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FRANS VAN WINDEN, MICHAL KRAWCZYK, AND ASTRID HOPFENSITZ

Ecole d'économie de Toulouse (TSE) - Manufacture des Tabacs
Aile Jean-Jacques Laffont - 21, allée de Brienne - 31000 TOULOUSE
Tél : +33 (0) 5 61 12 85 89 - Fax : +33 (0) 5 61 12 86 37 - **www.TSE-fr.eu** - contact@TSE-fr.eu

Investment, Resolution of Risk, and the Role of Affect*

FRANS VAN WINDEN[1#], MICHAL KRAWCZYK[2], AND ASTRID HOPFENSITZ[3]

[1] UNIVERSITY OF AMSTERDAM, CEPR, CES-IFO, AND TINBERGEN INSTITUTE
[2] UNIVERSITY OF WARSAW
[3] TOULOUSE SCHOOL OF ECONOMICS (GREMAQ)

Abstract

This experimental study is concerned with the impact of the timing of the resolution of risk on investment behavior, with a special focus on the role of affect. In a between-subjects design we observe the impact of a substantial delay of risk resolution (2 days) on investment choices. Besides the resolution timing all other factors, including the timing of payout, are held constant across treatments. In addition, state-of-the-art experimental techniques from experimental economics and psychology are used for eliciting preferences and to explicitly measure emotions and personality traits. Participants put their own money at stake. Our main finding is that the timing of the resolution of risk matters for investment, modulated by the probability of investment success. Emotions are found to play a significant role in this respect and explain our main finding. Our results support recent models of decision making under risk trying to incorporate anticipatory emotions but also uncover some important shortcomings related to the dynamics of emotions.

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Key words: Investment decision, delayed resolution of risk, emotions, experiment

JEL codes: C91, D81, G11

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[#] Corresponding author: Frans van Winden, CREED/Department of Economics, University of Amsterdam, Roetersstraat 11, 1018 WB Amsterdam, Netherlands. E-mail: f.a.a.m.vanwinden@uva.nl

1 Introduction

The recent financial and subsequent economic crisis has fuelled the discussion in economics regarding the rationality of financial markets and investment behavior. Instead of cold calculations, emotions like greed and fear are often referred to as motivational factors in debates about the crisis. The "animal spirits" that Keynes alluded to when he discussed the role of expectations in investment in his *General Theory* are back in business (see Akerlof and Schiller, 2009; Greenspan, 2008). In this paper we will investigate the role of emotions in risk taking in a much simpler but controlled setting, focusing on the time it takes for risks to materialize. Although this factor is typically ignored in economic theory, whenever we take a risk time passes between the decision to take the risk and the resolution of that risk. This time can be very short, as with on-the-spot lotteries, but it can also be very long, like in research for new drugs. Other examples can be found when looking at decisions concerning medical examinations or health and safety related activities. In mainstream economics this time dimension has received little attention. Only planning motives related to consumption smoothing facilitated by prior knowledge of outcomes have been considered (Drèze and Modigliani, 1972; Spence and Zeckhauser, 1972). However, there is a small but growing literature acknowledging that the timing of the resolution of risk can be important for other reasons. Kreps and Porteus (1978) proposed a theoretical formalization of preferences for early or later resolution. More recently, economists have begun to emphasize and to explore the role of anticipatory emotions in this context (Pope, 1983, 1995, 2004; Loewenstein et al., 2001). For example, the arousal felt when looking at a spinning roulette wheel may add to the attractiveness of a gamble with delayed resolution. On the other hand, anxiety can cause people to prefer a larger immediate electric shock to a lesser shock that would be delayed (Cook and Barnes, 1964; Loewenstein, 1987). Long-lasting uncertainties can even have long term health effects due to stress and anxiety (Lazarus, 1991).

Although emotions have received some attention in economics these studies typically focused on experienced emotions, particularly, regret and disappointment when outcomes are observed (Bell, 1982, 1985; Loomes and Sugden, 1982, 1986). Given the consequentialist character of mainstream economic models, this was a natural focus. Moreover, allowing for anticipatory emotions would have conflicted with the maintained axiom of temporal consistency (as in the model of Kreps and Porteus)[1]. The reason is that anticipatory emotions may change (reverse) an individual's preferences when the time of resolution draws near. Influenced by substantial psychological and neuroscientific evidence (e.g.: Isen and Geva, 1987; Chua et al., 1999; Critchley et al., 2001; Loewenstein et al., 2001; Lo et al., 2005), economists have recently picked up the challenge to develop new models incorporating anticipatory emotions, focusing on anxiety (Wu, 1999; Caplin and Leahy, 2001). These models, which will be discussed in greater detail below, offer a novel perspective on important issues like the equity premium puzzle and the simultaneous occurrence of insurance and gambling.

Likewise, it is crucial for advancing our understanding of the impact of (anticipatory) emotions, to develop a rich set of experimental data. Experiments enable us not only to test theoretical hypotheses and predictions but also to explore the role of different (anticipated and experienced) emotions and how these are affected by the delayed resolution of risk. In short, they can assist in testing and improving theoretical models. Moreover, by a systematic and gradually more complicated experimental approach fundamental knowledge may be gained about the typically complex and dynamic emotional patterns occurring in the ’wild’.[2]

A few experimental studies exist that have investigated people’s preferences regarding the timing of the resolution of risk, arguing in favor of a significant role of (anticipatory) emotions (Chew and Ho, 1994; Ahlbrecht and Weber, 1996; Lovallo and Kahneman, 2000; Noussair and Wu, 2006). We will discuss these papers in greater detail below. However for different reasons the design of these studies can be seen as problematic. They either use hypothetical scenarios or lack a research design leaving all factors except risk resolution constant. Furthermore, they all lack an explicit measure of emotions. We therefore think that the verdict is still out, and aim to fill this gap with our study.

The main goal of our experimental paper is to investigate the impact of the timing of the resolution of risk on investment behavior and the role of affect with a thorough experimental design. In a between-subjects design we observe the impact of a substantial delay of risk resolution (2 days) on investment choices. Besides the resolution timing all other factors and especially the timing of payout are held constant across treatments. In addition we use state-of-the-art

[1] Note the difference between an 'anticipated' emotion and an 'anticipatory' emotion. While the first describes the anticipation of future emotional state (e.g. regret) the latter refers to an emotion experienced during the anticipation of outcomes (like anxiety or excitement) (see Loewenstein et al., 2001).

[2] See, in this context, Cubitt and Sugden (2001).

experimental techniques for eliciting preferences and information about emotions. Doing so makes our experimental design novel in several respects. First of all, participants put their own money at risk in the investment task. Thus, not only monetary incentives were provided, but also real (out of pocket) losses were made possible, which is actually quite exceptional in economic experiments. Second, we used standard incentivized methods to measure participants' preferences with respect to risk, the timing of the resolution of risk, and the time of payment (i.e., their discount rate). Third, we employed a standard procedure in experimental psychology to explicitly measure anticipated as well as experienced emotions (as in Hopfensitz and van Winden, 2008). Moreover, anticipatory emotions experienced during the waiting period under delayed resolution – which involved two days – were elicited. Finally, we administered a web-based questionnaire before the experiment to obtain data on personal traits – related to anxiety, sensation seeking, and risk propensities – using well validated scales.

The rest of the paper is organized as follows. Section 2 presents the experimental design, the experimental procedures, and theoretical predictions derived from the main models of decision making under risk. Section 3 shows and discusses the behavioral results. Section 4 goes into the role of affect. It extends the analysis by extracting and testing predictions from the relevant literature. This section also provides an explanation of our main behavioral findings. Section 5 concludes.

2 Experimental design, procedures, and predictions

2.1 Design

To investigate the relevance of the timing of the resolution of risk for investment behavior, the experiment comprises two sessions (two days apart). At the first session, participants are confronted with the following individual choice task. Each participant has to allocate *20* euro (of their *own* money) to two "projects", A and B, where Project A is safe while Project B is risky. The return from Project A is always *1.2* times the amount allocated to this project. The return from B depends on the experimental condition. There are two conditions in this respect. In the Low Probability (*LoProb*) condition, with probability $p = 0.2,$ Project B returns *9* times the invested amount, and returns nothing otherwise (i.e., with probability $1\text{-}p = 0.8$). In the High Probability (*HiProb*) condition, with probability $p = 0.8,$ Project B returns *2.25* times the invested amount, and nothing otherwise. As a result, mean returns from the risky project are identical in both conditions, but the variance is higher under low probability. For convenience, in the sequel, only the money that is allocated to the risky project B is called *investment*. Each of these two probability conditions is investigated under two further conditions concerning the timing of the resolution of the investment risk. The resolution either takes place in the same session immediately after the investment decision (*Imm*) or is delayed till the beginning of the second session (*Del*). Details are discussed in section 2.2 when we explain the procedures. Each participant in the experiment is randomly assigned to one of the resulting four treatments: low probability - immediate (LoProb-Imm), low probability - delayed (LoProb-Del), high probability - immediate (HiProb-Imm) or high probability - delayed (HiProb-Del) (see also Table 1).

Table 1: Overview of experimental treatments

	Immediate (Imm)	**Delayed (Del)**
High Probability (HiProb)	Immediate resolution of risk p=0.8 to earn 2.25 times investment	Delayed resolution of risk p=0.8 to earn 2.25 times investment
Low Probability (LoProb)	Immediate resolution of risk p=0.2 to earn 9 times investment	Delayed resolution of risk p=0.2 to earn 9 times investment

Apart from the main investment task, three other tasks are employed to elicit potentially relevant preferences of the participants concerning timing of resolution, risk, and the time of payment (discount rate). After the investment decision, the preference for the timing of the risk resolution is measured. Participants indicate how much higher (or lower) the probability of the outcome from the risky project would have to be for them to be willing to switch to the other timing option (using a Becker-DeGroot-Marschak (BDM) procedure). Risk aversion is measured during the second session (after the resolution of the risk), by participants making multiple choices between two lotteries (see Harrison et al., 2007, for details and values used). Finally, at the end of the second session time preferences, that is, discount rates are elicited. Participants indicate when they would like to receive their payment from the experiment, choosing between immediate payment (via a bank transfer the next day) or payment plus different levels of interest in two months (design based on Coller and Williams, 1999). To make each measure incentive compatible, for each task one of the choices is randomly selected to be played out for real (see Appendix B for detailed instructions).

In addition to these revealed preferences measures, survey and self-report techniques are used to collect data on individual characteristics and emotions. In a web-based survey, to be completed before the first session of the experiment, data regarding demographic variables (age, gender, field of study) and some psychological traits are obtained. In view of the hypothesized importance of anxiety for decision making under uncertainty the survey includes the well-known STAI trait scale (Spielberger et al., 1970). Because of their apparent predictive power for risk taking, we further measure sensation seeking (Arnett, 1994), risk-propensity for various life domains (Nicholson et al., 2005) and general risk attitude (based on Dohmen et al., 2005). Details are provided in Appendix D.

Emotions are measured by self reports. More specifically, we measure the intensity with which various emotions are (1) anticipated at the time of the investment decision, (2) experienced after the resolution of the investment risk, and (3) recalled at the second session concerning the two-days waiting period in the treatments with delayed resolution.[3] For the first two measures we rely on earlier work (Hopfensitz and van Winden, 2008), while a novel measure is developed to deal with recalled emotions. The affect measures are further discussed below.

For an overview of the nature and timing of the different tasks and measures, see Figure 1.

2.2 Procedures

The experiment was announced by email using a web-based recruiting system. Upon registration participants received a link to a web page with a series of questions, which they were required to fill out at least 24 hours prior to the start of the experiment. The collected information consisted of general demographic data, the STAI trait scale, the sensation seeking scale, and a series of questions to measure risk attitude, as discussed above. To assure anonymity responses were linked to behavior in the experiment through a password that each subject had to choose. Participants were required to sign up for two sessions, two days apart. These sessions took place either on a Monday and Wednesday, or on a Tuesday and Thursday. Participants were also informed that their earnings from the experiment would be transferred to their bank account after completion of the experiment.

