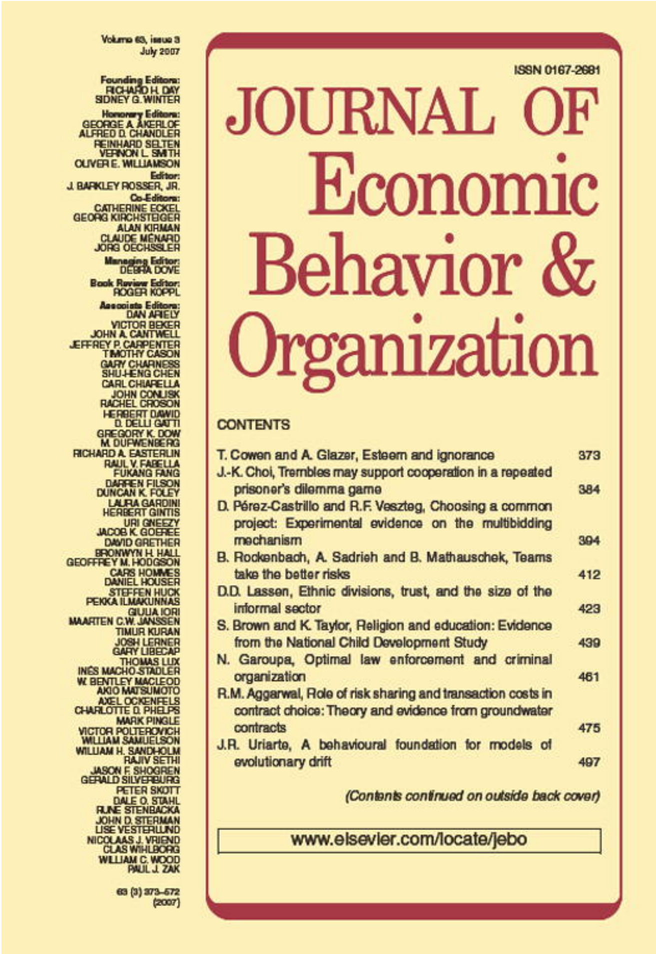

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CONTENTS

(Contents continued on outside back cover)

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Teams take the better risks☆

Bettina Rockenbach[a,1], Abdolkarim Sadrieh[b,*], Barbara Mathauschek[c]

[a] Chair in Microeconomics, University of Erfurt, Nordhäuserstr. 63, 99089 Erfurt, Germany
[b] Faculty of Economics and Management, University of Magdeburg, Postbox 4120, 39016 Magdeburg, Germany
[c] Laboratory of Experimental Economics, University of Bonn, Adenauerallee 24-42, 53113 Bonn, Germany

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Abstract

One reason why decision makers are often teams and not individuals may be that team decisions comply more closely with economic rationality. We compare individual and team decisions, when systematic deviations from the expected utility theory (EUT) and the portfolio selection theory (PST) are to be expected. We find almost no evidence for the greater compliance of team decisions with the principles of EUT. However, there is substantial evidence for the consistency of team decisions with the PST. Compared to individuals, teams accumulate significantly more expected value at a significantly lower total risk (measured in standard deviation, S.D.).

JEL classification: C91; C92; D81; D70; M10

Keywords: Decision under risk; Group decision; Expected utility; Portfolio selection

> "Teamwork is neither 'good' nor 'desirable.' It is a fact."
>
> Peter F. Drucker (1909–)

> "The great creative individual . . . is capable of more wisdom and virtue than collective man ever can be."
>
> John Stuart Mill (1806–1873)

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* Corresponding author. Tel.: +49 391 67 18492; fax: +49 391 67 11355.
E-mail addresses: Bettina.Rockenbach@uni-erfurt.de (B. Rockenbach), sadrieh@ww.uni-magdeburg.de (A. Sadrieh), bmathauscheck@uni-bonn.de (B. Mathauschek).
[1] Tel.: 49 361 73 74 521; fax: 49 361 73 74 529.

