Three Field Experiments in Ecological and Socio-Economics

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Chapter 1

Introduction

This dissertation focuses on experimental methods in Economics- methods that, until fairly recently, had been rejected by economists for being unscientific. It is somewhat ironic, for the natural sciences have long realized the power of this "unscientific" approach, and harnessed, cultivated, refined, and advanced experimental methods for over 500 years.

Experimental economics itself has evolved considerably since its inception, and there are today a number of different devices researchers use when employing experimental methods to study economic phenomena. In this dissertation, I use two relatively recent but increasingly popular experimental techniques: field experiments and stated choice experiments as the primary choice of methodology. Chapters 2 and 3 result from field experiments I conducted in the fishing communities of Chilika Lagoon, India, assessing in the framework of ecological economics the influence of risk attitudes and social divisions on the region's capacity to adapt to climate change. In Chapter 4, I contribute to an emerging sub-discipline in Socio-Economics that is concerned with examining the role of concerns and positionality in human preferences. Specifically, I use stated choice survey-experiments to examine the extent to which relative concerns matter to those in academia. Although the first two studies are in essence works in Ecological Economics and the third study might fall under the purview of Educational Economics, an underlying foundational continuum is apparent in this dissertation in its methodology- with tools from Experimental Economics and Socio-Economics providing much of the methodological apparatus throughout three studies that constitute this endeavor.

Experimental methods, and in particular field experiments, provide a very suitable methodological framework given the sociological nature of the objectives in all three studies. The foray of the experimental approach into economics has been relatively recent- and while Experimental Economics has established itself as a legitimate sub-discipline within the field of Economics, it is a discipline that is still looked upon with *at least* a degree of suspicion that exceeds routine scholarly skepticism. List (2011) sees much of the pessimism having to do with the perception that economic phenomena, unlike occurrence in the hard-sciences like Biology or Physics, are far too to be "controlled." It is unfortunate, because it is an appraisal that likely comes from within the field of Economics. Other social sciences like Psychology and Sociology have long accepted experimental methods as being indispensable cornerstones in the study of human behavior. Yet Economics, the self-proclaimed "Queen of the Social Sciences" has been reluctant to fully embrace experimental techniques.

The perception that economic phenomena cannot be controlled is a reasonable position- for there is an element of truth to it. However, it is the very reason, according to List (2011) that economists *should* take their experiments into the field: by using randomization as an instrumental variable, the researcher is able to balance the unobserved variables between the observed and the control state. It is this realization that has perhaps led to a growing number of economists to use field experiments in the last 15 years- a relatively recent period given the centuries old academic discipline that is Economics.

Chapter 2, in the context of adaptation to climate change, sheds light on two sociocultural aspects of fishing communities warrant attention. One, although economic theory regards human beings as risk averse, recent literature suggests that fishing communities may be less risk averse than individuals in other communities. Two, fishing communities in developing countries are often marked by social divisions on the basis of religion, ethnicity, tribe, etc. The implications of these two characteristics are of some concern, for risk-seeking persons are less likely to adapt, and social divisions can act as a barrier to community focused adaptation initiatives.

These two sociocultural aspects provided the necessary impetus for me to conduct a series of field experiments at Chilika Lagoon, India, and first examine fishers' attitude towards risk under various levels of climatic vulnerability, and explore the effect of such attitudes in fishers' willingness to adapt through the purchase insurance protecting against climate change induced

losses. In addition, I also examine whether social interactions can lead to enhanced total insurance coverage when an incentive is available as opposed to instances when no incentives are provided. I compare the results for groups that were made up of subjects of the same community (homogeneous groups), with the results of groups made up of subjects of different communities (heterogeneous groups).

The results indicate that social interactions have a greater effect in increasing adaptation levels in homogeneous groups than in heterogeneous groups. Nonetheless, when incentives are available, social interactions have a statistically significant impact on enhancing region wide adaptation for both homogeneous and heterogeneous groups.

In Chapter 3, I examine data collected in Chapter 2 in a gender based context. In particular, I am interested in assessing how much the prevailing and pervasive gender barriers that characterize Indian fishing communities have an impact on their ability to adapt to climate change. The experimental design is not dissimilar to that used in Chapter 2, and indeed such a design is quite conducive in the context of the experimental objectives of Chapter 3- (i) To determine whether men and women display different rates of adaptation arising from different attitudes towards risk, (ii) To determine whether men and women display different rates of adaptation arising from different attitudes towards uncertainty, (iii) To determine whether men and women respond differently to group discounts from the possibility of collective (group) adaptation, and (iv) To determine whether the gender composition of group considering collective adaptation has any bearing on adaptation choices.

A glaring finding of this study is that I observed higher levels of risk tolerance for both men and women than is often assumed in the literature. This is particularly concerning in the context of climate change adaptation. At low risk levels, I observe that men and women show similar levels of risk tolerance. At higher levels, however, I find female subjects to be less risk averse than male subjects. This result is in contrast to the findings of the vast majority of studies in the experimental literature on risk, where men are typically found to be more willing to undertake risks compared with women. A second noticeable finding in this study was that same gender groups showed more favorable rates of adaptation than mixed gender groups.

In Chapter 4, I employ stated choice experiments to examine the degree to which relative concerns matter in the professional domain to those in academia. In a survey-experiment administered to doctoral students and faculty in three countries, I look at positionality in the academic community in four domains- income, scientific output, grants availability and teaching effectiveness. The experiments are designed to separate concerns for relative standing when comparisons are upward and when comparisons are downward. Although I characterize this study as a stated choice experiment, it does, in many respects, also fit the definition of a field experiment, in the sense that the experimental subjects are drawn from the market of interest, that is in this case, the academic community. Much of the traditional and contemporary experimental literature does also employ students as subjects, however, this is done often for the sake of convenience, and the behavior of students subjects in a controlled laboratory setting is assumed to mirror that of individuals from the market being studied. Because the market of interest in this study is the academic world, by recruiting doctoral students and faculty as subjects, I am conducting what is inherently a *artefactual* field experiment, rather than a *framed* field experiment of the kind that the first two studies of this dissertation fall under (for a classification of field experiments see Harrison and List (2004)).

The findings from this experiment suggest notable levels of concerns for relative standing in some domains like scientific output, and negligible levels in other domains like teaching effectiveness. I further find that positionality matters a lot more when comparisons are upward rather than downward. Overall, however, I find lower levels of relative concerns for those in academia than have been found in previous studies using subjects drawn from other (non academic) pop-

ulations.

All three studies in this dissertation are also motivated greatly by my interest in Socio-Economics. In studying the impact of social divisions, the effect of societal gender roles and the role of social interactions in the two chapters resulting from my work in the Chilika fishing communities, I adopt an approach to the study of Economics that draws from and focuses on sociological constructs. Sociological constructs are similarly discernible in the study of social comparisons and positionality in academia- in weighing the importance of social comparisons in shaping preferences, the traditional rational actor model is in many ways amended.

This research contributes to the literature and policy in several ways. The results from the first two chapters highlight the need for a more pro-active role of the government and policy makers in combating the issue of climate change. My results make a strong case for the government to undertake efforts to reduce uncertainty as it relates to climate change information. Furthermore, I make a case for the government to provide stronger incentives that spur different and divergent groups to overcome differences and undertake collective action in adaptation initiatives. The results of my experiments examining positionality in academic settings have implications for faculty hiring, retention, promotion and compensation structures. In an environment where academics show high levels of concern for relative standing, for example, a non rigid pay structure of the type observed in countries like the United States (where professors of the same academic standing might have different salary levels) might result in a higher proportion of dissatisfied faculty members, even if their absolute income levels are higher than what it would be in a equitable compensation structure. And excessive concerns for positionality in an area like scientific output may actually act as a barrier that prevents faculty members from collaborating on research projects. In a scenario like this, institutions might focus on reducing concerns arising from relative differences by offering appropriate reward and compensation incentives that foster collaboration.

This dissertation serves as a critique of conventional economic theory in multiple aspects. Throughout the three chapters of this dissertation, experimental subjects exhibit what may be considered suboptimal behavior. In the Chilika experiments for instance, respondents show considerably lower levels of risk aversion than what is assumed in much of conventional theory. And in all three studies - the two chapters resulting from my work in fishing communities and the third from my study of positionality in academia - subjects make choices unexplained by the predictions of Nash equilibrium when decision making is put in a social context. The fishers of Chilika, for example, make markedly different climate change related collective action choices depending on who they're undertaking the said action with. In particular, demographic attributes like caste and gender of the fishers' group members is shown to have an effect on their choices. In the study of positionality in academia, similarly idiosyncratic behavior is seen in subject responses who show at least some concern not solely for absolute levels, but also relative levels of income and performance. The theoretical orthodoxy would, of course, assume that individuals maximize simply their absolute levels of endowments in these domains, regardless of their relative standing within the pertinent group(s) of comparison. In highlighting the relevance and validity of social comparisons in shaping preferences, the rational actor assumption is questioned.