[3] According to Robinson and Clore (2002) self-reports are "the most common and potentially the best way to measure a person's emotional experience".

First session

Upon arrival at the first session, participants were required to submit 20 euro in cash – which was explicitly mentioned in the announcement – and were asked to read and sign a participant consent form (see Appendix C). No one objected to this procedure. Subsequently, they were asked to draw a table number at random, to take their position in the lab and to fill in their password from the web questionnaire. Once everybody was seated, the instructions for the first part of the experiment were distributed and read aloud (see Appendix B). The instructions informed the participants about the investment task and the particular resolution timing (Immediate or Delayed) and probability (Low probability or High probability) condition they would be facing. They then had to submit their investment decision with respect to their 20 euro on the computer. Immediately after their decision, participants were asked to rate the extent to which they had taken into account a number of anticipatory emotions (such as hope and worry) and a couple of other emotions related to how one would feel immediately after the resolution.[4] Subsequently, the instructions for the second part of the experiment were distributed.

In this part, we measured participants' preferred resolution timing condition, using the BDM-procedure discussed above. Whether participants actually had to switch to the other timing condition was determined by the draw of a random number.[5]

Participants in the immediate resolution condition subsequently had to roll two dice to resolve their investment risk, and were immediately after that asked to indicate the intensity with which they experienced a number of emotions (see Figure 1). For participants in the delayed resolution condition the session ended after the timing preference task. When all participants had finished, the first session ended and participants were reminded that they would only be paid after the second session two days later.

[4] The six questions that were asked concerned the following emotions: "worry about the outcome", "enjoying hope for success", "excitement", "desire to know approximate earnings to plan expenditure", "expectation to feel really good in case of success", and "expectation to feel really bad in case of failure". In the delayed resolution treatment it was added to the first four: "during the two days to come". In addition, participants were asked to state (hypothetically) the certainty equivalent of their gamble (given their investment decision); however, we will not use these hypothetical data in this paper.

[5] In total, only 2 participants actually had to switch.

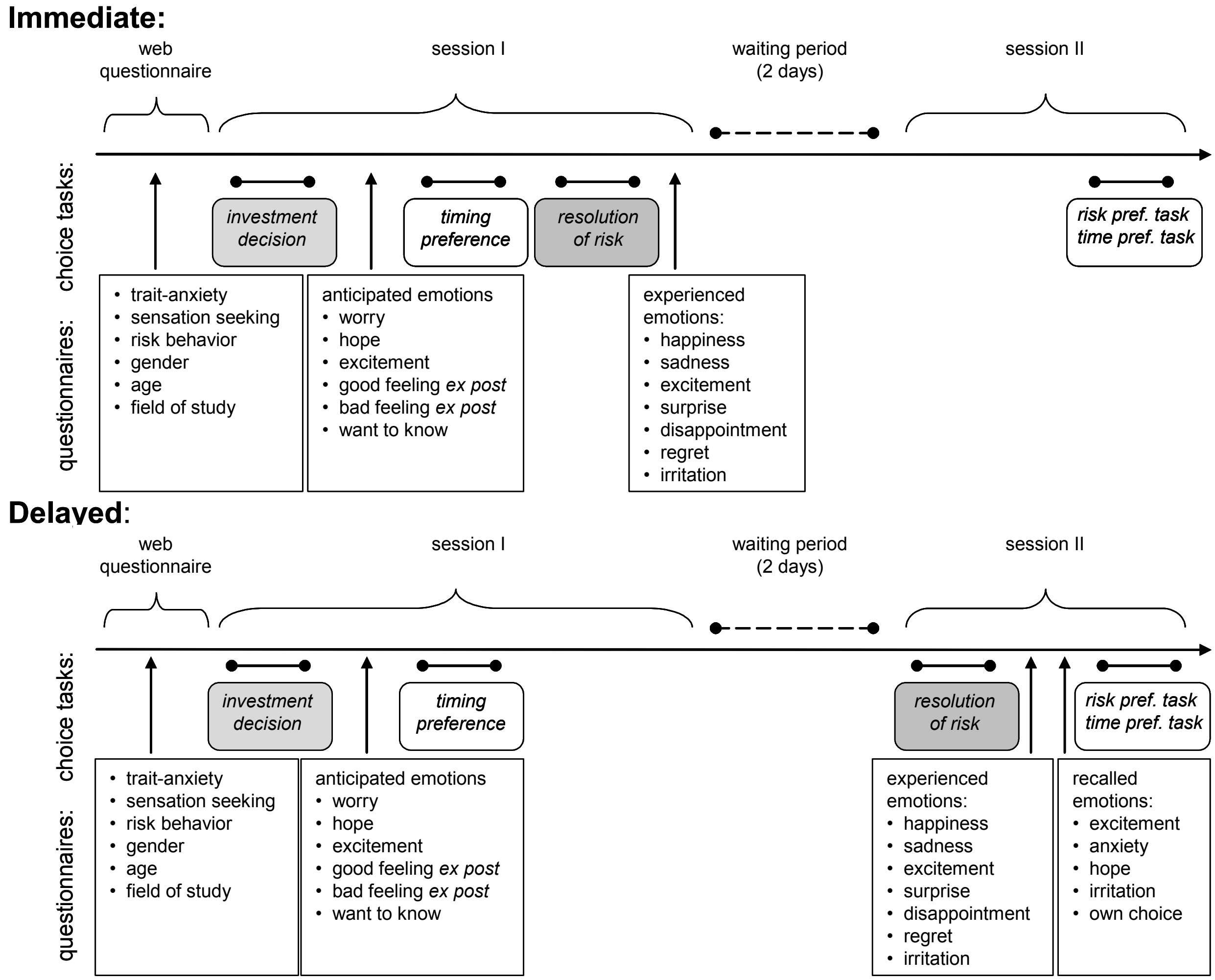

Figure 1. Order of events per resolution timing treatment: top panel: treatment Immediate; bottom panel: treatment Delayed

Second session

At the start of the second session participants had to present an ID before drawing a seat number for the lab. Once everybody was seated in the lab and had typed in their personal password, they were reminded of their respective decision or earnings from the first session. Participants who had their investment risk resolved at the first session were asked if knowing the outcome had influenced their spending behavior during the last two days. All others were asked to roll the dice to determine their investment outcome. Immediately after this dice roll, participants had to indicate the strength of the emotions they experienced when observing the outcome. In addition, participants were asked to recall the intensity with which they had experienced a number of emotions during the two-day waiting period (see Figure 1).

When finished, the instructions for the third part of the experiment were distributed. In this part risk preferences were elicited, with one of the choices being randomly selected to be played out for real. A volunteer determined the outcome by a dice roll.

Finally, total earnings (from the first and third part of the experiment) were presented to the participants, followed by instructions for the fourth and last part of the experiment. In this part participants were asked to indicate for 17 different interest rates whether they would prefer to be paid out immediately (that is, through a bank transfer on the next day) or rather have their earnings plus interest transferred in two months. Which interest rate was applied was again determined through a dice roll by one of the participants.

Participants were then called one by one to the reception room where, under the supervision of a cashier (not being an experimenter), they completed a money transfer form with their own bank account number and their total earnings. Dependent on their payment choice, the form was collected in a box labeled "tomorrow" or "in two months".

The experiment was conducted in September and October 2006 at the CREED laboratory of the University of Amsterdam. In total 127 mostly undergraduate students participated in 9 (double) sessions.[6] Participants came from a variety of disciplines, with 52 percent coming from economics or business; 26 percent of the participants were female. Each session took at most one hour and average (net) earnings amounted to about 25 euro.

2.3 Predictions based on utility theory and prospect theory

Because the choice task that participants were confronted with concerns the allocation of money to two projects where all possible outcomes and associated probabilities are known, we start with predictions derived from the two main theories of decision making under risk: Expected Utility Theory (EUT) and Cumulative Prospect Theory (CPT).

Expected Utility Theory. A utility function with wealth as argument should be virtually linear for amounts as small as those involved in our task (Rabin, 2000). In that case, expected utility maximizers are predicted to invest everything in the risky project, as the expected return from

[6] Data from one "second" session were lost. Missing values of risk aversion and time preference coefficients were replaced by sample means in regressions including these variables as explanatory variables, to make maximum use of the available data.

investment in the risky project B exceeds the return on the safe project A (in the low probability as well as in the high probability condition). However, with experimental earnings as argument, many experimental studies show a non-trivial level of risk-aversion, with estimates of constant relative risk aversion roughly centered around the 0.3-0.6 range (Holt and Laury, 2002; Harrison et al., 2006). For this range, non-extreme investment is optimal under both low and high probability. We will control for risk aversion by using results from the risk preference task in the second session of the experiment. Furthermore, EUT predicts that risk-averse participants will invest relatively more facing a high probability, as the low probability condition involves a larger mean-preserving spread.

As for the timing of the resolution of risk, the reduction of compound risk axiom of EUT entails that no effect on investment is predicted.[7]

Cumulative Prospect Theory. In CPT it is important to know the decision maker's reference point defining losses and gains (Tversky and Kahneman, 1992). While there is little theory to go by (Köszegi and Rabin, 2006), in our case, the 20 euro that participants brought to the experiment seem to be a natural reference point, implying that earnings above or below 20 euro are likely to be perceived as gains respectively losses.[8] Note that, in this case, 3 euro is the highest investment level that precludes any losses. Furthermore, empirical studies of CPT generally show an almost linear value function for small amounts. This leads to the prediction of either maximal investment (20 euro) or very low investment (0 or 3 euro), independent of the probability condition and the assumption regarding the reference point. Using the probably most often employed parameterization based on Tversky and Kahneman (1992), an investment level of 3 euro is predicted for both high and low probability.[9] However, using a value of 1.75 instead of 2.25 for the loss-aversion parameter, as suggested by some recent studies (see Abdellaoui et al., 2007, and references therein), would lead to a prediction of maximal investment for both probability conditions. Because these empirical findings are typically based on binary choice problems, it

[7] Because there are at most only two days in between, and the amount of money at stake is only a minuscule fraction of a participant's lifetime wealth, we neglect a planning motive for preferring early resolution.
[8] This should not be affected by the prospect of winning extra money during the second session as that money was basically meant to cover the opportunity cost of participation in that session.
[9] Their median estimates are: $\alpha = \beta = 0.88$, $\gamma = 0.61$, $\delta = 0.69$, and $\lambda = 2.25$, where α and β are the parameters of the power value function (α for gains, β for losses), γ and δ the parameters of the probability weighting functions (γ for gains, δ for losses), and λ is the loss-aversion parameter. The probability weighting function is given by:
$w^{+}(p) = p^{\gamma} / [p^{\gamma} + (1-p)^{\gamma}]^{1-\gamma}$ for gains, while a similar function is assumed to hold for losses (with δ substituted for γ).

remains to be seen whether extreme investment choices will turn up in our case of a quasi-continuous choice.

Without assumptions imposed on the distribution of parameters among the participants, it is difficult to predict for which treatment investment will be higher. For example, it can be shown that for heavily distorted probabilities, CPT may predict higher investment for low probability (due to the overweighting of small probabilities), whereas the opposite may hold in case of little distortion.

For the same reason as holds for EUT, no effect of the timing of the resolution of risk is expected.

3 Investment behavior and the timing of the resolution of risk

In this section we present our experimental findings concerning investment under the different treatments and compare observed behavior with predictions based on the above discussed theories.

