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# Global risk, Effort, and Emotions in an Investment Experiment\*

Ronald Bosman & Frans van Winden

## Abstract

This paper experimentally investigates investment behavior. We find that global risk – i.e. risk independent of an agent’s investment decision (like political risk) – substantially decreases investment. Also, if the capital used for investment is based on previous earnings (effort) instead of an endowment, investment decreases substantially. These results are neither in line with expected utility theory nor with some alternative theories of decision making under risk (like prospect theory or regret theory). We offer an explanation that takes the role of experienced and anticipated emotions into account. In addition, an emotion-based explanation is provided for related experimental findings concerning the common ratio effect.

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## 1. Introduction

Empirical evidence shows that political risk is important for private investment. For example, Alesina & Perotti (1996) find that political instability, measured by some index of social unrest, decreases investment. Bohn & Deacon (2000) find that ownership risk, related to a country's stability and to the type of government in power, reduces ordinary investment and affects the use of natural resources. From an economic point of view these empirical findings are understandable. If investors are confronted with political risk, they have a tendency to shift their resources to relatively safe havens (e.g. investment in a foreign country) and, consequently, invest less. But what happens if all investment options are subject to political risk? In that case, political risk becomes a global risk that is independent of an agent's investment decision. Empirically, this form of risk would seem to play a role in developing countries and transition economies where investors do not have access to foreign markets, or where the transaction costs of entering these markets are so high that investors do not see foreign investment as a feasible option.

According to standard economic theory global risk should have no effect on investment because it is common to all types of investment and affects their rate of return in the same way. Psychologically, however, this need not be the case. An important feature of global risk is the threat of losing one's economic resources. This threat may be important when making an investment decision because of *acute (experienced) emotions*, such as anxiety or fear, which may interfere with other motivations and/or cognitions. Psychological evidence shows that acute anxiety affects behavior and thoughts in quite systematic ways (for a review, see Loewenstein et al., forthcoming). For example, it is found that people who experience anxiety are motivated to reduce risks, make more pessimistic probability estimates, and are biased with regard to the type and amount of information that they use. There are psychological reasons, therefore, to expect that global risk affects investment decisions. In this paper we will investigate the relation between global risk and investment in a controlled laboratory experiment.<sup>1</sup> A novel feature of our study is that we offer an emotion based explanation for our results and the results of some related experimental work (in particular, on the common ratio effect, to which we return below).

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<sup>1</sup> A problem with field studies is that global (political) risk is hard to isolate. Moreover, studies typically rely on cross-sectional data of countries that differ in many important ways (e.g. political system, investment risks, tax regime, access to world markets, etc). In a laboratory experiment the degree of global risk can be carefully manipulated while keeping everything else constant, which offers the opportunity of control and replication.

An additional issue that we investigate in this paper is whether it makes a difference if the capital used for investment is based on the investor's own effort or not. To the best of our knowledge, this is the first experimental study investigating whether the way in which capital is obtained (earned or endowed) matters in the context of risk taking.<sup>2</sup> As we will argue in the next section, effort may influence the intensity of emotions to be experienced in the future when the investor learns about the investment outcome. An interesting issue is then whether investment decisions are influenced through the *anticipation* of these future emotions. This issue is also empirically relevant. In large private and public organizations surpluses are often generated via the entitlement of managers to the use of a budget that does not necessarily bear a strong direct relationship with the manager's own past effort, in contrast with for example the owner-entrepreneur of a small business. If past effort matters for investment in the laboratory because of anticipated changes in psychic costs, it may also be relevant for investment outside the laboratory. This would be important economically because entrepreneurial activity is considered to be a significant factor in economic growth, in developing and transition economies as well as developed economies. Regarding the latter, the recent upsurge in small businesses and in governmental attention for the creation of small firms is of interest in this context. The new angle taken in this study and our major finding that effort has a substantial negative effect on investment contributes to the literature in this area (see e.g. Libecap, 1999).

While in recent years the role of emotions in decision making has attracted growing attention in economics (Frank, 1988; Elster, 1996, 1998; Loewenstein, 1996, 2000), there have not been many attempts to relate emotions to decision making under risk and uncertainty. Some notable exceptions include Loomes & Sugden (1982) and Bell (1985), who formalized regret and disappointment aversion, respectively. Other exceptions are Caplin & Leahy (2001) who (theoretically) show that anticipatory anxiety may result in time inconsistency, Loewenstein et al. (forthcoming) who argue that emotional reactions to risk often diverge from cognitive assessments of risk, and Wu (1999) who incorporates the psychic cost of anxiety in a model of decision making with delayed resolution of uncertainty. Following Loewenstein et al., we distinguish between anticipated and experienced emotions. Acute or experienced emotions are immediate visceral reactions triggered by the decision

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<sup>2</sup> There is a related psychological study by Zeelenberg & van Dijk (1997) where via scenarios the effect of hypothetical effort on risk taking is investigated. In this study, it is found that effort leads to less risk taking. Finally, Boylan & Sprinkle (forthcoming) have investigated a similar issue in the sphere of taxation and compliance. They find that when income is earned tax payers respond to a tax increase by reporting more taxable income.

situation. Anticipated emotions are not experienced in the immediate present but expected to be experienced in the future. Basically, in our global risk experiment we investigate the impact of acute emotions on behavior, while in the effort experiment we examine how changes in future emotions affect behavior.

Another strand of literature that this paper relates to concerns the common ratio effect.<sup>3</sup> Loosely speaking, this effect entails that if all probabilities are multiplied with some common factor, decisions tend to favor risky options. While our (global risk) study bears a likeness to experimental work on the common ratio effect, there are some important differences. Most importantly, our set-up is a dynamic choice problem because global risk is introduced at a second, separate stage. Although there has been a rapid growth of experimental research on individual choice, dynamic choice problems have typically received little attention (see Cubitt et al., 1998; Cubitt & Sugden, 2001). Furthermore, we offer an emotion based explanation of our results – which run counter to the common ratio effect – and related experimental results (in particular of Cubitt et al, 1998). Finally, our set-up differs from the typical common ratio experiment with regard to the number of risky options from which subjects can choose. Generally, subjects are given one or several (hypothetical) binary lottery choices in a common ratio experiment. In our investment game subjects have considerably more freedom in deciding how much risk to take because they can invest any amount of their (real money) endowment in the risky option. Not only does this make our set-up more closely related to investment, it also offers the possibility to get a better view of individual differences in risk taking.

