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DO FISHERMEN HAVE DIFFERENT PREFERENCES?:

INSIGHTS FROM AN EXPERIMENTAL STUDY AND HOUSEHOLD DATA

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ABSTRACT

We combine an artefactual field experiments and household survey data to investigate whether involvement in a unique occupation such as fishery makes the fishermen exhibit different risk and time preferences than those in other occupations. Using a structural model approach, we integrate prospect theory and hyperbolic time discounting into a single framework to simultaneously estimate and correlate the parameters of both risk and time preferences with other demographic variables. The key finding is that fishermen are found to be less risk-averse and more patient than others.

Key words: Experimental Economics; Prospect Theory; Hyperbolic Discounting; Risk Behavior; Vietnam fishermen

JEL code: C93; D81; Q22

Introduction

Fishery exhibits a distinguishable working environment from other professions. This difference may impact fishermen' risk and time preferences which in turn affect their decision making behavior. For instance, it is widely agreed upon that fishermen' risk preference is a major determinant in their response to various changes in fishing stock, market, and weather conditions (Mistiaen and Strand, 2000). Likewise, fishermen' time preferences may influence their response to fishery management policy such as a conservation program since that program induces a trade-off between limiting fishing efforts today and receiving higher profits in the long run. Therefore, understanding fishermen' risk and time preferences is a key aspect of modeling and analyzing fishermen' decision making behavior.

In this paper, using a combination of experimental study and household data, we investigate whether fishermen have different risk and time preferences than others. Specifically, we use artefactual field experiments[1] (Harrison and List, 2004) to directly measure preferences of individuals regarding risk and time. The key finding is that fishermen are found to be less averse to risk and more patient than others.

As Tanaka, Camerer and Nguyen (2009) point out, few field experiments have linked wealth, demographic variables and business practices to measured preferences as doing so requires conducting careful experiments *and* collecting time-consuming survey responses. A unique feature of this study is our ability to choose villagers who were previously surveyed in the 2002 living standard survey in Vietnam (VNLSS 2002),

[1] Readers interested in the detailed discussion on the taxonomy of field experiments may refer to Glenn and List (2004). For simplicity, hence after we use the term field experiment to refer to artefactual field experiment.

conduct experiments with those villagers, and link their responses to the earlier survey data. Having previous survey responses in hand before the experiments were designed also enabled us to choose a sample of villages with a wide range of average incomes.

Regarding external validity of the experimental results, using a widely used survey such as VNLSS 2002 also provides us with more reliable test than other studies. A few other studies also link field experiment and household survey data. In these studies, the household surveys are usually conducted by the researchers themselves. The quality and generality of these surveys are not verified by other independent researchers. On the contrary, VNLSS 2002 is independently and jointly conducted by the World Bank and the General Statistical Office of Vietnam. Furthermore, VNLSS 2002 is considered one of household surveys with highest quality in Vietnam as indicated by its presence in many studies on Vietnam. Therefore, we can be confident in integrating VNLSS 2002 data into field experiment one as well as a reference point to test the external validity of the experimental results.

Another feature of our study is that using a structural model approach we incorporate risk and time preferences into a single framework of estimation. Most studies on risk and time preferences have typically focused individually on either risk preferences or time preferences. Fishery study is no exception. As will be discussed in the literature, there have been a great number of studies on fishermen' risk and far fewer on time preferences. However, there is no study that integrates risk and time preferences into a single framework of analysis despite these two kinds of preferences being interwoven in the decision making process. One of the main objectives of this paper is to fill this gap in the literature. To achieve this objective we explicitly take into account risk preferences when estimating the time preferences parameters for each individual including fishers. The standard approach to the estimation of time preferences parameters is to ask participants to make a series of choices between receiving x dollars today or y dollars for t days in the future. The time preferences parameters θ then are estimated based on the equation: $x = \varphi(\theta, t)y$, where $\varphi(\theta, t)$ is some time-discounting function. The shortcoming of this approach is that agents are actually interested in the utility received from having a certain amount of money rather than money itself. Thus, a more proper estimation equation would be $U(x) = \varphi(\theta, t)U(y)$. The conventional estimation equation $x = \varphi(\theta, t)y$ is true only if the agents are risk neutral. As Andersen, Harrison, Lau, and Rutstrom (2008) point out, assuming risk neutrality when estimating preferences parameters may underestimate the discount rates.

Not only do we incorporate risk preferences into estimation of time preferences parameters, we also consider more general forms of both utility and time discounting functions than the standard approach. Specifically, we consider the agents' utility function under prospect theory and their time preferences under the quasi hyperbolic discount function, allowing present biasedness to be an element. These more general forms of risk and time preferences are increasingly agreed upon to be more useful in describing humans' preferences than the standard expected utility and exponential time discounting functions. Anderson et al. (2004), for instance, find that the average Vietnamese villagers exhibit present biasedness, which is absent in exponential time discounting. Likewise, the loss aversion aspect of risk preferences in prospect theory utility is of great relevance to the fishery occupation in which receiving a negative profit for a fishing trip is not uncommon.

We organize the paper as follows: We first discuss relevant literature on fishermen' risk and time preferences. Special attention is given to studies using experimental methods. We then give a brief introduction to Vietnam's fishery. Next, we elaborate on the data and methodology used in this study. In this section, we also discuss the structural approach to estimate parameters of the utility function under prospect theory and quasi hyperbolic discounting models within a single framework. In the following section, we present the major findings and their interpretations. Finally, we conclude the paper and offer potential extensions of this research.

1. A Literature Review on Fishermen' Risk and Time Preferences

As mentioned, a typical feature of studies on fishermen' risk and time preferences is that they focus on only one of the preferences. As such, we will first review studies on risk preferences with focus given to experimental study. We then proceed to reviewing literature on fishermen' time preferences.

Literatures on Fishermen' risk preferences

Sutinen's (1979) paper is one of the early studies that specifically integrates the role of risk preference in fishing decision making behavior. In his study of remuneration practice in fishery, Sutinen assumes that fishermen exhibit risk-averse behavior, just like people in other occupations. Following Sutinen, it has been taken for relative granted that fishermen are risk-averse. Most empirical evidence on fishermen' risk behavior seems to support the hypothesis that fishermen are risk-averse. For instance, using the Random

Parameter Logit (RPL) framework to study location choice in the North Atlantic fishery, Mistiaen and Strand (2000) find that 95% of fishermen are risk-averse.

