Intertemporal Substitution or Reference-Dependent Preferences? Evidence from Daily Labor Supply of South Indian Boat-owners*

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September 2010

Abstract

We study the labor supply of South Indian boat-owners using daily data on labor force participation and the value of catches from 2000 to 2007. Our panel is among the most extensive ever used for this purpose and the first to pertain to a non-service related occupation in a developing country. Our analysis compares two hypotheses about the response of labor supply to increases in wages and income: the conventional framework of intertemporal substitution versus reference-dependent preferences. We show that boat-owners' labor participation depends not only on their expected earnings but also on their recent earnings, supporting income-reference-dependent preferences models. In our preferred specifications, participation elasticities with respect to expected earnings range between 0.57 and 0.61 while the responsiveness to changes in recent income is (in absolute value) a tenth the magnitude of the response to changes in expected earnings. The richness of our data allows us to estimate a participation equation conditional on expected earnings, recent earnings, recent effort, and individual effects. We exploit different sets of earnings shifters to identify participation elasticities (internationally-determined prices, lunar phases, and wind direction). Finally, our results also imply that short-term labor supply models should include recent earnings conditional on recent hours or days worked as an explanatory variable. Since recent earnings are positively correlated with expected earnings and negatively related to the probability of participation, omitting this variable yields downwardly-biased elasticity estimates.

*We thank Kevin Lang, Daniele Paserman, and Dilip Mookherjee for insightful comments and advice. Thanks to Iván Fernández-Val, Jordi Jaumandreu, and Marc Rysman for great suggestions and discussions. Thanks to participants at the IZA Summer School in Labor Economics and the Empirical Microeconomics Lunch at Boston University. We very much appreciate the data., information and assistance facilitated by Felipe Fernández from Fish Information Services, Rexon Fernando, and Daniel Martínez from Mercabarna. Mónica Martínez-Bravo and Marian Vidal-Fernández are grateful to the Fundación Ramón Areces for financial support.

1 Introduction

How workers respond to a temporary increase in wages is an old and fundamental issue in labor economics. Studying the behavior of the underlying labor supply model in order to accurately estimate and interpret the associated elasticities is crucial for predicting and evaluating the impact of labor tax and transfer policies.

Broadly speaking, there are two main hypotheses about how labor supply responds to wages and recent income changes: intertemporal substitution and reference-dependent preferences. The former and more traditional hypothesis posits that workers supply more labor (and therefore, consume less leisure) when wages are temporarily high. Hence, individuals increase their lifetime well-being by taking advantage of temporary opportunities to smooth consumption over time.[1]

Based on the life cycle model of labor supply, the first attempts to measure the rate of intertemporal substitution used variation in annual wages and hours worked. Most studies using this approach found small or even negative elasticities of labor supply (see Blundell and MaCurdy 1999 for a comprehensive review). However, in addition to the problem that annual variations in wages might not be transitory, the majority of workers covered by these studies had very limited (if any) ability to vary their hours or days worked because of institutional constraints (Kahn and Lang 1991; Dickens and Lundberg 1993). More recently, labor economists have focused on more flexible occupations where workers have wide latitude to determine when, how long, and how hard they can work.

At the same time, research has moved towards analyzing an alternative hypothesis that deviates from the conventional framework: reference-dependent preferences (see Kahneman and Tversky 2000 for a selection of papers). With such preferences, an individual's utility for any given period depends on a reference-income standard: if income falls below this standard, then the worker's marginal utility of income is higher than if income is above the standard. Unlike the traditional setup, a temporary increase in earnings may (but will not necessarily) lower labor supply because the desired reference-income can then be achieved with less work effort.

This paper uses a unique large panel on South Indian fishermen to test these two hypothesis simultaneously. Our findings provide new evidence for the existence of reference-dependent preferences. To our knowledge, this paper is the first to study reference-dependent preferences in a non-service occupation in a developing country.

