Are Commercial Fishers Risk Lovers?

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Abstract Empirical studies of fishers' preferences have found that most fishers are risk-averse, while expected-utility theory predicts risk neutrality even for sizable stakes. We test this prediction using data from a stated choice experiment with Swedish commercial fishers. Our results show that almost 90% of the respondents do not behave as expected-utility maximizers. 48% of the fishers can be broadly characterized as risk-neutral, 26% as modestly risk-averse, while 26% are strongly risk-averse. Fishers are more risk-neutral the higher the fraction of their household's income comes from fishing, while fishers with a positive attitude to individual quotas are more risk-averse. Sensitivity testing implies that decisions with modest stakes like a few days of fishing are not influenced by wealth level.

Keywords: Expected utility, Prospect theory, Risk preferences, Stated preferences, Swedish fisheries

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1. INTRODUCTION

Choice under uncertainty is traditionally approached, using expected utility theory. In a recent paper, Rabin (2000) shows, based on the assumption of diminishing marginal utility of wealth, that small stake risk aversion means an extreme risk aversion for larger stakes. Thus, Rabin's calibration theorem indicates that individuals must be risk-neutral for decisions invoking low stakes and this has also been discussed in Arrow (1971). However, this contradicts the findings in low stake laboratory experiments where individuals are risk-averse (e.g. Davis and Holt, 1993; Holt and Laury, forthcoming). Similarly, in a recent field experiment by Fehr and Götte (2002), 28 percent of bicycle messengers in Zurich, Switzerland, turn down the chance to play a real gamble offering a 50 percent chance to win five Swiss francs and a 50 percent chance to win zero in favor of a sure gain of two Swiss francs. Rabin and Thaler (2002) summarize their thoughts on page 229: "Our claim is that, because most people are *not* risk-neutral over modest stakes, expected utility should be rejected by economists as a *descriptive* theory of decision-making. Combined with the fact that most people are not insanely risk-averse over large stakes, the fact that most people are *not* virtually risk-neutral for modest stakes means that expected utility does not accurately describe the risk attitudes of most people" (italics in original).

Behavioral economics research on choice under uncertainty advocates prospect theory instead of expected utility theory (Kahneman and Tversky, 1979). This theory inter alia predicts risk-aversion for potential gains also when stakes are modest and that risk preferences are independent of initial wealth levels.

A key aspect when modeling and analyzing fishers' behavioral motivations is their risk preferences. However, despite the importance of understanding fishers' risk preferences, we still have few empirical studies in this area. Previous work finds, almost without exception, that all fishers are risk-averse (Bockstael and Opaluch, 1983, Dupont, 1993, and Mistiaen and Strand, 2000). In a recent paper, Eggert and Tveterås (2001) study risk preferences among a group of Swedish fishers and find that 30% of the trips can be characterized as not being risk averse.

In this paper, we elicit risk preferences among commercial fishers in Sweden using a choice experiment. Our study is, as far as we know, the first to estimate fishers' risk preferences using stated preference data. We collect information on the fisher's preferences by asking them to choose between pairs of different fishing trips described only by the mean and the spread of the net revenue. Thus, risk is characterized by the spread of the net revenue and it is assumed to follow a uniform distribution in order to reduce the cognitive burden when making a choice. We employ a utility function, which is independent of initial wealth levels and where the parameter sign indicates whether the respondent is risk-averse, risk-neutral, or risk-loving. This model fits into the prospect theory framework and it also corresponds to constant absolute risk-aversion (CARA). Thus it can provide a test of whether respondents are expected-utility maximizers. Each fisher makes six pair-wise choices between different fishing trips. From the choices, it is possible to obtain a lower and an upper bound of the size of the risk aversion.

Our results show that at least 87% of the respondents do not behave as expected-utility maximizers, while 13% could be seen as truly risk neutral. In the analysis we classify our respondents into three groups, which we label risk-neutral, modestly risk-averse, and strongly risk-averse, with the corresponding proportions of 48%, 26% and 26% respectively. The degree of stated risk aversion is then applied in a Cobb-Douglas production function. We find that fishers with a strong risk-aversion have a significant lower landing value and that this group earns 22% less compared to risk neutral fishers. The fraction of a household's income generated from fishing is a significant variable in explaining risk attitudes, the higher fraction the more risk-neutral. Fishers using trawl as the only gear tend to be risk-neutral compared to other fishers. The Swedish fisheries are regulated open access with no element of individual quotas (IQ), which implies a potential threat of seasonal closure when the total allowable catch for a species is caught. We asked fishers about their opinion about IQs and found that fishers who are positive about IQs are also more risk-averse. A group of respondents that explicitly supports the social democratic party or the left party appear to be more risk-averse compared to the rest. Notably, we find that wealth does not seem to influence risk preferences. Neither simple proxies like boat size or a property tax dummy, nor various measures of lifetime wealth could explain differences in risk attitudes. Thus, for the fishers in our sample, the short run decision of where and how to allocate a fishing trip of a few days seems to be independent of initial wealth level.

