel pleasant	(1)	(2)	(3)	(4)

A.2 yes_no: Importance of emotions for decision

At the end of the second questionnaire for STAI state (anxiety_t2), the following question was asked, to determine if subjects took emotions into account when making their decision:
    Subjects had to answer with yes or no:

> Was your decision influenced by how you might feel after the rolling of the white dice, which will determine the outcome of project B?

A.3 Regret

A.3.1 regret_1: Rating of regret and rejoicing with respect to either investment option.

To which extend are the following remarks for your decision applicable?

		not at all			very much so
regret_1_1.	For project A: I did not put more money in A, because I did not want to feel bad when project B end well (wins). [*regret as motivation for project B*]	(1)	(2)	(3)	(4)
regret_1_2.	For project A: I did not put less money in A, because I will feel really good if project B returns nothing (loses). [*rejoicing as motivation for project A*]	(1)	(2)	(3)	(4)
regret_1_3.	For project B: I did not put less money in B, because I will feel really good if project B ends well (wins). [*rejoicing as motivation for project B*]	(1)	(2)	(3)	(4)
regret_1_4.	For project B: I did not put more money in B, because I did not want to feel bad when project B returns nothing (loses). [*regret as motivation for project A*]	(1)	(2)	(3)	(4)

Note: Comments in square brackets were not included in the questionnaire and refer to the descriptions made in the text.

A.3.2 regret_2: Indirect measure of regret and disappointment (Zeelenberg et al., 1998):

We ask you now to think about the money that you invested in project B (no matter how much it was). Imagine that you roll the white dice and that you get a 5. Which means that you lost the money that you had invested in project B. How do you feel then?

		not at all			very much so
01.	Feel powerless?	(1)	(2)	(3)	(4)
02.	**Feel that you should have known better?**	(1)	(2)	(3)	(4)
03.	**Feel the tendency to kick myself?**	(1)	(2)	(3)	(4)
04.	Feel the tendency to get away from the situation?	(1)	(2)	(3)	(4)
05.	**Want to undo the event?**	(1)	(2)	(3)	(4)
06.	Want to do nothing?	(1)	(2)	(3)	(4)

Note: **Boldface** printed items were aimed at measuring regret, the remaining items were measuring disappointment.

A.3.3 regret_3: Experienced regret after outcome was known.

Please answer the following questions:

		not at all			very much so
01.	Are you disappointed by the outcome?	(1)	(2)	(3)	(4)
02.	Do you regret your decision?	(1)	(2)	(3)	(4)

B   Appendix: Instructions

B.1   Instructions in all treatments

Information about projects

In this phase you have to make a *single* decision concerning your working money. You have to allocate the 15 euro [30 euro] that you received over two projects. These projects will be labeled on the computer screen, when you make your decision, with the letters A and B.

In project A you will get for every euro that you put into this project, one euro. Thus, project A always gives a certain return. For the amount that you put in project B the following holds. With probability one half (1/2) you will lose this amount and with probability one half (1/2) you will receive two and a half (2 1/2) times this amount.

You can allocate your working money in multiples of 50 eurocent [1 euro] over the projects A and B in any possible combination that sums up to 15 euro [30 euro]. The table below shows for each possible combination that you can choose the returns and corresponding probabilities. All values are in euros.

In the following phase the return of project B will be randomly determined. Each participant has just received a white die. In the next phase everyone will be asked to throw this die a single time under supervision. Also if you have put nothing in project B, you will have to throw the die. If the die shows 1, 2 or 3, you will receive two and a half (2 1/2) times the amount that you put in project B. If the die shows 4, 5 or 6, you will lose the amount that you have put in project B.

[(Text added in treatments global-risk-low and global-risk-high):

At the end of the following phase, thus *after* the outcome of the projects is determined, you will be confronted with the risk to lose all your earnings.]

Money in project: A	Money in project: B	Certain return	Chance of 1/2 for extra earnings of
0.00	15.00	0.00	37.50
0.50	14.50	0.50	36.25
1.00	14.00	1.00	35.00
1.50	13.50	1.50	33.75
2.00	13.00	2.00	32.50
2.50	12.50	2.50	31.25
3.00	12.00	3.00	30.00
3.50	11.50	3.50	28.75
4.00	11.00	4.00	27.50
4.50	10.50	4.50	26.25
5.00	10.00	5.00	25.00
5.50	9.50	5.50	23.75
6.00	9.00	6.00	22.50
6.50	8.50	6.50	21.25
7.00	8.00	7.00	20.00
7.50	7.50	7.50	18.75
8.00	7.00	8.00	17.50
8.50	6.50	8.50	16.25
9.00	6.00	9.00	15.00
9.50	5.50	9.50	13.75
10.00	5.00	10.00	12.50
10.50	4.50	10.50	11.25
11.00	4.00	11.00	10.00
11.50	3.50	11.50	8.75
12.00	3.00	12.00	7.50
12.50	2.50	12.50	6.25
13.00	2.00	13.00	5.00
13.50	1.50	13.50	3.75
14.00	1.00	14.00	2.50
14.50	0.50	14.50	1.25
15.00	0.00	15.00	0.00

B.2 Announcement of global risk in treatments global-risk-low and global-risk-high

Announcement earnings

At the end of phase 3 of this experiment there is a chance of $1/3$ that you will lose *all* your earnings.