Only a few studies show results differing from Sutinen's assumption that fishermen are risk-averse. For instance, Bockstael and Opaluch (1983) were the first to test risk preferences empirically. They tested the special case of CRRA, r=1, which is U= lnx, i.e., assuming risk aversion that they could not reject. Diane Dupont (1993) used a similar methodology and could reject risk aversion in 3 of 4 fisheries, but actually drew the incorrect inference that fishermen were risk preferring (see further Mistiaen and Strand, 2000). Eggert and Tveteras (2004), using revealed data, found that a substantial amount were not risk-averse. Also, McConnell and Price (2006) argue that risk neutrality is common among fishermen.

Most of the studies mentioned above are based on the expected utility theory framework and use data from either surveys or logbooks. Instead of making initial assumptions or deriving general conclusions about risk behavior as the above studies did, we go a step further to directly measure the level of risk aversion. In other words, we are interested in parameterizing the level of risk aversion under the prospect theory framework using data from field experiment. The benefit of field experiment as Falk and Fehr (2003) point out is that it enables the researchers to generate truly exogenous variation in the data that would otherwise be unavailable in natural or empirical data. Further, random assignment of participants by hand-picking may help in reducing selection bias and problems with omitted variables.

One of the first experimental studies on fishermen' risk behavior is likely that by Eggert and Martinsson (2004). In Eggert and Martinsson's study, risk preferences of

Swedish commercial fishermen are estimated by using data from a choice experiment, or more specifically, from a stated preference experiment. There is some difference between the lab experiment and the stated experiment. Stated preference methods are the broad class of hypothetical data collection methods as opposed to revealed preference methods that include contingent valuation, rankings, con joint, choice experiments (sometimes called stated choice). The participants were asked to choose between pairs of fishing trips characterized by the mean and spread of net revenue. Risk is measured by the spread of net revenue and is assumed to follow a uniform distribution to make it easier for the experiment participants to make a choice (Johansson-Stenman et al., 2002). To investigate a pattern of risk behavior, the authors apply a constant absolute risk aversion (CARA) utility function: $U = -e^{-ry}$ which is independent of the initial wealth level (y). The Arrow-Pratt absolute risk aversion parameter r is then estimated.

Based on the sign of the estimated r, one can infer that the experiment subject is risk-averse, risk-neutral, or risk-preferred depending on whether r is positive, zero, or negative, respectively. Eggert and Martinsson find that 87% of the respondents in their study are not risk-neutral. Rabin (2000), on the other hand, points out that expected utility theory predicts that people will be virtually risk-neutral, not only over modest stakes but also over quite sizable and economically significant stakes. As such, we can infer that almost 90% of the experiment participants do not behave according to expected utility theory. Eggert and Martinsson also find that 48% of the fishermen can be broadly characterized as risk-neutral and risk-preferred, 26% as modestly risk-averse, while 26% are strongly risk-averse.

As Eggert and Lokina (2007) point out, while there is a growing interest in studying fishermen' risk preference, most studies involve commercial fisheries. To check the robustness of the results, Eggert and Lokina (2007), following a similar approach, investigate the risk preferences of artisanal fishermen in Tanzania. They find that about 53% of Tanzanian fishermen can be broadly considered as risk-loving or risk-neutral, 25% as modestly risk-averse and about 22% as strongly risk-averse. About 19% of fishermen in their sample behave as expected return maximizers. According to Lokina, this finding shows a marked difference from those in other commercial fisheries in which most fishermen are risk-averse.

The studies by Eggert and Martinsson (2004) and Eggert and Lokina (2007) point out that expected utility theory may be appropriate in describing risk behavior regarding long-term decisions or decisions involving a large amount of money, such as purchasing a new boat in which lifetime wealth is properly taken into account. However, most decisions in the fishery are made in view of immediate horizons. More importantly, as noted by Eggert and Martinsson (2004), loss aversion may explain why only a small proportion of the fishermen in their study are risk-averse. This aspect of loss aversion, however, is missing under the expected utility theory framework. Accordingly, it is worth exploring fishermen' risk behavior from an alternative model that incorporates broader aspects of risk behavior (Nguyen, 2008).

Literatures on fishermen' time preferences

While the literature on fishermen' risk preferences has been blossoming for sometime, studies on fishermen' time preferences are relatively few. Most of these studies address time preferences in relation to fishery management. For instance, Asche (2001) finds that in fishery where the Individual Transferable Quota (ITQ) is underway, the personal fisher discount rates are initially high before they start decreasing. Amegashie and Sumalai (2008) consider discount to be endogenously determined. Specifically, they argue that an increase in fishing effort today will lead to 1.) a decrease in fish stock in the future and 2.) a decrease in discount factor as a result of depreciating future investment payoffs. In their Yellow Stone Lake integrated economics and ecosystem model, Settle and Shogren (2004) find that, compared to constant discount, hyperbolic discounting can lead to greater present differences between the value of a resource with and without human intervention. Put differently, a human intervention program such as the policy to protect native cutthroat trout from exotic lake trout in Yellowstone Lake is more likely to be justified under hyperbolic discounting.

It is worth noting that all of the above studies discuss potential impact of time preferences on fishery management outcome. However, no study has directly investigated whether fishermen' time preferences behave according to exponential or hyperbolic discounting. Our study is the first to address this question.

2. A Brief Introduction to Vietnam's Fishery and Fishermen

Endowed with long coastlines and many rivers, Vietnam has a great potential for fishery development. "Com and Ca", which can be translated into English as "Rice and Fish", has been an important element of food consumption among Vietnamese for many centuries. According to recent statistics, the per capita annual consumption of fishery product was 13 kg in 2001 (VASEP, 2001). Fishery can be classified into two main branches: freshwater and ocean fishing. The former includes fishing in the rivers, lakes, and ponds. According to Nguyen (2002), there are about 550,000 fishermen in Vietnam, of which, 450,000 are ocean fishermen and 100,000 are freshwater fishermen. Freshwater fishing, characterized by simple boats and rudimentary equipment, requires much less financing and capital to operate than ocean fishing, which generally employs more advanced and expensive boats. In addition to fishery, most fishermen are involved in farming or aquaculture activities to earn additional income for the families (Nguyen, 2002).