Investment behavior. Figure 2 shows the distribution of investment in the two probability treatments, where, in line with EUT and CPT, the timing of the resolution of risk is neglected for the moment. Maximal investment (20 euro) turns out to be the mode in each treatment. However, a strong heterogeneity in investment choices, spread over the whole investment space, can be observed.[10] Furthermore, investment is higher under high than low probability (Mann-Whitney-Wilcoxon test: $p < 0.01$; Kolmogorov-Smirnov test: $p < 0.01$)[11]. Specifically, under high probability mean investment is nearly 5 euro (about 50%) higher and maximal investment is more frequent (48%) than under low probability (23%). Also, investment below 10 euro is very rare for high probability. These results are compatible with EUT predictions but are incompatible with CPT, using standard parameter estimates.[12]

[10] Strong heterogeneity in investment behavior is also reported by Hopfensitz and van Winden (2008), using a similar investment task, and by Choi et al. (2007), who let participants choose a point on a budget line of possible portfolios.
[11] All tests are two-sided, unless otherwise noted.
[12] We further find little evidence of an investment level of 3 being prominent. Only 7 out of 127 participants (5.5%) chose this particular level.

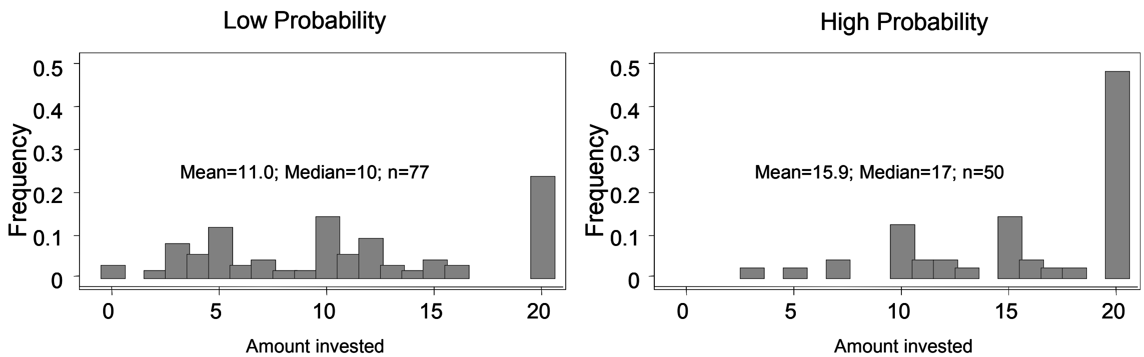

Figure 2: Histogram of investment in treatments LoProb (low probability) and HiProb (high probability)

To further investigate the predictive power of EUT concerning investment behavior we will use the individual data from the risk preference task. We obtain risk aversion estimates from the choices made in this task by following the procedure employed by earlier studies, using a CRRA utility function.[13] The mean value of the estimated risk aversion parameter is 0.539 (standard deviation: 0.397), while the median value is 0.595, which is between the estimates reported by Holt and Laury (2002) and Harrison et al. (2006). Thus, it seems that the fact that participants had to bring their own money did not lead to a (substantial) selection bias. Using these estimates we can generate predictions at the individual level. Figure 3 presents the frequency distributions of investment predicted by EUT for both probability treatments. In line with actual investment we observe a spike at maximal investment and, on average, a higher investment level under high probability. However, for each probability treatment, the hypothesis that actual and predicted investment levels come from the same distribution is rejected (Kolmogorov-Smirnov test: $p < 0.001$ for LoProb, and $p = 0.016$ for HiProb). Moreover, EUT has little predictive power at the individual level. Even though predicted and actual investment levels are (weakly) correlated in the low probability treatment (Spearman's $rho = 0.247$, $p = 0.077$) this is not at all the case in the high probability treatment (Spearman's $rho = 0.018$, $p = 0.900$).[14]

The risk-preference task is not well-suited to estimate the parameters required for assessing the predictive success of CPT at the individual level. However, in view of its poor performance at

[13] Assuming a CRRA utility function: $U(x) = x^{1-r}/(1-r)$, we compute for each of the four lists of binary choices the value of r corresponding to indifference in a particular row. Switching at a given row is associated with an interval for the value of r. Midpoints of the relevant four intervals (corresponding to the four lists) are averaged to arrive at a single measure of risk aversion.

[14] Results are not very different if correlations are conditioned on winning or losing in the investment task.

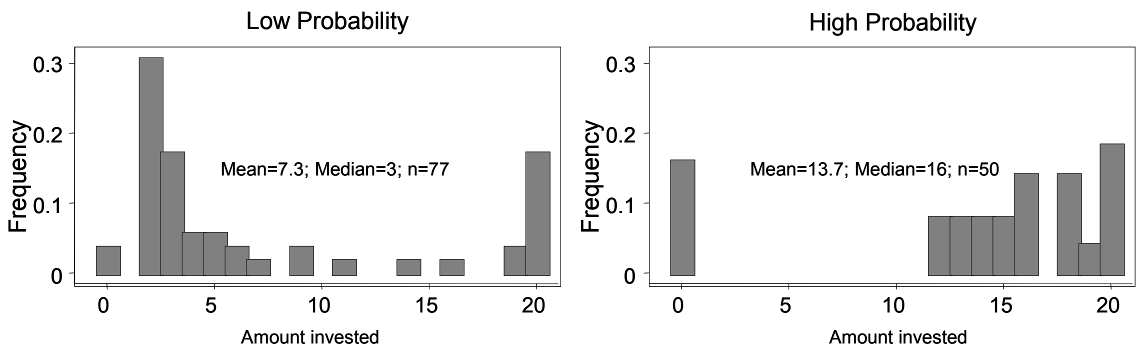

Figure 3: Histogram of predicted investment for treatments LoProb (low probability) and HiProb (high probability) using CRRA estimates and EUT.

the aggregate level, it is unlikely to do very well in this respect.[15] In any case, we find no evidence that losing (or winning) in the investment task affects behavior in the risk preference task, even though our experimental design (putting a participant's own money at stake) would seem to make losses particularly salient. Correlating the (exogenous) dummy variable indicating winning or losing in the former task with estimated risk aversion, no significant relationship is found (Spearman's $rho = 0.144, p = 0.151$).

In conclusion, using standard parameter estimates, we find little support for the predictive power of both EUT and CPT concerning the investment choices in the experiment. Below, we will investigate whether adding information on participants' time preferences, other measures of risk attitude, and some demographic data help improve the performance of the CRRA model predictions. First we turn to the issue, though, whether the timing of the resolution of risk influenced investment behavior.

Impact of the timing of the resolution of risk. Figure 4 shows the distribution of investment in the different resolution timing treatments. On average, investment appears to be about 2 euro higher under immediate resolution of risk. The effect is not equally strong for the two probability treatments, though. For the low probability treatment, the difference in investment is not significant (Mann-Whitney-Wilcoxon test: $p = 0.27$). For the high probability treatment, however, there is evidence of higher investment under immediate resolution of risk (Mann-Whitney-Wilcoxon test: $p = 0.091$). The difference in mean investment is about 2.5 euro. Moreover, more than half of the participants choose maximal investment under immediate resolution, whereas under delayed

[15] For some other experimental evidence against CPT as a theory of risky decision making, see Birnbaum (2004).

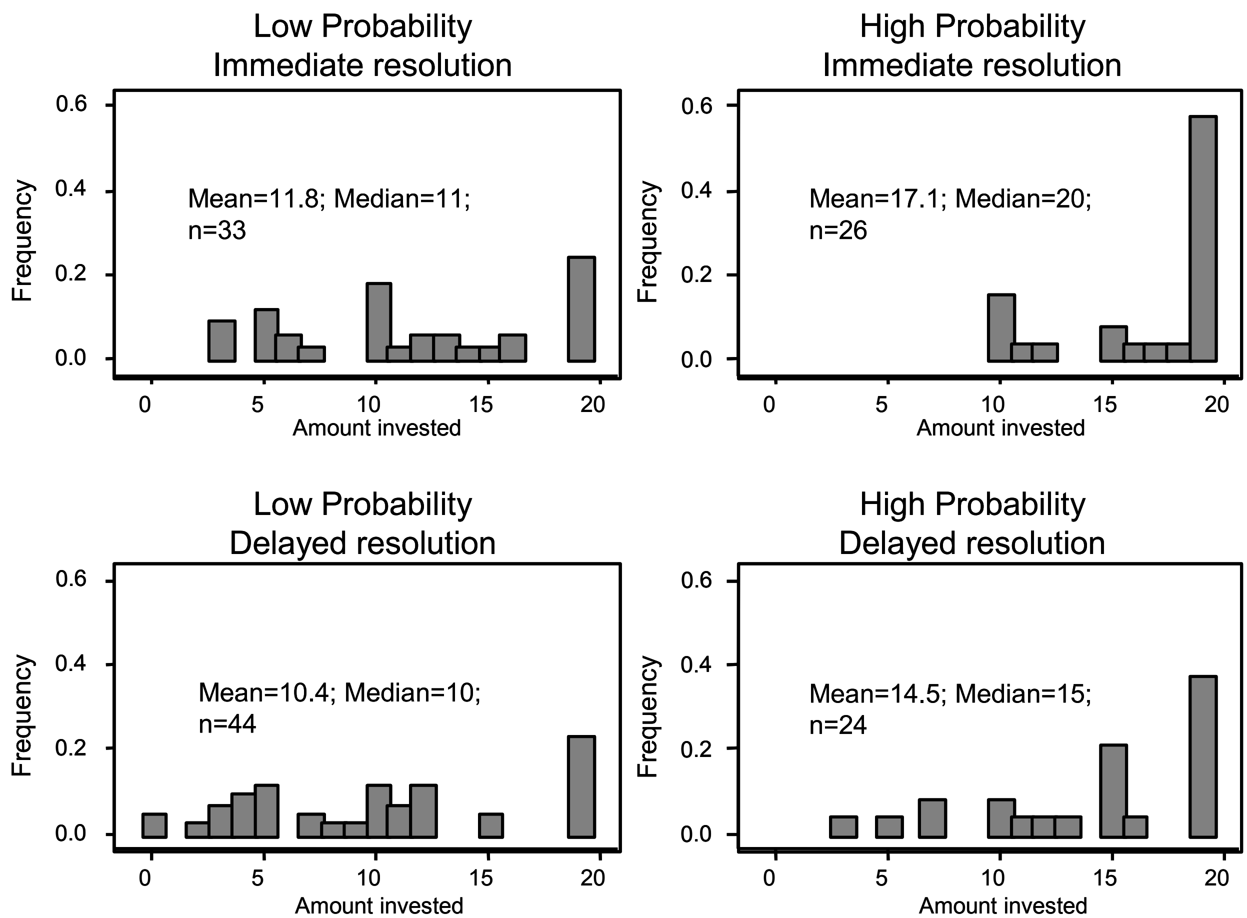

Figure 4: Histogram of investment by probability treatment (High and Low) and resolution timing (Immediate and Delayed).

resolution median investment equals 15 euro. Additional support is obtained from a two-way ANOVA test, suggesting both an effect of probability ($p < 0.01$) and an impact of the timing of the resolution of risk ($p = 0.056$). This evidence of a resolution timing effect runs counter to the no-effect predictions of both EUT and CPT.[16]

The data collected from the resolution timing task in the second part of the experiment also suggest some preference for immediate resolution, which is however independent of the probability treatment. As it turns out, about 50% of the participants are willing to take a loss of 22.5 eurocents or more in order to obtain or keep a risk resolution condition. For the high probability treatment and an investment of 10 euro an expected loss of 22.5 eurocents corresponds to a decrease of one

[16] This result also contrasts with Noussair and Wu's (2006) finding of more risk aversion when lotteries are immediately resolved. We will return to this study in the next section.

percentage point in the probability of winning.[17] If instead we take one euro as cutoff point this proportion drops to about 10%. This willingness to pay virtually always regards the immediate resolution of risk. Moreover, using a Mann-Whitney test, we cannot reject a similar willingness to pay in the two probability treatments.[18] We summarize our findings so far.

