Analysis

Time preferences and the management of coral reef fisheries

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A B S T R A C T

To investigate a potential relationship between financial and marine resource use decisions, we conducted a time preference experiment with 153 fishers and 197 SCUBA divers on Curaçao and Bonaire. The experiment was part of a socioeconomic survey wherein interviewees were asked about their fishing and diving practices, views on fish population and coral reef health, and preferred marine resource management approaches. We use a $\beta\delta$-model to identify discounting and present bias. Divers had a mean individual discount factor (IDF) of 0.91, significantly higher than fishers' mean of 0.82. Fishers and divers had similar distributions of IDFs and present bias; overall 66% of interviewees were non-biased, 22% future-biased, and 12% present-biased. IDFs and present bias were able to predict management preferences after controlling for demographic factors. However, the effect of discount factors is unique to divers, and the effect of present bias is concentrated among fishers on Curaçao. Differences in time preferences between fishers and divers should be considered when developing management strategies. Transfer payments from the dive industry could facilitate a transition to sustainable fishing practices. Establishing property rights alone may not be sufficient for ensuring sustainability if fishers are present-biased and greatly discount the future.

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1. Introduction

Individuals' time preferences (here discounting and present bias) have been extensively researched as they pertain to demographic characteristics and financial decisions (Frederick et al., 2002). Recently, theories describing how individuals conceive of decisions and tradeoffs have begun to be applied more expansively, and research has considered the environmental implications of time preferences (Hardisty and Weber, 2009). Much of the environmental research to date has focused on how social discounting could influence policies for mitigating global warming (reviewed in Carson and Roth Tran, 2009). Less research has focused on the marine realm, although notable exceptions include applications of time preference concepts to marine protected area design (Grafton et al., 2005; Sanchirico et al., 2006) and to ecosystem restoration (Sumaila, 2004). Research on the relationship between the discount factors[2] of individuals and the management of marine resources is sparse.

Open access problems aside, we hypothesize that individuals with higher discount factors and less present bias with regard to financial decisions (i.e., those who value the future more highly) would also be more inclined towards resource conservation (i.e., marine reserves and less damaging types of fishing gear). Conversely, one might expect that individuals with lower discount factors and more present bias would be more inclined towards unsustainable levels of resource exploitation. Little empirical work has focused on this theory as pertains to fisheries management. Substantially more research has addressed the risk preferences of fishers (Bockstael and Opaluch, 1983; Eggert and Lokina, 2007; Eggert and Martinsson, 2004; Eggert and Tveteras, 2004; Mistiaen and Strand, 2000; Opaluch and Bockstael, 1984; Smith and Wilen, 2005) than the time preferences of fishers.

To our knowledge, only two published studies present fishers' discount factors. Both of those studies elicited individual discount factors (IDFs) using hypothetical choices between various fisheries management

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regimes and the theoretical future income streams associated with those regimes (Akapalu, 2008; Curtis, 2002). There do not appear to be any published studies presenting time preferences elicited from SCUBA divers. Thus, the research presented here represents the first attempt to elicit fishers' and divers' time preferences using incentivized experiments (i.e., price lists associated with actual monetary payments), and further, to explore the relationships between experimentally-measured discount factors and stated resource management preferences.

We elicited time preferences from fishers and professional SCUBA divers on Curaçao and Bonaire, islands in the southeastern Caribbean. Those professions were targeted because both are financially dependent on the health of ocean resources — fishers for the abundance of their catches, and professional divers for attracting tourist clientele. These neighboring islands are former Dutch colonies with similar histories of resource exploitation and similar marine ecosystems. The time preference experiment was paired with a socioeconomic interview that included questions on fishing and diving practices, perceptions of fish population trends and coral reef health, and level of support for management options such as gear restrictions and marine reserves. Here, we evaluate time preferences, as well as demographic characteristics, to understand fishers' and divers' preferred strategies for managing coral reefs.

2. Methods

2.1. Socioeconomic Interviews

In fall of 2009 on Curaçao, and spring of 2010 on Bonaire, A.E.J. conducted in-person interviews with (full and part-time) fishers and professional SCUBA divers (i.e., dive instructors and divemasters). There are no records listing the fishers or divers on either island, so stratified random sampling of these groups was not possible. Instead, interviews were opportunistic, as exhaustive as possible, and as inclusive as possible of all demographic groups. Interviewees were identified via recommendations from local contacts, approaching individuals at fishing docks and in dive shops, and requesting the contact information for additional individuals at the end of each interview in what is termed a snowball sampling technique (Bernard, 1994). All divers were fluent or nearly fluent in English, and a Papiamento–Dutch–English translator was used for all fisher interviews.