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1. Introduction

Many important decisions are made by teams rather than by individuals (e.g. in managerial boards, production units, faculties, or families), even when the complexity of the task may not demand more than one decision maker. A straight-forward explanation is that team decisions are (in some dimensions) "better" than individual decisions. In fact, a number of experimental results on strategic interaction situations (Cason and Mui, 1997; Bornstein and Yaniv, 1998; Cox and Hayne, 1998; Kocher and Sutter, 2005) indicate that group decisions are more consistent with rationality than individual decisions.

In investment decisions, however, the evidence is mixed. Barber and Odean (2000) compare investment behavior of individuals and investor clubs and find that investment clubs under-perform individual investors. Adams and Ferreira (2003) study betting behavior of individuals and groups on ice breakup dates in Alaska and find that the distribution of bets placed by groups conforms more to the historic data. Blinder and Morgan (2005) study the decisions of groups and individuals in two different experiments (a statistical guessing task and a simple macroeconomic model) and find that groups outperform individuals in both settings. Bone et al. (1999) investigate whether individuals are affected towards more compliance with the axioms of expected utility theory (EUT) through the informal group discussions. They compare individual pre-discussion with individual post-discussion decisions in common ratio problems, which generally produce high numbers of EUT-inconsistent choices, and find that group discussion does not lead to an increase in the number of EUT-consistent choices. In fact, the rate of consistent choices even drops slightly from the pre- to the post-discussion round of individual decision making.

Investment decisions made by individuals have been shown to exhibit robust and substantial deviations from the normative principles of expected utility theory of von Neumann and Morgenstern (1944) and the portfolio selection theory (PST) of Markowitz (1952).[2] We address the question of whether investment decisions made by teams are structurally different from individual decisions.[3] We present an experimental investigation of team investment decisions in situations in which individuals frequently exhibit choice patterns that are inconsistent with EUT (*common ratio effect*, *the preference reversal effect*[4], and *the reference point effect*) and/or inconsistent with regard to the risk-value principle of PST.[5] For a controlled comparison between the team and the individual decisions, we also conduct sessions with individual decision makers facing exactly the same investment tasks as the teams.

From the experimental data we draw two main conclusions. On the one hand, we find almost no evidence for the compliance of team decisions with the principles of EUT. The observed team decisions are not distinguishable from the individual decisions in the cases of the common ratio effect and the preference reversal effect. Only concerning the reference point effect do we find significantly less inconsistent choice patterns in team decisions than in individual decisions. On the other hand, we find substantial evidence for the consistency of team decisions with the risk-value principle of PST. Compared to individual decision makers, teams accumulate significantly

[2] See Camerer (1995) and Kahneman and Tversky (1979) for surveys on the experimental work in the case of EUT. See Kroll et al. (1988a,b) and Rapoport et al. (1988) for experimental work in the case of PST.

[3] While the focus of the investigation of Bone et al. lies on the effect of group discussion on individual choice, we concentrate on the difference between individual and team decisions.

[4] Preference reversals are neither in line with EUT nor with PST. See Grether and Plott (1979).

[5] We use variance as a measure of risk in the risk-value model, mainly because it is free of personalized parameters and easily accessible in the context of lottery choices.

more expected value at a significantly lower total risk. In view of these results, we conjecture that team decision making may be adequately represented by a risk-value model based on the principles of PST. This result is in line with the observation by Gooding (1975, p. 1301) that “while investor groups’ average stock perceptions are highly related to relevant risk and return measures, significant differences may exist between portfolio managers’ and nonprofessional investors’ average multidimensional perceptions.”