The organization of the paper is as follows. In section 2, we discuss the research questions and some related literature in more detail. This section also presents the experimental design. Results are given in section 3, while section 4 links up our results with related work on the common ratio effect. Section 5 concludes.

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<sup>3</sup> The common ratio effect, discovered by Allais (1953), can be illustrated with the following example. Suppose you are confronted with a choice between \$3000 for sure, or a gamble where you win a prize of \$4000 with probability .8 (and a prize of \$0 with probability .2). Now, suppose the next choice is between a gamble where you win \$3000 with probability .25 (and \$0 with probability .75), or a gamble where you win \$4000 with probability .2 (and \$0 with probability .80). Numerous experiments where subjects faced similar choices have shown that people typically choose the sure \$3000 in the first choice and the gamble where they win \$4000 with probability .2 in the second (Starmer, 2000, p.337). These choices, however, are inconsistent with expected utility theory which predicts that someone who chooses the sure \$3000 in the first choice should choose the .25 chance of getting \$3000 in the second. In the second choice, all the probabilities of the first choice are simply multiplied by .25 which constitutes the so-called common factor. Because in our set-up global risk applies to both a safe and risky project, it can be seen as a common factor.

## **2. Research questions and experimental design**

### *Research questions*

In our Base Line (BL) experiment, subjects must allocate their capital (endowment) over two projects: a safe project and a risky project. The safe project can be seen as a deposit since it always gives a fixed return. The risky project resembles a stock, with an unsure return. In the Global Risk (GR) experiment there is a probability that subjects lose all the returns on their investments (including the investment itself), irrespective of whether they have invested in deposits or stocks. Since subjects are likely to perceive this probability as a prominent threat to their concerns (monetary earnings), negative emotions of the anxiety or fear type can be expected to be experienced when they make their investment decision (Ortony et al., 1988).<sup>4</sup>

By now, it is well established in psychology that anxiety, triggered by an undesirable prospect, systematically influences behavior towards risk. For example, Raghunathan & Pham (1999) find that anxious individuals are biased towards low risk/low reward options whereas sad individuals tend to go for high risk/high reward options. Anxiety, they argue, primes an implicit goal of uncertainty reduction while sadness primes reward replacement. Lerner & Keltner (forthcoming) find that fear and anxiety tend to favor cautious, risk averse, behavior, in contrast to anger, which appears to promote risk seeking. Another group of researchers (Eisenberg et al., 1996) also find that anxiety is positively correlated with risk aversion. Loewenstein et al. (forthcoming) reach a similar conclusion in their survey on emotions and risk: “many studies have found effects of fear and anxiety on various types of judgement that tend to favor cautious, risk averse, decision masking”(p.12). In other words, the available psychological literature strongly suggests that anxiety motivates individuals to take less risk. Applied to our GR experiment, this literature predicts that subjects will invest less in the risky project. Note that this would contradict standard expected utility theory, which predicts no effect of global risk

As we noted in the introduction, our experiment on global risk is related to the so-called common ratio effect, which entails that if all probabilities are multiplied with some common factor decisions tend to favor risky options (Starmer, 2000). Applied to our experiment, the common ratio literature would predict that global risk motivates subjects to take more risk. Our first research question then is whether global risk reduces investment (as predicted by the psychological literature on anxiety), promotes investment (as predicted by

the common ratio literature), or leaves investment unaffected (as predicted by expected utility theory).

The second research question is whether it makes a difference if the capital used for investment is given to subjects or the result of own effort. To that purpose, we will compare investment behavior in the BL experiment with behavior in the Real Effort (RE) experiment where subjects first earn their capital. According to standard economic theory such effort should not affect investment behavior. However, psychologically, the degree of “ego-involvement” becomes higher when subjects have to produce their own capital by making an effort. Because effort leads to more ego-involvement, subjects in the RE experiment feel more attached to their capital than subjects in the BL experiment. According to Lazarus (1991) ego-involvement is an important determinant of the intensity of emotions, in particular negative emotions.<sup>5</sup> Consequently, if (part of) the capital is lost because of a bad investment outcome, the psychological cost (in terms of negative emotions) is higher in the RE than BL experiment. On the other hand, if the investment outcome is positive, the psychological benefit (in terms of positive emotions) of the gain would not depend on whether effort has been expended or not. If subjects anticipate these psychological costs of effort, one would expect them to invest less in the RE experiment compared to the BL experiment. Although experimental evidence suggests that people do take anticipated emotions into account when making a decision (Zeelenberg et al., 1996), Loewenstein (2000) argues that people typically tend to underestimate the impact of future emotional factors on their own behavior and on the behavior of others (“hot-cold empathy gap”).

Our third research question concerns the predictive power of some psychologically orientated non-expected utility models of decision making under risk, to wit prospect theory (Kahneman & Tversky, 1979), regret theory (Loomes & Sugden, 1982), and disappointment theory (Bell, 1985).<sup>6</sup> An important feature of prospect theory is that prospects are “edited” with the help of a variety of decision heuristics. An important decision heuristic entails that “people often disregard components that alternatives share, and focus on the components that distinguish them”(p. 271). If we apply this theory to our investment set-up, where global risk

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<sup>4</sup> According to Ortony et al. (1988) anxiety is a fear type emotion (like worry, apprehension, nervousness) that arises when the individual is displeased about the prospect of an undesirable event. The intensity depends on the degree to which the event is undesirable and the likelihood of the event.

<sup>5</sup> Lazarus (1991) claims that ego-involvement is not very important for positive emotions like happiness, joy, and hope (pp. 268 and 285).