2. BACKGROUND

The seminal paper by Bockstael and Opaluch (1983) studied choice under uncertainty among fishers and found that all fishers in their sample had constant relative risk aversion (CRRA) equal to 1, i.e. the wealthier the fisher, the less risk averse. In their study, New England fishers made annual decisions on target species and location choice, indicating substantial income levels at stake and hence risk aversion is the expected outcome within the expected utility framework. Dupont (1993) applied the same framework, again to study annual choices of species and location, but added price uncertainty to the analysis. The strict assumption of risk-averse fishers was not rejected in three of four vessel types. However, fishers often make decisions on a more short-term basis. Target species, gear choice, and location choice are decisions often made by fishers at a trip level, where the duration normally is in the range 1 to 30 days. Mistiaen and Strand (2000) studied fishers' location choice on the trip level, where a majority were using fishing grounds that were "easily accessed", and found heterogeneous risk preferences among fishers and that 95% of the trips could be characterized as risk-averse.[1] For a trip, most likely shorter than 15 days[2] and a maximum net revenue per individual below $1000[3], risk-averse behavior is not optimal. As noted above, expected-utility theory predicts risk neutrality as the optimal strategy not only over modest stakes but also for quite sizable and economically important stakes (Rabin, 2000). Risk-averse behavior for repeated modest stakes will lead to substantial income reduction in the long-run, i.e. the more risk averse a fisher is, the lower the income that he will earn. Eggert and Tveterås (2001) study risk preferences among fishers mostly carrying out trips of less than five days, assuming that risk preferences are independent of initial wealth levels, i.e. CARA. The results indicate that 30% of the trips can be characterized as risk-neutral or risk-loving, i.e. in the latter case fishers seem to prefer the alternative with higher variation when the means are equal. Another study inspired by Bockstael and Opaluch (1983) is Holland and Sutinen (2000). Their results indicated risk-loving behaviour but, according to the authors, fishers in their sample tried to reduce risk in ways that were not captured by their model.

[1] Fishermen are assumed to be normally distributed in risk preferences and the 5% risk lovers are at least in part an artefact of this assumption (see Revelt and Train, 1998)

[2] Trip length is unclear, but the average vessel in their sample made 10 trips during a year. This implies an average trip length of 15 days, given an assumption of 150 days at sea per year per vessel.

[3] Vessel net revenue maximum is $2,750 and the largest vessel is 199 GRT, presumably with at least 3 crew-members.

3. MEASURING FISHER'S RISK PREFERENCES

In real world fisheries, fishers have to make several decisions concerning choices and trade offs between potentially large numbers of discrete choices. These choices may include selecting targeted species, gear type, and location choice and can be thought of as trade-offs between expected mean net revenue and net revenue risk, but aspects such as comfort, safety, and trip length may also influence their choices. In our framework, all these complex issues are condensed into a single choice between two alternatives, and the two alternatives are characterized by the two parameters, mean and spread of net revenue, alone. If fishers are risk-neutral only the mean matters, while risk-averse and risk-loving fishers will make a trade off between the mean and the spread of net revenue. Prospect theory predicts risk aversion for gains at stake and risk preferences being independent of initial wealth levels. In order to test this we need a utility function specification, independent of wealth and where risk preferences can be tested in an easy way. The CARA utility function specification meets these requirements. This function can also be applied within expected utility theory[4] and corresponds to the mean-standard deviation representation suggested by Meyer (1987). For the empirical analysis we have

(1) $$U(y) = -e^{-ry},$$

where y is income. We note that r corresponds to the Arrow-Pratt measure of absolute risk aversion ($-u''/u'$). This function is concave for $r>0$, i.e. reflecting risk aversion, and correspondingly reflects risk neutrality and risk-loving for $r=0$ and $r<0$,

[4] From a theoretical perspective it cannot, as it "is unacceptable since it violates the principle of decreasing absolute risk aversion" (Arrow, 1971, p.96). Still, it has often been used in empirical applications.