2. The experimental setup

In each session of the experiment, 16 lottery choices and eight lottery evaluations were preformed either by an individual subject (individuals treatment) or a team of three subjects (teams treatment). The lottery choice tasks were all pairwise choices. For the evaluation tasks we used the selling price elicitation procedure by Becker et al. (1964).[6]

Table 1 contains all lottery pairs used in the choice tasks. Each of the lotteries in the pairs 9–12 was also evaluated in an evaluation task. The lottery pairs are displayed in an order corresponding to the behavioral regularities they were designed to test for. The sequence in which the choice tasks were presented to the subjects is indicated in the second column of Table 1. Column 3 denotes the type of each lottery pair, which may either be an *investor lottery pair* (type I) or a *gambler lottery pair* (type G). In an investor lottery pair the lottery with the higher expected payoff also has the higher standard deviation, and in a gambler lottery pair the lottery with the higher expected payoff has the lower standard deviation. The lottery type allows us to identify consistent choices with respect to PST (see below).

The subjects were informed about the endowment, the prospects of lottery A (A1 and A2) and of lottery B (B1 and B2) as well as the respective probabilities (see Table 1). None of the other information in Table 1 was provided to the subjects. Each lottery was played immediately after its choice. The evaluation tasks followed after all choice tasks were completed. At the beginning of each session, the instruction sheet (available upon request) was read aloud to the subject or the subject group. The instruction sheets for both treatments were identical except for the parts that were concerned with the treatment variable, that is, individual or team decision. The subjects, alone or as a team, were then seated in front of a computer screen on which the tasks were displayed. In both treatments, the computer was operated by a student monitor, who was instructed in using the experimental software[7]. The student monitors were told not to interfere with the decision process.

The subjects recorded their decision on a decision sheet. In the individuals treatment, the decision sheet was signed by the single subject. In the teams treatment, the decision sheet was only accepted if all three team members had signed it. Apart from this *all-signatures rule*, the mode of team decision making was not restricted. The decision making in all sessions was videotaped. The subjects in the individuals treatment had been asked to make comments on their decisions. The subjects in the teams treatment discussed their decisions freely. No explicit time limit was given, but the posters for subject recruitment had announced a duration of about one-and-one-half hours. The actual duration of the sessions, including instructions, was less than an hour. The sessions in the teams treatment usually took a little longer.

[6] Each subject reports a minimum selling price p. A number r is randomly drawn in the range of outcomes. The subject receives r, if $r \geq p$. Otherwise, the lottery is played. It is dominant to report the certainty equivalent. The dominance argument was presented to the subjects in the instructions.

[7] The software was programmed using *RatImage* (Abbink and Sadrieh, 1995). Lotteries were presented numerically and graphically as a *wheel of fortune*.

Table 1
Lottery pairs used in the 16 choice tasks

No.	Sequence	Type	Endowment	Lottery A						Lottery B					
				A1	P(A1) (%)	A2	P(A2) (%)	EV	S.D.	B1	P(B1) (%)	B2	P(B2) (%)	EV	S.D.
Common ratio tasks															
1	1	I	0	600	60	0	40	360	293.9	320	90	0	10	288	96.0
2	15	I	0	320	45	0	55	144	159.2	600	30	0	70	180	275.0
3	9	I	0	320	30	0	70	96	146.6	600	20	0	80	120	240.0
4	5	I	0	600	10	0	90	60	180.0	320	15	0	85	48	114.3
5	6	G	0	640	60	0	40	384	313.5	500	80	0	20	400	200.0
6	16	G	0	500	60	0	40	300	245.0	640	45	0	55	288	318.4
7	11	G	0	640	30	0	70	192	293.3	500	40	0	60	200	245.0
8	2	G	0	500	20	0	80	100	200.0	640	15	0	85	96	228.5
Preference reversal tasks															
9	3	I	0	200	80	50	20	170	60.0	650	30	0	70	195	297.9
10	7	I	0	200	90	50	10	185	45.0	450	20	150	80	210	120.0
11	10	G	0	250	90	0	10	225	75.0	500	20	100	80	180	160.0
12	13	G	0	150	90	50	10	140	30.0	600	20	0	80	120	240.0
Reference point tasks															
13	4	I	0	300	100	0	0	300	0.0	500	40	250	60	350	122.5
14	8	I	500	−200	100	0	0	−200	0.0	0	40	−250	60	−150	122.5
15	12	G	0	600	20	100	80	200	200.0	250	100	0	0	250	0.0
16	14	G	500	−250	100	0	0	−250	0.0	−400	80	100	20	−300	200.0

Note: the lotteries A and B of the pairs 9–12 were used in the eight evaluation tasks that followed the choice tasks.