<sup>6</sup> According to Starmer (2000), the number of non-expected utility models now number well into double figures. Because we are interested in the role played by emotions, rather than testing theories of decision making under

is common to both the safe and risky options, it can be conjectured that subjects will ignore this risk (the so-called “isolation effect”). Regret and disappointment theory try to capture the idea that people dislike regret and disappointment and take these emotions into account (without experiencing them necessarily) when making a decision (for a psychological review of these emotions, see Zeelenberg et al. (1999)). Regret typically arises when the decision outcome is compared to a counterfactual outcome that might have been obtained *had one chosen differently*. On the other hand, disappointment originates from a comparison between the decision outcome and a counterfactual outcome that might have been resulted *had another state of the world occurred*. Applied to our investment game, both regret and disappointment theory predict that subjects become more risk seeking in the presence of global risk. The intuition is that with global risk the likelihood of finding yourself in a situation where you might regret your decision or be disappointed decreases. With regard to effort, note that all of the above models predict that the way in which capital is obtained (earned or endowed) does not matter for risk taking.

A last issue is whether in the GR experiment investment decisions themselves generate anxiety. Although this issue seems neglected in the psychological literature it is economically important because it refers to a potentially psychic cost of investment. For this analysis we use self-reports of experienced emotions.

### *Experimental design*

All experiments were run in the CREED-laboratory of the University of Amsterdam (winter 1999/spring 2000). In total 139 subjects participated in the experiments. About 64% of the subjects were students of economics or econometrics. The other 36% were students from various fields such as chemistry, psychology, mathematics, and law. The investment game was framed as neutral as possible, avoiding suggestive terms such as investment or global risk. Subjects received a show-up fee of 5 Dutch guilders (approximately 2 U.S. dollars), independent of their earnings in the experiment. On average, subjects earned 32.9 guilders in the BL experiment, 29.0 in the GR experiment, and 34.3 guilders in the RE experiment. The whole experiment took about 45 minutes (except for the RE experiment, which took about one hour and 15 minutes).

We will now briefly discuss the design of the Base Line experiment and, subsequently, indicate in which way the other experiments differ. Before subjects play the investment game

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risk, we are quite selective in our discussion. For tests of the descriptive power of existing theories, see Harless



in the BL experiment and receive instructions about it, they receive an envelope containing 30 Dutch guilders in cash. Subjects are told that this is their ‘working money’ with which they can earn more money but, possibly, also lose money. If they end up with more than 30 guilders, the difference will be paid out to them at the end of the experiment. If they earn any less, subjects must pay the difference back to the experimenter at the end of the experiment. After subjects have checked the content of the envelope they receive the written instructions of the investment game (an English translation is provided in the appendix). Furthermore, they receive two cups (one for the safe option, denoted project A, and one for the risky option, project B), a white die, and a decision form. The risky project yields a return of 2.5 times the amount invested with probability 0.5 and a return of zero with probability 0.5, while the safe project always gives a certain return of one guilder per guilder invested. After the instructions are read aloud and three examples are given to illustrate the game, subjects have to allocate their working money over the two projects (cups). In addition, they have to write down their investment decision on a form. Immediately afterwards, subjects are asked to fill out a questionnaire with questions concerning the emotions they experienced, their motivations, and background.<sup>7</sup> After filling out the questionnaire, each subject has to throw the white die (not being observed by others except for the experimenter) in order to determine the outcome of the risky project. Subsequently, subjects are paid out in private.

The Global Risk experiment is set up in the same way as the Base Line experiment except that now global risk is introduced. All subjects receive a written announcement and a red die immediately after they have received their working money (but before they receive the instructions of the investment game). The announcement states that with probability 1/3 all earnings out of the experiment are lost. It further states that this will be determined by having the subject throw the red die at the end of the experiment (after having learned the outcome of the risky project but before being paid out).

The only difference between the Real Effort and the BL experiment concerns the way in which the working money of 30 guilders is obtained. In the Real Effort experiment the money is not given to subjects but has to be earned by doing a computerized task. Note that subjects receive the instructions of the investment game after they have completed the effort task. The task is an individual two-variable optimization task that lasts for 30 minutes.<sup>8</sup> It

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& Camerer (1994) and Hey & Orme (1994).

<sup>7</sup> About half of the subjects in the BL experiment received the question concerning experienced emotions at the beginning of the experiment (after the reception of the envelope containing the working money of 30 guilders) before they received instructions about the investment game.

<sup>8</sup> See van Dijk et al. (2001).

consists of 10 periods, where in each period subjects have to search for a maximum value. This maximum, which varies over the periods, can be imagined as the top of a mountain. The payoff for a period is related to the position on the mountain at the end of the period, with a maximum of 3 guilders. The time limit has been chosen such that almost all subjects are able to find the maximum value within this limit.<sup>9</sup> When subjects complete the effort task, they receive an envelope containing their earnings in cash. After this the RE experiment continues in the same way as the BL experiment.

Emotions in the BL and GR experiment are measured in the following way. We use a list of twelve emotion names and ask subjects to report the experienced intensity of each emotion on a 7-point scale, ranging from “no emotion at all” to “high intensity of the emotion”. We ask subjects to report their experienced emotions immediately after they have made their investment decision. The list of emotion names includes the following: irritation, anger, anxiety, contempt, envy, hope, sadness, joy, happiness, shame, fear, and surprise. Note that the list not only includes the (negative) emotions that we expect to be particularly relevant in our setting. Both positive and negative emotions are included to avoid that subjects are driven in a particular direction.

### **3. Results**

#### *Base Line Experiment*

Average investment in the risky project in the BL experiment is 20.3 guilders (st. dev.=6.97). Figure 1 shows the distribution of investment in the risky project. As can be seen from this figure, investments range from 7 to 30 guilders, with large peaks at 20 (the mode) and 30 guilders. Furthermore, there are several smaller peaks at 10, 15, and 25 guilders. A majority of the subjects (75%) appears to be risk averse in the BL experiment since they invest only a part of their working money in the risky project. The other 25% of the subjects are either risk neutral or risk seeking.

[FIGURE 1]

We have also investigated whether investment is influenced by gender, educational background (economics or not), or experience with economic experiments. None of these

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<sup>9</sup> Only one subject in the RE experiment earned less than the maximum amount of 30 guilders. In the analysis,

factors turn out to have an effect on investment. The fact that gender does not have an effect on risk taking is perhaps somewhat surprising in the light of some psychological evidence: “large number of studies have found that males tend to be more risk-averse than females” (Loewenstein et al., forthcoming, p.37). While these gender differences appear to be particularly pronounced when it comes to physical, or life-threatening risks, they have also been observed in other risk contexts such as pension investment decisions.