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Chapter 2

Can Fishers Pass the Climate Test? A Field Experiment

Abstract: In the context of adaptation to climate change, we shed light on two sociocultural aspects of fishing communities that warrant attention. One, although economic theory regards human beings as generally risk averse, recent literature suggests that fishing communities may be less risk averse than individuals in other communities. Two, fishing communities in developing countries are often marked by social divisions on the basis of religion, ethnicity, tribe, clan etc. The implications of these two characteristics are of some concern, for risk-seeking persons are less likely to adapt, and social divisions can act as a barrier to community focused adaptation initiatives.

In a series of field experiments conducted at Chilika Lagoon, India, we examine fishers' (fishermen) attitude towards risk (measurable risk as well as uncertainty) under various levels of climatic vulnerability, and explore the implications of such attitudes in fishers' willingness to adapt through the purchase insurance protecting against climate change induced losses. We further examine whether social interactions in the socially divided region can lead to enhanced total insurance coverage under economies of scope.

Keywords: Risk, Uncertainty, Climate Change, Fisheries

JEL Classification: Q54, C93, Q22, D81

2.1 Introduction

Although the vast majority of economic literature regards humans as risk-averse, recent studies suggest that individuals in the fishing industry may be more drawn to risky propositions than most other populations. A stated-choice experiment by Eggert and Martinsson (2004) in Sweden found evidence of risk-aversion in only 52% of studied fishers. Furthermore, the study found that households that receive a higher proportion of their income from fishing activities tend to be less risk-averse than those households that receive smaller portions of their income from fishing. The high number of work related deaths among fishers serves as evidence supportive of the hypothesis that the decision to engage in fishing as an occupation requires a predisposition towards risk that exceeds that found in the general population. In fact, work related deaths in the fishing sector consistently exceed that of any occupational sector in the United States (United States Bureau of Labor Statistics, 2012). The risks associated with fishing are likely even higher in developing countries, where fishing communities often lack modern infrastructure that may reduce the dangers associated with fishing activities. Eggert and Lokina (2007), in a field study conducted in Tanzanian fisheries, classified only 32% of their subjects as risk-averse. Studies that have used techniques alternative to the standard expected utility approach to elicit attitudes towards risk have reached similar conclusions (see for example Nguyen and Leung, 2009). We were interested in examining whether fishers approach decisions pertaining to climate change adaptation[1] with similar attitudes towards risk. In the context of climate change adaptation, low levels of risk aversion are of obvious concern, for risk averse individuals are more likely to adapt. We then examine the role of social interactions and economies of scope in enhancing community wide adaptation in fishing communities.

Other than their propensity for risk, other facets of fishing populations make adaptation initiatives particularly complex for them, and act as potential barriers to adaption. We focus here on one such facet- the divisive and heterogeneous nature of fisheries in developing countries that make community driven adaptation measures especially challenging. These social divisions may appear in a number of forms. The Batticaloa fisheries of Sri Lanka, for example, serve as a common pool resource to members of three ethnic groups- the *Sinhalese*, the *Tamils*, and the *Moor*. In the artisanal fisheries off the coast of Cameroon such divisions are instead determined by tribe membership, with the *Yassa*, *Batanga*, *Babimbi*, *Douala* and *Bakuerians* tribes constituting the majority of traditional fishing settlements. In Thailand, the fishing communities of Songkhla Lake have becoming increasingly segregated, with the once intermixed Buddhist and Muslim fishing villages becoming unprecedentedly disassociated from one another (Horstmann, 2011). In several regions of the world, even when neighboring fishing villages share common socio-ethnic characteristics, inter-village interactions are in many cases infrequent (see for example de Melo and Piaggio, 2012), and projects requiring collective action, absent. We were interested in studying whether these divisions act as a barrier to adaptation. In particular, we were interested in assessing whether social interactions and economies of scope can increase adaptation rates in fisheries given the pervasive communal antagonisms that seem to define fishing communities worldwide.

A failure of fishing communities to sufficiently cope with and respond to climatic pressures could be devastating, with repercussions extending beyond merely the communities in question. A plethora of research predicts the impact of climate change to be particularly adverse on agricultural, mining, forestry, fishing and other segments which collectively make up the primary

[1] The World Bank describes adaptation as the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects. Adaptation can be carried out in response to (ex post) or in anticipation of (ex ante) changes in climatic conditions. It entails a process by which measures and behaviors to prevent, moderate, cope with and take advantage of the consequences of climate events are planned, enhanced, developed and implemented."

sector of an economy (see Morton, 2007; Chang, 2002; Lindner et al., 2010). Because developing countries tend to be heavily dependent on the primary sector of their economies, the impact of climate change on developing countries has long been viewed as an issue that warrants a great deal of attention. Researchers examining the effect of climate change on food output have nearly universally warned against decreasing food-yields and an increase in hunger levels in the face of global warming (Parry et al., 2005; Schmidhuber and Tubiello, 2007). Even if urgent steps are taken to mitigate greenhouse emissions, a certain amount of irreversible damage has already occurred, and in the absence of sufficient adaptive undertakings, the ramifications of these damages, as well as of the damages caused be future events, could be significant.

Historically, the continent of Asia has been affected by a number of natural calamities. The Indian Ocean Tsunami of 2004, the 2005 earthquake in Pakistan, the floods in South East Asia in 2007 and the 2011 Tohoku earthquake in Japan are among a considerable number of natural disasters that have severely impacted the region since the turn of the century. Climate change is likely to bring about an increase in both the number of adverse weather events as well as the extremity of such events. The Indian subcontinent has been identified as a region likely to experience significant disturbances caused by climate change. As a result, vulnerable populations, including those in agriculture, fishing and other climate-sensitive occupations may experience severe income loss as a result of extreme weather. Consequently, the purchase of income insurance becomes a realistic option for those who are seeking to limit crippling income loss induced by possible adverse weather events.

2.1.1 Insurance as an Adaptation Strategy

The purchase of this type of insurance coverage is neither a substitute to, nor a complement to adaptation. Rather, it is an intervention that fits the very definition of an adaptation strategy. The decision to buy insurance is an (ex-ante) adjustment meant to cope with, or alleviate the negative effects of climate change (income loss) at a cost (insurance premium). Moreover, insurance coverage results in the distribution of risk thereby creating a shared risk arrangement across policy holders. The temporal and geographical spread of losses makes the economic repercussions of adverse weather manageable for vulnerable populations in the risk pool. Insurance can thus be thought of as a community level adaptation initiative that curtails heavy economic damages at the individual level. This certainly does not imply that income insurance be the *only* intervention undertaken in a community- like most adaptation strategies, insurance coverage addresses only one aspect of climatic effects. A comprehensive adaptation plan should encompass a multitude of measures that moderate the economic, physical, sociological, psychological and health related effects of climatic events.

Although a considerable level of progress has been made in the field in the last two decades, a high degree of uncertainty still characterizes the climate sciences. What is known, however, and agreed upon by scientists is that the earth's atmosphere is warming at an unprecedented rate, and that this warming poses several threats to the livelihoods of several million people. Nonetheless, there is unpredictability in projections of temperature increase, in the timing of adverse weather events, in identifying precise locations of such events, and in estimating potential damages caused by such events. These unknowns make it impossible to precisely estimate the vulnerability of any one individual. Any individual considering income-insurance, or any other adaptation strategy must make her decision in the face of this uncertainty.

2.1.2 Objectives and Research Methods: A Brief Overview

This study uses an orally conducted framed field experiment (Harrison and List 2004) supplemented by numerous questionnaires and surveys in order to examine whether fishers in Chilika Lagoon in India are willing to purchase income-insurance to protect themselves from losses arising out of adverse weather events.

Several unique sociocultural facets of Chilika Lagoon motivated our choice for selecting it as a research site. First, and perhaps most importantly, it is a fishing community that is expected to experience severe effects from climate change. The Costa Rica study found a high degree of risk aversion, as well as moderate levels of ambiguity aversion among coffee farmers- especially for farmers who chose not to adapt to climate change at low risk levels. The study also observed higher adaptation levels under economies of scope arising from cost-saving coordination amongst farmers. Nonetheless, the conclusions of the Costa-Rican study cannot be used to predict adaptation behavior of communities in other parts of the world- especially those regions, like the fishers of Chilika Lagoon, that have completely different sociocultural characteristics than those of Costa Rican coffee farmers.

A second reason for selecting Chilika as our study site was that the Chilika region is a manifestation of India's caste-based division of society. Such social divisions in fisheries are certainly not limited to India. There are several examples of both inland fisheries and coastal fisheries in different regions of the world where multiple fishing communities share a common pool fishing water resource. While in India these fishing communities are usually demarcated by social castes and subcastes, in other regions of the world fishing communities are often divided based religion, ethnicity, clan or tribe.

