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Decisions under unpredictable losses: An examination of the restated diversification principle

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Abstract

An experimental test of the descriptive adequacy of the *restated diversification principle* is presented. The principle postulates that risk-averse utility maximizers will pool risks for their mutual benefit, even if information is missing about the probabilities of losses. It is enough for people to assume that they face equal risks when they pool risks. The results of the experiment support the principle.

Keywords: Group behavior, loss sharing, unpredictable losses, experiment, risk pooling.

1 Introduction

In a nutshell, the *diversification principle* says that, if risk-averse utility maximizers can choose between two assets with identical but random returns, they will prefer to invest half of their endowment in each asset (Rothschild & Stiglitz, 1971). The principle can be paraphrased in the following means: If two risk-averse utility maximizers with assets of the same value face the same distributions of potential losses, they will gain by sharing the potential losses equally (Skogh, 1999).

The *restated diversification principle* holds for any distribution of outcomes, as long as the distribution is the same for both people. It does not matter whether the probability of a loss is small or large; in both cases, the people gain by sharing the loss. This implies that sharing loss is also mutually favorable if information is missing about the probabilities of losses. It is not even necessary that the distribution of outcomes is the same for both people; it is enough that they both accept that there is no reason to assume that their probabilities of losses differ (presumption of equality). Possible differences can therefore be neglected if there is no knowledge about them.

When information about the probabilities of losses is missing, mutual sharing of losses may be superior to insurance since an insurance premium is normally based on technical or actuarial information on the probability of losses. Without such information, the pricing will become arbitrary and the negotiation cost may be large. Insurance under apparent ambiguity, when information about the probabilities of losses is lacking, may not be possible at all (Hogarth and Kunreuther, 1989). Loss-sharing, however, can be undertaken without pricing the potential loss.

The restated diversification principle was first presented by Skogh (1999) in the case of two identical pool members. Skogh and Wu (2005) generalized the principle to the case where individuals' losses differ in amount or in probability and to the case where individuals' attitudes toward risks differ. This paper tests the descriptive adequacy of the restated diversification principle with an experiment. In particular we test the following two hypotheses:

H1 : Under apparent ambiguity, people will share potential losses.

H2: If the distribution of potential losses is different across people but unknown, people will still share potential losses.

The experimental design, results, and discussion are presented in Sections 2, 3, and 4, respectively.

2 Experimental design

Each participant received SEK20 as a show-up fee. Participants were then divided into groups of four. They were told that they would go through three rounds, and,

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at the beginning of each round, they would receive an endowment of 80 tokens, half of which may be lost by the end of the round. In each round, the participants had to pick a ball from a bucket containing 100 colored balls. If a black ball was picked from the bucket, the participant lost 40 of the 80 tokens.

The participants could carry the potential loss individually, insure themselves against the loss, or share it with other players in their group. They could cooperate only with other members of their group. Participants could freely communicate within the group, and there was no time limit set for each round. Participants had the following alternatives in each round:

1. *No action*. The round played alone, with the potential loss of 40 tokens.

2. *Equal loss sharing*. Each of the four group members covers one-fourth of the losses of the group. For instance, if one of the group members drew a black ball, each participant in that group would pay 10 tokens to cover the loss. If two participants received a black ball, each group member would pay 20 tokens, and so on.

3. *Partial loss sharing.* Fewer than four group members share their losses. This was the case when one or two participants in a group chose to take another action instead of sharing the losses.

4. *Sell insurance,* A player insures other players by charging a premium in advance. Each player was allowed to insure losses up to 40 tokens in each round. This was to avoid insolvent insurers.

5. *Buy insurance.* The player buys insurance and pays one or more other members in the group to cover the potential loss.

Note that participant could agree on any type of insurance solution, as long as they did not insure for losses of more than 40 tokens. The insurance premium had to be set by participants themselves. Thus, insurance involved negotiating between buyers and sellers over the insurance premium. Let us now describe the differences among the three rounds.

1. Participants were given 80 tokens. In the first round, participants received the information that the bucket contains 100 balls of various colors and that if a black ball were picked, they would lose half their endowment. There was no information on the number of black balls or even if there were any in the bucket at all. All participants picked a ball from the same bucket.

Table 1: Number (Percentage) of players adopting each action.

	Round 1	Round 2	Round 3
No action	5 (6.25)	2 (2.5)	6 (7.5)
Equal loss sharing	72 (90)	72 (90)	68 (85)
Partial loss sharing	3 (3.75)	6 (7.5)	6 (7.5)
Sell insurance	0 (0)	0 (0)	0 (0)
Buy insurance	0 (0)	0 (0)	0 (0)
N	80 (100)	80 (100)	80 (100)

2. Participants were given 80 tokens. In the second round, participants received the information that there were four different buckets and that each contained 100 balls of various colors. Each participant was randomly assigned one bucket. If a black ball were picked, 40 tokens were lost.