### *Global Risk experiment*

Average investment in the risky project in the GR experiment is 16.9 (st. dev.=9.1). Compared with the BL experiment, the average investment is significantly and substantially (about 15%) lower when global risk is present (Mann-Whitney test,  $p=0.04$ , two-tailed). This brings us to the first result.

RESULT 1: *Global risk depresses average investment significantly and substantially.*

Result 1 is clearly not in line with expected utility theory, which predicts a zero effect. It is also not in line with the isolation effect of prospect theory (which says that common features are typically ignored) and with regret or disappointment theory (which suggest more investment). Furthermore, result 1 is at odds with the common ratio effect that is often found in one stage decision problems, which would suggest an increase in investment.<sup>10</sup> In the next section, we come back to this result when we link up our results to some related experimental studies.

[FIGURE 2]

Figure 2 shows the distribution of investment in the risky project in the GR experiment. As can be seen from this figure, there appears to be more variation in investment when there is global risk. Moreover, the range is larger. Some subjects do not invest anything in the risky project (or a small amount) while others invest their whole endowment. A Mann-Whitney test shows that the variance of investment in the GR experiment is significantly higher than the variance of the BL experiment ( $p<0.05$ ).

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we have multiplied this subject’s relative investment (investment/working money) with factor 30.

<sup>10</sup> Cubitt & Sugden (2001) also find evidence of a ‘reverse common ratio effect’, albeit with a completely different design involving so-called accumulator gambles.

RESULT 2: *Global risk significantly increases the variance of investments.*

Furthermore, the shape of the distribution is different in the presence of global risk. In the GR experiment it appears to be U-shaped while in the BL experiment inverted U-shaped. Finally, note that the mode has shifted under the influence of global risk. Whereas in the BL experiment the mode is an investment of 20 guilders, the mode in the GR experiment is 10 guilders.

#### *Real Effort Experiment*

In the RE experiment, average investment in the risky project is 17.2 guilders (st. dev.=7.43). Compared to the BL experiment, average investment is significantly and substantially (about 15%) lower when subjects had to make an effort to obtain their working money (Mann-Whitney test,  $p=0.03$ , one tailed).

RESULT 3: *If subjects have to earn their working money first, average investment decreases significantly and substantially.*

In the previous section we presented psychological evidence suggesting that effort increases the intensity of experienced negative emotions when the investment outcome is unfavorable, while it leaves the intensity of experienced positive emotions unaffected in case of a favorable outcome. Results 3 supports the hypothesis that subjects anticipate the psychological cost of effort and, consequently, invest less money in the risky project. Note that result 3 is neither in line with standard economic theory nor in line in with regret or disappointment theory (all of which predict no effect).

#### [FIGURE 3]

Figure 3 shows the distribution of investment choices. Although the mode in the RE experiment is the same as in the BL experiment (20 guilders), the proportion of subjects that invested everything is lower in the RE experiment. The variance of investment in the RE experiment is not significantly different from the variance in the BL experiment. Compared to the BL experiment the distribution in the RE experiment is more skewed to the right.

*Further exploration: experienced emotions in the BL and GR experiment*

The results of the GR experiment are in line with the psychological literature suggesting that anxiety, induced by global risk, motivates subjects to reduce risk. For convenience, we refer to this type of anxiety as *environmental-anxiety* because it is generated by the environment and not the result of subjects' own decisions. Besides this type of anxiety, it is also possible that decisions themselves cause anxiety. For example, the more one invests in the risky project, the more is at stake and the more one may worry. We refer to this type of anxiety as *decision-anxiety* because it is generated by subjects' own decisions. Interestingly, all the psychological studies on anxiety that we discussed in section 2 deal with the first type of anxiety, while the second type is neglected. From an economic point of view decision-anxiety is potentially important because it would imply an additional psychic cost of risk taking.<sup>11</sup>

To shed more light on the role of these two types of anxiety we use data on experienced emotions that were reported by the subjects immediately after the investment decision. Intensity scores of experienced emotions in the BL experiment are presented in the first column of table 1.<sup>12</sup> Positive emotions like hope, happiness, and joy, obtain a relatively high score, while among the negative emotions anxiety appears to be the most prominent one.

[TABLE 1]

We now turn to the relation between emotions and the amount invested in the risky project. Focussing on the correlation between investment and each of the emotions that we measured, it turns out that investment is (marginally) positively related to anxiety (Spearman rank-order coefficient: 0.31,  $p=0.066$ ). In other words, the more one invests, the more one worries about a possible bad investment outcome. Furthermore, we find that anxiety is strongly positively

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<sup>11</sup> In their theoretical study, Caplin & Leahy (2001) argue that “the incorporation of anxiety into asset pricing models may help explain both the equity premium puzzle and the risk-free rate puzzle”(p.56). The intuition is that owning stocks involves an extra psychic cost, due to experienced anxiety, which increases their required return. More generally, Caplin & Leahy argue that “by ignoring anxiety, conventional measures of risk aversion underestimate the effect of uncertainty on asset prices”(p.69).

<sup>12</sup> The number of observations on emotions in the base line experiment is smaller than in the investment analysis because about half of the subjects reported their emotions at the beginning of the experiment before any decision was made. We have pooled these two groups of subjects in the above investment analysis because no significant differences in investment behavior are found (Mann-Whitney test,  $p=0.28$ , two-tailed; Kolmogorov-Smirnov test,  $p=0.43$ ). The emotions reported at the beginning of the experiment are not further considered here because they turned out to have no predictive power for investment behavior (there is no significant correlation between investment and any of the twelve emotions that we measured; Spearman rank-order coefficient,  $p<0.10$ . This

correlated to fear (coefficient: 0.68,  $p < .01$ ), which suggests that anxiety and fear refer to a similar underlying emotion (cf. Ortony et al., 1988).