An abundance of studies aimed at assessing attitudes towards risk have been conducted in developed countries. Only a handful of researchers have measured risk attitudes of specific populations in developing countries in the context of climate change. Those that have, like Alpizar et al. (2011), have generally considered subjects that are relatively well-off. A third reason we conducted our research in Chilika was that we anticipated that the low incomes of fishers of this region may influence their response to pressures put forth by climate change.

Our preference for an experimental study rather than an econometric or theoretical study was motivated by a number of factors. First, the use of field experiments directly allowed us to predict how effectively traditional fishing communities with unique sociocultural characteristics would be able to respond to climate induced pressures. Second, the use of field experiments allowed us to manipulate variables provided by economic theory to assess how changes in these variables affect adaptation behavior. Third, the realism provided by field experiments enabled us to make scientific inferences about how our subjects might make real world choices in their natural environment.

We do acknowledge that there are some limitations that must be realized when using field experiments to study behavior. In particular, a common criticism of field experiments is that the researcher is not able to exert the same level of traditional "scientific control" over field experiments as she is when conducting laboratory experiments. Nonetheless, we concur with the view in the literature that field experiments provide the researcher with a great deal of power- what is given up in control, is instead made up for with increased "realism" (Levitt and List, 2009).

In light of the conceptual framework presented here, we define the following four research questions: (1) Are Chilika fishers less risk averse than vulnerable communities in other regions of the world, if so, what are the implications of this for their willingness to adapt to climate change? (2) Are fishers in low income regions like Chilika uncertainty averse, and does uncertainty aversion has any bearing on the willingness to pay for income-insurance; (3) To what

extent do economies of scope enhance community wide insurance coverage? (4) Do the social divisions in regions like Chilika act as a barrier to adaptation?

This paper proceeds as follows. Section 2 provides a geographical and sociocultural description of the Chilika Region. A thorough understanding of the Chilika community is helpful in understanding our choice of Chilika Lagoon as an experimental site. Section 3 outlines the experimental design. Section 4 describes the procedure used in conducting the field experiment. Section 5 reports the results of our study, and Section 6 discusses these results and highlights their implications.

2.2 Research Setting

2.2.1 A General Overview of the Chilika Region

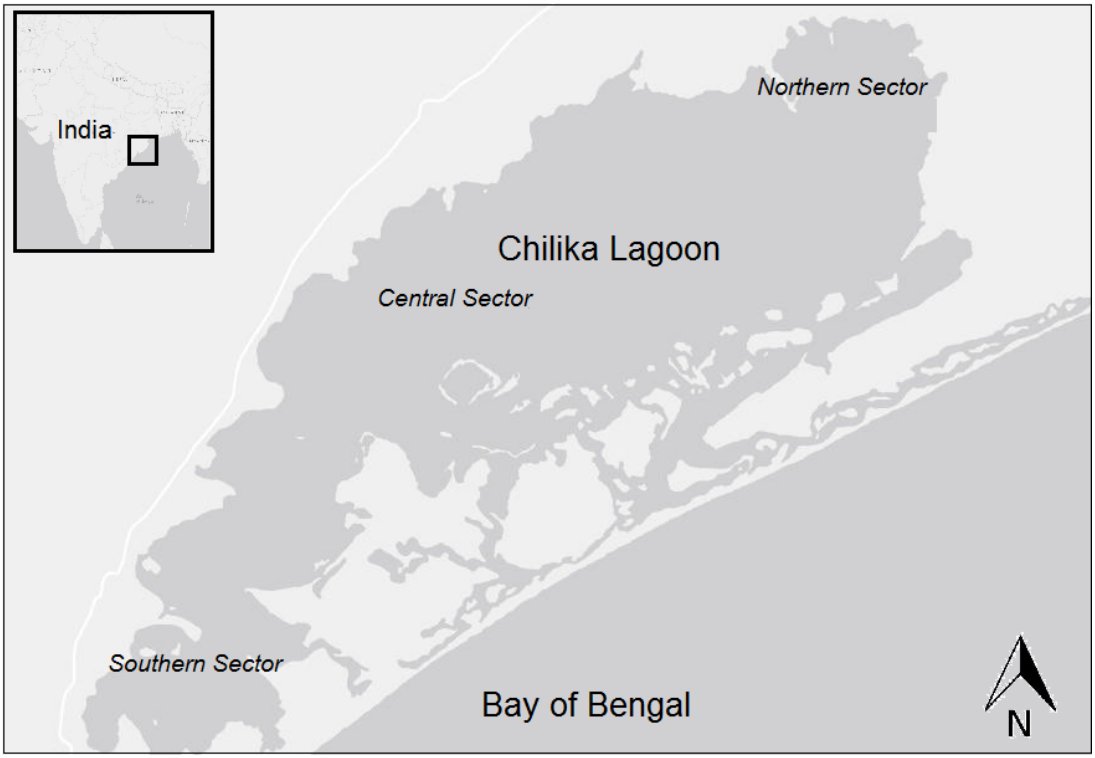

Figure 2.2.1: Map of Chilika Region. Sectorial divisions of lagoon (Northern, Central and Southern) are provided.

Sprawling over an area of more than 1100 sq km during the peak of rainy season, the pear-shaped brackish water lake is sandwiched between the densely populated districts of Puri, Khordha and Ganjam in the eastern state of Orissa.

68,128 adults (36,540 male, 31,588 female) and 54,211 children [2] depend on Chilika Lagoon for their livelihood (Pattanaik, 2007). Most live in the 141 villages that are spread around the lagoon,

[2]Several children work as fishers in Lagoon. It is not our objective to explore the ethical and social issues regarding the employment of children. However, we shall assume that children are not involved in household decision-making, and thus we shall not be including any children as subjects in our field experiments.

Variable	Population	Sample	Population	Variable	Category	Population	Sample
Community				Age (Yrs)	All	43.5	42.1
	Khatia	55%	68%				
	Nolia	4 %	7 %	Gender	Male	54%	54%
	Niary	6%	2%		Female	46%	46%
	Kandara	24%	14%				
	Tiara	3%	7 %	Education (Yrs)	All	6	7
	Gokha	3%	1%				
	Outsider	5%	1%				

Table 2.2.1: A summary of relevant demographic characteristics for our subjects as well as for entire population of fishers in the region. Our sample characteristics are similar to population characteristics. We are therefore confident that our sample is not biased.

and house the 92 primary fishing cooperatives of the region. The majority of fishers belong to one of the six traditional fishing communities or social *subcastes*- Khatia (68%), Kandara(14%), Tiara(7%), Nolia(7%), Niary(2.3%) and Gokha(1.7%) (Sekhar, 2007). Relationships between the subcastes are poor, and marked by frequent conflicts, hostility and mistrust.

Despite the social discord in the region, a shade of cooperation is apparent in certain aspects of inter-community relationships . For example, fishers of the region have been particularly unified in opposition to outsiders (persons not belonging to one of the fishing subcastes), who, often with the permission of the local government, have attempted to enter the Chilika market (Sekhar, 2007). Another example of coordination between fishing groups is reflected in the territorial and functional coordination of fishing activities- a mutual agreement between the region's subcastes dictates where in the lagoon each community is allowed to fish, what kind of fish species they are permitted to catch, and what kind of fishing gear they may use. (see Table 2.2.2). Since climate change is one of the common threats facing Chilika, the readiness of fishers to participate in a cooperative response will determine the effectiveness of adaptation.

Table 2.2.2: Fishers by Subcaste, Gear, Fish Species and Region

Subcaste	Fishing Gear	Species	Region
Khatia	Nets	Primarily brackish and saltwater fish	Middle Region
Kandara	Traps	Prawns, Crabs	Middle Region, Mouth of Lagoon
Tiara	Bamboo Traps	Prawns	Periphery areas
Nolia	Drag nets, Cast Nets	Marine Fish	Mouth of Lake, Adjoining areas of Sea
Niary	Nets	Marine Fish	Mouth of Lake
Gokha	Drag nets	Marine Fish	Primarily Adjoining Sea

Source: Sekhar, Chilika Developmental Authority

The mutual agreement between fishing subcastes also specifies how many days each community is allowed access to the lagoon (see Figure 2.2.2). The number of fishing days in the typical Chilika fisher's year is 238 (approximately 20 days per month). The number is fairly constant across all communities in the region. However, with an increase in climate change induced adverse weather events of distressing severity, it would seem reasonable to expect a decline in well being of fishers as a consequence of a reduction in the availability of fishing days.

Chilika fishing communities can by no means be considered prosperous. Members of most fishing communities are classified as 'scheduled castes' by the government of India because of their historically disadvantaged position under the caste system. Most fishers in the region have an income of less than INR 40,000 per year, assets under INR 10,000 and and debts of over INR

25,000 per person (Japan International Cooperation Agency, 2009).[3]

Chilika Lagoon has witnessed and endured several geographical and ecological transformations over the course of many centuries. The massive lagoon was once a part of the Bay of Bengal. However, a group of islands formed by silt deposits now separate Chilika from the sea. The water-spread, depth and salinity of Chilika Lagoon's waters have also varied- and severe transformations have occurred in relatively short periods of time. With a rapidly changing climate, such changes are expected to continue, only with increased intensity.