All decisions were paid. By default, each team member received a payoff equal to the amount the team had earned. The possibility of an internal reallocation of the team earnings had neither been pointed out nor excluded, but redistribution was not discussed in any team.[8] No subject earned less than DM 20 or more than DM 26.[9] All 32 sessions (16 individuals and 16 teams) were run at the University of Bonn. Each subject was permitted to participate in a single session only. A total of 64 subjects took part in the experiment, most of whom were undergraduate students of law or economics. None of the subjects had taken part in a lottery choice or evaluation experiment before. All experimental data is available upon request.

3. Are team decisions consistent with the axioms of EUT?

The lottery pairs of the choice tasks were selected to test for three classical patterns of choice that are not consistent with axioms of EUT. The lottery pair sequences 1–4 and 5–8 were designed to test for the *common ratio effect*. Each of the lotteries in the pairs 9–12 was presented in both in a choice and in an evaluation task. The combination of decisions was used to check for the *preference reversal effect*. Finally, the pairs 13–16 were devised to check for the *reference point effect* (also referred to as *loss aversion* or *reflection effect*).

All three behavioral regularities have a direction; that is, they predict a specific structural constellation of the choices that is inconsistent with the axioms of EUT. These are the *predicted inconsistencies*. In the common ratio tasks with two binary outcome lotteries, subjects regularly choose the lottery that has a medium winning prize if the winning probabilities in both lotteries are perceived high. The contrary is observed if the winning probabilities in both lotteries are perceived low. In the preference reversal tasks, subjects regularly choose the lottery with a medium prize and a high probability of winning (P-bet) but at the same time assign a higher selling price to the lottery with a high prize and a smaller probability of winning ($-bet). The reference point effect predicts that subjects will select the less risky alternative when the choice is presented in the domain of positive payoffs, but will choose the more risky alternative, when choice is presented in the domain of negative payoffs.

In all three cases, however, a different pattern of choices can also evolve that is not only inconsistent with the axioms of EUT, but also with the behavioral explanation of the predicted inconsistencies. This type of choice pattern is called an *unpredicted inconsistency*. The relationship between the frequency with which predicted and unpredicted patterns of behavior are observed seems to be a sensible measure for the explanatory power of the behavioral hypotheses. Since in our setup observing both multiple predicted and multiple unpredicted inconsistencies is possible, we classify each individual and each group in one of the following four categories: *no inconsistencies*, *more predicted inconsistencies*, *equally many predicted and unpredicted inconsistencies*, and *more unpredicted inconsistencies*.

The distribution of individuals over the four categories in Table 2 clearly supports the case for the behavioral explanations of the common ratio and the preference reversal effects. Not only do most subjects violate EUT, but a large majority of them fall in the category with more predicted than unpredicted inconsistencies. The binomial test significantly rejects the null hypothesis that individuals are equally likely to exhibit more predicted than unpredicted patterns of choice at the

[8] The absence of payoff re-allocations amongst group members is also reported by Bone et al.

[9] At the time the experiment was conducted, the wage paid to student teaching aids at German universities was roughly DM 15 an hour and the exchange rate US$ to DM was ca. US$ 60 for DM 1.00.

Table 2
Individuals (teams) classified by the relationship of exhibited predicted to unpredicted inconsistencies

Set of tasks	Common ratio		Preference reversal		Reference point	
Treatment	Individuals	Teams	Individuals	Teams	Individuals	Teams
No inconsistencies	4	2	5	1	4	12
More predicted inconsistencies	10	10	9	12	6	2
Equally many predicted and unpredicted inconsistencies	1	2	0	1	1	0
More unpredicted inconsistencies	1	2	2	2	5	2

Note: individuals (teams) exhibiting no inconsistencies are counted in the first, but not in any other category.