respectively. Johansson-Stenman et al. (2002) develop a methodology for testing risk preferences in experiments. They assume that net revenue is uniformly distributed in their experiment, a distribution that is easy to communicate and to be understood by the respondents in a survey. For a CARA specification and a uniform density function, this results in

$$(2) \qquad E(u) = \int_{y_{min}}^{y_{max}} \frac{-e^{-ry}}{y_{max} - y_{min}} dy = \frac{1}{r}\left[\frac{e^{-ry_{max}} - e^{-ry_{min}}}{y_{max} - y_{min}}\right].$$

In empirical applications of expected utility it is common to express income, y, as a sum of initial wealth, *W*, and net revenue, *x*, where the sum of these two components is the final wealth.[5] If we replace y_{max} by $W+x_{max}$ and y_{min} by $W+x_{max}$ in the right hand side of equation (2), we see that the initial wealth term cancels out. Kahneman and Tversky (1982) find support for individuals' evaluation of potential gains being risk averse, i.e. *r* larger than zero, and independent of wealth. Through hypothetical choices between alternative fishing trips with different uniform net income distributions, the respondent implicitly states his degree of absolute risk aversion. For example: For trip A income will be in the range SEK 100-1900, while income in trip B will be in the range SEK 370-1550. A risk neutral (r=0) fisher would prefer trip A, with its higher mean, and disregard the risk reflected as a higher spread. If a respondent is indifferent between the two trips, we have $E(u_A) = E(u_B)$ and hence:

$$(3) \qquad \frac{e^{-ry_{max\,A}} - e^{-ry_{min\,A}}}{y_{max,A} - y_{min,A}} = \frac{e^{-ry_{max\,B}} - e^{-ry_{min\,B}}}{y_{max,B} - y_{min,B}}.$$

[5] By using a good estimate of life-time wealth for W, we can use the responses to calculate relative risk aversion.

There is no algebraic solution to this equation, but it can easily be solved for r using any standard numerical method. In the example above indifference corresponds to r = 0.000 53. Consequently, for an individual who prefers trip A r < 0.000 53. We use equation (3) to construct six alternatives with different levels of absolute risk aversion in the experiment. In each pair-wise choice the individual either states an upper or a lower limit for his risk preferences. Thus, from the choice pattern an upper and lower bound of absolute relative risk aversion is obtained.

4. EXPERIMENT

The choice experiment was one part of a mail survey to commercial fishermen on their attitudes to the current status of monitoring, enforcement and management of Swedish commercial fisheries. The survey also included questions on socio-economic characteristics of the respondents and their household in addition to questions related to their fishing business.

In the introduction to the choice experiment, the respondents were informed of the framework of the experiment. They were asked to assume that they earned their average income during the previous month and that their next fishing trip was a choice between two trips. The net revenue from these trips will vary in terms of mean and spread.[6] Moreover, the net revenue is assumed to follow a uniform distribution, i.e. the probability is identical for any amount in the given interval, although it was not framed by using these wordings in the survey. Finally, it was stressed that despite their great skills as fishers they cannot influence the probability distribution in order to avoid self-serving bias. In the experiment, each respondent made six pair-wise

[6] The choice of mean income levels was based on information from data used in Eggert and Ulmestrand (1999) and Eggert and Tveterås (2001).

choices. The first alternative in each choice set had the same mean and spread over the six choices, while the second alternative started with a significantly lower mean and spread, and then gradually increased over the six choices both in terms of mean and spread, i.e. the degree of absolute relative risk aversion decreases. The mean and interval levels used are given in Table 1.

[TABLE 1]

These levels were chosen after testing with a focus group of commercial fishers and administering a pilot survey to commercial fishers.[7] The six alternatives presented to the respondents are constructed by applying equation (3), where the first choice is assumed to be equal for a respondent with an absolute risk aversion equal to 0.00379. A possibly more intuitive description is to state the relative risk premium (RRP). Trip B_1 has a lower spread than trip A_1, but this comes at the expense of a lower mean. The difference in mean is SEK 240, which means that anyone who prefers B_1 to A_1 requires an RRP of at least SEK 240. The second choice alters at RRP = 135 and the following values in SEK of RRP are, 85, 40, 0, and –30. A respondent who consequently prefers fishing trip A to trip B in all six alternatives, seems to be a risk lover and to have an RRP which is smaller than –30, i.e. for the chance of earning up to SEK 1900 instead of 1640, where the lower bounds are 100 and 420 respectively. Basically, he accepts an expected mean, which is more than SEK 30 below the expected mean in trip B_6.