A total of 388 interviews were conducted: 126 fishers on Curaçao, 51 fishers on Bonaire, 112 divers on Curaçao, and 99 divers on Bonaire. Based on the number of interviews, the number of potential interviewees identified but with whom it was not possible to schedule interviews, and general knowledge of the fishing and diving communities, we estimate that there are approximately 200 fishers on Curaçao, 80 fishers on Bonaire, 120 professional divers on Curaçao, and 130 professional divers on Bonaire as of 2010. Based on these estimates, our sample represented 63% and 65% of the fishers on Curaçao and Bonaire respectively, and 86% and 83% of the divers on Curaçao and Bonaire respectively.

Of the interviewees, eight fishers and five divers declined to participate in the time preference experiment because they refused to have their participation in the interview be at all associated with a monetary payment. Nine fishers and eleven divers had multiple switch points in one or more price lists. Because such responses imply either that this is an inappropriate approach for measuring IDFs for those interviewees, or that they did not properly understand the questions, those individuals are not included in this analysis. Five fishers did not provide full demographic information. Thus, here we only examine the responses of 153 fishers and 197 divers.

2.2. Eliciting Time Preferences

Methods for eliciting time preferences have become well-honed, and the research presented here utilizes the best techniques currently available in attempt to capture the most accurate responses (Coller and Williams, 1999). Price lists (sets of questions offering choices between receiving payments sooner and later) accompanied by real monetary payments were used to elicit time preferences. At the end of each socioeconomic interview, participants were asked twenty-one questions — three price lists were used, each with seven questions (Appendix A). All price lists presented choices between sooner, smaller payments, and later, larger payments. Payments ranged from twenty to fifty florins (Fl.; 1 USD = Fl. 1.75). This maximum payment of Fl. 50 was chosen because it is roughly equivalent to a fisher or diver's daily income, thus one would not expect participants to be indifferent between payment choices. Additionally, it is a denomination of the local currency, so participants should have been familiar with its purchasing power, yet the amount is not so high as to make the experiment cost prohibitive.

The quantities of money offered were consistent across price lists. All sooner payments ranged from Fl. 50 down to Fl. 20, while all later payments were held constant at Fl. 50. The sole difference among the price lists was the dates at which payments were to be distributed. The first price list contained choices between payments the upcoming Friday and payments two weeks from Friday. The second price list contained choices between payments Friday and one month from Friday. The third price list contained choices between payments two weeks from Friday and a month from Friday. The experiment instructions and all questions were read aloud to interviewees.

To encourage careful consideration of responses, each interviewee was offered a cash payment in accordance with their answer to one of the twenty-one time preference questions. After responding to all questions, participants pick a numbered chip from a sack, and the quantity of their payment was determined based on how they answered the question corresponding with the number on the chip. For example, an interviewee who chose the chip marked with number seven, and who in response to question seven chose to receive Fl. 50 two weeks from Friday over Fl. 20 on Friday, would then actually be given Fl. 50 two weeks from Friday.

We employed front end delays (i.e., no payments were made at the time of interview) to equate the transaction costs of choosing the sooner and later payments, and to reduce the dependence of responses on level of trust for the researcher (Cardenas and Carpenter, 2008). All interviewees were required to retrieve their payments at a specified future date, time, and location. On Curaçao, we distributed payments on Friday afternoons at Dienst Landbouw, Veeteelt & Visserij (LVV), where the fisheries department is located. On Bonaire, we distributed payments on Friday afternoons at the office of Stichting Nationale Parken (STINAPA), the headquarters of the island's marine park. Each interviewee was given a card stating the date and time that their payment could be picked up along with directions to the payment distribution location.

2.3. Calculating Discount Factors and Present Bias

For the point in each price list where the participant switched from preferring the sooner to preferring the later payment (i.e. the switch point), we took the mean between the sooner payment amounts in the question before the switch and in the question where the switch was made. The mean is used, as is common practice, because price list questions do not enable the determination of the exact switch point, rather the discrete range within which the switch occurs. We then divided that mean by Fl. 50, the highest payment option in each question, yielding discount factors from ≥ 1.0 down to 0.4 (Table 1). For example, a participant chooses sooner payments over later payments in response to all price list questions until asked to choose between Fl. 50 in two weeks from Friday and Fl. 20 on Friday, and at that point chooses to wait two weeks to receive Fl. 50. He would have a mean switch point of 25 (the mean of the Fl. 30 and Fl. 20 sooner payment amounts between which the switch was made), which when divided by 50 yields a discount factor of 0.5.