MAIN FINDING *The timing of the resolution of risk influences investment behavior, albeit only in the high probability treatment. This runs counter to both EUT and CPT.*

Time preference and other measures of risk attitude. Before we proceed with an investigation of the role of affect, we first want to see whether other individual data collected in the experiment can help improve the performance of the CRRA model. We consider participants' estimated discount rate and their self-reported tendency to take real life risks. Discount rates were estimated using the time preference task in the final part of the experiment. Estimates are roughly in line with those encountered in the literature, with a median annual discount rate of 0.35 (see Coller and Williams, 1999).[19] We will use a (censored Tobit) regression model to assess the influence of these variables and some demographic data (gender, age, field of study), in addition to the influence of the optimal (EU) investment level predicted by the CRRA model. Furthermore, we incorporate dummy variables to allow for treatment effects, using the high probability - immediate treatment (HiProb-Imm) as base category.

Results are presented as model 1 in Table 2. The reader is kindly requested to ignore for the moment the other two models in this table, which will be discussed below. As it turns out, neither the estimated optimal investment level (CRRA-model), nor the individual discount rate, nor the

[17] More specifically, we have computed for each participant the expected loss resulting from accepting a lower probability of winning in a timing condition. Suppose, for example, that someone invested 10 euro in the HiProb condition and showed indifference between an 80 percent probability of winning under immediate resolution and 82 percent probability of winning under delayed resolution of risk. This means that the additional gain of $10 \times 2.25 = 22.5$ euro is foregone with a probability of 2 percentage points. In other words, this person is willing to pay up to $0.02 \times 22.5 = 45$ eurocent in expected terms for the immediate resolution condition. It turns out that the median of this highest acceptable loss is 22.5 eurocents.

[18] Note that the observed behavioral impact of resolution timing violates the assumption of EUT. The assumption of EUT makes the BDM-procedure incentive compatible (see, e.g., Horowitz, 2006). We will return to our willingness-to-pay finding below.

[19] Coller and Williams obtain a value of about 0.2, depending on treatment, which would suggest that our participants were more impatient. However, note that the amounts involved in our study were substantially lower, which typically leads to heavier discounting (Frederick et al, 2002). Furthermore, the earlier payment was to be made "within about a week" rather than in a month time as in Coller and Williams' case, thus possibly leaving room for an immediacy effect (see, e.g., Hoch and Loewenstein, 1991). Also in this respect, we do not think that our participants formed a biased sample.

self-reported risk attitude (concerning different life domains)[20] shows a significant impact. The same holds for the demographic variables. Only the treatment dummy variables representing probability and the timing of the resolution of risk show a significant effect. In line with what we observed above: (i) investment is lower when the resolution of risk is delayed and the probability is high (HiProb-Del), while no effect is observed for low probability (the corresponding coefficients are not significantly different); (ii) investment is generally higher for high probability than for low probability. Leaving out the risk attitude variable and the discount rate – as the latter shows some (weak) correlation with the risk aversion parameter in the CRRA model (Pearson's $r = 0.18$, $p = 0.084$; Spearman's $rho = 0.097$, $p = 0.362$)[21] – improves the significance of optimal investment, which now reaches the ten percent level in a directed one-sided test ($p = 0.061$). This seems to be mainly driven by the (weak) correlation between predicted and actual investment in LoProb, which we observed above. This also happens to be the treatment where no resolution timing effect on investment is observed. The fact that resolution timing matters motivates our interest in models allowing for an intrinsic preference for the timing of the resolution of risk, to which we turn next.

4 The role of affect

A pioneering model allowing for an intrinsic preference for resolution timing is Kreps and Porteus (1978). In their model, inter-temporal decisions obey a "temporal consistency" axiom, which requires that a choice at time t between two lotteries that bring the same immediate consumption will not be reversed at time $t+1$. As a result, investment should only depend on the time between the resolution of the risk and payment, and not on the time between the decision and the resolution. Translated to our experiment, this model would predict no effect of the timing of the risk resolution on investment, unless being paid in about seven days (time consumed by the bank transfer) rather than nine days (including the two days in between the sessions) matters, which seems highly unlikely. In contrast, we find that the timing does influence investment, albeit only in the high probability treatments. As the temporal consistency axiom effectively nullifies the potential impact

[20] Similar results are obtained when the general question concerning risk taking is used instead.
[21] Mixed findings are reported on this issue in the literature. For example, Anderhub et al. (2001) find some positive correlation (with significance depending on the treatment of the data), while van Praag and Booij (2003) obtain a moderately negative correlation in their dataset. We find no correlation between estimated risk aversion and (self-reported) risk attitude, independent of whether risk propensity in any of the five life domains is considered or responses to the general risk attitude question. This is consistent with the notion that the propensity to take risk is a multi-faceted trait (MacCrimmon and Wehrung, 1986; Dohmen et al., 2005).

of anticipatory emotions, like hope or worry, and any delay in the resolution of risk can trigger such emotions, the question arises whether this neglect plays a role in the prediction failure.

However, before turning to the role of anticipatory emotions we want to address first Köszegi and Rabin's (2006) model of "reference-dependent risk attitudes". Their model allows for a behavioral effect of anticipated disappointment after the resolution of risk. It can be thought of as unifying prospect theory and disappointment-aversion theory (Bell, 1985; Loomes and Sugden, 1986; Gul, 1991) in a single framework, where outcomes are either resolved "shortly after" or "long after" the decision-maker commits to a decision. In the latter case, expectations are assumed to be based on the decision which will then determine the reference point for the evaluation of the future outcome. For our study the main prediction of their model is that people are likely to become more risk averse if the resolution comes long after the decision. The basic intuition is that the investment decision will induce a higher reference point and thereby a larger negative effect of anticipated disappointment. However, due to the lack of a precise definition of "shortly after" it is not completely clear whether these categories apply to our treatments. Whatever the interpretation it should be noted that this model cannot explain our finding that the resolution timing effect only occurs under high probability.

4.1 Anticipatory emotions

The most likely candidate for an explanation of the resolution timing effect observed under high probability of investment success (but not for low probability), are emotions expected to occur during the time elapsing between the investment decision and the risk resolution. To provide an explanation, these anticipatory emotions – like hope and worry–need to have a different impact on investment for the two probability conditions. The few existing theoretical and experimental studies that are relevant for our topic are suggestive in this respect.

Wu (1999) proposes that the (empirically found) overweighting of small probabilities reflects excessive cognitive attention during the waiting period for the potential gains or losses. In contrast probabilities of outcomes receiving relatively little attention are underweighted. Moreover, the longer the waiting period, the stronger should be these effects. In Wu's terminology any psychological utility or disutility of waiting for uncertainty to be resolved is termed "anxiety". In more conventional terms, though, one can say that anxiety is assumed to result from a disproportional dwelling on low outcomes, while hope stems from a disproportional dwelling on high outcomes. In our experiment, delayed resolution of risk would consequently lead to a more negative assessment of investment in HiProb (due to anxiety about losing) and a more positive assessment of investment in LoProb (due to hope for the large gain). Based on Wu's model of anticipatory emotions, investment is therefore predicted to be negatively affected by a delay in HiProb, and positively in LoProb. This is equivalent to saying that immediate resolution should be preferred under HiProb, while delay would be welcomed under LoProb. Some experimental support for a switching preference for uncertainty resolution related to small probabilities is provided by Ahlbrecht and Weber (1996). Furthermore, Chew and Ho (1994) find that a preference for delayed resolution (interpreted as hope) is more prevalent in case of a small probability of winning a large gain. However, both studies rely on hypothetical choice situations.

While the aforementioned studies provide a potential explanation for our observed resolution timing effect under high probability, they also suggest a difference in investment for low probability which we do not find. More precisely, investment should be higher when resolution is delayed and the probability is low. However, some other studies rather point at a more general dislike of delay, which might counterbalance this effect.

Specifically, Lovallo and Kahneman (2000) asked participants about the attractiveness of different (hypothetical) gambles and their liking of a delayed resolution of the risk involved. They find that generally people like early resolution better (for reasons other than planning), particularly for mixed gambles, characterized by the possibility of a loss.[22] Their interpretation is that people want to avoid dread and fear. Their data also suggest that mixed gambles with a higher mean-preserving spread are found less attractive, which would imply in our case that LoProb is experienced as less attractive than HiProb. Low attractiveness ratings for delayed resolution given a low probability of success can be explained by the theoretical model of Caplin and Leahy (2001). In their model, anxiety arises when future consumption is uncertain. Because of the anticipated negative hedonic value of anxiety, delayed resolution will be unattractive and investment discouraged. As in Wu (1999), an extended waiting period is assumed to result in a greater buildup of anticipatory emotions, suggesting that anxiety-related emotions will become more important the greater the delay in resolution.

Together, these two factors, namely the differential impact of hope and anxiety and a

[22] See further Ahlbrecht and Weber (1996) who observe a relatively large proportion of participants (43%) choosing early instead of late resolution, and findings by Eliaz and Schotter (2007).

general dislike of delay, would help explain our main behavioral finding. However, it should be noted that the studies from which these factors are derived are either theoretical studies or experimental investigations using hypothetical choice situations. This raises the question whether this explanation will survive our experimental design with real incentives, a real delay and explicit emotion measures. The next section addresses this question.

4.2 A regression model incorporating affect

We now turn to an analysis of how affect is related to investment in the experiment. We start with some general evidence of the role played by affective traits and states. Thereafter, the regression model of section 3 will be extended to incorporate our affect measures, followed by tests of the models presented in the previous subsection.

As discussed in section 2, we measured sensation seeking and trait anxiety as potentially important affective traits. Sensation seeking is seen as a predisposition for excitement about taking risks (Arnett, 1994), while trait anxiety reflects a predisposition to experience anxiety (Spielberger et al., 1970). Therefore, we expect sensation seeking to be positively correlated with investment, and trait anxiety to be negatively correlated. Moreover, if a prolonged waiting period gives anticipatory emotions more time to build up, these correlations should be stronger under delayed resolution of risk. Indeed we observe a significant negative correlation between trait anxiety and investment, but only in case of immediate resolution of risk (Spearman's $rho = -0.419$, $p < 0.01$).[23] Sensation seeking shows a positive but insignificant correlation with investment under both timing conditions.

For a first assessment of the importance of affective states across the resolution timing conditions, we look at the importance of anticipated emotions when the investment decision was taken. Table 3 presents the mean of the self-reported intensity with which various anticipated emotions played a role.

[23] See also Hopfensitz and van Winden (2008) who find weak experimental evidence for a negative effect of trait anxiety on investment in a similar task with immediate resolution.

Table 2. Regression modeling of investment choices (censored Tobit regression)

Explanatory	Model 1		Model 2		Model 3	
variables:	Coefficient	St. Err.	Coefficient	St. Err.	Coefficient	St. Err.
HiProb_Delayed	-5.21*	2.49	-4.68*	2.36	-3.81	2.31
LoProb_Immediate	-8.17**	2.26	-4.32	2.18	-4.61*	2.18
LoProb_Delayed	-9.02**	2.41	-6.38**	2.22	-6.83**	2.09
EU-optimal investment	0.12	0.12	0.09	1.02		
Discount rate	-0.93	1.21	-1.42	1.02		
Risk in life domains	1.25	1.08	0.37	0.96		
Anxiety trait			-0.03	1.65	-0.67	1.60
Sensation seeking			-1.87	2.00	-1.35	1.84
HiProb_Imm x PosAntEmo			5.62**	2.10	5.70**	2.12
HiProb_Del x PosAntEmo			0.40	1.46	0.73	1.44
LoProb_Imm x PosAntEmo			1.73	1.21	1.97	1.23
LoProb_Del x PosAntEmo			2.90*	1.18	3.24**	1.18
HiProb_Imm x NegAntEmo			-5.40*	2.24	-5.00*	2.12
HiProb_Del x NegAntEmo			-4.06**	1.47	-3.98**	1.48
LoProb_Imm x NegAntEmo			-4.64**	1.24	-4.42**	1.24
LoProb_Del x NegAntEmo			-3.18**	0.96	-2.88**	0.95
Female	-1.52	1.66	-2.78	1.46	-2.79	1.48
Age	0.03	0.25	0.08	0.21	0.12	0.20
Economist	2.01	1.48	1.27	1.20	1.01	1.19
Pseudo R^2	0.05		0.13		0.13	
N	117		117		117	
Model comparison		1 vs. 2		2 vs. 3		
LR chi^2		55.21		3.30		
p-value		< 0.001		0.35		

** significant at 5% level ** significant at 1% level.*

It turns out that for all emotions ratings are higher in the treatments with immediate resolution of risk. The difference is statistically significant for the emotions Hope, Excitement and Worry in both probability treatments.[24] The prospect of feeling good or bad about the outcome of the resolution, and the measure of how much they Want To Know the outcome, appear to play a similar role in both timing conditions.[25]

[24] Except for Excitement under high probability, where the difference is only weakly significant ($p = 0.10$), the significance of the three emotions is high for both probability treatments ($p < 0.05$).