Camerer et al. (1997) and Chou (2002) were among the first studies to find evidence for a reference-income standard in a highly flexible occupation. Using individual-level data from New

[1] Such results are consistent with a dynamic model assuming time-separable utility and the absence of credit constraints.

York City and Singapore taxi drivers, respectively, they argue that drivers work fewer hours on days with higher hourly wages, as predicted by a target earnings model.[2] In both studies, the authors regress hours on daily income divided by the total number of hours worked that day. However, this approach will lead to a negative bias on estimated elasticities if hours are stochastic. Therefore, the authors instrument wages with the average daily wage of other workers on the same day. Yet a remaining concern with this approach is the possible existence of daily shocks that affect wages that are also correlated with labor supply conditional on the wage.

By contrast, a well-known paper by Farber (2005), which uses the same data on New York taxi drivers as in Camerer et al., takes a different approach to examining whether short-term income effects matter for labor supply. Farber's results are opposite to the previous studies of taxi drivers: he finds that the probability of finishing a shift depends on cumulative hours worked rather than cumulative earnings – a behavior entirely consistent with the conventional labor supply model. However, Farber acknowledges that he cannot directly estimate wage elasticities, because his data lacks an exogenous shift in earnings opportunities.[3]

In another study, Oettinger (1999) measures the labor supply elasticities of stadium vendors. Using game attendance as an instrument for earnings, Oettinger (1999) estimates a positive wage elasticity (0.55-0.65) consistent with intertemporal substitution. He also shows that failing to control for demand produces elasticity estimates that are severely downwardly biased. Due to data limitations however – the number of hours worked is fixed and no information exists on other sources of earnings during the rest of the week – he cannot directly test for recent earnings' effects.

Recently, Fehr and Goette (2007) examined the results of a randomized experiment involving bicycle messengers in Switzerland and find their behavior to be consistent with reference-dependent preferences: when wages are temporarily high, messengers sign up for more shifts but expend less effort per shift. This result could also be consistent with the optimal solution of a standard neoclassical model with a utility function that is not time-separable in which, if individuals have been working more shifts recently, they will also be more tired. To distinguish between these two competing theories, Fehr and Goette (2007) test a subset of the sample of messengers for loss aversion.[4] Loss averse individuals are much more sensitive to the loss of a unit below than to the gain of a unit above the reference income. They show that only loss-averse individuals exhibit a negative response to wage increases, favoring the model with reference-dependent preferences.

[2] Target earnings are an extreme version of reference-dependent preferences where marginal utility of income is extremely high at income levels below the reference/target and extremely low below it and thus, there is a sharp kink in the utility function at the reference/target.

[3] The most recent papers on taxi drivers model reference-dependent preferences and analyze the extent to which reference points increases with permanent wages as well as how these income standards vary across individuals and days (Farber 2008; Crawford and Meng 2009 and Doran 2009).

[4] In this case loss aversion was measured by observing choices between different lotteries. For details see Fehr and Goette (2007).

In this paper, we use individual-level panel data for 279 boat-owners from South India from 2000 to 2007 to study daily labor supply responses to temporary earnings increases. Our contribution to the existing literature is two-fold. First, to our knowledge, our data is among the most extensive ever used for the purpose of measuring labor supply changes to earnings increases. Our large sample – with over 1,000 observations per worker – allows us to combine the strategies used by Farber (2005) and Oettinger (1999) and to simultaneously estimate labor supply elasticities and short-term income effects conditional on recent effort and individual effects.

On the one hand, Farber tests whether the likelihood of continuing to work depends on recent earnings conditional on hours worked, but he is unable to estimate elasticities because he does not have exogenous wage shifters. On the other hand, Oettinger uses game attendance as a source of exogenous variation of vendors' wages to identify labor supply elasticities. However such occupation is not full-time and he does not have information on other sources of earnings during the rest of the week. The richness of our data allows us to concurrently test whether recent earnings (conditional on recent effort) affect participation, as well as to use a set of exogenous wage shifters to estimate labor supply elasticities.