3. Data

A noteworthy aspect of this study is the combination of experimental and household survey data. These two data are collected in two different contexts and for multiple purposes. The experimental data aims at understanding how agents make decision under a controlled environment while the household data observes how people make decisions in a real world context, and more precisely, the outcome of their decisions. We can ask if there is consistency in the participants' behavior in these two different contexts (Harrison and List, 2004). One may argue that the subjects are less serious under experimental conditions compared to reality, especially when the subjects' reward is relatively small. Fortunately, participants in our experiment can receive rewards of up to several days of salary for reasonably-made decisions[2]; hence, participants have strong incentive to take their decision making seriously (Tanaka, Camerer and Nguyen, 2009). That said, we agree with Levitt and List (2007) in that human decisions are not only influenced by

[2] The average experimental earning for three games was 174,141 dong (about 11 dollars), roughly 6 to 9 days' wages for casual unskilled labor (Tanaka, Camerer and Nguyen, 2009).

monetary payoffs but also by other factors such as the process and context in which the decisions are made. Cross-situational consistency is still a matter of debate (Bouma, Bulte and Soest, 2008).

The baseline information is compiled from the 2002 living standard survey (VNLSS 2002), which covers a total of 75,000 households in Vietnam. The survey provides key information on socioeconomic characteristics of Vietnamese households and individuals. The sample was designed in such a way that each household had the same probability of being selected. In the 2002 survey, 25 households were interviewed in each of the 142 and 137 rural villages in the Mekong Delta (in the South) and the Red River Delta (in the North, excluding villages in Hanoi City) respectively. Experiments were conducted in July and August of 2005 with the members of those households previously interviewed during the VNLSS 2002 survey[3]. In particular, we chose nine villages, five villages in the south and four villages in the north, with substantial differences in mean income, inequality, and market access to permit statistically significant cross-village comparisons. We then combined the data using ID numbers of individuals who participated in both the experimental study and VNLHSS 2002 household surveys as the linking variable.

As highlighted in the introduction, by considering the agents' risk preferences, we develop an empirical strategy that can improve upon the estimation of the time preferences parameters. To be able to do so we conducted two experiments addressing

[3] Several households had moved during the period 2002-2005. As such, we finally had 184 participants in the experiments. Among these 184 participants, 3 participants didn't show up at the experiment or decided not to participate; however, we use information on their household income level to calculate the village's means income and some other summary statistics.

risk and time preferences respectively. Detail of the experiments is reported in Tanaka, Camerer and Nguyen (2009). In what follows we summarize the most relevant points of these two experiments.

In the risk preference experiment, each participant was asked to choose between option A and option B under different scenarios. Each scenario is characterized by monetary rewards and the corresponding probabilities of receiving those rewards. After all participants in the experiment completed making decisions, a scenario was randomly selected to decide how much the participants would receive from the experiment. On average, the participant earned 21,431 VND which is equivalent to 1.3 USD.

To estimate the parameters of the utility function under prospect theory for each individual, we generate 35 scenarios. These scenarios are divided into three sub-components. The first two sub-components aim at measuring the risk aversion and probability weighting function parameter. The third sub-component focuses on estimating the loss aversion parameter.

Like Holt and Laury (2002), we present the difference in expected payoffs for each scenario in Table 1. There are 35 scenarios grouped into 3 series. Series 1 includes scenario 1 to scenario 14. Notice that the expected payoff for option A is the same for all scenarios whereas it increases for option B in correspondence with the scenario number increase. Thus, the expected payoff for scenario 6 and 7 are the same under option A while it is higher for scenario 7 under option B. The same pattern is observed in series 2 (scenario 14 to scenario 29) except that option B has a higher expected payoff than option A immediately beginning with the first question. Series 3 is the last batch (scenarios 29-

35). We notice the same pattern of expected payoffs as observed in series 1 and series 2; however, there is also a chance of losing money.

As such, in each series, the scenarios are ordered in such a way that plan B improves compared to plan A. To be consistent the individual will either choose plan A for all scenarios or switch to plan B in some scenarios and then choose B for all remaining scenarios in the series. Note also that we gave examples in the experimental instruction to illustrate to the participants that it was acceptable for them to choose option A in all scenarios of a given series (no switching); likewise they could make a switch directly in the first scenario of the series (choosing option A for every scenario in the series). Table 2 presents the distribution of participants by the switching points in series 1, 2 and 3. At any given point, there are always some participants who make the switch from A or B. Also, some people never make a switch in any given series. As such, we can trust the participants' comprehension of the experimental instructions.

The time preferences experiment is designed in such a way as to enable us to estimate not only the discount rate (δ), on which most other studies focus, but also the present biasedness parameter (β). There are 75 questions in the experiment. Each question takes the form: You are asked to choose between Option A: receiving x dong t days in the future or Option B: receiving y dong today. These 75 questions are divided into 15 groups of five questions each. Like the risk experiment, to ensure that participants make consistent choices, for a given group, option A offers the same amount of money for every question whereas option B is ordered by the increasing amount of money awarded. Put differently, in each group option B improves as one moves to the next question. For each of the 15 groups, the participant is asked to choose a question that marks a switch[4] from option A to option B. After all participants have finished making choices, someone randomly picked a bingo ball to decide which question would be played for real payment. Also, we assigned and publicly announced in every experiment a trusted agent to deliver the money to those who chose to receive money in the future. This assignment aims at erasing any doubt of not receiving the money in the future if a participant chose to do this.