If, for example, a respondent chooses A in the first three choice sets and then B for the remaining, we know that the demanded RRP to accept the riskier alternative is bounded between 85 and 40. Basically, the grid search approach will provide us

[7] Fishers in the focus group systematically picked alternatives, indicating $0<r<0.0018$. This lead us to construct two alternatives within this interval, one alternative at each “end point”, i.e. r=0.0018 and r=0, and finally two “extreme” alternatives, i.e. r=0.00379 and r=-0.00041. In the pilot survey roughly 15% systematically picked the left alternative and 15% preferred the right alternative for all six trips.

with information on a specific value for lower and upper bounds on the degree of absolute relative risk aversion except in the case when a respondent chooses the same alternative in all choices, where one of the bounds goes to infinity (positive if choosing B and negative if choosing A). Thus, it is then possible to classify respondents into one of seven categories of risk aversion. The responses to the choice experiment results in an outcome variable, which have an ordinal ranking. Thus, we use an ordered probit model to allow for this in the estimations (see e.g. Greene, 2001).

5. RESULTS

The sample was drawn from the commercial fishing vessel register, which is administrated by the Swedish Board of Fisheries. The register contains the name of a contact person for each vessel who is either the owner of the vessel or a representative of the company owning the vessel. In the latter case, the representative is probably one of the owners of the company and works on board. The register contained 1426 different names from which a random sample of 600 was drawn. The survey was conducted in February 2002, with a reminder sent out three weeks later. In the reminder, we asked the respondents to at least send in a blank questionnaire with a comment on why they didn't want to participate, if that was the case. In total 340 (57%) individuals returned the questionnaire, 41 of these were blank and almost another hundred had non-responses to various items. The final analysed sample consisted of 202 respondents for which we present some descriptive statistics in Table 2.

[TABLE 2]

We find that the median Swedish fisher has a vessel eleven meters long and carried out 130 twelve-hour fishing trips together with his colleague during 2001[8]. Clearly, the respondents come form a heterogeneous group of fishers in terms of, for instance, vessels. The smallest vessels are in the range 5-9 meters with capacity of a few gross registered tons, while the largest vessels are 40-50 meters with capacity of many hundreds of gross registered tons. Swedish fishery regulations distinguish three classes of vessel length, i.e. vessels below 12 meters, vessels between 12 and 24 meters and vessels above 24 meters, which is the rationale for dividing vessels into length groups. Furthermore, 31% of the fishers use trawl only, while both trawl and gear that remains fixed in one place in the water, e.g. gillnet and traps, by 11%. A majority of the responding fishers, 54%, are positive about introducing IQs in Swedish fisheries. Today, Swedish fisheries are regulated open access with no element of IQs, which implies a potential threat of seasonal closure when the total allowable catch for a species is caught. The average fisher has a monthly personal income after all taxes are paid and potential transfers received of SEK 9000, which is roughly 60% of the household's income.[9] We also note that the median (mean) annual net revenue, SEK 117000 (124000) corresponds very well to the interval of annual net income SEK 94000-134000 in the experiment. The latter figures come from multiplying the lowest/highest mean values (SEK 760/1030) in the experiment by the actual median and mean numbers of fishing trips.

The educational level is distributed as follows, 14% has at least completed a semester at university, while 30% has a medium length education of 10-12 years in school. The remaining 56% has a basic schooling of a maximum 6-9 years depending

[8] Sex was not recorded in the survey, but less than 1% in the register are females.

[9] In order to compare income between households, we employ the equivalence scale used by the National Tax Board (RSV) in Sweden. The scale assigns the first adult the value of 0.95, the following adults are set at 0.7 and each child at 0.61 units.

on their age. Only 11% expressed explicit support for the social democrats or the left wing party, while the corresponding figure in the General Election in September 2002 in Sweden was 48,7% (SCB, 2002).[10] 24% of the households paid a capital tax for the year 2000, which implies possession of assets valued above SEK 1 million.[11]

The results of the choice experiment are presented in Table 3. Of the 202 respondents, 26% consequently chose trip B, which indicates an absolute relative risk aversion larger than 0.00379 or a demanded RRP larger than 240. The riskiest choice, i.e. preferring the A_6 trip (and all other A trips in the experiment), implies a negative return of 3% compared to the safer alternative B_6 and this was chosen by 35% of the fishers.[12] The interior switches from trip A to trip B in the choice experiment were evenly spread; 8%, 12%, 6%, 9% and 4%. We group the respondents who choose B at least until choice 4 together and label these 48% as risk-neutral. Moreover, we categorized 26% of the fishers always choosing *B* as strongly risk-averse and the residual of 26% belongs to modestly risk-averse group.