1% level (one-sided) for the common ratio effect and at the 5% level (one-sided) for the preference reversal effect. Thus, concerning these effects, our experimental results from the individuals treatment support earlier findings.

The comparison of the individuals to the teams in Table 2 reveals that the treatment variable seems to have practically no influence on the emergence of the common ratio and preference reversal effects. All in all, teams exhibit patterns of inconsistencies that seem very similar to those of individuals. We find no significant differences between individual and team decisions applying the *U*-test to the distributions of the total number of, the number of predicted, and the number of unpredicted inconsistencies. Given the similarity between the decision patterns of teams and individuals it is not surprising that teams exhibit significantly more predicted than unpredicted inconsistencies in the common ratio and preference reversal tasks (binomial test is significant at the 2% level, one-sided).

In the tasks concerning the reference point effect, significantly more individuals than teams made choices that were inconsistent with the axioms of EUT (Fisher's exact test at the 1% level, one-sided). Amongst those who made inconsistent choices, however, we find individual and team behavior to be very similar. The inconsistent choices of neither individuals nor teams exhibit a clear tendency towards the predicted behavioral pattern. Even though we find groups slightly more consistent with EUT in the reference point tasks, overall we must conclude that team decisions are not substantially more often consistent with the axioms of EUT than individual choices.

4. Are team decisions consistent with the principles of PST?

To test for choice behavior with respect to different risk-value constellations, we designed two different types of lottery pairs: the *investor lottery pairs* and the *gambler lottery pairs*. The classification is based on the comparison of the expected values (EV) and standard deviation (S.D.) of the two lotteries contained in the pair. Of the 16 lottery pairs that were used in the experiment, eight were investor lottery pairs and eight gambler lottery pairs. Table 1 contains an entry for the type of each lottery pair: investor lottery pairs are marked with an I and gambler lottery pairs are marked with a G.

An investor lottery pair resembles a typical investment decision: the lottery with the higher EV also features the higher risk (the higher S.D.), whereas the other lottery has both the lower EV and the lower risk (the lower S.D.). Thus, the lottery with the greater EV (EVmax lottery) can be interpreted as a risky investment, such as an investment in stocks, whereas the lottery with the smaller EV (EVmin lottery) is comparable to low risk asset, such as a bond. Thus, choosing from an investor lottery pair means facing the trade-off between risk and value.

In a gambler lottery pair one of the two lotteries has both the higher EV and the lower risk (the lower S.D.), whereas the other lottery yields less EV at a higher risk. Gambling of any kind resembles this type of choice. For example, choosing to participate in a national lottery instead of keeping the price of the lottery ticket means choosing a lower EV at a much higher risk. This may be attractive simply because the lottery promises extremely high prizes, even if the chances of winning are extremely low. In a gambler lottery pair there obviously is no trade-off between risk and value since the EVmax lottery has the lower risk.

The first question to ask is whether individuals and teams differ in the amount of expected value and the amount of risk (measured in S.D.) they collect in the course of the experiment. To compare the data, we calculated the accumulated expected values and the accumulated standard deviations of the 16 lotteries chosen by each individual and by each team. The result is that the teams collect significantly more expected value with their choices than individuals (*U*-test 1% level, one-sided) and this at a significantly lower risk (*U*-test 5% level, one-sided).

In the investor lottery pairs, the observed difference between the choices of the teams and of the individuals is relatively small; teams accumulate significantly more expected value than individuals (*U*-test, 10% one-sided), however, at an accumulated risk that is not significantly different from that of individuals (*U*-test with $p > 20\%$, one-sided). The results for the gambler lottery pairs are much more extreme: with their lottery choices, teams accumulate significantly more expected value than individuals (*U*-test, 1% level, one-sided) at a significantly lower risk (*U*-test, 1% level, one-sided).

To analyze the extent of the treatment difference, we calculate the difference between the expected value of the chosen lottery and the minimum of the two lotteries' expected values. These values are summed up over all tasks and normalized over the maximal possible difference. The measure has the advantage of focusing on the rate of expected value accumulation that exceeds the default minimum. The standard deviation measure is derived in an analogous manner. The averages are displayed in Table 3.