4. Empirical Strategy:

Following Andersen, Harrison, Lau, and Rutstrom (2008), we build upon the random utility model to develop an empirical strategy. In the experiment we ask the participant to choose between receiving x VND today (Option A) or y VND for t days in the future (Option B). U(x) is denoted to be the utility that the agent gains from having an amount of x VND and φ(t) as a time discounting function. His utility would be:

$$
\begin{aligned}
U_i^A &= U_i(x) && \text{if he chose option A} \\
U_i^B &= \varphi(\theta; t)U_i(y) && \text{if he chose option B}
\end{aligned}
\tag{1}
$$

Only agent i knows U_i^A and U_i^B. As researchers we don't observe U_i^A and U_i^B; rather we assume that i's utility and time preferences take some functional forms. Also, we can observer i's demographic characteristics. Thus, we can write:

$$
\begin{aligned}
U_i^A &= PT_i\,(x;\ Z_i) + \varepsilon_i^A && \text{if he chose option A} \\
U_i^B &= D_i(\theta; t; Z_i)PT_i\,(x;\ Z_i) + \varepsilon_i^B && \text{if he chose option B}
\end{aligned}
\tag{2}
$$

[4] Participants are allowed to choose all option A or option B in a given group. We give examples in the instruction to illustrate such cases to participants.

where PT and D are the utility and discount functions that we assume agent i follows respectively. Z_i is a vector of i's demographic characteristics such as being a rosca member. ε_i^A and ε_i^B are the error terms. By standard conventions, ε_i^A and ε_i^B are assumed to follow normal distribution and are identically and independently distributed.

Next, we are going to specify the functional form for the utility PT and discount function D according to which agent i may likely behave. The better PT and D describe the true risk and time preferences of the agent, the smaller the error terms. In this regard, our empirical model is more complete and comprehensive than other models in the time preferences literature in two aspects. First, by incorporating the utility function into the time discount model we take into account the risk preferences parameters into the estimation of the time preferences parameters. Most studies on time discounting implicitly assume that the agents are risk neutral (Andersen et al., 2008). Secondly, we allow both the utility function and discount function to take more general forms. As for risk preferences, we assume the participants behave according to prospect theory which incorporates other elements of risk time preferences such as loss aversion and probability weighting. The discount function takes into account the present biasedness of time preferences in addition to the standard discount factor. As Tanaka, Camerer and Nguyen (2009) point out, if standard models are an adequate approximation, then our richer instruments will deliver parameter values of the extra variables which affirm the virtue of the simpler models.

More specifically, as for the utility, we assume that the agents behave according to the cumulative prospect theory (Tversky and Kahneman, 1992) and the one-parameter form of Drazen Prelec's (1998) axiomatically-derived weighting function:

$$PT(x,p;y,q)=\begin{cases} v(y)+w(p)(v(x)-v(y)), & x>y>0 \quad \text{or} \quad x<y<0 \\ w(p)v(x)+w(1-p)(v(y)) & x<0<y \end{cases} \tag{3}$$

where $v(x)=\begin{cases} x^{\alpha} & \text{for} \quad x>0 \\ -\lambda(-x^{\alpha}) & \text{for} \quad x<0 \end{cases}$

and $w(p)=\exp[-(-\ln p)^{\gamma}]$

$U(x,y;p)$ is the expected prospect value over binary prospects consisting of the outcome (x, y) with the corresponding probability (p, 1-p).

As for the discounting function, applying Benhabib, Bisin and Schotter's (2007) model and using the same set of data, Tanaka, Camerer and Nguyen (2009) find that the quasi hyperbolic exponential discount function best fits the data. Applying this finding, we can formally write:

$$\varphi(\theta;t)\equiv\varphi(\beta,\delta;t)=\beta\exp(-\delta t) \tag{4}$$

where δ is the standard discount rate.

The observed choices made by each individual in the risk experiment allow us to estimate the utility according to (3) while observed choices in the time preference experiment enable us to estimate (4). Recall that in the experiment we ask participants to choose option A or option B for each of the scenarios in both risk and time preferences experiments. Considering participant i, let $U_i^{A;j}$ be the utility he receives from option A for scenario j. Using (2), we can specifically write:

$$U_i^{A;j} = PT_i^{A;j}(X_i;\ Z^{A;j}) + \varepsilon_i^{A;j} \tag{5}$$

where $PT_i^{A;j}$ is the utility under prospect theory defined in (3) that agent i receives from option A for scenario j; X_i is a vector of i's demographic characteristics such as age, education, etc.; $Z^{A;j}$ is information on scenario j including probabilities and payoffs for option A and B; $\varepsilon_i^{A;j}$ is the error term which captures either misspecification in the functional form of PT or unobserved characteristics of agent i. By standard convention we also assume that $\{\varepsilon_1^{A;j}, \varepsilon_2^{A;j} ......\varepsilon_N^{A;j}\}$ are independently and identically distributed (i.i.d) and follow a normal distribution. We denote the joint density of this distribution as f (ε).

Likewise, we can write the following expression if agent i chose option B:

$$U_i^{B;j} = D(\theta; t; X_i) PT^{B;j}(X_i;\ Z^{B;j}) + \varepsilon_i^{B;j} \tag{6}$$

There are two important points worth noting before we move on. Firstly, there is no discounting function in equation (5) because in the time experiment section all option A's give the opportunity of receiving the rewards today. Secondly, given that there is no time discounting in the risk experiment, equation (6) can be reduced to:

$$U_i^{B;j} = PT^{B;j}(X_i;\ Z^{B;j}) + \varepsilon_i^{B;j} \tag{6'}$$

Similarly, in the time preferences experiment given that all payoffs are positive and received with certainty, the utility under expected utility becomes the standard utility.

Thus, equation (3) can be simplified as: $PT(x) = x^{\alpha}$. This version of utility, in turn, greatly simplifies equation (3) and (4).