3. Participants were given 80 tokens. In the third round, participants were told that there were four buckets, each of which contained 100 balls of various colors. They were informed that one bucket had 70 black balls, one bucket had 50 black balls, one bucket had 30 black balls, and one bucket had 10 black balls. Each participant was randomly assigned to one of the buckets but never knew which bucket. He or she knew only that the buckets had different numbers of black balls but did not know if his or her bucket contained the lowest or highest number of black balls. Again, if a black ball were picked, 40 tokens were lost.

The decision of each participant was written on a form, one for each round. After each round, losses were calculated and payments were made. The experiment took about 30 minutes. For each token left, the participants received SEK0.5. The experiment took place at different occasions in 2006 at Växjö University. A total of 80 participants — 20 groups of four — participated in the experiment. The average age of participants was 22 years, and 40 percent of them were women.

The Appendix shows the instructions.

3 Results

The results of the experiment are presented in Table 1. In the first round, participants picked a ball from the same bucket. If a black ball was picked, they lost 40 tokens. A first option for the participants was to take no action. Only five participants made this choice; four of these belonged to the same group. A second option was to share

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losses equally among all group members. Seventy-two participants, or 18 groups, chose this action. Three participants partially shared their losses since one in that group chose not to do anything.

The pattern in the second round, with four different buckets with unknown distribution of losses, was similar to the first round. The number of individuals or groups that chose to share their losses among all group members did not change. Two individuals from different groups chose to take no action; therefore, the remaining group members chose partial loss-sharing.

In the third round, participants knew the number of black balls in different buckets, but they did not know which bucket they would pick from. The results were still similar to the previous two rounds. The majority — 68 participants or 17 groups — chose to share their losses equally among all group members. Six participants chose not to take any action, and another six participants shared their losses partially.

Note that not a single participant chose to insure someone else and, consequently, not a single participant bought insurance in any of the rounds. In the first two rounds, the reason for that choice could be that it is difficult to set a premium ex ante because of missing information about the probabilities of losses. However, participants did not buy or sell insurance in the final round either, when the distribution of balls was known. We will discuss this further in the next section.

The results here are clear cut; however, for the record, the proportion of participants that choose equal sharing was significantly larger than the proportions of participants choosing alternative actions (Chi-square test, $p < 0.0001$). Also, the change in the proportion of participants choosing equal sharing compared to other actions across rounds was not significant (McNemar test).

4 Discussion

One previous study, Ahmed and Skogh (2006), examined the restated diversification principle, but the present paper differs from the previous study in two important ways:

First, in Ahmed and Skogh (2006), participants received 1,000 tokens as an endowment that could be lost in five risky rounds. Participants were divided into groups of four and informed of an urn that contained 100 balls of various colors. In each round, each player randomly picked one ball. A black ball would cost the participant 500 tokens. In each round, participants could also take actions to reduce the risk of large losses. One of the actions was to share losses with other participants. The information on the risk varied across rounds: In the first round, there was no information on the probability of a loss; in the final round, there was full information of the probability. The results showed that participants shared losses when information about the probabilities of losses was missing, in a way that supports the restated principle. However, a large percentage of the participants chose to do nothing. Participants may have believed that cooperation did not pay: In each round, half of the endowment could be lost. If they believed probabilities of losses would be relatively large, bankruptcy could be the expected outcome of the five rounds and gambling, in that case, may be a way to survive by luck. In this paper, we present results from an experiment in which we overcome the problem of bankruptcy by giving our participants a new set of tokens in each round.

The second difference from Ahmed and Skogh (2006) is that we also tested the second hypothesis stated above by using different urns for different group members in the last two rounds.

The observations clearly show that participants share losses when information about the probabilities of losses is missing in a way that supports the descriptive adequacy of the restated diversification principle. That is, sharing is chosen exclusively because it eliminates the problem of pricing when losses are unpredictable. Our observations also show that participants share losses even if they know that the distribution of losses is different across group members — but they do not know in what way because of the lack of information that discriminates among group members. Participants share potential losses by applying the presumption of equality.

A noteworthy result that needs to be commented is that none of the participants bought or sold insurance in the experiment. In the first two rounds, the reason is probably that an insurance premium could not be set, as information about the probabilities of losses was lacking. However, in the last round, this information was known, so the question remains as to why not a single insurance contract was established. One reason could be that participants found insurance to be a more complicated choice than loss-sharing since it involved negotiation between the buyer and the seller over the insurance premium. Another explanation could be that mutual insurance, where participants insure each other at the same premium, is equivalent to loss-sharing. Hence, if everyone in the group wanted to buy and sell insurance, then they might as well just share losses instead. An interesting extension of the experiment would be to include a fifth person in the group that acts only as an insurer. A possible explanation could also be that cooperating with other group members in previous two rounds establishes a bond among participants that makes it is hard to deviate from the group behavior to individual behavior. Introducing anonymity among group members might limit this possibility. Replications are requested.