*RESULT 4: Anxiety is (marginally) positively related to investment in the risky project in the Base Line experiment.*

The second column of table 1 shows the intensity scores of experienced emotions in the presence of global risk. Again positive emotions like hope, happiness, and joy, obtain a relatively high score, while of the negative emotions anxiety is the most prominent one now, followed by irritation. We first investigate whether there are some overall differences in reported emotion between the BL and GR experiment. Comparing average experienced emotions, subjects in the GR experiment are significantly more irritated (Mann-Whitney,  $p < 0.05$ , two-tailed). No significant differences are found with respect to the other emotions. However, because there is a strong positive correlation between irritation and anxiety (coefficient: 0.54,  $p < 0.01$ ), there is some indication of anxiety to be more prominent when there is global risk.

*RESULT 5: Subjects in the Global Risk experiment experience significantly more irritation than subjects in the Base Line experiment. Because irritation is strongly positively correlated to anxiety, there is some indirect evidence that subjects are more anxious in the presence of global risk.<sup>13</sup>*

Next, it is investigated whether there is a correlation between investment and emotion in the presence of global risk. It turns out that there is no significant correlation for any of the emotions that we measured ( $p < .10$ ). This implies the following result.

*RESULT 6: There is no correlation between investment and anxiety in the global risk experiment.*

In the BL experiment we found a significant positive correlation between investment and anxiety whereas in the GR experiment there is no evidence of such a correlation. We offer the

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may be due to the fact that the reporting took place before subjects received instructions about the experiment (the investment game).

<sup>13</sup> In the Base Line experiment irritation and anxiety are not correlated ( $p = 0.94$ ).

following explanation, which takes the role of both decision- and environmental-anxiety into account. In the absence of global risk, investment is positively related to anxiety. The more one invests, the more is at stake and the more one worries about a bad outcome. Now, if global risk is introduced, the initial effect is that subjects become anxious. This environmental-anxiety motivates subjects to invest less in the ensuing investment game, which is in line with the psychological evidence presented in section 2. If anxiety caused by the environment motivates subjects to invest less while at the same time anxiety is positively related to investment, this explains why there is no significant correlation between investment and anxiety in the presence of global risk.

#### **4. Related work on the common ratio effect**

Our results show that if investors are confronted with global risk, that is, risk independent of one's investment decision, average investment decreases significantly. This result is neither in line with standard economic theory or prospect theory (which predict no change in behavior) nor with the frequently observed common ratio effect or regret and disappointment theories (which suggest more investment). In addition, we found that if investors have to work to obtain their capital, average investment again decreases significantly. To explain this finding we referred to a greater ego-involvement due to the effort to obtain the capital, and that investors anticipate the higher psychic (emotional) costs of a bad investment outcome. In this section, we link up our results of the global risk experiment with some related experimental work on the common ratio effect. We will argue that by taking the role of emotions into account, a new light can be shed on risk taking behavior. The results of the effort experiment will not be discussed any further in this section because there are no related studies on the effect of (past) effort on risk taking.<sup>14</sup>

As we proposed in the introduction, a distinction should be made between anticipated emotion (emotion expected to be experienced in the future) and acute emotion (emotion experienced in the immediate present). This is an important distinction because it takes the dual role that emotions may have into account (Elster, 1998). On the one hand, emotions

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<sup>14</sup> Thaler & Johnson (1990) argue that sunk costs can be important because of mental accounting. For example, they find that a prior loss induces risk seeking if the possibility exists to break even in terms of some reference point. When such a possibility does not exist, prior losses typically induce risk averse behavior. In light of this study one could argue that in the effort experiment investors consider their position after the effort task as a loss – for example because their opportunity costs of time are higher than their effort task earnings – and therefore become more risk averse. This argument, however, is not very appealing because subjects earned substantially more than what they could earn in the market (almost all subjects were undergraduate students who earned 30 guilders in the half hour effort task whereas in the market they would probably earn 15-20 guilders per hour).

shape our preferences because they can be seen as some (anticipated) psychic cost or benefit (as in the effort experiment). On the other hand, when emotions are experienced, they shape the process of rational decision making itself because of their effects on thought and reasoning (e.g. attention, access to memory, attribution, probability estimates, etc).<sup>15</sup> For example, Caplin & Leahy (2001, p.71) discuss psychological evidence showing that subjects who experience anxiety avoid potentially relevant information. In other words, anxiety stimulates to ‘put one’s head in the sand’. Virtually all current theories of choice under risk are cognitive and consequentialist. This means that people make decisions based on an assessment of the consequences of possible choice alternatives. Feelings triggered by the decision situation do not play any role in such assessments. Some cognitive theories, such as regret or disappointment theory, do take anticipated emotions into account – in the sense that they are considered as some future psychic cost – but in none of these theories there is any role for acute emotions triggered by the decision situation. However, as argued by Loewenstein et al. (forthcoming), emotional reactions to risk often diverge from cognitive assessments of those risks. If such divergence occurs, the emotional reaction often drives behavior. We will argue that in some decision situations under risk acute emotions are more likely to play a role than in others. If emotions play a role and their intensity is sufficiently high, cognitive assessments of risk (including anticipated emotions) may be thwarted or perhaps even dominated by the emotional reaction.

To link up our results with related experimental work on the common ratio effect, it is helpful to use the taxonomy of dynamic choice problems presented in table 2. This taxonomy is similar to the one used by Cubitt et al. (1998), except for problem 6 which they do not consider in their study on dynamic choice principles. Note that according to expected utility theory all decision problems in table 2 are equivalent.

[TABLE 2]

The first problem, referred to as scaled-up, is equivalent to our base line experiment where subjects invest in the safe or risky project without any common factor (no global risk). In the second problem, the common factor  $q$  and the choice between the safe and risky option are scaled-down to a single stage game. In the third problem, the common factor is framed as a first stage and the outcome of the chosen option as a last stage. In the first stage there is some

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<sup>15</sup> For a review, see Loewenstein et al. (forthcoming).



probability  $q$  of going to the last stage while with probability  $1-q$  the game is ended without winning anything. A decision must be made before the outcome of the first stage is known (precommitment). The fourth problem has the same decision tree as the third problem but is framed as a choice between two options, each consisting of a two-stage game. The fifth problem is similar to the third except that the outcome of the  $q$  lottery is known when the choice between the safe and risky option has to be made. Finally, in the sixth problem, equivalent to our global risk experiment, the common factor  $q$  is framed as a post lottery where with probability  $q$  all investment earnings are lost.