[25] The variable Want To Know stands for the statement: "I wanted to know approximately how much I would win to plan my expenses". The idea was to tap with this statement the importance of the economic planning consideration discussed in subsection 2.3. To our surprise, the mean response was higher for Immediate (where clearly no expenses can take place between the decision and the resolution) than for Delayed. Further, it did not correlate with the response

Table 3. Intensity of anticipated emotions under immediate and delayed resolution.

	Hope	Excitement	Good Feeling *Ex Post*	Worry	Bad Feeling *Ex Post*	Want To Know
Immediate resolution	4.101	3.288	4.338	2.542	4.338	3.254
Delayed resolution	1.500	2.294	4.176	1.294	3.029	2.852
Overall Average	2.708	2.755	4.251	1.874	2.881	3.039
Mann-Whitney test: Immediate vs. Delayed	$p < 0.01$	$p < 0.01$	$p = 0.68$	$p < 0.01$	$p = 0.38$	$p = 0.31$

Because of the substantial correlations among the anticipated emotions, we performed a factor analysis to identify the main dimensions. It turns out that two factors represent more than 60 percent of the overall variance of the six emotion items (see Table 4). The first can be identified as representing Positive Anticipated Emotions (PosAntEmo), characterized by Hope, Excitement, and Good Feeling Ex Post. The second can be identified as representing Negative Anticipated Emotions (NegAntEmo), characterized by Worry, Bad Feeling Ex Post, and Want To Know. We expect that positive anticipated emotions will be related to higher investment while negative anticipated emotions will lead to lower investment.

Table 4. Factor analysis of anticipated emotions

	Factor Loading	
	Positive Anticipated Emotions (PosAntEmo)	Negative Anticipated Emotions (NegAntEmo)
Hope	0.842	0.314
Excitement	0.830	0.003
Good Feeling *Ex Post*	0.613	- 0.244
Worry	0.274	0.796
Bad Feeling *Ex Post*	-0.310	0.725
Want To Know	-0.179	0.620
Proportion of variance explained[a]	0.329	0.284

[a] The proportions of variance explained by the third and fourth factor were only 13.1 and 12.2 percent, respectively.

To evaluate the role of affect for explaining our main behavioral finding, we expand our

to the question about actual changes in expenses asked during the second session. (The latter also suggested that the planning consideration was weak, with the majority of the subjects stating that they did not adjust their spending, choosing 0 or 1 on a 5-point scale). Given the correlation of Want To Know with Bad Feeling Ex Post (*0.31, $p < .01$*), but not with Good Feeling Ex Post, it seems to relate more to avoiding negative monetary surprises. See also the factor analysis below.

regression model of section 3 (model 1) by including the affective trait variables (sensation seeking and trait anxiety) and the two anticipated emotions variables based on the factor analysis: Positive Anticipated Emotions (PosAntEmo) and Negative Anticipated Emotions (NegAntEmo), using the factor loadings as weights to arrive at an aggregate value of emotional intensity. Because of the hypothesized interaction with probability and resolution timing the emotion variables are interacted with the treatment dummies.[26] The results are shown as model 2 in Table 1. Model 3 gives the results when the economic variables (of model 1) are left out.

First of all, note from the pseudo-R^2 value and the likelihood ratio test that the new model performs significantly better. Moreover, leaving out the economic variables does not affect the model's explanatory power (see the model comparison), and hardly affects the results in a qualitative sense. We focus, therefore, on the more parsimonious model 3.

First, observe that the importance of the treatment dummies has decreased substantially. More specifically, the coefficients of the low probability dummies (LoProb-Imm and LoProb-Del) are about 35% smaller, while the coefficient of HiProb-Del is now no longer significant.[27] The improvement in the predictive power of the model appears to come from the affect variables.[28] More specifically, the improvement stems from the anticipated emotions variables, since no effect is observed for the trait measures (trait-anxiety and sensation seeking). Note however that trait-anxiety is correlated with Negative Anticipated Emotions (Spearman's $rho = 0.243$, $p = 0.006$), while sensation seeking is correlated with Positive Anticipated Emotions (Spearman's $rho = 0.156$, $p = 0.008$). This evidence bears out that emotion traits are dispositions for emotional states.

Next, observe that under delayed resolution negative anticipated emotions become relatively more important in the case of high probability (due to PosAntEmo losing its impact). In contrast, positive anticipated emotions become more important in the case of low probability

[26] As in model 1, willingness to pay in the resolution timing task shows no relation with investment if added as variable or interaction term. Note, in this context, that willingness to pay was measured after the investment decision, which should already have adjusted for emotions, including the unattractiveness of delay (they could not renew their investment decision). This may be the reason that relatively few people spend a non-trivial amount on switching (about 10% at least 1 euro). As a consequence, variation may be too little to capture an effect.

[27] Although the coefficient of LoProb-Imm is less negative, again (as in model 1), it does not significantly differ from that of LoProb-Del ($p = 0.233$).

[28] In addition, there is some (weak) evidence now of a gender effect, which is negative for female participants, in line with earlier findings (e.g. Charness and Gneezy, 2004; Bajtelsmit et al, 1997).

(where PosAntEmo gains a significant impact under delayed resolution).[29] Consequently, with a state-of-the-art experimental design, we find support for the hypothesized differential impact of emotions in the high probability and the low probability conditions if the resolution of risk is delayed. Moreover, we also have some evidence of the predicted general dislike of delay and its negative effect on investment. This is suggested by the negative coefficient of HiProb-Del (HiProb-Imm being the baseline treatment) and the more negative coefficient of LoProb-Del compared to LoProb-Imm. Further evidence to that effect is provided by the earlier observed predominant willingness to pay for switching to the early resolution timing condition (see section 3). Together, these findings support the explanation of our main behavioral finding that we tentatively put forward in subsection 4.1.[30]

EXPLANATION OF MAIN FINDING *Our main behavioral finding of a resolution timing effect in the case of a high probability of investment success can be explained by the impact of anticipated emotions. Delaying the resolution of risk has a differential emotional impact dependent on the probability of success. Negative emotions (like worry) become relatively more important in case of a high probability and positive emotions (like hope) in case of a low probability. In response, investment is discouraged in the treatment High Probability - Delayed and encouraged in the low probability treatments. Additional evidence of a general dislike of delay, which reinforces the negative influence of anticipated emotions in case of a high probability but counterbalances their positive influence in case of a low probability, helps explain why the timing effect shows up in the former but not in the latter.*

4.3 Back to theory and some additional evidence

Our experimental results are clearly supportive of recent efforts to incorporate anticipatory

[29] There appears to be an asymmetry in the impact of negative and positive anticipated emotions. While NegAntEmo always plays a role, resolution timing and risk affect the impact of the PosAntEmo. The overall stronger impact of negative emotions is in line with many similar findings in the psychological literature (see Baumeister et al., 2001).

[30] Because of the observed role of affect, the design of Noussair and Wu (2006), who found greater risk aversion under immediate than under delayed resolution, seems problematic. Their experiment consisted of two rounds, with (always in the same order) the immediate resolution task in the first round, and the delayed resolution task in the second round (using Holt and Laury's (2002) design). However, the resolution under "immediate" in fact occurred *after* subjects had finished the second round. Consequently, subjects were presumably still experiencing anticipatory emotions when making their decisions in the second round, which may have influenced their decisions. Another, technically problematic issue is that they did not allow for indifference in their risk preference task, while only about one-step differences were found between switching in the immediate and the delayed resolution tasks.

emotions into economic models of decision making under risk. However, these results also suggest that the existing models fail in capturing the dynamics of emotions. For example, it seems in contrast with Wu's (1999) model that high probability is perceived as a relatively more attractive gamble than low probability under early resolution of the risk (Immediate). There are two pieces of evidence to that effect: (a) the positive influence on investment of Positive Anticipated Emotions in HiProb-Imm, whereas in LoProb-Imm only Negative Anticipated Emotions show an impact; and (b) the fact that the value of the Negative Anticipated Emotions variable (capturing negative emotional intensity) is larger for LoProb-Imm than for HiProb-Imm (Mann-Whitney-Wilcoxon test, $p = 0.027$), while there is no difference regarding Positive Anticipated Emotions in this respect. Apparently, the length of the waiting period matters in a way that is not well captured by this model. Against Caplin and Leahy's (2001) model runs the finding of a similar value of the Negative Anticipated Emotions variable in both probability treatments for delayed resolution (HiProb-Del and LoProb-Del), while the coefficients of the Negative Anticipated Emotions variable are not more negative in case of the low probability than in case of the high probability. Furthermore, in sharp contrast with both of these theoretical models, we observe a lower intensity of anticipated emotions under the delayed resolution of risk and, if anything, a generally weaker impact.[31] These results are in line though with empirical findings suggesting that people give lesser weight to, and underestimate the impact of their future emotions in decision making (Loewenstein, 1996; Loewenstein and Schkade, 1999). If robust, these findings would suggest that the role of affect tends to be weaker (instead of stronger) under the delayed resolution of risk. Finally, note from the components of the Positive Anticipated Emotions and Negative Anticipated Emotions variables (see Table 4), that it is not only emotions that are experienced before the resolution of risk that count, but also emotions experienced after the resolution, which are neglected in both models.

Further support for the importance of emotion dynamics is gathered from our measures of recalled emotions (see Appendix A). We find evidence of a discrepancy between anticipated and experienced emotions and of a non-linear time path for anticipatory emotions. Furthermore, the recalled emotions data give additional evidence of a differential role of emotions under immediate and delayed resolution of risk. To save space we have relegated the details to the appendix.

[31] The values of PosAntEmo and NegAntEmo are lower in the delayed treatment for each probability condition, using a pairwise comparison (Mann-Whitney-Wilcoxon test, $p < 0.01$), except for NegAntEmo in HiProb where $p = 0.07$. The impact of PosAntEmo is greater under immediate than delayed resolution for HiProb (t-test, $p = 0.05$) but not significantly different for LoProb. The impact of NegAntEmo is lower (in absolute terms) under delayed resolution for both probability treatments, albeit not significantly so.

5 Concluding discussion

With a design satisfying state-of-the-art methodological criteria our experiment has established that the timing of the resolution of risk matters for investment behavior. This finding cannot be explained by the main economic theories of decision making under risk (EUT and CPT). In contrast, by incorporating participants' anticipated emotions into the analysis we were able to provide an explanation. What investors anticipate are feelings during the time interval that elapses between the investment decision and the resolution of the risk. It turns out that, dependent on the probability of a successful investment, delaying the resolution of the risk makes different kinds of these anticipatory emotions more prominent. Negative anticipatory emotions (like worry) become more important in case of a high probability of success, whereas positive emotions (like hope) gain prominence in case of a low probability. The action tendency of the former is to discourage investment while the latter encourage investment. We also observed a general dislike of delay, which reinforces this negative emotional action tendency in the high probability condition but counterbalances the positive emotional action tendency in the low probability condition. Together, these findings help explain why we observed a resolution timing effect under high probability but not under low probability.