Table 3 shows that individual and team choices in investor lottery pairs are similar; in both cases slightly less than the maximum expected value is accumulated at about 90% of the additional risk. The picture is different in the gambler lottery pairs, in which 100% EV accumulation could have been achieved at minimal risk. In these tasks, teams on average collect 25% more of the additional EV than individuals (75 to 50%). At the same time, teams on average only accumulate 23% of the risk that exceeds default minimum risk while individuals accumulate double as much (46%).

Thus, we find that teams and individuals tend to make similar choices when there is a trade-off between the lottery with the higher expected value and the lottery with the lower risk, for example in an investor lottery pair. When it comes to gambling, that is, when it comes to choosing the lottery with the lower expected value at a higher risk, however, teams tend to be significantly less

Table 3
Average normalized expected value (EV) and standard deviation (S.D.) measures

	Average normalized EV measure		Average normalized S.D. measure	
	Individuals	Teams	Individuals	Teams
Investor lottery pairs	0.96	0.98	0.88	0.91
Gambler lottery pairs	0.50	0.75	0.46	0.23
All lottery pairs	0.91	0.96	0.75	0.69

Table 4
Relative frequencies of observed and hypothetical EVmax lottery choices

	Investor lottery pairs	Gambler lottery pairs	All pairs
Observed individuals	0.81	0.56	0.69
Observed teams	0.88	0.73	0.80
Hypothetical teams, if ...			
... minority for EVmax	0.98	0.88	0.93
... majority for EVmax	0.86	0.57	0.72
... unanimity for EVmax	0.59	0.23	0.41
... excess-risk vetoing	0.86	0.88	0.87

risk seeking. This means that teams' portfolios tend to be on the efficient frontier of the risk-value curve more often than individuals' portfolios. It seems that the informal group discussions increase the frequency of decisions that are consistent with PST.

5. Excess-risk vetoing

Most of the teams in our experiment employed some form of majority vote to make their decisions. However, as the low frequency of observed non-EV maximizing choices in the gambler lottery pairs indicates, many teams seems to have added a special type of veto to the majority rule in order to hinder unreasonable gambling: the selection of a risky choice could be vetoed if the risk was not compensated by a substantial gain in expected payoff. The notion underlying such an *excess-risk vetoing* rule is in line with the spirit of the risk-value principle of PST because as long as there is at least one team member with preferences that are consistent with PST, the team decision will be on the efficient frontier. Thus, a common preference (and unanimous vote) of all team members for the high risk and low EV lottery is the only situation in which a team using excess-risk vetoing makes a decision that is inconsistent with the principles of PST. Note that we are not suggesting that teams explicitly devise or implement such a rule. We rather believe that excess-risk vetoing implicitly arises in the team discussion. A team member who points out that a substantial gain in expected payoff at a lower risk is possible has a strong persuasive argument.[10]

To test the behavioral relevance of the excess-risk vetoing rule, we compare its out-of-sample predictive power to that of the three standard voting schemes, Minority for EVmax, Majority for EVmax, and Unanimity for EVmax. First, we form all possible 3360 hypothetical groups of three subjects that can be constructed from the 16 subjects in our individuals treatment. In each of these hypothetical "teams", we let the three members "vote" for a lottery choice, where each vote is determined by the actually observed decision of the subject in the corresponding task. These hypothetical votes are combined to derive the team decisions using each of the four mentioned voting schemes.[11] Table 4 contains the relative frequencies with which individuals, teams, and hypothetical teams choose the EVmax lottery.

Comparing the frequency of maximum EV choices by actually observed teams to those by the hypothetical teams provides some support for the excess-risk vetoing rule. No other rule induces

[10] In the Persuasive Argument Theory (PAT) proposed by Burnstein et al. (1973), the group decision is influenced by the strength and number of persuasive arguments for the competing alternatives.