We now look at problems 1-6 and take the role of anticipated and experienced emotions into account. In problem 1, which is used as a benchmark, acute emotions are not likely to play a significant role when a decision must be made. There is no threat or other emotion inducing event prior to the decision between the safe and risky option. Furthermore, the fact that we found a relation between actual investment and anxiety (measured ex post) does not necessarily imply that subjects already experienced an acute emotion at the time of the investment decision. Cognitive assessments of risk as captured by prospect, regret, or disappointment theory are more likely to be at work.

The common ratio effect shows up when problem 1 is compared to problem 2. In problem 2, subjects typically are more risk seeking than in problem 1. Acute emotions are not likely to play an important role when a decision must be made in problem 2 (again there is no threat or other emotion inducing event). Cognitive assessments of risk can be expected at work. Some cognitive theories, like prospect theory and regret theory, offer an explanation for the increased risk seeking in problem 2 (which is related to probability transformation in the former and anticipated regret in the latter).

There is a good deal of evidence that the common ratio effect disappears when problem 1 is compared to problem 3 (Kahneman & Tversky, 1979; Starmer, 2000). According to Davis & Holt (1993) this can be explained by the fact that problem 3 is more transparent than problem 2. It seems that subjects are able to isolate the common factor in the precommitment problem, as proposed by prospect theory. In problem 3 acute emotions are more likely to play a role because the risk announced in the first stage has not been resolved yet when a decision must be made. We offer two scenarios concerning the likely impact of emotions in problem 3. In the first scenario we assume that hope instead of anxiety is induced by the risk of the first stage (that is, hope to get successfully through this stage). Whereas acute anxiety motivates to reduce risks and affects the way information is processed, no such

biases appear to be associated with hope (Lazarus, 1991, p.285). Experienced hope is thus not likely to disturb the cognitive assessments of risks in any systematic way. According to Ortony et al. (1998) the difference between hope and anxiety is that the former is elicited by being pleased about the prospect of a desirable event and the latter by being displeased about the prospect of an undesirable event. Now, if in problem 3 individuals focus more on the desirable aspect (hope of going to the last stage) than on the undesirable aspect (fear of not going to the last stage), hope rather than anxiety will be elicited. The second scenario we consider is that the risk of not going to the last stage is sufficient to induce acute anxiety. The motivation to take less risk (as a result of anxiety), however, is counteracted by the influence of another motivation, namely the desire to avoid anticipated negative emotions, such as regret. Because in problem 3 there is a chance that the consequences of one's choice are not revealed, less negative emotion may be anticipated in problem 3 than in problem 1. This may induce individuals to take more risk in problem 3. If these two motivations more or less balance, the net result is that behavior in problem 1 is the same as in problem 3.<sup>16</sup>

Problem 4 is basically problem 3 albeit framed in a slightly different way. Cubitt et al. (1998) find that risk taking does not differ between problems 3 and 4. They conclude that 'frame independence' holds. When taking emotions into account, there is no apparent reason why anticipated or experienced emotions would differ between these two problems. In other words, they seem to be emotionally equivalent. Consequently, the decision-making scenarios that we offered for problem 3 are also applicable to problem 4.

As holds for problem 4, there has not been much experimental work on problem 5 (prior lottery). Cubitt et al. (1998) examined problems 1-5 and find that risk taking only differs between problems 3 and 5, with more risk taking in problem 3. They refer to this finding as a violation of 'timing independence' and offer two explanations. First, agents may consciously make use of the opportunity to precommit themselves and make riskier choices than in the absence of such an opportunity. Second, agents "experience endogenous preference shifts, as a result of their experiences of risk, which they fail to anticipate"(p. 1378). In our view, the violation of timing independence can be easily explained in terms of

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<sup>16</sup> Another reason why acute emotions may not be important in experiments where subjects faced problem 3 is that a lottery choice typically involves a low financial stake because it is part of a sequence of other lottery choices. Although there is evidence that financial stakes are generally not very important for risky choices (see the review of Camerer & Hogarth, 1999), this need not be the case in situations where acute emotions are potentially important. Emotions typically start to play a role when something happens that is relevant to one's concerns. Given that one's concerns are affected, a higher financial stake implies greater emotional intensity. As argued in this section, in many set-ups of the common ratio problem acute emotions are not likely to play a role. Therefore, changes in the financial stake may not affect behavior in these designs.

emotions. When subjects make a choice in problem 5, the outcome of the  $q$  lottery must have been favorable. It is likely that this favorable outcome induces positive emotions, such as happiness or joy. Psychological evidence suggests that people who feel good are inclined to take less risk than people who feel neutral, in particular when the stakes are high (Isen & Geva, 1987). The idea is that people who experience a good mood want to maintain that mood (mood maintenance hypothesis): “People who feel good risk losing that state, as well as any tangible stake, if they lose a gamble. Therefore, with more to lose than controls, they are more risk averse than controls” (Isen quoted in Caplin & Leahy, 2001).

Problem 6, finally, is equivalent to our global risk setting. To the best of our knowledge it has not been studied experimentally before. Our study of the effect of global risk comes down to comparing behavior in problems 1 and 6. On average, subjects invest less money in the risky project in problem 6 than in problem 1. As argued in section 2, acute emotions, in particular anxiety and fear, are likely to play a role when a decision must be made in this situation. The reason is that only in problem 6 there is a clear threat to lose all of one’s earnings out of the experiment, whereas in the other problems this threat is not present or at least not as prominent. For example, in problems 3 and 4 subjects have not earned any money yet when the common risk  $q$  is being resolved. Because our investment game involves a considerable financial stake, this threat may be quite salient. In that case, anxiety induced by global risk can constitute a powerful motivation to avoid or reduce risks, which interferes with the cognitive processes that underlie behavior in theories of decision making under risk. This may explain why, in contrast with the isolation effect of prospect theory, global risk is not ignored by subjects, or why it does not lead to more risk seeking as predicted by several other cognitive theories in which anticipated emotions play a role (e.g. regret theory and disappointment theory).