Our study provides support for Keynes' claim that "animal spirits" are an important driving factor in investment behavior. Statements by (other) successful investors, like the famous long-time CEO of General Electric John (Jack) Welch, emphasizing the importance of gut feelings, also support this view (see Akerlof and Schiller, 2009). In fact, the tendency to prefer early resolution and to assume less risk under delayed resolution if the probability of losing is small, can clarify several phenomena observed in the field. For example, it would help explain why individuals are willing to pay so much for insurance policies, even when the maximal possible loss is small. Also, it may shed a new light on why people seem reluctant to take on investment risks (e.g. the equity premium puzzle). Our results suggest that this would particularly hold for cases where the chances of running losses are relatively small and the resolution of risk is distant in time. In line with this, lotteries with a low probability of a large gain are typically resolved days or weeks after the purchase of a ticket. While gambling devices offering "on the spot" resolution, such as scratching cards ("instants") or roulette, show lesser skewed prospects, that is, better odds of winning and lower maximal returns (Forrest et al., 2002).

Our findings concerning the importance of anticipatory emotions in case of a delayed resolution of risk clearly buttress recent endeavours to incorporate such emotions in economic models. However, we also observed some shortcomings of the existing models (Wu, 1999; Caplin and Leahy, 2001) which are particularly related to the dynamics of emotions. For example, these theoretical models cannot explain the observed switch in the relative impact of positive versus negative anticipated emotions between the two resolution timing conditions. Also, counter to the assumptions of these models, the intensity and general impact of anticipated emotions turned out to be weaker under delayed resolution. The experimental results of our paper suggest that one should not focus too much on a single type of emotion (like anxiety) if one is interested in explaining behavior. Both positive and negative emotions, likely to be experienced during the waiting period and after the resolution of risk, should be taken into account. Moreover, the unexpected finding of a weaker role of affect under delayed resolution deserves further research. Our data support the hypothesis of a misalignment between anticipated and experienced emotions in case of a (substantially) delayed resolution of risk, with future emotions being underestimated (see Kahneman et al., 1997). What causes this failure of affective forecasting is as yet unclear. Furthermore, it would be important to investigate to what extent our results are robust under repeated decision making. On the one hand, one can imagine that experience with the task at hand might make it less emotional. On the other hand, the experience of (sustained) losses or gains could easily fuel emotions or perhaps lead to moods with additional effects on decision making.

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Appendix A: Emotion dynamics

Our experimental findings show the importance of taking anticipated (anticipatory) emotions into account when modeling investment decisions. However, two further issues, have so far been neglected in studies of financial risk taking dealing with affect. The first concerns the question to what extent emotions anticipated when an investment decision is made are later actually experienced. The second concerns the time-profile of anticipatory emotions, that is, the development of these emotions during the waiting period before the resolution of the risk. During the experiment we collected data on experienced and recalled emotions which allow us to tentatively explore the two issues mentioned above.

We start with the dynamics of anticipatory emotions experienced during the waiting period. To identify time profiles, we used a continuous retrospective self-report method (see Larsen and Frederickson, 1999) inspired by Sonnemans (1991), focusing on four emotions: hope, excitement, anxiety, and irritation. For each emotion participants were shown a computer screen with a line representing the forty-eight hours that elapsed between the moment the investment decision was made (at the first session) and the moment the resolution of the risk took place (at the second session). Participants were asked to report each instance they experienced the given emotion by clicking on one of the forty-eight line segments corresponding to the time at which the emotion was felt. Subsequently, they could rate the intensity of the experienced emotion on a seven-point Likert scale.

For each of the four emotions, Figure 5 presents the development of the mean intensity scores over the forty-eight hour waiting period. Instead of a gradual build-up of emotional intensity – as assumed in the model of Wu (1999) – a rather U-shaped pattern shows up supporting the psychological evidence referred to by Caplin and Leahy (2001). Furthermore, note that for Hope, Excitement and Anxiety, the peak observed at the end during the last two hours (that is, just before the resolution of risk) is more pronounced than the peak in the first two hours (right after the decision), which makes the time pattern for these emotions more J-shaped.[32] Remember that similarly the anticipation of hope, excitement and worry was higher under immediate than under delayed resolution (see Table 3). Assuming that 48 hours are not enough to distort the recall of emotions substantially, these outcomes would be consistent with myopic affective forecasting. Research on 'empathy gaps' and 'projection bias' suggests that people are notoriously shortsighted, attaching too much weight to the present (see e.g. Loewenstein, 1996; Gilbert et al., 2002). According to Kahneman et al. (1997, p. 396): "many errors of predicted utility are caused by the practice of evaluating an entire extended outcome by evaluating the transition to it." In our case it would make understandable also the observed lower intensity scores for anticipated emotions under the delayed resolution of risk.

Our next findings – regarding the issue of whether anticipated emotions were actually experienced – in fact provide some support for the presence of myopic emotional forecasting. Using the data on emotions experienced after the resolution of the risk, we examine whether the anticipated "good feeling *ex post*" (in case of successful investment) and "bad feeling *ex post*" (in case of failure) were actually experienced. To that purpose we first construct an index of "positive experienced emotions" (PosExpEmo) and one of "negative experienced emotions" (NegExpEmo) by simply summing up the intensity scores regarding the relevant emotions.[33] For subjects who actually observed a negative investment outcome, it turns out that NegExpEmo is not correlated

[32] The difference between the two is (marginally) significant in case of Excitement (sign test, $p = 0.068$).
[33] For PosExpEmo: happiness and excitement; for NegExpEmo: sadness, disappointment, regret, and irritation.

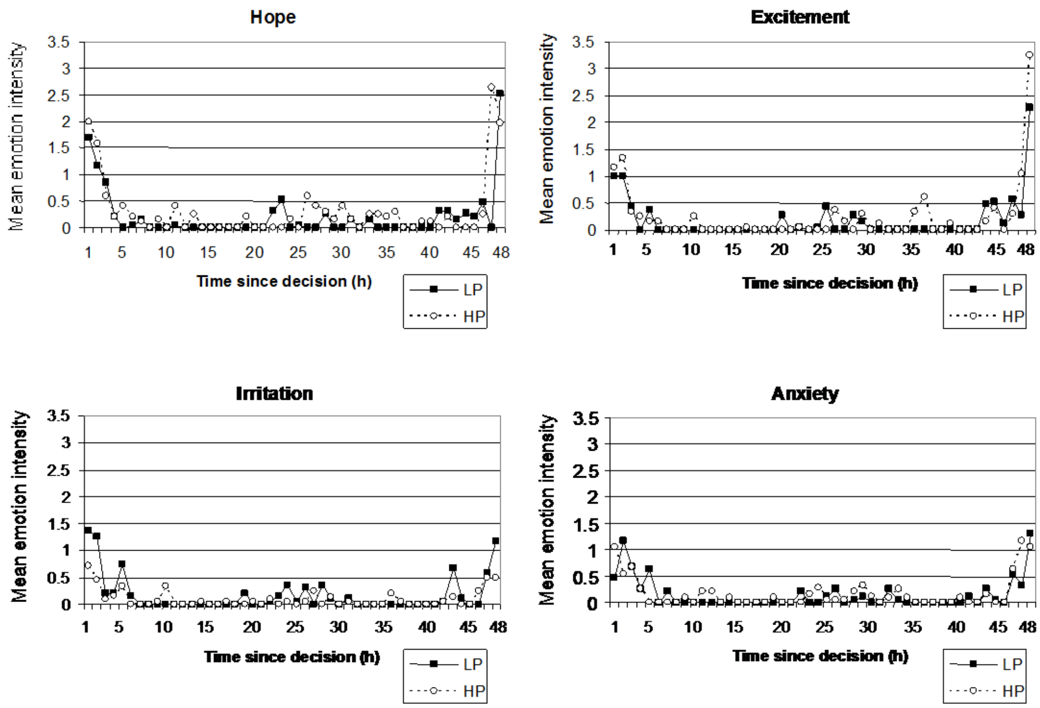


Figure 5. Time profiles of the mean intensity of recalled emotions.

with the extent to which they had taken into account the "expectation to feel really bad in case of failure" in their investment decision. However, for subjects who were successful, PosExpEmo is found to be highly correlated with the weight subjects attached to the "expectation to feel really good in case of success", but only under the immediate resolution of risk (Spearman's *rho* equals *0.66* in HiProb-Imm and *0.5* in LoProb-Imm).[34] Because the anticipation of feeling real bad in case of failure induces less investment (in line with the negative effect of NegAntEmo in Table 2) while, if anything, investment will be reinforced by the expectation of feeling real good, the more interesting result seems to be the lack of correlation for PosExpEmo under the delayed resolution of risk.[35] It appears, therefore, that subjects were significantly better in forecasting their emotions when the resolution of the investment risk followed immediately, albeit more so in case of investment success than in case of failure.[36]

In summary, these observations suggest a misalignment between anticipated and experienced emotions in the direction of myopic affective forecasting and an underestimation of the intensity of future emotions under the delayed resolution of risk.

[34] The correlation is significant in case of HiProb-Imm ($p < 0.01$), but the small number of wins precludes statistical significance in LoProb-Imm.

[35] Similar results are found at the individual emotion level: five of the six significant correlations between (equally valenced) anticipated and experienced emotions concern immediate resolution.

[36] Under delayed resolution there are also no significant correlations between the anticipated and recalled emotions of hope, excitement and anxiety.

Appendix B: Instructions (handouts; translated from Dutch)

[The handouts presented below were used for the Low Probability, Delayed resolution treatment (LoProb-Del). Instructions for other treatments, which involve minimal necessary changes, are available from the authors on request.]

Handout 1

Introduction
You have brought 20 euro as working money to this experiment. You may earn extra money with it but you may also lose money.

In today's session you will have to make a **single** decision concerning your working money. This will be further explained below. You will be also asked to answer a number of questions.

The decision that you must take concerns splitting your working money of 20 euro between two projects. We will refer to these projects as project A and project B. **The outcome of the projects will be decided at the beginning of the second session on _______**

Your total earnings from both sessions will be transferred to your bank account on the next working day after the second session on ___, that is on _____. Please take into account the delay involved in such operations. To make the transfer possible, you will have to give us your bank details during the second session.

Information about projects
You will now have to make a single decision concerning your working money. You have to allocate your 20 euro over two projects. These projects will be labeled on the computer screen, when you make your decision, with the letters A and B.

Project A: Investing in this project you will get **1.2 euro for every euro that you put into the project**. Thus, project A always gives a certain return (namely 1.2 times the invested amount).

Project B: For the amount that you put in project B the following holds. With probability one over five **(20 percent chance) you will get 9 times the amount you put into the project and** with probability four over five **(80 percent chance) you will lose this amount.**

You can allocate your working money in multiples of 1 euro over the projects A and B in any possible combination that adds up to 20 euro.

The table below shows for each possible combination that you can choose the earnings and corresponding probabilities. The **net** earnings are computed by subtracting 20 euro from the total earnings. All values are in euro.