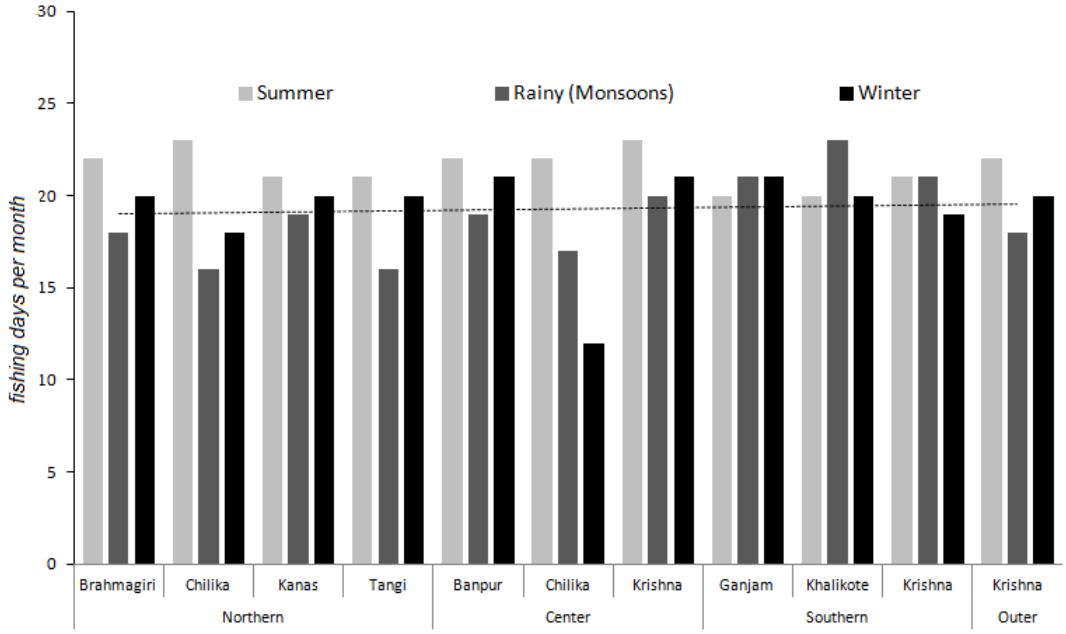

Figure 2.2.2: The number of fishing days available per month in different areas of the lagoon during different seasons. The Chilika is divided into 4 sectors: Northern, Center, Southern and Outer. Each sector is further divided into multiple blocks. The dashed line is the average number of fishing days (approximately 20) throughout the year.

Climate change is expected to directly impact the livelihoods of Chilika fisheries. The state of Orissa, including the Chilika region, witnessed one of the most devastating cyclones in the world in 1999. The 'super-cyclone' resulted in severe damages to the region's fishers, sweeping away fishing boats, gear and homes, thereby crippling the possible number of days fishers were able to fish. Beyond the economic repercussions of the disaster, the super cyclone has massive ramifications on fishers' attitudes and beliefs. A survey conducted by Iwasaki et al., 2009 found that 72% of those in the region expect another cyclone with the severity of the 1999 cyclone to occur in the Chilika region in the near future. Respondents ranked cyclones as the natural hazard most damaging to their livelihoods, followed by a perceived risk ranking of floods, high temperatures and drought. The possibility of loss income as a direct result of fewer fishing days remains a serious concern for Chilika fishers.

[3] 1 U.S. Dollar (USD) = Indian Rupee (INR) 53.95 as of April 20th, 2012

2.3 Experimental Design

Table 3.3.2 summarizes the design of all the experiment. Subjects were randomly assigned into two person groups, with the letter A or B identifying each group member. The experiment was conducted over 9 rounds, the first four rounds constitute the baseline, followed by five rounds for experimental treatments. Due to the numerous rounds in our experiment, we are concerned about our results being impacted by order effects. We reduced the possibility of our results being affected by order effects by administering treatment rounds in varying order.

Table 2.3.3: Experimental Design and Description of Rounds

Rnd	**Fisher A**	**Fisher B**	**NI**	**ES**	**SI**
	Lost Fishing Days Faced Under Bad Outcome				
	Baseline Rounds				
1	5 days (Mildly Vulnerable)	20 days (Completely Vulnerable)	No	No	No
2	10 days (Moderately Vulnerable)	15 days (Severely Vulnerable)	No	No	No
3	15 days (Severely Vulnerable)	10 days (Moderately Vulnerable)	No	No	No
4	20 days (Completely Vulnerable)	5 days (Mildly Vulnerable)	No	No	No
	Treatment: Uncertainty				
5	*Unknown Vulnerability*	*Unknown Vulnerability*	No	No	No
	Treatment: Social Interactions				
6	10 days (Moderately Vulnerable)	15 days (Severely Vulnerable)	Yes	No	Yes
7	10 days(Moderately Vulnerable)	15 days (Severely Vulnerable)	Yes	Yes	Yes
8	10 days(Moderately Vulnerable)	15 days (Severely Vulnerable)	Yes	Yes	No
9	10 days (Moderately Vulnerable)	15 days (Severely Vulnerable)	Yes	No	No

Note: The probability of a bad outcome (an adverse weather event is always 10%.
NI: Neighbor Information. Yes if subjects are informed of their partner's vulnerability level.
ES: Yes if economies of scope available, SI: Yes if social interactions permitted

In addition to a basic participation fee of INR 25, a random round was selected to make actual payments to subjects based on the choices they made. This was done to elicit genuine responses from the subjects that would accurately reflect their decision making in the real world. However, due to constraints in our budget, payments were were made using a scale of 20:1.

All rounds followed the same basic structure. In each round, a certain scenario with a constant risk level, but varying vulnerability level was presented to the fishers, and they were asked to either purchase, or decline income-insurance at the specified cost. The occurrence/absence of adverse weather was simulated by drawing pieces of paper- marked and folded, from a bucket. The income of fishers was assumed to be 100 INR per day if fishing. This is simply a rounded approximation of actual average daily income in the region.

Those who declined insurance risked losing income because of lost fishing days if an adverse weather event were to occur. In the absence of adverse weather, however, those that declined insurance received their full 20 day fishing income. On the other hand, those that chose to purchase insurance were assured of their 20 fishing day income, regardless of the weather outcome. However, they did incur the cost of insurance (200 INR, i.e., two days worth of wages)- a cost that would dissuade some fishers from purchasing insurance.

Subjects were not permitted to talk with one another unless explicitly allowed to do so in a particular round. This was important because social interactions was one of the treatments of the experiment. In order to isolate the effect of social interactions, it was necessary to permit social interactions only in certain rounds.

In order to facilitate comparisons in risk-aversion levels, we follow Holt and Laury (2002) in employing a coefficient for risk aversion, σ. Based on this approach, and under the assumption of constant relative risk aversion, the utility function for an individual for a given amount of money, y, when $y > 0$

$$u(y) = y^{(1-\sigma)}$$

In instances when $\sigma > 1$, the following modification is suggested:

$$u(y) = \frac{y^{(1-\sigma)}}{1-\sigma}$$

Notice that at $\sigma = 0$, $u(y) = y$, suggesting risk neutrality. For values of $\sigma > 0$ the individual is risk averse, while for values of $\sigma < 0$ the individual is risk-loving.

This implies that an individual, in order to be indifferent between two gambles, must set her degree of risk aversion σ such that

$$u(y_1) = u(y_2)$$

where y_1 and y_2 are the payoffs respectively of gamble-1 and gamble-2.