## **5. Conclusion**

The experimental evidence presented in this paper supports the view that anticipated and experienced emotions systematically affect decision making under risk. Currently, there is a rapid growth in non-expected utility models that try to account for the observed violations of expected utility theory in laboratory experiments, such as the common ratio effect discussed in the previous section. Virtually all of them are cognitive and consequentialist. While some of these theories take anticipated emotions into account (e.g. regret or disappointment) acute emotions triggered by the decision situation do not play a role. According to Starmer (2000),

who provides a survey of this line of research: “the use of models incorporating probability weights and loss aversion will grow rapidly, and my normative judgement is that, if it doesn’t, it ought to”(p.370). While we do not question the relevance of concepts such as probability weighting or loss aversion in further developing our understanding of decision making under risk, we believe it is desirable to explore the descriptive qualities of such cognitive concepts under different affective conditions.<sup>17</sup> Our results of the global risk experiment suggest that acute emotions triggered by the decision situation – due to the existence of a salient threat – motivate subjects to take less risk. In addition, the results of the effort experiment show that by having subjects work for their capital investment goes down because subjects seem to anticipate the greater psychic costs in case of investment failure, due to larger ego-involvement.

Examining risk behavior under different affective conditions would thus seem to constitute an interesting avenue for future research. With regard to forward looking emotions such as fear and anxiety, for instance, does it matter how likely the emotion inducing event is? According to Caplin & Leahy (2001) “many decision are sensitive to the possibility rather than probability of negative outcomes”(p. 70). For the global risk experiment this would entail that raising the probability of losing all the returns on investment from zero to some small positive number may have a large effect, whereas changes within some midrange may have little effect. Another interesting issue for future research concerns the timing of the decision to be taken. In many situations people do not immediately have to make a decision after an emotion inducing event. By delaying the decision emotions may cool off. Some recent work on rejections in the ultimatum game, however, suggests that anger type emotions can be quite robust because they show up (again) when one actually has to make a decision (Bosman et al., 2001). Whether the behavioral effects of anxiety are also robust in this sense is an interesting issue for further study. Psychological evidence suggests that the intensity of anxiety is U-shaped with respect to time. The initial reaction of an individual to some salient threat is generally intense anxiety which then decreases for a while up to some point where the anticipation of the threatening event fuels the emotion again (Loewenstein, et al., forthcoming). Given that the time path of anxiety is U-shaped, does this also imply that the behavioral effects of anxiety are U-shaped? If the intensity of an emotion is low, it may not have much effect on behavior. As argued by Loewenstein (2000), emotions progressively seize command over behavior when their intensity increases. This would imply that the

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<sup>17</sup> This suggestion is in line with Loewenstein et al. (forthcoming) who consider examining “the effects of

(strongest) behavioral effects of anxiety show up directly after an individual learns about the threat and immediately prior to the realization of the threat, with perhaps little or no behavioral effects in the intermediate phase. Finally, we mention delegation (having someone else decide) as an interesting topic for future research. In this case, on the one hand the concerns (and induced emotions) of the agent to whom the decision is delegated start to play a role and, on the other hand, the emotional reaction of the delegator to the decision taken (which may not be accepted ex post, for instance). The consequences for optimal contracting are also of interest in this respect.

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## **Appendix: Instructions investment game in base line experiment (translated from Dutch)**

### *Information about projects*

In this phase you have to make a single decision concerning your working money. You have to allocate the 30 guilders that you received over two projects. These projects are denoted as A and B. You just received two cups with the letters A and B. The cup with the letter A represents project A and the cup with the letter B project B. For each guilder that you put in project A you will receive one guilder. Thus, project A always gives a certain return. For the amount that you put in project B the following holds. With probability one half (0.5) you will lose this amount and with probability one half (0.5) you will receive two and half (2.5) times this amount.

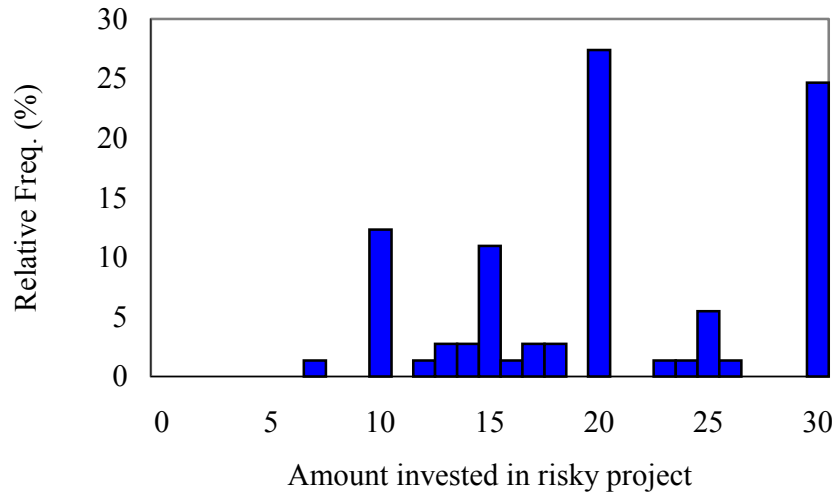
You can allocate the working money in whole guilders over the cups A and B in any possible combination that sums up to 30. The table below shows for each possible combination that you can choose the returns and corresponding probabilities. We will later give some examples to illustrate this table.

When you have allocated the working money over the projects A and B, you have to record your decision on the enclosed "Form". On this form you indicate how much money you have put in project A and how much money in project B. You also have to fill in your table number on this form. Once you have completed the form, the allocation of your working money over A and B cannot be changed any more.