Second, our study is the first to focus on data from a developing country. Understanding the behavior of workers in a poor country is relevant from a policy perspective. In particular, they might face strong liquidity constraints and/or live at near-subsistence levels. The development literature (e.g., Banerjee and Duflo 2007) suggests that poor individuals living near subsistence levels have limited access to credit and exhibit different patterns of consumption and income generation. In turn, the poor may represent a group most likely to exhibit labor supply behavior limited by a minimum subsistence target. Therefore, transfers and labor tax reforms may lead to larger short-term income effects among the poor compared to the general population and occupation groups previously studied. Identifying differences in behavior between fishermen in South India and taxi drivers and bicycle messengers in Manhattan or Zurich might reveal different implications for policy.

The richness of our data provides a simple way to distinguish between intertemporal substitution and reference-dependent preferences. While the former hypothesis predicts that labor supply should be independent of recent earnings, the latter implies that short-term income effects are relevant for determining labor supply, because the higher are recent earnings, the more likely it is that the reference income has already been achieved, and thus that labor effort will be reduced. Therefore we test whether labor supply depends only on expected earnings or also on recent (weekly) earnings, conditional on recent effort (days worked in the past week) and individual effects. In doing so, we exploit different sets of exogenous earnings shifters to identify participation elastici-

ties (internationally-determined prices, lunar phases and wind direction). We also show that our results are robust to the set of variables excluded from the participation equation, and that they do not appear to be driven by credit constraints.

Our estimates provide evidence of reference-dependent preferences. Boat-owners' labor force participation decisions are found to depend on expected earnings as well as on recent earnings. However, compared to substitution effects, recent earnings effects appear small. In our preferred specifications, estimated intertemporal elasticities are significantly positive and range between 0.57 and 0.61, while short-term income effects are small but statistically significant. In particular, for an average boat-owner, the response of labor participation to changes in recent income is (in absolute value) a tenth of the magnitude of his response to changes in expected earnings. We argue that these small but significant short-term income effects are not driven by credit constraints. Our results imply that a 10% increase in expected earnings on any particular day raises the probability of working that day by 6%. Furthermore, the realization of such an earnings increase translates into a 2.5% increase in the boat-owner's recent income in the following week. According to our estimates, this change in recent earnings lowers the numbers of days worked in the following week by less than 0.01 days.

Thus, this study adds to the growing body of research supporting the existence of reference-dependent preferences, and moreover, it extends the evidence to the case of a non-service industry in a developing country.

It is important to note that while the majority of the recent literature on daily labor supply analyzes working hours and daily reference-income earnings, our setup is slightly different. Boat-owners do not have such flexibility in their choice of hours worked. They need to stay a minimum number of hours to wait for their nets to be filled, and they return to the shore at approximately the same time to sell the catch. Since their major labor decision is whether to take their boat out to sea or not on a particular day (extensive margin), we analyze their daily participation equation and weekly reference income. While it may be true that boat-owners might decide to change hourly efforts or go to sea a couple of hours earlier or later than the average boat-owner depending on their earnings, we cannot directly test this hypothesis since we do not have data on the exact daily hours they spend working.

Finally, our results show that models of short-term labor supply should include recent earnings conditional on recent hours or days worked as an explanatory variable. Since recent earnings are positively correlated with expected earnings and negatively related to the probability of participation, omitting this variable could yield severely downwardly biased elasticity estimates.

The rest of the paper is structured as follows. Section 2 describes the institutional environment.

Section 3 reports summary statistics. Section 4 describes the empirical strategy. Sections 5 and 6 discuss the main results, and Section 7 concludes the paper.