Functionally, this implies that:

$$\frac{y_1^{(1-\sigma)}}{1-\sigma} = \frac{y_2^{(1-\sigma)}}{1-\sigma}$$

The following example illustrates this:

An individual is asked to select one of two available choices: Choice A involves a definite payoff of \$300. Choice B involves a payoff of \$500 with a probability of 0.5 or payoff of \$0 otherwise. She will be indifferent between these two payoffs, if, for her level of risk coefficient, σ,

$$1 \times \left(\frac{300^{(1-\sigma)}}{1-\sigma}\right) = \frac{1}{2} \times \left(\frac{500^{(1-\sigma)}}{1-\sigma} + \frac{0^{(1-\sigma)}}{1-\sigma}\right)$$

which occurs at, σ = -0.35

An individual who is indifferent between Choice A and Choice B has a risk aversion coefficient of -0.35, indicating risk a preferring personality. For a risk lover with $\sigma < -0.35$, $u(y_A) > u(y_B)$. On the other hand, $0 < \sigma < -0.35$ indicates an otherwise risk seeking personality, who in this particlar context, would prefer the safer option (Choice A) or the riskier option (Choice B). It should be quite apparent that the risk averse fisher will, in this example, reject the risky gamble (although she may yet prefer certain risky gambles over safe gambles in other contexts with alternative payoff scenarios), as for all risk averse individuals (i.e, for all $\sigma > 0$), $u(y_A) > u(y_B)$

2.3.1 Experimental Baseline: Rounds 1 to 4

The experimental baseline was setup in Rounds 1-4. In each of the first four rounds, fishers were asked to make a choice between purchasing or declining income-insurance given possible outcomes under two possible states of nature: good (no adverse weather event) and bad (an adverse weather event occurs), at a given probability level of 0.10 of climate change induced adverse weather event. The probability level of 0.10 indicates that the region can be expected

to experience one adverse weather every ten months. In order to ensure that our subjects understood the experiment, for simplicity, we held the probability level of an adverse weather event constant in all rounds (10%). We did, however, vary the individual vulnerability level of the subjects (as determined by number of days lost from the adverse weather event) throughout the experiment. We believe this to be a genuine reflection of the real world- although the residents of a particular region face the same probability of experiencing adverse weather events, the vulnerability level of each resident of the region is not the same. Some may be acutely vulnerable and face debilitating losses, while others may only be mildly vulnerable and face minor losses if an extreme weather event were to occur.

Table 2.3.4: Baseline, Uncertainty Description

Potential Days Lost Out of 20 Available	**Net Days**	**Declines (in INR)**		**Purchases (in INR)**		σ
		Good	*Bad*	*Good*	*Bad*	
5 days (Mild Vulnerability)	15 days	2000	1500	1800	1800	11.75
10 days (Moderate Vulnerability)	10 days	2000	1000	1800	1800	2.30
15 days (Severe Vulnerability)	5 days	2000	500	1800	1800	0.53
20 days (Complete Vulnerability)	0 days	2000	0	1800	1800	0
0-20 (Unknown Vulnerability)	Unknown	2000	Unknown	1800	1800	N/A

Note: σ Coefficient of risk aversion if indifferent between declining and purchasing insurance

Specifically, fishers were told that if they were to decline income insurance, they would be able to continue fishing at the current rate of 20 days per month under good outcomes. However, in the case of a bad outcome, they faced a loss of fishing days. In Round 1, they faced a loss of 5 fishing days per month (from the currently available 20 days a month) if the adverse weather event were to occur at the probability level of 0.10. For our analysis, we classify a fisher who faces a loss of 5 fishing days as *mildly* vulnerable. The mildly vulnerable fisher, if indifferent between accepting and declining income insurance, would have a coefficient of risk aversion of 11.75 . This indicates a very high level of risk aversion. Although individuals in general are risk averse, we expect very few fishers to exhibit such a high degree of risk aversion. Consequently, we believe that most fishers would decline income insurance in Round 1.

In Rounds 2,3 and 4 we progressively increased vulnerability levels- subjects faced a loss of 10 days, 15 days and 20 days respectively in each of these rounds in the event of adverse weather. We shall classify a fisher who may lose 10 fishing days as *moderately* vulnerable, a fisher who may lose 15 fishing days as *severely* vulnerable, and a fisher who may lose 20 fishing days as *completely* vulnerable. In other words, if the adverse weather event were to occur, the mildly vulnerable fisher would still have 15 days to fish. And should the adverse weather event occur, the moderately vulnerable fisher would have between 10 days to fish. Similarly the severely vulnerable fisher would have between 5 days while the completely vulnerable fisher would not have any fishing days in the event of the bad outcome.

The risk level of an adverse weather event was, like in Round 1, assumed to be 10% in all rounds. In Round 2, a coefficient of risk aversion of 2.30 characterizes the moderately vulnerable fisher indifferent between purchasing and declining insurance coverage. Similarly, the severely vulnerable fisher indifferent between purchasing and declining coverage (Round 3) exhibits 0.53. Finally, the completely vulnerable fisher has a coefficient of risk aversion 0, if indifferent between purchasing and declining income insurance (Round 4). A coefficient of risk aversion of zero indicates risk neutrality. Therefore, all those subjects who decline insurance under complete vulnerability have a coefficient of risk aversion of less than zero, and can therefore be considered risk seekers.

2.3.2 Round 5: Testing for Uncertainty Aversion

Round 5 was designed to test whether uncertainty in vulnerability levels can affect decisions to purchase income insurance. In our baseline rounds, fishers knew exactly how many days they would lose in the event of bad weather- they knew exactly how vulnerable they were. But what if there was a situation where they did *not* know whether they were mildly, moderately, severely or completely vulnerable? In other words, what if they had no knowledge about how many fishing days they may lose in the event of adverse weather? In this scenario the number of fishing days the fisher may lose any number of the 20 days she currently enjoys if the bad outcome were to occur. This is a situation of total uncertainty (or ambiguity) in vulnerability levels. One of the objectives of our study was to examine how Chilika fishers make insurance purchase decisions under uncertainty.

The Ellsberg Paradox is perhaps the most frequently cited example in explaining uncertainty aversion.[4]. Individuals in general are believed to be uncertainty averse- they prefer known risks over unknown risks. It has been shown that ambiguity aversion can alter people's decision making. Several studies have examined the role of uncertainty in insurance markets. Alary et al., 2010 found that ambiguity aversion increases the demand for self-insurance, and raises the optimal insurance coverage. Bryan, 2010 argued that because of ambiguity aversion persons in developing countries are reluctant to purchase insurance, as they fear that the insurance will pay out when not needed, and not pay out when needed.

Obviously, in the context of climate change, understanding general attitudes towards uncertainty (as opposed to known risk) is important in assessing the community's willingness to adapt. We hope to answer the following questions: are Chilika fishers uncertainty averse like Costa Rican coffee farmers? And if yes, does uncertainty aversion increase or decrease Chilika fishers' purchase decisions of a commodity, like income insurance, that curtails extreme damages that may be caused from climatic events?

The question in this round was asked in a format identical to previous rounds- with the exception being that subjects were told that if an adverse weather event were to occur, they could lose 5,10, 15 or 20 days at the same probability level of 10%. Once again the good outcome/bad outcome was simulated by drawing folded pieces of paper from a bucket. This ensured that experimental integrity was maintained as subjects could feel satisfied that the experiment was not rigged. Moreover, like in previous rounds, we felt confident that we would elicit genuine responses from subjects, as they were aware that this could be the randomly selected round for which they would receive an actual monetary payment based on the choices they made. The monthly cost of income insurance, and the assumed wage per day of fishing remained at 200 INR, and 100 INR respectively.

2.3.3 Rounds 6-10: Social Interaction and Insurance Decisions

Subjects played the last four rounds of the experiment in groups. These rounds were designed to test our remaining hypotheses- that economies of scope, social interactions, and social divisions have an impact on fishing communities' adaptation decisions. The independent and joint effect of social interactions and economies of scope were studied using a 2x2 experimental design (*Round 6* : Neither economies of scope nor social interactions, *Round 7* : Economies of scope possible but no social interactions, *Round 8* : Both economies of scope and social interactions available, *Round 9* : No economies of scope but social interactions possible. The impact of social divisions was studied by comparing insurance purchase decisions of groups where both members belonged

[4]Ellsberg showed that people prefer a bet involving an urn containing 50 yellow and 50 white balls over another urn that contains 100 yellow and white balls in an unknown proportion (Chow and Sarin, 2001)

to the same subcaste, with insurance purchase decisions of groups where both members belonged to different subcastes within the 2x2 framework described above. Throughout rounds 6 through 9, the probability of an adverse weather event remained at 10%, the daily income from fishing remained at INR 100 and all fishers were again assumed to have a total of 20 fishing days every month in the absence of adverse weather. However, the cost of insurance could be reduced in those rounds where economies of scope were made available to subjects.

Although subjects were aware of who they were partnered with in previous rounds, those rounds were administered on subjects independently. Our focus in rounds 6-9 moved away from individual level insurance decisions to group purchasing behavior.

In Round 6, in addition to being informed of their own vulnerability, subjects were also made aware of the vulnerability of the subject with whom they were partnered. For all groups, Fisher-A was given a moderate level of vulnerability (10 lost fishing days), while Fisher-B was assigned a severe level of vulnerability (15 lost fishing days). Interactions between group members was still not permitted, and the possibility of economies of scope arising from joint insurance purchases had not been yet introduced.

The question was framed as follows: *"Dear Fisher A (Fisher B), assume that if an adverse weather event were to occur with the same 10% probability level, you would lose 10 (15) of the 20 days you currently fish for every month. Your partner, Fisher B (Fisher A), on the other hand would lose 15 (10) days. Assume that all fishers still have a daily income of 100 INR. The cost of insurance is still INR 200, and this assures you of your 2000 INR income regardless of whether the adverse weather event occurs. Would you like to purchase insurance for yourself?"*.