Given scenario j and using (3) & (4), the probability that option A is chosen can be expressed as:

$$\begin{aligned}
&Pr(A) = Pr\left\{PT_i^{A;j}(X_i;\ Z^j) + \varepsilon_i^{A;j} - D(\theta; t; X_i)PT^{B;j}(X_i;\ Z^{B;j}) - \varepsilon_i^{B;j} \geq 0\right\} \\
&\therefore Pr(A) = Pr\left\{U_i^{A;j} - U_i^{B;j} \geq \varepsilon_i^{B;j} - \varepsilon_i^{A;j}\right\} \\
&\therefore Pr(A) = \Phi\left(U_i^{A;j} - U_i^{B;j}\right) \\
&\text{where } \Phi(x) = \int_x f(\varepsilon)d\varepsilon \text{ is the cummulative distribution of the error term } \varepsilon
\end{aligned} \tag{7}$$

Next, we define the latent index for option A given scenario j as follows: $I_i^{A;j} = U_i^{A;j}(X_i;\ Z^j) - U_i^{B;j}(X_i;\ Z^{B;j})$. Likewise, the latent index for option B is defined as: $I_i^{B;j} = U_i^{B;j} - U_i^{A;j}$. We can then write Pr(A) = $\Phi(I_i^{A;j})$ and Pr(B) = $\Phi(I_i^{B;j})$.

To apply the maximum log-likelihood estimation technique, we note that the conditional log-likelihood for each individual depends on the utility function parameters (α, λ, γ) under prospect theory (3) and the present biasedness parameter (β, δ) under the quasi hyperbolic exponential time discounting function (4) as well as the observed choices. More specifically, the conditional log likelihood for participant i can be expressed as:

$$\ln l^i(\alpha, \lambda, \gamma, \beta, \delta; y^j, X_i, Z^j) = \sum_{j=1}^{110}\{[\ln\varphi(I_i^{A;j})|y_i^j=1] + [\ln\varphi(I_i^{B;j})|y_i^j=0]\} \tag{8}$$

where $y_i^j=1$ when individual i chooses option A in scenario j and $y_i^j=0$ when individual i chooses option B in scenario j; X_i is a vector of individual i's characteristics.

To address the correlation between the parameters $(\alpha, \lambda,\ \gamma;\ \beta,\ \delta)$ and demographic variables, we allow each of the parameters to be a linear function of the latter as follows:

$$\begin{aligned}\psi &= \psi_0 + \tau_F X_F + \tau X + \xi \\ \theta &= \theta_0 + \varphi_F X_F + \varphi X + \ell T + \nu\end{aligned} \tag{9}$$

where $\psi \equiv (\alpha, \lambda, \gamma)$ and $\theta \equiv (\beta, \delta)$;

X_F is a binary variable indicating whether the individual is a fisher;

X is a vector of other socioeconomic and demographic variables including age, education, income, distance to market, involvement in trade, or work as a government official; T is a binary variable indicating whether the participant is the trusted agent in the trust experiment;

ξ and υ are the error terms which are assumed to be i.i.d and uncorrelated: $Cov(\xi, \upsilon)=0$.

The joint likelihood for all individuals can then be written as:

$$L(\varphi, \theta; y, Z) = \sum_{i=1}^{N} \ln l^i(\varphi, \theta; y^j, Z^j) = \sum_{i=1}^{N}\sum_{j=1}^{110} \{[\ln \phi(I_i^{A;j}) \mid y_i^j=1] + [\ln\phi(I_i^{B;j}) \mid y_i^j=0]\} \tag{10}$$

where N is the number of participants in the experiment.

The maximum likelihood estimation for $(\alpha, \lambda, \gamma;\ \beta, \delta)$ is therefore:

$$(\hat{\alpha},\ \hat{\lambda},\ \hat{\gamma};\ \hat{\beta},\ \hat{\delta}) = \arg\max L(\alpha, \lambda, \gamma, \beta, \delta; y, Z) \tag{11}$$

We develop a maximum likelihood programming in Stata to estimate the correlation of the interested parameters with other socio economic variables based on (11). It is worth noting that we can derive (10) only under the assumption that the error terms for each individual are independent across scenarios. A more realistic assumption would be to allow for some correlation between these errors terms. If such were the case, a cross-sectional time series approach would be more appropriate (de Palma et al., 2008). Following this approach, the likelihood distribution for each individual would be:

$$\int_{\phi}\prod_{i=1}^{N}\{\phi(I_i^A) \mid y_i = 1 + \phi(I_i^B) \mid y_i = 1\} f(\phi) d(\phi)$$

where f(Φ) is the assumed joint distribution of the parameters to be estimated.

One can then apply the simulated maximum likelihood technique (Train, 2003) to estimate the interested parameters. However, this approach requires a great deal of computational time[5] in exchange for uncertain gain in efficiency. Instead, we apply the standard maximum likelihood procedure taking into account potential intracluster correlation[6].

5. Main Findings

We first investigate the descriptive statistics of key variables used in the analysis. We classify the statistics according to the experimental site; S stands for the Southern sites whereas N stands for the Northern ones. As can be seen in Table 3, the majority of participants work in the farming sector. The mean year of schooling is around 7 years. This relatively high educational level is a crucial factor to ensure the participants' comprehension of the experiments (Tanaka, Camerer, Nguyen 2009). It is worth noting that there exists a number of differences between the North's and the South's participants

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[5] For instance, Andersen, Harrison, Lau, and Rutstrom (2008) in a complementary document to their paper in Econometrica mentioned that it may take 4 days to run the simulated maximum likelihood.

[6] We apply the cluster option in Stata which takes into account arbitrary intra-group correlation.

in several aspects. Southern participants are wealthier. The proportion of participants who work in the fishery is also greater in the South. On the other hand, there is a greater proportion of participants in the North working for the government. Given these differences between the North and South, we use a binary variable in the subsequent econometric models indicating whether the participant is in the South or North.

Next, to check whether the participants are more likely to behave according to the prospect theory and quasi hyperbolic exponential discounting, we conduct hypothesis testing: Ho: $(\lambda, \gamma, \beta) = (1, 1, 1)$ where λ, γ, β are the common estimated means of the corresponding parameters. These estimated means are the constant coefficients found in Table 4 and Table 5. All of the χ^2 statistics are significant at the level of 1%; thus, the data are not likely to be supported by the standard expected utility and exponential discounting.