[TABLE 3]

We report the results from the ordered probit model in table 4. These results are based on regressions with three reference groups, the risk-neutral, the modestly risk-averse, and the strongly risk-averse. We also tested with the seven reference groups without any changes in results.

[TABLE 4]

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[10] We included all who stated either "don't know" or "don't want to answer", which were 40% of the respondents, in the group of others. In the latest General Election in Sweden (September 2002) 19.9% of the eligible population did not vote (SCB, 2002).

[11] Real estate property values in Swedish coastal areas have risen dramatically over the last ten years. Owning a house today with low mortgages in a coastal area often implies paying capital tax.

[12] As a comparison, the average bet at the horse race track offers a negative 17% return due to a standard 17% race take. In their study of racetrack bettors, Golec and Tamarkin (1998) use a Taylor series expansion of a CARA power function and find that bettors love skewness, but not variance. Whether fishers are skewness lovers remain a task for future research.

The interpretation of the coefficients in Table 4 is that a positive sign indicates that risk neutrality increases with that specific variable. We see that the higher the proportion of the household's income that comes from fishing, the more risk-neutral the fisher. The coefficient of Individual Quota is negative and significant, indicating that those who are positive to IQs are more risk-averse. We find that pure trawl fishers are significantly more risk neutral compared to the others. The group of left voters was significantly risk-averse in their preferences compared to the others. From our results it seems that a wealth effect on risk preferences is absent for Swedish fishers, the wealth variable is a constructed lifetime wealth measure based on their equivalent household income and whether they pay property tax. We also tested the property tax variable and the boat length, which are sometimes used as proxies for wealth, but found them to be insignificant.[13]

Table 5 presents result from a production function regression based on those 159 out of 202 fishers who had supplied all the information needed. From the survey we find each fishers' annual landing value, annual effort, boat length, and to which risk category they belong. We use a Cobb-Douglas model, as testing lead to rejection of a translog specification. Fishers' risk preferences are represented by the three groups mentioned above, where risk1 and risk2 correspond to strongly risk averse and modestly risk averse, respectively. The risk neutral group is the reference alternative and has been excluded to avoid over identification. The adjusted R-squared is 0.35 and the coefficients of boat length and annual fishing effort are significant and with the expected sign. The group of strongly risk-averse fishers, risk1, has significantly

[13] Lifetime wealth was based on equivalenced household income and tested for discount rates in the interval, 2-20%, together with an additional wealth of SEK 300 000 for those not paying property tax and SEK 1,300,000 for those paying property tax. For the additional wealth several amounts were combined with different lifetime earnings, but were insignificant for all alternatives. Boat length was also insignificant as a single variable.

lower values for their landings. The log-log specification tells us immediately that their landings are on average 22% lower compared to the risk-neutral fishers.

[TABLE 5]

6. DISCUSSION AND CONCLUSIONS

This is, to our knowledge, the first attempt to elicit fisher's risk attitudes using stated preference data. We characterise almost half, 48%, of the respondents as risk-neutral, while 26% are modestly risk-averse, and the remaining 26% are strongly risk-averse.

Several of the respondents have added personal comments to emphasize their choices. One fisher who consequently chose the most risk-averse alternatives remarked:

> *"Due to the drastic decline in cod catches my interest in taking chances has declined. Now it is a matter of keeping the business going"*

Two of the fishers who consequently chose the least risk-averse alternatives, respectively made the remarks:

> *"I take a lot of chances"* and *"Taking chances is part of the charm of fishing"*

However, some did not respond and one of them remarked:

> *"I'm not answering this very academic question. You simply go for a strategy which yields the highest average profit"*

To us, this sounds like a perfect risk-neutral fisher. Using data from stated preferences implies a potential problem of not revealing true preferences. About 60% of the respondents either consequently chose trip A or trip B, while almost 40% started with the riskier trip A and then switched to trip B as the mean of B approached the mean of trip A. It may well be that some of the respondents chose the “extreme” alternatives as a means of reducing the cognitive burden in answering the questions. The use of a lexicographic strategy, consciously or not (Nisbett and De Camp Wilson, 1977), is helpful for the respondent in solving the exercise, even though his underlying true preferences may be more complex (Payne et al. 1993). Some respondents may have spent most effort on the first pair wise choice, and then repeatedly marked the same type of trip. For those with strong risk-aversion, we could confirm their preferences by a production function, which showed that their landing values are 22.5% lower than the risk neutral fishers. For those systematically preferring the most risky alternative there was no such test, thus this group of 35% is potentially over estimated. Future studies could probably avoid or test for such potential bias by spreading the degree of absolute risk aversion over a larger interval, which would also be spread symmetrically around the risk-neutral alternative.