Money in project A:	**Money in project B:**	**When project B succeeds (20 percent chance)**		**When project B fails (80 percent chance)**	
		Earnings (V)	**Net earnings (V-20)**	**Earnings (V)**	**Net earnings (V-20)**
20	0	24	4	24	4
19	1	31.8	11.8	22.8	2.8
18	2	39.6	19.6	21.6	1.6
17	3	47.4	27.4	20.4	0.4
16	4	55.2	35.2	19.2	-0.8
15	5	63	43	18	-2
14	6	70.8	50.8	16.8	-3.2
13	7	78.6	58.6	15.6	-4.4
12	8	86.4	66.4	14.4	-5.6
11	9	94.2	74.2	13.2	-6.8
10	10	102	82	12	-8
9	11	109.8	89.8	10.8	-9.2
8	12	117.6	97.6	9.6	-10.4
7	13	125.4	105.4	8.4	-11.6
6	14	133.2	113.2	7.2	-12.8
5	15	141	121	6	-14
4	16	148.8	128.8	4.8	-15.2
3	17	156.6	136.6	3.6	-16.4
2	18	164.4	144.4	2.4	-17.6
1	19	172.2	152.2	1.2	-18.8
0	20	180	160	0	-20

The result of project B will be determined at the beginning of the second session on ___. Each participant will receive two dice. Everyone will be asked to throw them once under supervision. Note that even if you have put nothing in project B, you will also have to throw the dice.

One of the dice shows tens: 00, 10, 20 up to 90; the other shows units: 0, 1 up to 9. The sum of both numbers (where a combination of 00 and 0 represents 100) can be any number between 1 and 100 with equal probability.

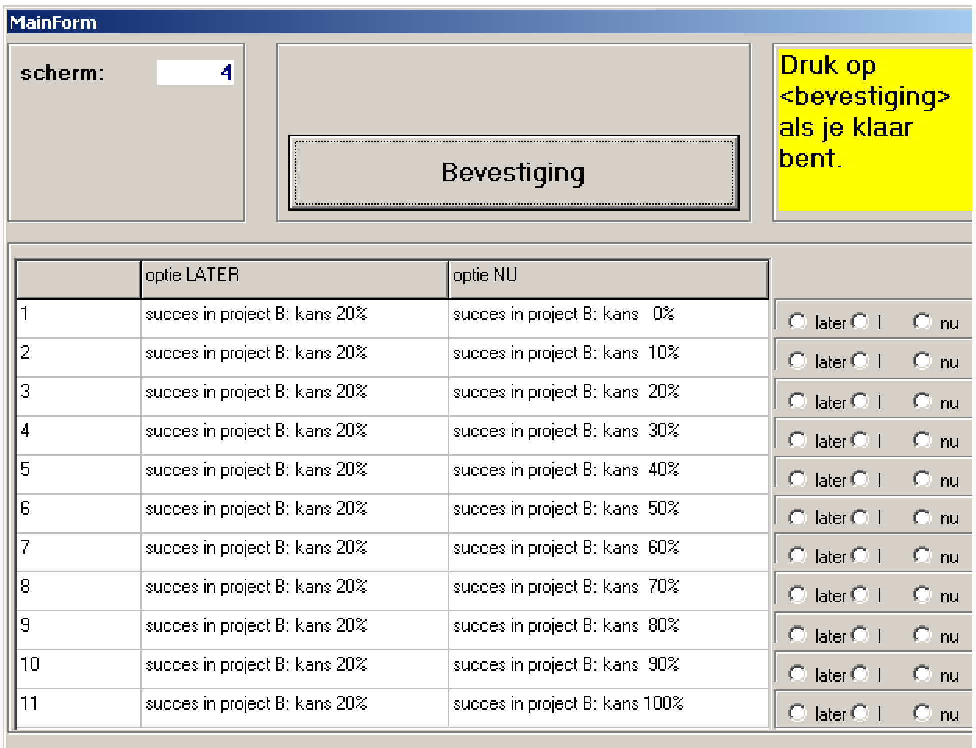
If the sum is 20 or less (20 percent chance), you will receive 9 times the amount put in project B. If the sum is 21 or more (80 percent chance), you will lose the money put in project B.

Your total earnings will be equal to the earnings from project B plus earnings from project A (the latter being equal to 1.2 times the amount in project A). If you have a question, please raise your hand. We will then come to your desk to assist you.

We will now start the computer program for you to make your decisions.

Handout 2 (Low Probability, *Delayed*)

In this part of the experiment you will have to make a number of choices. The table in this handout serves as an illustration of how the choices will look like on the screen. It will always be a choice between the option to determine the outcome of project B today (we call it Option NOW) and the option to let it happen in two days (Option LATER). The probability of success for project B will always be 20 percent for option LATER (this chance is identical to the one you have faced when you were splitting your working money), so you can always choose to stay in the situation as it was when you were making your decision. In contrast, the probability of success in project B will vary in option NOW, as explained below.


MainForm

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Bevestiging

Druk op <bevestiging> als je klaar bent.

	optie LATER	optie NU	
1	succes in project B: kans 20%	succes in project B: kans 0%	later I nu
2	succes in project B: kans 20%	succes in project B: kans 10%	later I nu
3	succes in project B: kans 20%	succes in project B: kans 20%	later I nu
4	succes in project B: kans 20%	succes in project B: kans 30%	later I nu
5	succes in project B: kans 20%	succes in project B: kans 40%	later I nu
6	succes in project B: kans 20%	succes in project B: kans 50%	later I nu
7	succes in project B: kans 20%	succes in project B: kans 60%	later I nu
8	succes in project B: kans 20%	succes in project B: kans 70%	later I nu
9	succes in project B: kans 20%	succes in project B: kans 80%	later I nu
10	succes in project B: kans 20%	succes in project B: kans 90%	later I nu
11	succes in project B: kans 20%	succes in project B: kans 100%	later I nu

Whatever you choose, the amount that you put in project B will remain unchanged and so will the time when the earnings will be transferred to your bank account.

Please note: in order to collect your earnings, you will have to be present for both sessions. There will also be new opportunities to win money during the second session.

One of your choices between NOW and LATER will be randomly selected and implemented (that is to say, really played out with the corresponding probability of success in project B). Make thus your choices carefully.

We will now explain in greater detail the choices you will be making. For this, please look at the table above.

You see that 11 choices have to be made. In each case you have to choose between option NOW and option LATER. As mentioned before, under option NOW you will learn the results of project B during the today's session, whereas under option LATER you will learn it during the session in two days. The table also shows the probabilities of success for project B. This chance is always 20 percent for option LATER but varies for option NOW.

Please remember that one of your choices will be randomly selected to be played out for real.

For an example, look at the second decision problem (in the second row of the table). If you choose for option NOW, project B will succeed with probability 10 percent and whether it does in fact succeed or not will be determined during this session. If you, on the other hand, go for option LATER, the probability of success in project B will be equal to 20 percent and you will learn the outcome of this project during the second session in two days.

The other choices are similar, except for the fact that the probability of success in project B under option NOW increases as you go down the table.

For every choice problem you are asked to choose between options NOW and LATER by clicking on the buttons on the right side of the table (NOW or LATER). If you do not have any preference, such that you cannot decide which option should be selected, please click on "I" (for "Indifferent").

You can thus choose NOW in some of the rows, choose LATER in other rows and have no preference (choose I) in still other rows. You can change your choices and make them in any order you want.

Note that as you go down the rows of the table, the probability of success in project B always increases by 10 percentage points. It can happen that we want to know more precisely about your preference between options NOW and LATER. In such a case, you will see a new table with some more choices of the same sort.

When you are done with your choices, one of them will be randomly selected and played out for real. If you want to know precisely how this will happen, read the following. Otherwise, go to the Summary.
The computer will randomly draw a number between 1 and 100 to determine the chance of success (in percentage points) for project B under option NOW. If you made a choice for this particular percentage, it will be implemented. Otherwise, we will make us of your choices between NOW and LATER for probabilities that are just above and just below the selected number. By doing so we will assume that: you prefer option NOW if in both of these two problems you have picked NOW or if you have picked NOW in one of them and I in the other; you prefer option LATER if in both of these problems you have picked LATER or if you have picked LATER in one of them and I in the other; you are indifferent if you have chosen I in both of these decision problems.

Summary

In each row of the table you have to choose whether you prefer option NOW, option LATER or whether you are indifferent (I), taking into account the corresponding time when the result of project B is revealed and the appropriate probability of success.

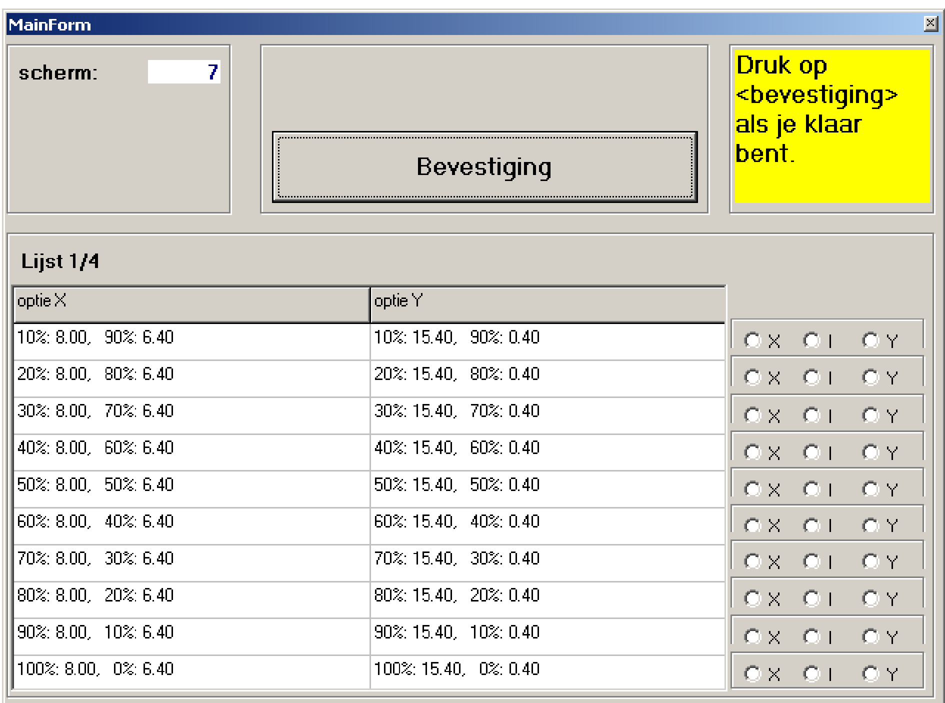
You can choose NOW for some rows, LATER for other rows and I for still others. You can change your choices and make them in any order you want.
When everyone is ready, the computer will randomly select one of the choices for implementation. In case you do not have a preference for the selected decision problem, one of the options will be chosen randomly.

If you have a question, please raise your hand. We will then come to your table to assist you. Otherwise, you can start making your choices on the list that will appear on your screen.

Handout 3

In this part of the experiment you will have to make a number of choices. What you have to do is quite similar to the choices between options NOW and LATER that you have been making during the previous session, however this time the options are different. In total you will have to fill out four lists of ten choices between an option **X** and an option **Y**. One of these choices will be randomly selected to be paid out to you.

We will now explain to you the choices you have to make.
For an example, look at the lists in this handout.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scherm: 7

Bevestiging

Druk op <bevestiging> als je klaar bent.

Lijst 1/4

optie X	optie Y	
10%: 8.00, 90%: 6.40	10%: 15.40, 90%: 0.40	X I Y
20%: 8.00, 80%: 6.40	20%: 15.40, 80%: 0.40	X I Y
30%: 8.00, 70%: 6.40	30%: 15.40, 70%: 0.40	X I Y
40%: 8.00, 60%: 6.40	40%: 15.40, 60%: 0.40	X I Y
50%: 8.00, 50%: 6.40	50%: 15.40, 50%: 0.40	X I Y
60%: 8.00, 40%: 6.40	60%: 15.40, 40%: 0.40	X I Y
70%: 8.00, 30%: 6.40	70%: 15.40, 30%: 0.40	X I Y
80%: 8.00, 20%: 6.40	80%: 15.40, 20%: 0.40	X I Y
90%: 8.00, 10%: 6.40	90%: 15.40, 10%: 0.40	X I Y
100%: 8.00, 0%: 6.40	100%: 15.40, 0%: 0.40	X I Y

It shows ten decisions. Each decision is a choice between "Option X" and "Option Y". Both options give with some probability a high outcome and with some probability a low outcome. We will explain these options later on.