The estimation results of the utility parameters (equation 1) are shown in Table 4. Each parameter is estimated separately. Taking into account the potential issue of seemingly unrelated regressions (SUR), we use identical regressors in these estimation equations. Identical regressors ensure separate estimation receives the same efficiency as that by the generalized least squares (GLS) which produces efficient estimators (Greene, 2003). We first look at the determinants of α, which is used as a proxy for risk aversion. A positive value of the coefficient implies that the corresponding variable has a negative impact on the risk aversion level, or the greater this variable is, the less risk-averse the participant is. The most interesting finding is that fishermen are found to be less risk-averse than workers in other occupations (the base category). The specification test for the occupation coefficients also indicates that fishermen are less risk-averse than workers in other job categories. This suggests that participants in occupations involving high risk might, over time, become more willing to take risks, though it is not necessary that fishermen are more risk loving than people in other occupations (Smith and Wilen, 2005).

Other factors that have a highly significant impact on the risk aversion level include education, and participation in a bidding Rotating Organization Savings and Credit Associations (roscas). Specifically, bidding roscas members are more risk-averse. This finding suggests roscas may act as insurance devices among the risk-averse population. Participants with higher levels of education are also found to be more averse to taking risk. This effect of education on risk aversion is consistent with that found in the study by Dohmen et al. (2005) but not in agreement with Yesuf and Bluffstone (2007) who find that literate Ethiopian farmers are less risk-averse than illiterate ones. The effect of market distance on risk aversion, though significant only at 10%, is interesting. The closer the participant lives to the market, the less averse he or she is. It could be that living close to the market exposes the participant to the daily uncertainties of business activities, thereby acclimatizing the participant to income fluctuation.

Extending our discussion to loss aversion, we find that being a fisher doesn't make the participant significantly less averse to loss. The key factor influencing loss aversion is the mean village income. The richer the villagers are, the better they can jointly support their village fellows who are facing loss. Accordingly, the richer the village is, the less loss-averse the villagers are. This finding is of great relevance to community/village-oriented cultures in Vietnam where risk sharing among villagers is typical. People in the North are also significantly less loss-averse than those in the South, which may be due to socio-historical reasons. Northerners have been under the socialist regime for a much longer period and have developed a stronger belief in the social safety network, which acts as a support net during times of loss.

Next, we are going to address the correlation between time preferences and demographic variables. Table 5 presents the main estimation results. The key finding is that fishermen are found to have a significantly lower discount rate. Put differently, fishermen are found to be more patient than others. It is possible that constantly facing fishery regulations such as the stock recovery programs which require postponing earning profits today to earn higher ones in the future accustom fishermen to being more patient. There are other variables that have a significant effect on discount rates, although the effect is less significant. The older the participant is, the more patient he or she is. This result supports the hypothesis that people seems to be more patient as they get older (Anderson et al., 2004). Conventional wisdom holds that women tend to be more patient than men; interestingly, male participants in our study are found to be more patient than female participants. Rosca members are more patient than non-members. As expected, people living in richer communities are also more patient. This finding is consistent with that in Tanaka, Camerer and Nguyen's (2009) study. People with higher relative income, however, are found to be less patient. This finding is inconsistent with the hypothesis that richer people are more patient than poorer ones. Members of bidding rosca, on the other hand, are less patient.

As far as the correlation between present biasedness and demographic variables is concerned, the only variable which has a significant result at a level of 5% is being a bidding rosca member. Specifically, members of bidding roscas are found to be more present biased. Members of rosca in general, however, are found to be less present biased. The result is significant at a level of 10%.

Policy implications

Several policy implications benefit from the finding that fishermen are less averse and more patient than others. First, fishery closure is a matter of debate among policy makers as they attempt to balance the fishermen' economic well-being with the need for biological preservation. Fishery managers are concerned that fishermen would prefer less variation in revenue as a possible result from fishery closures, and they are also concerned with the resulting need for fishermen to relocate to other fishing grounds. The finding in this paper shows that fishermen are not so much afraid of income variation but rather of income loss. Thus, a more relevant question is how closures may lead to a reduction in fishing revenue, as fishermen are just as loss averse, in terms of revenue loss, as people of other occupations. Second, a number of programs that aim to help the poor in developing countries, such as the World Bank-initiated microfinance programs, assume fishermen are risk-averse, and therefore develop programs implementing risk sharing mechanisms to encourage more risky investment behavior. According to our finding, a more effective program would aim at developing a safety net to protect fishermen in the event of economic loss.

In terms of time preferences, the findings that fishermen have lower discount rates—or equivalently, are more patient—offer important policy implications. Curtis (2002) notices that the stock recovery program would benefit significantly if fishermen were more patient. This is because patient fishermen would be more willing to trade-off between fishing less today and receiving more profits in the future. The fishermen' willingness to participate in turn reduces the operation cost of the program significantly. Likewise, patient fishermen are more likely to appreciate the ITQ systems which might take sometime to reap the full benefits.

6. Conclusions

We integrate prospect theory and the quasi-hyperbolic discounting model into a single framework to investigate whether working in fishery inclines fishermen to different risk and time preferences than others. The combination of experimental field data and household survey data plays an important role in the investigation process.

The key finding is that fishermen are found to be less averse to risk and more patient. The insignificant effect of working in fishery on loss aversion implies that fishermen are afraid of loss of income as much as those in other professions. To articulate it differently, fishermen are less afraid of income variation than income loss. Likewise, fishermen are found to be as present biased as others.

We discuss several policy implications given the above findings. It is worth noting that these policy implications hold true only under the condition that fishermen in real life exhibit the same risk and time preferences as observed in our experimental field study. A promising direction of doing research could be to investigate the external validity of the results we find here. For instance, we can study whether fishermen with lower estimated discount rates are more likely to participate in a voluntary conservation program. Such a study is complementary to ours.