Round 7 was identical to Round 6 except that economies of scope were now present. Fishers were still aware of the vulnerability of their experiment partner. We made economies of scope possible by allowing group members the possibility of sharing the cost of insurance. In other words, if both fishers in the group chose to purchase coverage, the cost of insurance to each fisher was reduced to INR 100. If only one fisher chose to purchase insurance, the cost to her remained at INR 200. While both fishers were aware of each other's vulnerability, the absence of social interactions between fishers meant that they had no knowledge of the insurance purchase decision of their partner. As a result, a fisher considering insurance coverage was forced to consider the prospect of paying the entire cost of insurance out of his own pocket.

In Round 8, we allowed for both social interactions as well as economies of scope. That is, not only were fishers allowed to share the cost of insurance such that each fisher in a group only paid 100 INR if both members of the group purchased coverage, but fishers were allowed to interact with the subject with whom they were paired. By allowing fishers to communicate, we were essentially giving subjects an opportunity to coordinate adaptation decisions to their advantage.

Finally, in Round 9, we still allowed subjects to interact but withdrew the possibility of economies of scope from joint adaptation. This was necessary to isolate the effect of social interactions on insurance purchase decisions, and to complete the 2x2 experimental design. Although subjects were allowed to interact with one another, the absence of economies of scope meant that the cost to an individual purchasing insurance was 200 INR regardless of the purchasing decision of her partner.

2.4 Predictions

Based on the conceptual framework presented here, we define the following hypotheses:

Prediction 1. *Higher vulnerability levels will induce wider community insurance coverage. Nonetheless, consistent with risk aversion studies done on fishing communities in other regions*

of the world, expect lower levels of risk aversion than observed in non fishing populations.

Prediction 2. *Uncertainty aversion will induce higher levels of community wide insurance coverage when vulnerability levels are unknown, than the corresponding situation when vulnerability levels are known.*

Prediction 3. *Economies of scope will induce higher levels of coverage across all subcastes.*

Prediction 4. *Social interactions between members of the same subcaste will have a greater effect on group insurance coverage decisions than social interactions between members of different subcastes.*

2.5 Field Experiment

Fishers were invited to participate in the field experiment through announcements at the local *bazaar*. Further, announcements were made at the *gotha-gora* (community meeting place) of several fishing villages. Also, mayors of a number of villages were requested to inform residents about the upcoming experimental sessions.

A total of 181 subjects participated in the field study. Because of the fishers' limited reading and writing skills, the decision was made to use an oral face-to-face technique supplemented by strong visual aids with minimal written instructions (see Appendix for visual aids and instruction sheets). However, we do not believe that our use of face-to-face interviews, rather than a paper and pencil experiment is a limitation. This is because the experiment was conducted by a group of trained researchers, and included individuals with prior experience in the area. Consequently, we believe that we were able to minimize any possibilities that any part of the experiment may be misunderstood by the subjects. Of course, using this sort of experimental technique meant that the experiment could not be administered to large groups at once. For this reason, the entire study took longer to conduct than typical paper-and-pencil experiments that can be simultaneously administered on several subjects.

We were aware of some of the problems highlighted by Alpizar et al. (2011) in conducting the field experiment, and prepared for our experiment accordingly. For instance, we knew that our subjects also are part of communities that have inhabited in the study area for several centuries, and have a lot of experience with extreme weather. As a result, the fishers have formed their own expectations about the likelihood of future weather events and potential damages. We were concerned that this may result in our subjects disregarding information we provide to them during the experiment. A second concern was that because the fishers are a highly spiritual community that link weather events to the supernatural, their pre-existing beliefs may override relevant experiment details.

We took a number of precautions to safeguard against these concerns. First, in conducting the experiment we used research assistants who were from the Chilika region and had a more intimate understanding of the local people. These research assistants were effectively able to communicate intricate experimental details in a manner that locals could relate to. Second, we repeated experimental instructions several times until we felt confident that the subjects would only consider information presented to them in their decision making. Third, we conducted several practice rounds prior to conducting the actual experiment. This allowed subjects to become more familiar with the experiment, and nurtured them to omit any pre-existing knowledge while making decisions.

Participants were assigned to groups of two, with each group member identified as either Fisher-A or Fisher-B. Name tags were given to fishers in order to avoid the possibility of any confusion regarding the assigned letters. Subjects were instructed to only talk with one another

when specifically permitted to do so in certain experimental rounds. This was necessary to isolate the effect of social interaction. Fishers were warned that failure to follow these instructions could result in expulsion from the experiment without compensation.

Full confidentiality of responses was assured. In addition, participants were requested not to disclose details of the experiment to others at any time in the future. This was done because not all fishers participated in the experiment at the same time. The experiment was conducted over a period of several weeks. By ensuring that subjects had not discussed specifics of the experiment with their acquaintances, we reduced the possibility of bias arising out of subjects' prior knowledge about experimental details affecting our results.

Details of the experiment, including our research objectives were then communicated to the fishers. The notion of climate change and its implications was explained to the participants. Specific consequences of climate change on the Chilika region, such as increased frequency of cyclones, tropical storms and droughts were cited. The concept of "insurance" was described to the fishers as a possible adaptation choice.

Fishers were assured of a compensation of 25 Indian Rupees (INR) for participation. They were also told that they could earn additional money based on the choices they made during the experiment. The entire pay-off structure was then described, and subjects were told that a random round would be selected for actual payment. This ensured that fishers played every round purposefully.

Adverse weather events involved chance, and were simulated by drawing folded pieces of paper from a bucket that specified the number of fishing days the fisher would have in the month. In Round 4, for example, where the fisher is completely vulnerable (that is, she loses all 20 fishing days in the 10% chance that bad weather occurs), 50 pieces of paper were placed in a bucket. Out of these, 5 pieces of paper were marked "zero" - each representing the number of fishing days she may have remaining if an adverse weather event occurs. The other 45 pieces of paper were marked '20 days', and these indicated the good outcome (no adverse weather). A similar procedure was used to select a random round for which subjects would receive actual compensation.

Subjects who were inconsistent in their responses were excluded from participation in remaining rounds. In the case of our experiment, an inconsistent subject is one who declines insurance coverage when facing a certain vulnerability level, but accepts coverage when facing a lower vulnerability level.

2.6 Results

181 subjects participated in the field experiments. Out of these, results for 15 were found to be inconsistent, and thus not included in the analysis. Our analysis and discussion therefore only consider the 166 fishers whose responses were consistent throughout the baseline rounds of the field experiments.

2.6.1 How Risk Averse are Chilika Fishers?

Table 2.6.5 summarizes our sample's insurance purchase decisions at the four different levels of vulnerability. When mildly vulnerable (Round 1), only 7 (4.2%) of the 166 subjects with consistent responses chose to purchase income insurance. When the level of vulnerability was increased to moderate (Round 2), an additional 27 subjects chose to purchase insurance- bringing the total number of subjects purchasing insurance to 34 (20.5%). Even at severe vulnerability levels (Round 3) only 63(38%) chose to purchase insurance, while a mere 93(56%) purchased coverage when completely vulnerable (Round 4).

Using these numbers we can estimate the median level of risk aversion for our subjects as being between 0 and 0.53- a range that is close to risk neutrality. Moreover, 44% of subjects declined insurance even under complete vulnerability, and would be characterized by a degree of risk aversion, $\sigma < 0$, and may thus be described as risk- seeking.

Table 2.6.5: No. of Subjects Purchasing/Declining Insurance at each Damage Level

Potential Days Lost From 20 Available	**Declines**	**Purchases**	σ
5 days (Mildly Vulnerable)	159 (95.8%)	7 (4.2%)	11.75
10 days (Moderately Vulnerable)	132 (79.5%)	34 (20.5%)	2.30
15 days (Severely Vulnerable)	103 (62%)	63 (38%)	0.53
20 days (Completely Vulnerable)	73 (44%)†	93 (56%)	0

† Subjects who decline insurance under complete vulnerability have a coefficient of risk aversion, $\sigma < 0$ and can therefore be classified as risk risk-takers

Our findings confirm what we had theoretically anticipated- that fishing populations are less risk averse than many non fishing populations. In the Costa Rican study, for example, Alpizar et al. (2011) estimated the median degree of risk aversion for coffee farmers facing climate change induced threats to be between 2.25 and 3.4.

We find that attitudes towards risk in the Chilika region are closer to those obtained in recent studies that have been conducted specifically on fishing populations (see for example Eggert and Martinsson (2004), Eggert and Tveteras (2004), Eggert and Lokina (2007)). That Chilika fishers are less risk averse than many nonfishing populations is a result that we do not find surprising. Beyond the general predisposition towards risk that characterizes a number of fishing communities worldwide, fishers in the Chilika region are low income subsistence fishers, and may not have the capacity to divert a portion of their income towards the elimination of risk.