You will have to choose one of the two options by clicking on the button X or Y on the right. For some decisions you may not care whether you receive Option X or Y, in which case you should click the button labeled "I" for "Indifference".

You will have to fill out four such decision sheets and make ten choices on each of them. But only one of the choices will be used in the end to determine your earnings. Because each decision is equally likely to be selected and played out for real, it is important that you make your decisions carefully.

We will now explain the options on the decision sheet. For an example**,** please look at the first choice in the first row.

If you choose Option X you will get 8.00 euro with probability one in ten (10 percent chance) and 6.40 euro with probability nine in ten (90 percent chance), if this row is selected for real payments. To determine the outcome we will roll a ten-sided dice with numbers from 1 to 10 (0 stands for 10). If the dice shows the number 1 then you will earn 8.00 euro. If the dice shows any other number then you will receive 6.40 euro. Since there are nine numbers other than 1 on the dice, there is a probability of 90 percent (nine in ten) that you receive 6.40 euro and 10 percent (one in ten) that you earn 8.00 euro.

Similarly, option Y yields 15.40 euro with probability 10 percent and 0.40 euro with probability 90 percent.

The other decisions are similar, except that as you move down the table, the chances of the higher payoff for each option increases. In fact, for Decision 10 in the bottom row, no dice roll will be needed since each option pays the highest payoff for sure. So you actually have here a choice between 8.00 and 15.40 euro.

When everybody has made his decisions, we will ask one participant to roll a die four times: first a four-sided die to decide which list (1, 2, 3 or 4) is selected, next a ten-sided die to decide which of the ten choices is selected, then a die to select X or Y for those who are indifferent in this decision problem, and finally a ten-sided die to determine the outcome of options X and Y (only the option that you have selected will apply to you). Note that all dice rolls will apply equally to all participants.

Summary

You will make ten choices on each of four lists. For each decision row you will have to choose whether you prefer Option X or Option Y.

You may for example choose X for some decision rows and Y for other rows, you may also be indifferent between the options X and Y and pick I for still other rows. You may change your decisions and make them in any order.

When you are finished, one decision will be picked as described and your earnings for this choice will be added to your previous earnings.

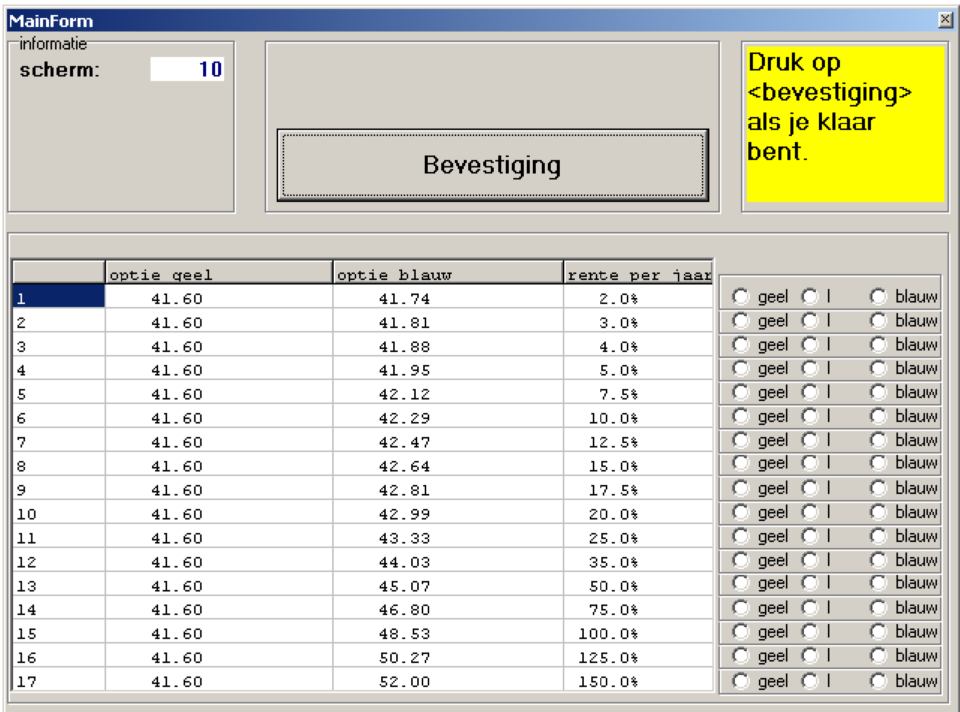
If you have any questions, please raise your hand. We will come to your desk to assist you.

Otherwise, we will start with the choices which you will see on the screen.

Handout 4

In this part of the experiment you will have to make 17 choices between option YELLOW and option BLUE. One of these choices will be randomly selected to be paid out to you.

We will now explain to you the choices you have to make. Please take a look at the table in this handout.


MainForm

informatie

scherm: 10

Bevestiging

Druk op <bevestiging> als je klaar bent.

	optie geel	optie blauw	rente per jaar	
1	41.60	41.74	2.0%	geel I blauw
2	41.60	41.81	3.0%	geel I blauw
3	41.60	41.88	4.0%	geel I blauw
4	41.60	41.95	5.0%	geel I blauw
5	41.60	42.12	7.5%	geel I blauw
6	41.60	42.29	10.0%	geel I blauw
7	41.60	42.47	12.5%	geel I blauw
8	41.60	42.64	15.0%	geel I blauw
9	41.60	42.81	17.5%	geel I blauw
10	41.60	42.99	20.0%	geel I blauw
11	41.60	43.33	25.0%	geel I blauw
12	41.60	44.03	35.0%	geel I blauw
13	41.60	45.07	50.0%	geel I blauw
14	41.60	46.80	75.0%	geel I blauw
15	41.60	48.53	100.0%	geel I blauw
16	41.60	50.27	125.0%	geel I blauw
17	41.60	52.00	150.0%	geel I blauw

The table shows seventeen decisions. Each decision is a choice between option YELLOW and option BLUE:

- with option YELLOW your earnings will be transferred tomorrow
- with option BLUE, a higher amount will be transferred in two months time.

You will have to choose one of the two options by clicking button YELLOW or BLUE on the right. For some decisions you may not care whether you receive Option YELLOW or BLUE, in which case you should click the button labeled "I" for "Indifference".

You will have to make seventeen choices but only one of the choices will be used in the end to determine your earnings. Because each decision has an equal chance of being used in the end, it is important that you make each choice carefully.

We will now explain the options on the decision sheet. For an example, please look at the first choice in the first row. Option YELLOW always means that your earnings from the experiment will be transferred to you tomorrow. When you are making your choices, this column thus always shows your earnings from previous parts. In this example this is 41.60 euro. Option BLUE means in this example that 41.74 euros will be transferred to you in two months. Note that this amount is 0.33 percent higher than the amount paid by option YELLOW. This corresponds to a nominal annual rate of 2 percent, as indicated in the fourth column.

The other decisions are similar, except that as you move down the table, the amount that option BLUE pays increases.

When everybody has made his decision, we will ask a participant to roll a die twice: first to select one of the 17 choices and then, for those who selected I (Indifferent) in this row, to select option YELLOW or BLUE. The outcomes of the rolling of the dice will apply to all participants.

Summary

You will make seventeen choices. For each decision row you will have to choose whether you prefer Option YELLOW or Option BLUE.

You may for example choose YELLOW for some decision rows and BLUE for other rows, you may also be indifferent between the options YELLOW and BLUE for still other rows. You may change your decisions and make them in any order. When you are finished, one of the seventeen decision rows will be selected randomly as described before and the option you have chosen in this row will be implemented.

Please raise your hand if you have any questions. We will then come to your desk to assist you. Otherwise, you can start with the choices in the table that will appear on the screens.

Appendix C. Declaration of consent

Declaration: I hereby declare my participation in 2 sessions of the experiment on ___ and ___, 2006. I acknowledge that, depending on my choices, I can lose up to 20 euro in the experiment. I am also aware that I will lose this amount if I do not participate in both sessions without a valid reason (e.g. a sick note). I realize that my earnings from the experiment will be transferred to my bank account after the second session and take responsibility for providing the experimenters with wrong bank details.

Signature

Appendix D. Questionnaires

D. 1. Risk propensity scale (Nicholson et al., 2005)
Note: One question about career risk was skipped, since it was considered irrelevant for undergraduate students. Question 06 is based on Dohmen et al. (2005).

Below you find a number of statements, that people use to describe themselves. Read each of them and rank them on a scale from 1 to 5. There are no right or wrong answers. Do not think for too long but choose according to your first impression.

[answer on scale from 1=never to 5=very often]

01. In my adult life I have taken recreational risks (e.g. rock-climbing, scuba diving)
02. In my adult life I have taken health risks (e.g. smoking, poor diet, high alcohol consumption)
03. In my adult life I have taken financial risks (e.g. gambling, risky investments)
04. In my adult life I have taken safety risks (e.g. fast driving, city cycling on a bike with poor brakes, riding a car without a seat belt on)
05. In my adult life I have taken social risks (e.g. standing for election, publicly challenging a rule or decision)

[answer on scale from 1=not at all to 5=very much so]

06. Taken all things together, I am very willing to take risk.

D. 2. Trait anxiety (STAI ; 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.

[answer on scale from 1="almost never" to 4="almost always"]

07. I feel pleasant
08. I tire quickly
09. I feel like crying
10. I wish I could be as happy as others seem to be
11. I am losing out on things because I can't make up my mind soon enough
12. I feel rested
13. I am "calm, cool and collected"
14. I feel that difficulties are piling up so that I cannot overcome them
15. I worry too much over something that really doesn't matter
16. I am happy
17. I am inclined to take things hard
18. I lack self-confidence

19. I feel secure
20. I try to avoid facing a crisis or difficulty
21. I feel blue
22. I am content
23. Some unimportant thought runs through my mind and bothers me
24. I take disappointments so keenly that I can't put them out of my mind
25. I am a steady person
26. I get in a state of tension or turmoil as I think over my recent concerns and interests

Note: The answers are used to calculate a value between 20 and 80, representing the anxiety trait of the subject [ANXIETY-trait].

D. 3. Sensation seeking (Arnett, 1993)

Below you find a number of statements, that people use to describe themselves. Read each of them and rank them on a scale from 1 to 4, indicating whether or not they describe you correctly. There are no right or wrong answers. Do not think for too long but choose according to your first impression.

[answer on scale from 1="does not describe me at all" to 4="describes me very well"]

27. I can see how it would be interesting to marry someone from a foreign country.
28. When the water is very cold, I prefer not to swim even if it is a hot day.
29. If I have to wait in a long line, I'm usually patient about it.
30. When I listen to music, I like it to be loud.
31. When taking a trip, I think it is best to make as few plans as possible and just take it as it comes
32. I stay away from movies that are said to be frightening or highly suspenseful.
33. I think it's fun and exciting to perform or speak before a group.
34. If I were to go to an amusement park, I would prefer to ride the rollercoaster or other fast rides.
35. I would like to travel to places that are strange and far away.
36. I would never like to gamble with money, even if I could afford it.
37. I would have enjoyed being one of the first explorers of an unknown land.
38. I like a movie where there are a lot of explosions and car chases.
39. I don't like extremely hot and spicy foods.
40. In general, I work better when I'm under pressure.
41. I often like to have the radio or TV on while I'm doing something else, such as reading or cleaning up.
42. It would be interesting to see a car accident happen.
43. I think it's best to order something familiar when eating in a restaurant.
44. I like the feeling of standing next to the edge on a high place and looking down.
45. If it were possible to visit another planet or the moon for free, I would be among the first in line to sign up
46. I can see how it must be exciting to be in a battle during a war.