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The paper relates to the vast literature on decision under risk. Savage (1954) put forward the subjective probability theory, where the distinction between known and unknown probabilities is meaningless because subjective probabilities are never unknown. Empirical evidence, however, has shown that people do, in fact, make such a distinction (Ellsberg, 1961). A justification of the subjective probability theory is that people cannot make decisions without assignment of probabilities. Yet, the results of the present experiment show that this is not completely correct: Loss-sharing among people takes place without assignment of probabilities.

The paper also relates to the prospect theory of Kahneman and Tversky (1979). Prospect theory predicts that people are risk-averse in the domain of gains and risk-seeking in the domain of losses. The results in this paper might then look inconsistent with the prediction of prospect theory, as participants did not appear to be risk-seeking when facing potential losses. Alternatively, it may be the case that participants actually were in the domain of gains when making their decision since they received a show-up fee that could not be lost in the experiment; in addition, they gained 40 tokens guaranteed in each round. Putting it in this way, participants should be risk-averse, and the experiment may have not implemented potential losses. On the other hand, a similar experiment by Kühberger, Schulte-Mecklenbeck, and Perner (2002) shows that participants who have lost half of their given endowment have a tendency of being risk-seeking. It is difficult to arrive at definite conclusions by hypothesizing from known facts and observations from other studies.

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Appendix: Translation of written instructions

General instructions

Welcome! Thank you for participating in this experiment. The experiment will take a maximum of one hour. The purpose of the study is to gain greater insight into economic decision-making. To express our gratitude and to compensate you for your time, you have already been given a show-up fee of SEK 20. In addition to this, you also have the opportunity to earn more money during the experiment.

As you already have noticed, this experiment will be conducted in groups of four, and you have already been matched with three other participants whom you are seated with. In this experiment, you and your group members will go through three rounds, and in each round you and your group members have to make a decision. In each round, you and your group members will receive 80 tokens each. The total gains to you from the experiment depend on the tokens remaining when the three rounds are over. For each token you have left, you will be paid SEK0.5.

In each round, you and your group members have to pick a ball from a bucket containing 100 colored balls. If a black ball is picked from the bucket, you will lose 40 of the 80 tokens. Hence, each round may result in a loss of 40 tokens. You may take this risk individually, share losses with others in the group, or you may also buy or sell insurance. The alternative actions are described below:

A. *No action*. You go through the round yourself with the potential loss of 40 tokens.

B. *Equal loss-sharing*. Each of you in the group covers one-fourth of the total losses of the group. For instance, if one of your group members draws a black ball, each of you in the group will pay 10 tokens to cover the loss. If two in your group receive a black ball, then each of you will pay 20 tokens, and so on.

C. *Partial loss-sharing.* It is also possible that two or three of you share the potential losses. This may be the

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case if one or two of your group members chooses to take another action instead of sharing the losses.

D. *Sell insurance.* You may insure other group members by charging a premium in advance. You are allowed to insure losses up to 40 tokens in each round. For example, the premium for coverage of 40 tokens could be equal to 5, 10, 20, 30 or so on, depending on what you believe about the risk of receiving a black ball. If you insure another person in your group, you will first pick a ball for yourself and then pick a ball again for the person you insured. Partial cover of the loss may also be applied.

E. *Buy insurance.* You may buy insurance from other group members and pay them a premium in advance to cover the potential loss. You and your insurer have to decide what premium to set. Hence, if you pay a premium to another group member to cover all your losses, your earnings from that round will be 80 tokens minus the premium paid.

You can discuss freely with other members of your group. Your choice of action in each round is to be written down on a decision form that you will receive before each round together with specific information related to each round. The picking of balls will take place after your decision has been collected.

Information given in the first round

You have been given 80 tokens. You will be asked to pick a ball from a bucket that contains 100 balls of various colors. If you pick a black ball, you will experience a loss of 40 tokens. You have the possibility to take any of the actions defined earlier. You will pick a ball after you and your group members have decided what actions to take. You and your group members will pick a ball from the same bucket.

Information given in the second round

You have been given 80 tokens. There are four buckets containing 100 balls of various colors. The four buckets will be randomly assigned to you and your group members: one bucket for each of you. You will then be asked to pick a ball from your bucket. If you pick a black ball, you will experience a loss of 40 tokens. You have the possibility to take any of the actions defined earlier. You will pick a ball after you and your group members have decided what actions to take.

Information given in the third round

You have been given 80 tokens. There are four buckets containing 100 balls of various colors: one bucket has 70 black balls, one bucket has 50 black balls, one bucket has 30 black balls, and one bucket has 10 black balls. The four buckets will be randomly assigned to you and your group members: one bucket for each of you. You will not, however, know which bucket contains which number of black balls. You know only that the buckets contain different numbers of black balls. You will then be asked to pick a ball from your bucket. If you pick a black ball, you will experience a loss of 40 tokens. You have the possibility to take any of the actions defined earlier. You will pick a ball after you and your group members have decided what actions to take.