Our findings in the baseline rounds are of some concern, for they indicate a general propensity towards risk taking, and a lower willingness to adapt to climate change than typically assumed in the literature. We further discuss the implications of these results in Section 3.7 (Discussion).

Logistic Regression Results

In an attempt to explore our findings more closely, we conducted a logistic regression using the subjects' insurance purchase decision under complete vulnerability level as the dependent variable. An assortment of subject characteristics compiled during the pre-experimental survey stage of the study were used as independent variables in the model. The dependent variable assumes a value of 1 for fishing who purchases income insurance, while it assumes a value of 0 for the fisher who declines coverage.The results of this regression are provided in Table 2.6.6.

Our results indicate that fishers with higher income levels are more risk averse, and therefore likely to purchase insurance coverage. We also find that fishers who are boat owners (or at least partial boat owners) as opposed to those who are not are more likely to purchase income insurance protecting against climate change induced damage. This might be explained by a number of reasons. Firstly, boats are typically the most costly occupation related assets in fishing communities. As a result, fishers who have invested in such high value occupational assets face the possibility of asset loss or damage under extreme weather. Secondly, those who own assets such as fishing boats are most likely self-employed, and anticipate total income loss if their boats were to be rendered inoperable.

The results of the logistic regression also indicate that men are more likely to purchase insurance than women, and that older fishers are more likely to accept coverage compared with

Table 2.6.6: Logit regression results

Characteristic	Description	Mean	$\partial y/\partial x$	P-val
Majority	1 if belonging to majority community, 0 otherwise	0.572	0.602	0.174
Marital status	1 if married, 0 otherwise	0.861	0.507	0.360
# of Dependents***	Total number of dependents	1.373	0.583	0.005
Boat Owner***	1 if household at least partially owns boat, 0 otherwise	0.681	1.369	0.008
Age*	0 if under 35 , 1 if between 35 and 55, 2 if over 55	1.000	0.752	0.055
Gender**	1 if female	0.446	-0.849	0.036
Supercyclone	1 if affected by 1999 Super Cyclone	0.602	0.774	0.104
Income Level*	0 if under 37250 INR (quartile 1) 1 if > INR 3725 & < 4500 (quartile 2) 2 if > INR 4500 & < 6000 (quartile 3) 3 if > INR 6000 (quartile 4)	1.548	0.400	0.099
Education Level	Number of years of formal education	5.843	0.053	0.580
Pseudo R-square	0.279			
# of Subjects	166 (consistent responses only)			

Note: (i) Dependent variable is 1 if subject purchases insurance when "completely vulnerable". 0 if she declines coverage (ii) * denotes significance at 10% level, ** at 5%, and *** at 1% .

younger fishers. The majority of the studies in the literature we examined conclude that, in general, women are more risk averse than men (see, for example Brick et al. 2012). Our results are, however, more consistent with the Alpizar et al. (2011) study of Costa Rican coffee farmers, where men displayed higher levels of risk aversion than women, and were found to be more likely to adapt to climate change.

Although a fisher's marital status was not found to be a significant predictor of likelihood of purchasing income insurance, the variable number of dependents was found to be statistically significant. This result is not surprising. Individuals who have a larger number of dependents are more likely to be risk averse so as safeguard their dependents against threats such as climate change.

Interestingly, although pre-experimental focus group interviews revealed persisting distressing memories of the 1999 supercyclone, we found that fishers who personally experienced damages or know a family member or friend who experienced damages from the 1999 supercyclone were not more likely to purchase income protection. The cyclone inflicted widespread damage in the state of Orissa. Even though the Chilika region itself escaped the brunt of the cyclone, it left residents of the area in constant fear about the possibility of future events that may more directly affect the local fishing population. Despite the lingering fear about the possibility of future adverse weather events similar to the supercyclone, we believe that because several years have passed since the disaster, those fears may not necessarily translate to precautionary actions today. Consequently then, those who experienced severe damages, or those who personally know someone who experienced severe damages from the cyclone more than a decade ago may not be more willing to invest in adaptive measures such as insurance.

The variable education was not found to be significant enough predictor of insurance purchase behavior. Fishers who chose to purchase coverage, as well as those who chose to decline it, were scattered across all education levels. Consequently, we do not believe there is a strong relationship between attitudes towards risk and a fisher's education level. This result is consistent

with the findings of several studies in other parts of the world. Alpizar, for example, did not find a statistically significant relationship between education and climate change adaptation behavior when studying coffee farmers in Costa Rica.

Our results also show that being of a majority community is not a statistically significant predictor of an individual's likelihood to adapt to climate change through the purchase of income protection. In contrast, Brick et al., 2012, find the majority *colored* fishing population in South Africa to be more risk averse than fishers of other ethnicities in the country. Within the context of climate change, minority groups are believed to possess a lower *adaptive capacity*, and therefore considered more vulnerable than majority groups.

2.6.2 Are Chilika Fishers Uncertainty Averse?

One of our research objectives was to test whether fishers in the low income Chilika region are averse to uncertainty and if their income insurance purchase decisions are altered when they're unaware of their vulnerability to adverse weather events- that is, when they have no information regarding potential damages that may be caused to them by climate change induced extreme weather. Figure 2.6.3 summarizes insurance purchase decisions of fishers when faced with unknown vulnerability.

Mild	Moderate	Severe	Complete	Uncertainty Attitude	# Subjects
Declines				Inconsistent	2 (1.2%)
Declines			Purc.	Uncertainty Averse	10 (6%)
Declines		Purchases		Uncertainty Averse to Risk Neutral	11 (6.6%)
Decl.	Purchases			Not Classifiable	21 (12.7%)
Purchases				Not Classifiable	7 (4.2%)

Mild	Moderate	Severe	Complete	Uncertainty Attitude	# Subjects
Declines				Not Classifiable	71 (42.8%)
Declines			Purc.	Not Classifiable	20 (12%)
Declines		Purchases		Not Classifiable	18 (10.8%)
Decl.	Purchases			Uncertainty Tolerant	6 (3.6%)
Purchases				Inconsistent	0 (0%)

Figure 2.6.3: Results: Attitudes Towards Uncertainty. The upper table shows insurance purchase decisions under unknown vulnerability for subjects who purchase insurance when vulnerability levels are known. The lower table shows insurance purchase decisions under unknown vulnerability for subjects who decline insurance when vulnerability levels are known.

In the context of our experiment, unknown vulnerability implies that there is uncertainty in the number of fishing days a fisher may lose in the case of an adverse weather event. If a fisher had some knowledge of her vulnerability level- if she knew her vulnerability to be minor, moderate, severe or total in the event of adverse weather, her uncertainty decreases. An uncertainty averse fisher can then be described as one who would be willing to pay a certain premium that would

help her better gauge her vulnerability, or more specifically, help her narrow the range of possible values her losses may take.

According to the design of the experiment, a fisher facing uncertainty in vulnerability levels may lose 5, 10, 15 or 20 (if the extreme weather event were to occur) days she enjoys in a typical month in the absence of extreme weather events. For such a fisher, a basic numeric expected vulnerability still exists, of course- one that can be computed based on the standard expected value approach which takes a simple arithmetic average of all possible outcomes. Using this expected value approach, this fisher would be characterized by an expected vulnerability level of 12.5 fishing days. Notice that this expected vulnerability of 12.5 lost fishing days is in between the range for the moderately vulnerable fisher (10 lost days) and the severely vulnerable fisher (15 lost days). Our assessments of a subject's attitude towards uncertainty involves a comparison of this expected value of 12.5 lost days under unknown vulnerability with the subject's expected vulnerability when levels of vulnerability are known.

An uncertainty averse fisher is more likely to purchase income insurance when there is uncertainty in the number of fishing days she may lose from an adverse weather event, than the corresponding situation where she knows how many days she may lose from such an event- assuming of course that the expected vulnerability[5] (expected number of days lost) under unknown vulnerability is no greater than the expected vulnerability under known vulnerability. Clearly then, those fishers who *only* purchase insurance at a known vulnerability level of severe or higher (when they know their number of days lost in the event of an adverse weather event to be 15 or 20), but accept the offer to purchase insurance when faced with a uncertain level of vulnerability (expected vulnerability 12.5 days) exhibit evidence of risk aversion. Of the 51 fishers that chose to purchase insurance when facing unknown levels of vulnerability, 11 chose to purchase insurance only when facing (known) severe vulnerability, and declined coverage at lower levels. An additional 10 of these 51 subjects chose to purchase insurance only when facing (known) total vulnerability, but declined coverage at lower levels. Therefore, a total of 21 of the 51fishers adapting under unknown vulnerability may be classified as being uncertainty averse.