In our sample, differences in risk preferences are mainly explained by the following factors; proportion of household income, the type of gear used, political preferences, and attitudes towards introducing an IQ system. The attitudes towards an IQ system are interesting from a policy perspective. Today, Swedish fisheries are regulated open access with a total allowable catch for each species, implying a potential threat of seasonal closure when the total allowable catch is landed. Fishers in favour of IQs are more risk-averse, and may see IQs as a means of reducing uncertainty of e.g. shortened length of the fishing season. Neither the choice of gear type nor the age of fishers influence risk attitudes. Finally, we find that wealth does not influence risk preferences. We carefully explored different measures of lifetime wealth but all of them were insignificant in explaining differences in risk attitudes.

For the fishers in our sample, decisions over modest stakes like how to allocate a few days of fishing do not depend on the level of wealth.

Bockstael and Opaluch (1983) confirmed the hypothesis that the fishers in their sample were homogeneously risk-averse. In their sample, fishers made an annual choice of location and species implying high stakes. In such cases or when stakes are even higher like in the investment decision of purchasing a new fishing vessel, the expected-utility prediction of risk aversion seems reasonable. However, fishers often make decisions on a more short-term basis. Target species, gear choice, and location choice are recurrent decisions made by fishers on a per trip basis, indicating a time span of 1 to 30 days for each trip. The standard point of departure for economics is that rational agents have a long-term planning horizon, e.g. dynamic labour supply and lifetime wealth supposes that an individual evaluates over many years. This idea is frequently challenged by modern research in behavioural economics. Camerer et al. (1997) find that wage elasticity is negative for New York cabdrivers, i.e., they would rather take one day at a time and work shorter hours during good days while working longer hours during bad days. Moreover, expected utility theory cannot explain why stocks have outperformed bonds over the last century by a surprisingly large margin, which is referred to as the equity premium puzzle (Mehra and Prescott, 1988). In fact, the standard theory of expected utility is questioned and some influential scholars even claim that it "is plainly wrong and frequently misleading" (Rabin and Thaler, 2001, p. 230). Two useful concepts from modern research on choice under uncertainty are loss aversion and mental accounting, both of which may explain modest-scale risk aversion. Loss aversion is part of prospect theory (Kahneman and Tversky, 1979), where decision makers react to changes in wealth rather than to levels of wealth. It is found that individuals are roughly twice as sensitive to losses than to gains, i.e. a coinflip bet is only accepted if the odds are better than two-to-one. Mental accounting (Kahneman and Tversky, 1984) refers to the implicit methods individuals use to code and evaluate outcomes from, for example, investments or gambles. One example relating to mental accounting is that long-term investors seem to evaluate their portfolio more frequently than the actual time horizon of the investment. Benartzi and Thaler (1995) call the combination of short evaluation periods and loss aversion, myopic loss aversion, and hold that this phenomenon explains the equity premium puzzle. Loss aversion is probably also an important aspect for fishers, which in our results is reflected by the majority of respondents being risk-averse. Short evaluation periods or narrow bracketing is a way of simplifying decisions by isolating them from the entire stream of decisions in which they are embedded (Read and Loewenstein, 1996). The sub-optimal expected utility behaviour of the fishers in the Mistiaen and Strand (2000) study makes sense if we take narrow bracketing into account. The fishers do not evaluate the annual outcome of several trips, but more probably evaluate each trip separately. Our study also seems to reflect myopic risk aversion among the most risk-averse. These fishers, 26% of the respondents, were willing to accept a 22% reduction in expected net revenue for a modest reduction in risk. Probably these fishers will continue choosing the risk-averse strategy all year around earning 22% less than they could do, because they evaluate each fishing trip separately[14], instead of evaluating less frequently.