There remain areas for improvement relating to the causal relationship between involvement in fishery and risk and time preferences. The causality may go both directions. For instance, a number of studies in labor economics have shown that less risk-averse agents are more likely to choose riskier jobs for better compensation (Viscusi and Hersch, 2001). King (1974) finds that individuals from wealthier families choose riskier occupations; Cramer at al., (2002) show that less risk-averse agents are attracted to entrepreneurship which is a risky occupation. Thus, it could be that working in fishery makes people more accustomed to taking risks. But, it could also be the case that less risk-averse people would choose a risky occupation, such as fishery, to suit their preferences. Likewise, people with a certain type of time preferences may choose to work in fishery or the other way around. In the context of cross-sectional data like ours, it is not possible to solve all endogeneity problems. As such, we have been very cautious in discussing the main findings. These findings can be best viewed from a correlation perspective. The causal relationship between preferences and occupational choice is still an open question. It may be that fishery attracts people with a certain type of preferences. At the same time, we believe that preferences are both biologically and environmentally influenced. Working under such a special environment as fishery may affect fishermen' risk and time preferences. To quote Strotz (1956): "My own supposition is that most of us are 'born' with discount functions . . . [but that] true discount functions become sublimated by parental teaching and social pressure." It is possible that being faced with constant fishery regulations which require postponing earning profits today for higher ones in the future accustom fishermen to be more patient. Likewise facing with uncertainty on an almost daily basis makes them less averse to risk. Future research can more clearly establish the causal relationships between risk behavior and other variables by using panel data or randomized field experiments (Tanaka, Camerer and Nguyen, 2009).

Finally, our study shows that new research methodologies can be applied to the study of economics. Estimation of risk and time preferences parameters can be integrated into a single framework. Field experiments and household data can be combined and can complement each other. The methodology developed in this study is applicable to a broad spectrum of research, both within fishery and in other fields as well.

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Table 1. Expected Payoff Difference of Pairwise Lottery Choices

Option A	Option B	Expected payoff difference (A-B)
Series 1		
3/10 of 40,000 and 7/10 of 10,000	1/10 of 68,000 and 9/10 of 5,000	7,700
3/10 of 40,000 and 7/10 of 10,000	1/10 of 75,000 and 9/10 of 5,000	7,000
3/10 of 40,000 and 7/10 of 10,000	1/10 of 83,000 and 9/10 of 5,000	6,200
3/10 of 40,000 and 7/10 of 10,000	1/10 of 93,000 and 9/10 of 5,000	5,200
3/10 of 40,000 and 7/10 of 10,000	1/10 of 106,000 and 9/10 of 5,000	3,900
3/10 of 40,000 and 7/10 of 10,000	1/10 of 125,000 and 9/10 of 5,000	2,000
3/10 of 40,000 and 7/10 of 10,000	1/10 of 150,000 and 9/10 of 5,000	-500
3/10 of 40,000 and 7/10 of 10,000	1/10 of 185,000 and 9/10 of 5,000	-4,000
3/10 of 40,000 and 7/10 of 10,000	1/10 of 220,000 and 9/10 of 5,000	-7,500
3/10 of 40,000 and 7/10 of 10,000	1/10 of 300,000 and 9/10 of 5,000	-15,500
3/10 of 40,000 and 7/10 of 10,000	1/10 of 400,000 and 9/10 of 5,000	-25,500
3/10 of 40,000 and 7/10 of 10,000	1/10 of 600,000 and 9/10 of 5,000	-45,500
3/10 of 40,000 and 7/10 of 10,000	1/10 of 1,000,000 and 9/10 of 5,000	-85,500
3/10 of 40,000 and 7/10 of 10,000	1/10 of 1,700,000 and 9/10 of 5,000	-155,500
Series 2		
9/10 of 40,000 and 1/10 of 30,000	7/10 of 54,000 and 3/10 of 5,000	-300
9/10 of 40,000 and 1/10 of 30,000	7/10 of 56,000 and 3/10 of 5,000	-1,700
9/10 of 40,000 and 1/10 of 30,000	7/10 of 58,000 and 3/10 of 5,000	-3,100
9/10 of 40,000 and 1/10 of 30,000	7/10 of 60,000 and 3/10 of 5,000	-4,500
9/10 of 40,000 and 1/10 of 30,000	7/10 of 62,000 and 3/10 of 5,000	-5,900
9/10 of 40,000 and 1/10 of 30,000	7/10 of 65,000 and 3/10 of 5,000	-8,000
9/10 of 40,000 and 1/10 of 30,000	7/10 of 68,000 and 3/10 of 5,000	-10,100
9/10 of 40,000 and 1/10 of 30,000	7/10 of 72,000 and 3/10 of 5,000	-12,900
9/10 of 40,000 and 1/10 of 30,000	7/10 of 77,000 and 3/10 of 5,000	-16,400
9/10 of 40,000 and 1/10 of 30,000	7/10 of 83,000 and 3/10 of 5,000	-20,600
9/10 of 40,000 and 1/10 of 30,000	7/10 of 90,000 and 3/10 of 5,000	-25,500
9/10 of 40,000 and 1/10 of 30,000	7/10 of 100,000 and 3/10 of 5,000	-32,500
9/10 of 40,000 and 1/10 of 30,000	7/10 of 110,000 and 3/10 of 5,000	-39,500
9/10 of 40,000 and 1/10 of 30,000	7/10 of 130,000 and 3/10 of 5,000	-53,500
Series 3		
5/10 of 25,000 and 5/10 of -4,000	5/10 of 30,000 and 5/10 of -21,000	6,000
5/10 of 4,000 and 5/10 of -4,000	5/10 of 30,000 and 5/10 of -21,000	-4,500
5/10 of 1,000 and 5/10 of -4,000	5/10 of 30,000 and 5/10 of -21,000	-6,000
5/10 of 1,000 and 5/10 of -4,000	5/10 of 30,000 and 5/10 of -16,000	-8,500
5/10 of 1,000 and 5/10 of -8,000	5/10 of 30,000 and 5/10 of -16,000	-10,500
5/10 of 1,000 and 5/10 of -8,000	5/10 of 30,000 and 5/10 of -14,000	-11,500
5/10 of 1,000 and 5/10 of -8,000	5/10 of 30,000 and 5/10 of -11,000	-13,000

Table 2: Number of subjects by switching points

(1) Series 1 and 2

Field experiments		Switching point (question) in Series 1															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Never	Total
Series 2	1	6		2	1	1	5	***2***	***3***	***2***	***2***	***1***				***8***	33
2					1		1	***1***	***1***								4
3			1	1					***1***		***1***						4
4							1	***1***		***1***	***1***					***3***	7
5				2	2	2	1	***3***	***1***	***1***		***1***				***1***	14
6			1		1	3	2			***2***							9
7		2				1	2	***8***	***2***		***1***	***1***				***3***	20
8					1		2	***4***	***7***	***2***	***1***					***2***	19
9							2	***3***	***4***	***2***	***3***	***3***				***1***	18
10								1		2			1				4
11							1	2		1	2	2	2				10
12							1	1	1			3	1				7
13									1			1	1				3
14						1			1					1			3
Never		1		1			3	2	5	1	3	2				11	29
Total		9	2	6	6	8	21	28	27	14	14	14	5	1	0	29	184

Bold italics indicates choices compatible with EU (α=1) and risk-aversion.