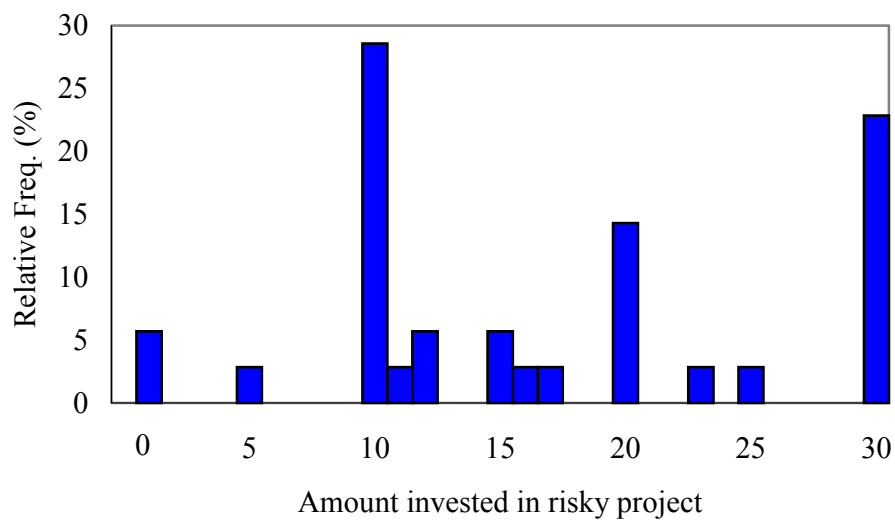
In the next phase the return of project B will be randomly determined. Each participant has just received a white die. In the next phase everyone will be asked to throw this die a single time under supervision. If the die shows 1, 2, or 3, you will receive two and half (2.5) times the amount that you put in project B. If the die shows 4, 5, or 6, you will lose the amount that you have put in project B.



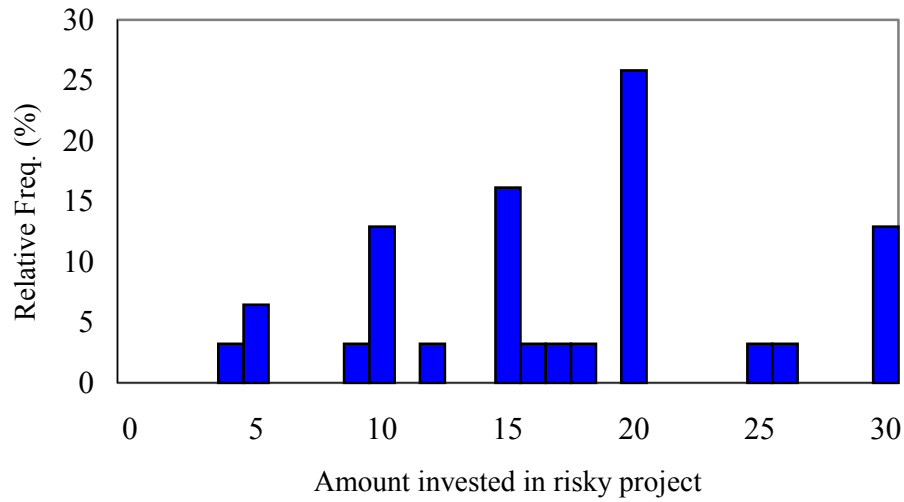
Money in Project		Certain return	Probability of 0.5 of an additional return of
A	B		
0	30	0	75
1	29	1	72.50
2	28	2	70
3	27	3	67.50
4	26	4	65
5	25	5	62.50
6	24	6	60
7	23	7	57.50
8	22	8	55
9	21	9	52.50
10	20	10	50
11	19	11	47.50
12	18	12	45
13	17	13	42.50
14	16	14	40
15	15	15	37.50
16	14	16	35
17	13	17	32.50
18	12	18	30
19	11	19	27.50
20	10	20	25
21	9	21	22.50
22	8	22	20
23	7	23	17.50
24	6	24	15
25	5	25	12.50
26	4	26	10
27	3	27	7.50
28	2	28	5
29	1	29	2.50
30	0	30	0



**Figure 1.** Investment in Base Line Experiment (n=73)



**Figure 2.** Investment in Global Risk experiment (n=35)



**Figure 3.** Investment in Real Effort experiment (n=31)

**Table 1.** Intensity scores of experienced emotions immediately after investment decision

Emotion	Base Line (n=35)	Global Risk (n=35)
	mean <sup>a</sup> (st. dev.)	mean <sup>a</sup> (st. dev.)
Sadness	1.80 (1.16)	2.00 (1.21)
Happiness	3.66 (1.47)	3.69 (1.59)
Shame	1.37 (1.06)	1.66 (1.35)
Fear	2.71 (1.84)	2.51 (1.72)
Envy	1.57 (1.04)	1.74 (1.15)
Hope	5.46 (1.17)	5.23 (1.54)
Anger	1.26 (0.51)	1.83 (1.52)
Anxiety	3.26 (1.84)	3.31 (1.76)
Joy	3.54 (1.38)	3.51 (1.52)
Irritation	1.94 (1.39)	2.77 (1.85)
Contempt	1.89 (1.69)	1.71 (1.23)
Surprise	2.74 (2.09)	2.46 (1.79)

Note: <sup>a</sup>The intensity scale ranges from 1 (no emotion) to 7 (high intensity)

**Table 2.** Sequence of events in common ratio problems

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1. Scaled-up:	(i) choose: safe option or risky option* (ii) outcome of chosen option
2. Scaled-down:	(i) choose: (1-q) safe option or (1-q) risky option (ii) outcome of chosen option
3. Precommitment:	(i) announcement of risk q (ii) choose: safe option or risky option (iii) resolution risk q; if continuation: (iv) outcome of chosen option
4. Two-stage:	choose: option A or option B option A: (i) announcement risk q (ii) resolution risk q; if continuation: (iii) outcome of safe option option B: (i) announcement risk q (ii) resolution risk q; if continuation: (iii) outcome of risky option
5. Prior lottery:	(i) announcement risk q (ii) resolution risk q; if continuation: (iii) safe option or risky option (iv) outcome of chosen option
6. Post lottery:	(i) announcement risk q (ii) safe option or risky option* (iii) outcome of chosen option (iv) resolution risk q

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Note: q denotes the common factor. Problems 1-5 are similar to those of Cubitt et al. (1998). Problem 1 is equal to our base line and problem 6 to our global risk experiment.

\*In our experiment the choice between the safe and risky option stands for the investment decision (allocating the working money over the two projects).