Overall, expected-utility theory cannot explain Swedish fishers' behaviour when decisions concern relatively small amounts compared to their total lifetime wealth. From expected utility theory we expect decreasing absolute risk aversion and

[14] Fishers stated their choice only for the next trip, knowing that the previous month was average. However, recalling the effect of loss aversion, large variations in landings would actually make them even more risk-averse. Only a fairly long period of continuous luck could potentially make them more risk-neutral.

hence CRRA. For a CRRA model where lifetime wealth is properly taken into account (Rabin and Thaler, 2002), there are only two acceptable choice sequences, which do not imply absurd values for relative risk aversion (RRA). To behave in accordance with expected-utility maximization, fishers should either prefer trips $A_{1\text{-}4}$ and then switch to B_5, or prefer trips $A_{1\text{-}5}$ and then switch to B_6. Preferring B_4 to A_4 in our experiment implies a RRA above 500 for a modest lifetime wealth of SEK 1,000,000. For our sample, not more than 13% can be characterized as expected-utility maximizers, while at least 87% cannot.

Instead of the expected-utility theory, we suggest that future research on increasing our understanding of risk attitudes among fishers should use the tools developed in psychology and behavioural economics, in particular prospect theory, loss aversion, mental accounting, narrow bracketing, and myopic loss aversion. In our experiment even the worst outcome entailed a positive net income, whereas in real life, fishers now and then experience negative net income. Another feature of prospect theory is that it predicts risk-seeking preferences in choices that involve losses. One natural extension of this work would be to explore fishers' risk preferences when choices involve losses.

References

Arrow, K. 1971. Essays in the Theory of Risk-Bearing. Chicago, IL: Markham Publishing Company

Benartzi, S. and R. Thaler. 1995. Myopic Loss Aversion and the Equity Premium Puzzle. *Quarterly Journal of Economics* 110(1): 73-92.

Bockstael, N. and J. Opaluch. 1983. Discrete Modeling of Supply Response under Uncertainty: The Case of the Fishery. *Journal of Environmental Economics and Management* 10(2): 125-37.

Camerer, C., L. Babcock, G. Loewenstein, and R. Thaler. 1997. Labor Supply of New York City Cabdrivers: one day at the time. *Quarterly Journal of Economics* 112(2): 407-441.

Davis, D. and C. Holt. 1993. A Experimental economicspp. viii, 572, Princeton: Princeton University Press

Dupont, D.P. 1993. Price Uncertainty, Expectations Formation and Fishers' Location Choices. *Marine Resource Economics* 8(3): 219-47.

Eggert, H. and M. Ulmestrand, 1999. A Bioeconomic Analysis of the Swedish Fishery for Norway lobster (*Nephrops norvegicus*). *Marine Resource Economics* 14:225-244

Eggert, H. and R. Tveterås. 2001. Stochastic Production and Heterogeneous Risk Preferences: Commercial Fishers' Gear Choices. Working Papers in Economics, Department of Economics, Gothenburg University, http://swopec.hhs.se/gunwpe/

Fehr, E. and L. Götte. 2002. Do Workers Work More if Wages are High? Evidence from a Randomized Field Experiment. Working Paper No. 125. Institute for Empirical Research in Economics, University of Zurich.

Golec, J. and M. Tamarkin. 1998. Bettors Love Skewness, Not Risk, at the Horse Track. *Journal of Political Economy* 106(1): 205-225.

Greene, W. 1997. *Econometric Analysis*. 3rd ed. Upper Saddle River: Prentice-Hall.

Holland, D.S. and J.G. Sutinen. 2000. Location Choice in New England Trawl Fisheries: Old Habits Die Hard. *Land Economics* 76 (Feb): 113-149.

Holt, C.A. and S.K.Laury. Forthcoming. Risk Aversion and Incentive Effects. *American Economic Review*.

Johansson-Stenman, O., F. Carlsson, and D. Daruvala. 2002. Measuring Hypothetical Grandparents' preferences for Equality and Relative Standings. *Economic Journal* 112 (479): 362-83.

Kahneman, D. and A. Tversky. 1979. Prospect Theory: An analysis of decision under risk. *Econometrica* 47(2):263-292.

Kahneman, D. and A. Tversky. 1982. The Psychology of Preferences. *Scientific American* 246:136-142.

Kahneman, D. and A. Tversky. 1984. Choices, Values and Frames. *American Psychologist* XXXIX: 341-50.

Mehra, R. and E. C. Prescott. 1988. The Equity Premium Puzzle. *Journal of Monetary Economics* XV: 145-61.

Meyer, J. 1987. Two-Moment Decision Models and Expected Utility Maximization. *American Economic Review*, 77(3), 421-30.