Each participant has received with this announcement a red die. After the end of the 3 phase, thus **after** *the outcome of the projects is determined*, each participant will be asked to roll this die a single time under supervision. If the die shows 5 or 6, you will lose **all your earnings**. If the die shows 1, 2, 3 or 4, you will keep your earnings. Please note, your earnings depend on the decision that you will take now, in phase 2.
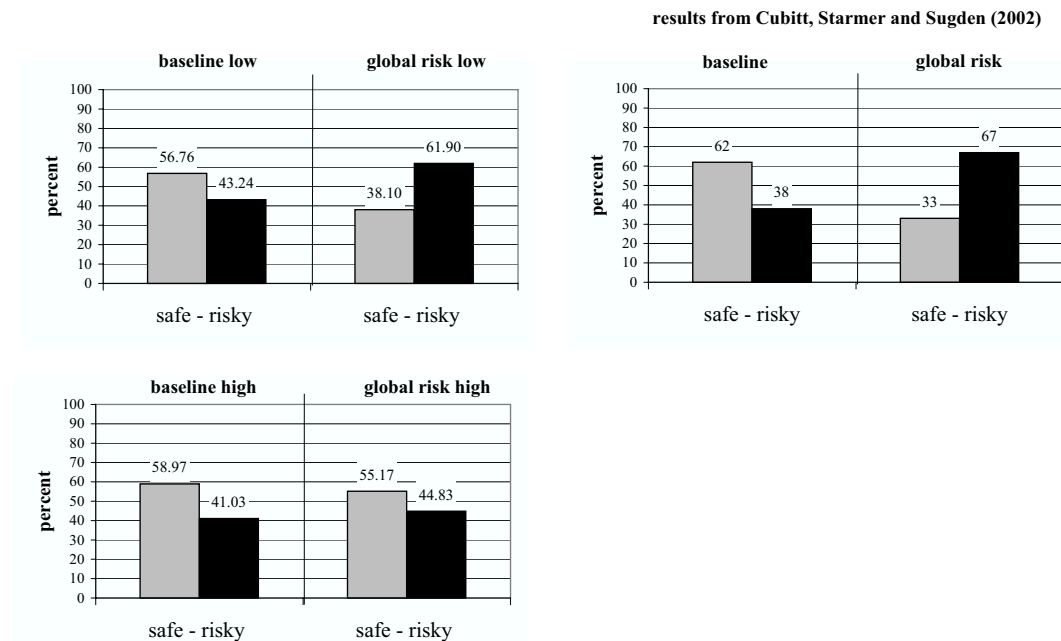
Figure 7: Simulated binary investment

C Appendix: Comparing binary with continuous investment

As we have seen in Section 3.1 investment behavior in our experiment, differs dependent on treatment. To ensure that our investment results can be compared with results from choice problems of a similar kind we compare our data to results from Cubitt et al. (1998). In their experiment, subjects were asked to choose between a risky and a safe alternative, where the risky choice corresponds to investing all money in the risky project and the safe choice corresponds to investing all money in the safe project[12]. To compare the results, we present investment in an artificially binary way (see Figure 7). We consider subjects investing ≤ 7.5 (≤ 15) in the risky project as tending to the 'safe' alternative and subjects investing > 7.5 (> 15) as tending to the 'risky' alternative.

We observe in treatments *baseline-low* (*baseline-high*) a distribution of 57 percent (59 percent) of subjects choosing the safe alternative. This result is very similar to the observations by Cubitt et. al who find that 62 percent of subjects choose the safe alternative.

Further, in treatment *global-risk-low* we observe a marginally significant different distribution from *baseline-low*, of 38 percent of subjects choosing the safe option (z statistic: $p = 0.09$). These results are in line with the results by Cubitt et al., who observe in their treatment involving global risk, 33 percent of safe choices. Somewhat surprisingly we observe though in treatment *global-risk-high* a majority of 55 percent of subjects choosing the safe option, which seems to oppose the tendency observed by Cubitt et al. (z statistic global-risk-high vs. Cubitt et al.: $p = 0.056$).

We therefore observe a very similar investment pattern as Cubitt et al. with low stakes, but a shift if stakes are increased.

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[12] For a discussion of the differences of their game to out investment problem see the discussion in Bosman and van Winden (2001)

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