2 Background

2.1 Boat-owners

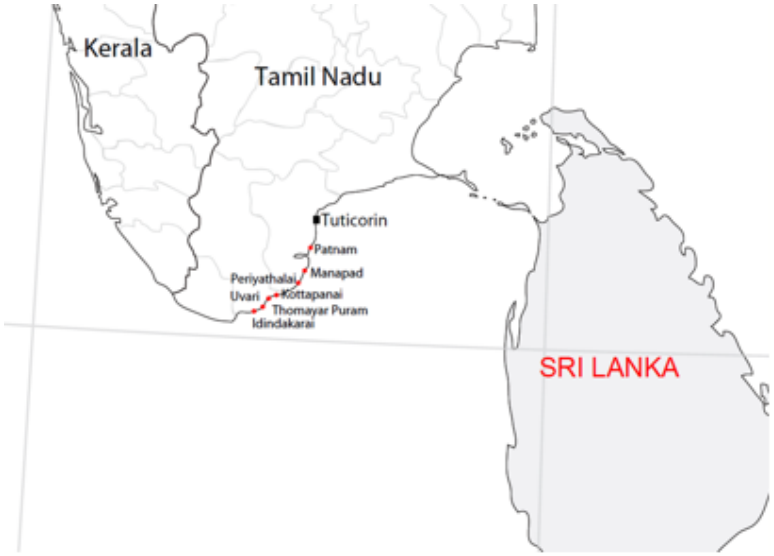
We study 279 boat-owners from eight villages along the coast of the southern region of the Gulf of Bengal in the state of Tamil Nadu; 30 are located in Idindakarai, 28 in Kootapanai, 15 in Manapad, 43 in Periyathalai, 29 in Thomayar Puram, and 66 each in Uvari and in Patnam. Figures 1 and 2 illustrate their exact locations.

Figure 1: Map of India

Households belong to a Catholic fishing community, which converted from a Hindu Cast about 400 years ago. Thus, following their religion, boat-owners usually work from Monday to Saturday. On a typical night, a boat-owner goes to sea around 1 A.M. together with three or four laborers. These workers are paid a daily wage of approximately 200 Rupees. Once out on the water, each boat-owner decides the direction of his sail and the type of fishing net depending on the fish species he expects to catch in that location. Then, they wait a few hours and draw in their catches. Of course, the boat-owner's experience, the laborers' ability, weather conditions, and pure luck play important roles in the success of the catch.

Around 7 A.M. they head back to the beach, where every boat-owner sells his catch to a middleman (or a so called auctioneer) who markets the vast majority of the catch to multinational fish-processing companies. Boat-owners are price takers; companies buy 45 different fish species

Figure 2: Zoom Map: Villages in Tamil Nadu



at internationally-determined market prices that depend on the season and type of fish. Examples of the type of seafood traded are tunas, cephalopods, crabs, and lobsters. The remaining fish that are too small under international legal minimum size standards are sold at the local market for a very low price.

All boat-owners, except those from Patnam, belong to a fishermen's society with over 7,000 members spread over the districts of Tirunvelli and Tuticorin. Although this society has been increasing in members and in area, it does not yet operate in Patnam, a village that is located further north. The society was created in 1991 to increase boat-owners' income by selling directly to companies and avoiding independent auctioneers' mark-ups.

We think that the success of the society is a result of an increase in price transparency and earnings. Since boat-owners in Patnam might earn less due to additional middleman price mark-ups, we will later exploit this difference between villages to test for differences in participation elasticities due to possible liquidity constraints.[5]

The society and auctioneers in Patnam work in a similar fashion: they lend money to boat-owners to buy the boat, to pay for boat-related expenses and gear, as well as for eventual consumer credits. In exchange for marketing and loan services, both Patnam auctioneers and the society keep a commission of seven percent of daily sales. In addition, they keep ten percent of the value of total catches, which they deduct from the principal owed by the boat-owner. Finally, another three percent is automatically placed into a savings account and refunded to the boat-owner in

[5]Nevertheless, we cannot exclude the possibility that any differences in earnings elasticities are driven by unobserved differences between Patnam boat owners and fishermen in other villages.

December for the celebration of Christmas and the New Year. Boat-owners who belong to the society also contribute one percent of their daily earnings to a pension fund, and two percent for life insurance and the society's administrative costs.