Mistiaen, J. A., and I. E. Strand. 2000. Location Choice of Commercial Fishermen with Heterogeneous Risk Preferences. *American Journal of Agricultural Economics 82* (November): 1184-1190.

Nisbett, R. and T. DeCamp Wilson. 1977. Telling More Than We Can Know: Verbal Reports on Mental Processes. *Psychological Review 84(3):231-259.*

Payne, J., J. Bettman and E. Johnson. 1993. The Adaptive Decision maker. Cambridge: Cambridge University Press.

Rabin, M. 2000. Risk Aversion and Expected-Utility Theory: A Calibration Theorem. *Econometrica* 68(5): 1281-1292.

Rabin, M. and R. H. Thaler. 2001. Anomalies: Risk Aversion. *Journal of Economic Perspectives*. 15(1): 219-32

Rabin, M. and R. H. Thaler. 2002. Response: (Anomalies: Risk Aversion). *Journal of Economic Perspectives*. 16(2): 229-30

Read, D., and G. Loewenstein. 1996. Temporal Bracketing of Choice: Discrepancies between Simultaneous and Sequential Choice. Carnegie Mellon University, *Department of Social and Decision Sciences Working Paper*.

SCB (2002) http://www.scb.se/statistik/me0101/me0101_tab511.xls

StataCorp. 2001. Stata Statistical Software: Release 7.0 College Station, TX: Stata Corporation.

Table 1.

Fishing trips in the absolute risk aversion experiment*

	Min. income	Mean income	Max. income	Relative risk premium if indifference between A and B	Absolute risk aversion if indifference between A and B
Trip A_{1-6}	100	1000	1900		
Trip B_1	240	760	1280	240	0.003 79
Trip B_2	310	865	1420	135	0.001 80
Trip B_3	340	915	1490	85	0.001 11
Trip B_4	370	960	1550	40	0.000 53
Trip B_5	400	1000	1600	0	0
Trip B_6	420	1030	1640	-30	-0.000 41

* All values in SEK. US$1 = SEK 9.20 (June, 2002)

Table 2.

Descriptive statistics for responding vessel holders, n = 202.

Variable	Description	Mean	Std. Dev.	Min	Max
Boat12	= 1 if boat length less than12m	0.644	0.480	0	1
Boat24	= 1 if boat length more than 24m	0.089	0.286	0	1
Prophinc	Proportion of household income from fishing.	60.9	24.8	0	100
Indquota	= 1 if positive to individual quota	0.540	0.500	0	1
Age	Age in years	48.2	10.9	20	74
Wealth	Wealth (in million SEK)	2.50	1.09	0.772	6.86
Uni	1 = if university degree	0.139	0.346	0	1
Olevel	1 = if elementary schooling (including O-level)	0.564	0.497	0	1
Left	1 = if left voters	0.109	0.312	0	1
Trawlonly	1 = fish with trawl only	0.312	0.464	0	1
Trawlfixed	1 = fish with trawl and fixed gear	0.109	0.312	0	1

Table 3.

Results of the absolute risk aversion experiment

Relative risk premium (SEK)	No.	Freq	Cum. Freq.
240 < RRP	52	52	0.26
135 < RRP < 240	17	69	0.34
85 < RRP < 135	23	92	0.46
40 < RRP < 85	13	105	0.52
0< RRP < 40	18	123	0.61
-30< RRP < 0	8	131	0.65
RRP < -30	71	202	1.00

Table 4.
Ordered Probit model explaining risk attitudes

Variable	Coefficient	Standard Error	P-value
Boat12	0.065	0.254	0.798
Boat24	0.045	0.370	0.904
Prophinc	0.013	0.004	0.001
Indquota	-0.295	0.169	0.081
Age	-0.011	0.009	0.204
Wealth	0.019	0.083	0.820
Uni	0.377	0.291	0.195
Olevel	0.172	0.196	0.382
Left	-0.545	0.272	0.045
Trawlonly	0.462	0.273	0.091
Trawlfixed	-0.313	0.287	0.276
_cut1	-0.357	0.563	
_cut2	0.429	0.563	

Table 5. Cobb-Douglas production function

Variable	Coefficient	Standard Error	P-value
Logeffort	0.417	0.075	0.000
Logloa	0.284	0.133	0.034
Risk1	-0.225	0.119	0.060
Risk2	-0.039	0.115	0.732
Constant	5.197	0.486	0.000
Adj. R-squared	0.35		
Number of observations	159		