[11] Note that in the investor lottery pairs, the excess-risk vetoing rule coincides with the Majority for EVmax because an excess-risk veto is not possible. In the gambler lottery pairs, however, excess-risk vetoing is possible and the excess-risk vetoing rule coincides with the Minority for EVmax rule.

Table 5
Sum of the squared deviations of observed teams' from hypothetical teams' EVmax choice frequencies

Decision rule	(Relative frequency of EVmax choices made by observed teams − relative frequency of EVmax choices made by hypothetical teams)^2		
	Investor lottery pairs	Gambler lottery pairs	All pairs
Minority for EVmax	0.33	0.29	0.63
Majority for EVmax	0.23	0.53	0.76
Unanimity for EVmax	1.25	2.25	3.50
Excess-risk vetoing	0.23	0.29	0.52

choice frequencies in the hypothetical teams that come closer to the experimentally observed frequencies. This impression is confirmed by the figures in Table 5, which contains the sum of the squared deviations of the relative frequency of EVmax choices by the observed teams from relative frequency of EVmax choices by the hypothetical teams. The deviation measure is smallest for the excess-risk vetoing rule. More rigorous statistical tests of the excess-risk vetoing hypothesis cannot be applied using this method since the results of the hypothetical groups, which were formed from the observed 16 subjects' decisions in the individuals treatment, are statistically interdependent.

6. Summary and conclusions

The present paper reports an experiment designed to test for the compliance of team decisions under risk with the principles of two influential theoretic benchmarks: expected utility theory and portfolio selection theory. A series of lottery choice and evaluation tasks was presented to 16 individual subjects and to 16 teams, each consisting of three subjects. The tasks were designed to check for the common ratio effect, the preference reversal effect, and the reference point effect. Furthermore, the lottery pairs allowed a test of the risk-value principle of PST.

The first result of the experiment is that both the common ratio effect and the preference reversal effect are observed in the team decisions to the same extent as in the individuals' choices. The two effects were robust in the sense that predicted inconsistencies were significantly more frequent than unpredicted inconsistencies. The second result is that the teams accumulated significantly more expected value than the individuals and this at a significantly lower total risk (S.D.). The effect was mainly driven by the difference between the team and the individual decisions in the gambler lottery pairs. By choosing the lottery with the high EV and the low risk significantly more often in these pairs, the teams exhibited a greater compliance with the risk-return principle of PST than the individuals.

In the light of this evidence, team decision making seems to be most adequately represented by a risk-value model. We propose *excess-risk vetoing* as a possible team decision process that is well in line with the risk-value model and compare its predictions to the observed team decisions. Excess-risk vetoing is an enhanced majority rule that allows each team member to veto a nominated prospect with another prospect that has a higher EV at a lower risk (lower S.D.). Since the latter prospect dominates the former in the risk-value space, the vetoing team member has a persuasive argument by pointing out that an "excess-risk" can be reduced without a sacrifice of EV. Comparing the predictions of the excess-risk vetoing rule as well as the predictions of the minority, the majority, and the unanimity rules to the observed team decisions, we find that the excess-risk vetoing rule organizes our data best.

Our results imply that the avoidance of excess-risk (amongst other factors such as information and power sharing) may favor team (committee) decision making over individual decision making. Obviously, our experimental data cannot be used to measure exactly the actual benefits of team decision making. In particular, the question of whether the cost of a committee decision process is compensated by the benefit of the decisions that are closer to the efficient frontier of risk and return remains an open empirical issue. However, our results clearly indicate that attempts to quantify the trade-off may be very valuable to organizations.

An open question is directed towards the method of risk measurement. In our study, we have taken the conventional position of measuring risk only on the basis of objective characteristics of the lotteries, specifically by employing the standard deviation measure. Some authors, however, have argued that measures of perceived risk are better suited to explain decision making under risk.[12] Differences in risk perception may account for the differences between individual and team decisions. For future research in this direction, however, the problem of establishing an accurate and meaningful measurement of risk perception, especially in the context of teams, has to be mastered.

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