(2) Series 3

Switching point (question) in Series 3	1	2	3	4	5	6	7	Never	Total
Student Subjects	8	15	7	7	9	2	0	7	55
Field Experiments	38	26	27	29	26	6	3	29	184

Table 3: Basic descriptive statistics

Experimental side	S1	S2	S3	S4	S5	N1	N2	N3	N4
Number of Subjects									
Total	22	16	18	22	22	18	22	24	20
Mean household income in 2002 (in 1 million dong)									
Total	36.6	35.8	20.3	18.5	15.0	28.0	17.5	9.1	6.8
Age (mean)	47.7	44.6	48.8	43.1	48.3	54.1	42.5	49.9	48.6
Gender (1=male) (mean)	.59	.88	.83	.68	.82	.44	.36	.50	.50
Education (mean) (years)	7.2	7.1	8.4	5.8	5.0	7.8	8.0	4.8	7.6
Number of illiterate subjects	1	1	1	1	2	2	1	4	2
Acquaintance ratio (mean)	.42	.86	.76	.74	.82	.62	.91	.98	.90
Main occupation of the subject (%)									
Farming	0	13	17	91	77	6	0	83	75
Livestock	5	19	56	50	32	6	45	54	10
Fishery	0	94	22	9	9	0	0	17	0
Trade	36	0	0	5	5	28	14	8	5
Business	23	0	17	0	5	6	14	8	10
Government officer	9	19	22	14	14	22	18	25	10
Casual work	27	0	11	5	14	0	5	17	10
Not working	23	0	17	0	9	50	9	8	15
No. of ROSCA contributors	14	44	17	64	41	39	55	83	35
Data from the 2002 Living Standard Measurement Survey (sample: 25 households)									
Village Gini coefficients	.44	.19	.30	.36	.38	.29	.38	.28	.36
Distance to nearest market	.0	5.0	.0	4.2	.0	.0	1.0	3.0	.3
Number of households receiving remittance from overseas									
	7	2	1	1	0	5	2	0	0
Daily wage for male labor for harvesting (1000 dong)									
	-	-	30	30	30	18	18	20	20

Table 4: Correlation between risk preferences parameters and demographic variables under Prospect Theory

	γ(Weighting function)	α (Value function)	λ (Loss aversion)
Age	-.002	-.003 *	.035
Gender (1=male)	-.125 **	-.004	-.607
Education	.002	-.021 ***	.163
Farm/livestock	-.029	.004	-1.005
Fishery	.051	.244 ***	-.205
Trade	-.003	-.010	1.294
Business	.010	-.032	-.170
Government officer	.010	.082	-1.771 *
Relative income	.027	-.034	-.477
Mean village income	-.005	-.002	-.406 ***
Distance to market	-.007	-.027 *	-.145
ROSCA	-.092	.123 *	-.406
ROSCA*Bidding	.200 **	-.206 **	-.029
South	.047	-.000	2.114 **
Constant	.960 ***	1.012 ***	3.255
Number of clusters	181	181	181

Note: * Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level. We conducted robust regressions, and adjusted standard errors for correlations within individuals.

Table 5: Correlation between time preferences parameters and demographic variables under quasi-hyperbolic discounting

	Demographic variables for **δ**	Demographic variables for β
δ (Discount rate)	.280	.103
β (Present bias)	.898 ***	.720 **
Age	-.002 *	.003
Gender (1=male)	-.087 **	.048
Education	.005	-.005
Acquaintance ratio	-.022	-.131
Trusted agent	-.045	.065
Farm/livestock	-.028 *	.059
Fishery	-.112 ***	.059
Trade	-.059	-.036
Business	.228	-.126
Government officer	-.062 **	-.018
Relative income	.067 **	-.012
Mean village income	-.004 **	.009 *
Distance to market	.010	.001
ROSCA	-.121 **	.147 *
ROSCA*Bidding	.227 **	-.265 **
Log (savings)	-.001	.007
Exp/income ratio	.002	-.001
South	-.014	-.022
Clusers	181	181

Note: * Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level. We conducted robust regressions, and adjusted standard errors for correlations within individuals.

Figure 1. Locations of Experimental Sites

APPENDIX

Table A.1: Variable definitions

Variable name	Description
Age	Age of the subject
Gender	Gender of the subject, 1=male
Education	Number of years the subject attended school
Acquaintance ratio	Number of other subjects the subject knows by name divided by the total number of subjects in the session
Farm/livestock	Subject's main occupation is farming or raising livestock
Fishery	Subject's main occupation is fishing
Trade	Subject's main occupation is trading
Business	The subject is engaged in household business
Government officer	The subject works for a local government
Relative income	Subject's household income divided by the mean household income of the village
Mean village income	Mean household income of the village (million dong)
Gini coefficient	Gini coefficient of the income among 25 households surveyed in 2002
Distance to market	Distance to the nearest local market (km)
ROSCA	1=the member of ROSCA, 0=otherwise
ROSCA*Bidding	1=the member of Bidding ROSCA, 0=otherwise
Binary (South)	1= field experiment in the South (non-student subjects)
Trusted agent	The subject is a trusted agent of delayed delivery of money
Log (savings)	Logged savings. Savings is measured as the total value of savings in cash, gold and savings accounts.
Exp/income ratio	Household expenditure divided by household income per year