An uncertainty loving fisher, on the other hand would be one who purchases insurance at a certain vulnerability level, but declines it when faced with unknown vulnerability levels, assuming now that her expected vulnerability under unknown vulnerability is no less than the expected vulnerability when her vulnerability level is known to her. Specifically, a risk averse fisher may choose to insure herself when she knows that the only loss she faces is moderate (expected vulnerability of 8 lost fishing days), but if she is ambiguity loving, she may yet to decline insurance when facing unknown levels of vulnerability, despite the higher degree of expected vulnerability under unknown levels of vulnerability (expected vulnerability of 12.5 lost fishing days). A total of 27 fishers purchased insurance when facing a moderate level of vulnerability. Out of these, only 6 declined insurance when their level of vulnerability was unknown. These 6 fishers may be classified as ambiguity loving.

By the same reasoning, we are unable to assess attitudes towards uncertainty for those subjects who purchase insurance when facing uncertainty in vulnerability levels, and, when vulnerability levels are known, also purchase insurance in rounds where expected vulnerability is lower than the expected 12.5 day vulnerability under uncertainty. Accordingly, out of the 51 subjects who purchase insurance under uncertainty, we are unable to assess uncertainty attitudes for 7 subjects who purchase insurance when mildly vulnerable, and 21 subjects that decline insurance when mildly vulnerable but purchase insurance when moderately vulnerable .

[5]based on standard mathematical expected value analysis

2.6.3 Do Social Interactions and Economies of Scope Increase Region-wide Coverage?

Insurance providers routinely offer reduced rates for group coverage for members of cooperatives, communities and other organizational forms that entail social groupings. Whether such an insurance initiative were to be implemented by a private firm, or perhaps, more realistically, by the government- the costs of setting up the program would be lowered if a large number of individuals were covered. The realization of such benefits for individuals requires the concerned individuals to organize themselves in a coordinated manner that would facilitate economies of scope.

In rounds 6 to 9 we employed a 2x2 experimental design that assesses the extent to which economies of scope and social interactions individually as well as jointly facilitate region wide insurance coverage protecting against climate change induced adverse weather. In these rounds, all subjects were partnered with one other subject resulting in a total of 83 two person groups. Each subject was assigned a letter- A or B. A moderate level of vulnerability (10 lost days) was assigned to Fisher A, while a severe level of vulnerability (15 lost days) was assigned to fisher B. Throughout rounds 6 to 9, subjects were aware of the vulnerability of their partner.

In previous rounds, we were concerned solely with individual adaptation decisions. In rounds 6 to 9, we focus instead on group purchase decisions. Table 2.6.7 summarizes the group level purchase decisions for each round constituting our 2x2 design with four experimental treatments. The same information is presented graphically in Figure 2.6.4.

Table 2.6.7: Number of Groups with Different Number of Fishers Purchasing Per Treatment

No. of Fishers Purchasing Insurance	Treatment 6 ES- No, SI- No	Treatment 7 ES- No SI- Yes	Treatment 8 ES- Yes SI- No	Treatment 9 ES- Yes SI- Yes
Both Purchase	6 (7.23%)	9(10.84%)	30 (36.14%)	42 (50.60%)
One Purchases/One Declines	41 (49.40%)	38 (49.40%)	33 (39.76%)	21 (25.30%)
Both Decline	36 (43.37%)	36 (43.37%)	20 (20.10%)	20 (20.10%)

ES: Economies of Scope, SI: Social Interactions

Round 7 was identical to Round 6, with the only exception being that economies of scope were made available. This allowed subjects to share the cost of insurance, thereby reducing the cost of the policy to each member of a group from 200 INR to 100 INR if both group members chose to purchase coverage. If only one member of a group chose to purchase insurance, the cost remained at 200 INR. Social interactions, however, were still permitted. The results in this round were more encouraging - the number of groups in which both subjects chose to purchase insurance increased to 30 (out of the 83 groups). This increase is statistically extremely significant (McNemar Test p-value < 0.01) compared with Round 6, when neither economies of scope not social interactions were permitted.

In comparison, in Round 9, when social interactions were permitted, but economies of scope were not possible, the number of groups where both subjects chose to purchase insurance increased only by 3 from Round 6. Using the same McNemar Test, this increase is not statistically significant (p-value= 0.25, $\chi^2 = 1.33$).

Until now, we've presented the individual effects of social interactions and economies of scope on fishers' insurance purchase decisions. We've observed that while economies of scope have a significant effect on insurance purchase decisions, social interactions do not. But what if both social interactions and economies of scope were offered simultaneously? In other words, do social interactions offer any benefit when economies of scope are available? This was the objective of

Round 8, and a question best answered by comparing the results of Round 8 (both economies of scope and social interactions available) with those of Round 7 (economies of scope not possible, but social interactions permitted). Once again we use the McNemar test to make this comparison, and this time, find a statistically significant increase (p-value > 0.01, $\chi^2 = 10.08$) when both economies of scope and social interactions are available. Our results therefore indicate social interactions alone do not expand community wide adaptation initiatives. However when there an incentive available- such as the realization of economies of scope, social interactions can greatly enhance overall adaptation in a community. We discuss the implications of this finding further in Section 2.7.

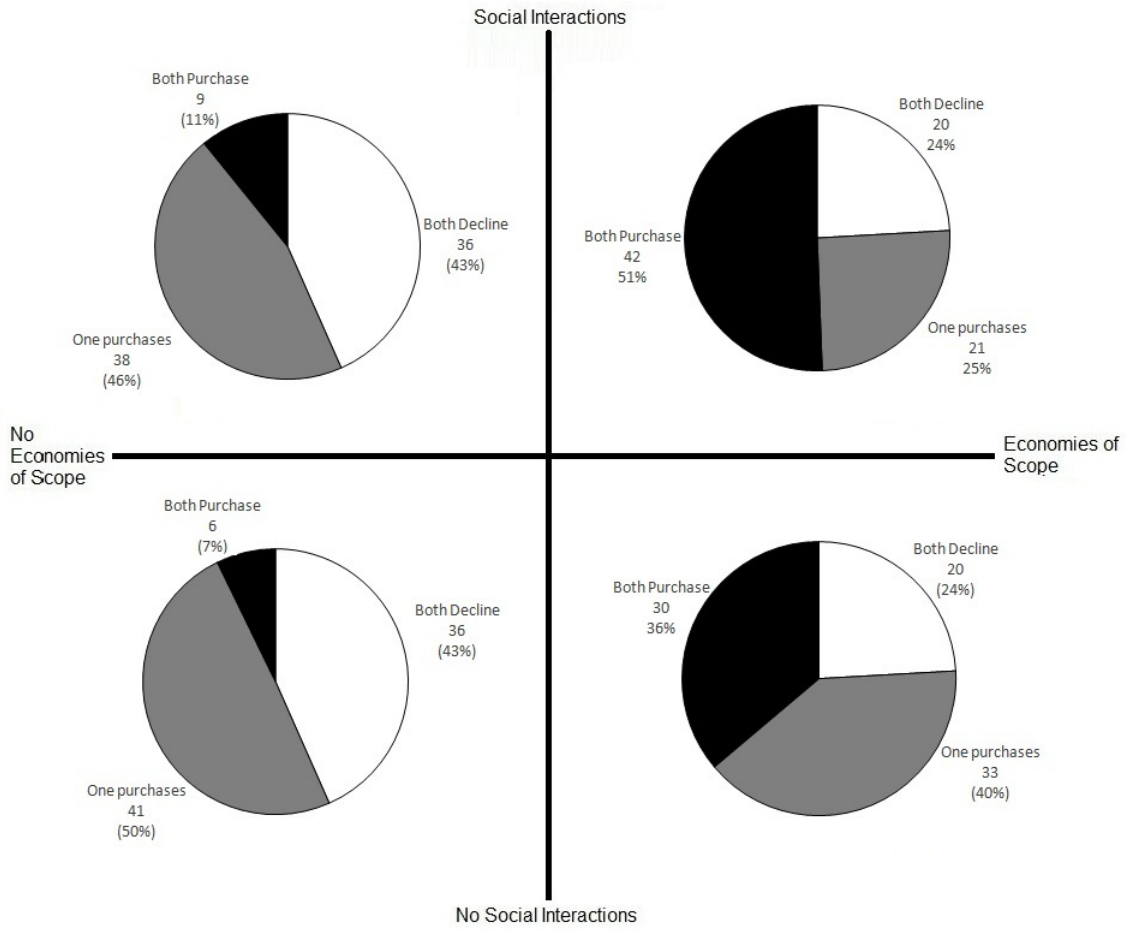

Figure 2.6.4: Adaptation Decisions under Different Experimental Treatments

2.6.4 Social Division: A Barrier to Adaptation?

Like many inland fisheries in developing countries, Chilika Lagoon is home to multiple independent endogamous hereditary communities that depend on the lagoon's resources for their livelihoods. Members of a particular subcaste consider themselves different from members of other subcastes, and share a a collective identity defined by the subcaste to which they belong. One of the objectives of our study was to assess whether these social divisions that are typical

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