This flexible repayment agreement provides boat-owners with some source of insurance, since on low-income days their dues are lower. Moreover, once in the contract, additional debt is costless for the boat-owner since the amount of compensation he pays back is independent of the amount owed. Unsurprisingly, more successful boat-owners are granted larger loans. The boat-owner can terminate the contract at any time as long as he can pay back his outstanding loan balance. In the case of Patnam, if a boat-owner switches auctioneers, the new auctioneer settles the debt with the previous one. However, switching of auctioneers rarely occurs. According to the villagers, these interlinked, shared arrangements are superior over separate debt and marketing contracts because boat-owners face limited liability and benefit from costless monitoring of day-to-day catch successes.[6] Information about the success of individual boat-owners flows freely since every day all catches are traded at the same place and observed by all present auctioneers. Moreover, the society and auctioneers keep thorough hand-written records of all sales and loan transactions, and at the end of each year, they provide a copy of individual sales records to each one of their boat-owners. Each boat-owner thus has a precise record of his catches. These are the records we use in our analysis from January 2000 to July 2007, yielding a total of about 300,000 observations.

In addition, boat-owners and their wives were surveyed in 2005 and 2007. The survey included questions on a wide variety of topics, such as socio-demographic characteristics, networks and other sources of income, inventory of assets, income shocks, and savings along with a module about fishing expenses and techniques.

2.2 Determinants of earnings

Boat-owners' daily earnings depend on the quantity of fish they catch and the price paid by multinational fish-processing companies. Unfortunately, neither the middlemen nor the boat-owners keep track of the prices paid by these companies. However, since frozen fish is sold internationally, the exchange rate and the international price of Indian fish should be the main determinants of the price boat-owners receive for their catch.

Fish Information and Services (FIS), a widely recognized consulting firm for global seafood industry information, reports that the vast majority of exported Indian fish (calamari, octopus, and cuttlefish) is sold in Europe.[7] In particular, Spain has the largest fish trading companies in

[6] Limited liability is also Basu's (1992) key argument for the predominance of share contracts in agricultural areas of low-income countries. Platteau and Nugent (1992) provide a useful general discussion of contract choice in fisheries of low-income economies.

[7] The rest of the merchandise - mainly tuna - is exported to East Asia and particularly Japan. We contacted

the continent and receives the majority of the fish that is redistributed to the rest of Europe. The largest Spanish fish market, Mercabarna, provided us with all available information they had on Indian fish. They only keep records of fish species that are consistently traded for at least a year and the total sales of which are significant, either due to its price or its quantity. In particular, for the Indian case, they provided us with records on the average price at which frozen Indian calamari is sold to retailers, which corresponds to the largest proportion of Indian sea product traded in the Spanish fish market.[8] Information was available for all years except from 2000. Price data is daily for 2006 and 2007 and weekly during the period 2001-2005. Probably because the calamari is frozen and it can be stored, these prices do not vary significantly within a week and sometimes remain constant even within a month.

According to boat-owners, the main factors that affect the quantity of the catch are the season, the weather conditions, and the lunar calendar. Consistently, a broad body of literature in natural science and land economics (a sample are Smith 2002, Smith and Wilen 2005, and Watson and Pauly 2001) supports the hypothesis that weather conditions, expertise – the knowledge of when and where to catch a particular type of fish – and luck are the main factors that affect catch volume.

Therefore, we acquired daily weather characteristics from the closest Indian meteorological department station in Tuticorin, a town located approximately 20 kilometers away from the closest village, as depicted in Figure 2. This information was available for all years except for 2007. Most boat-owners have radios from which they obtain weather forecasts.

Moreover, since the choice of the fishing spot is also a determinant of catch abundance and all boats run on kerosene, we include the real daily price at which kerosene is traded at the closest international fuel market in Singapore.[9] It is very likely that boat-owners face a trade-off between choosing a potentially good catching point that is further away or staying closer to save fuel.

Finally, there is some evidence from the biology literature on the relation between fish abundance and lunar phases. Some authors suggest that the lunar phases are related to fish abundance through its relation to night brightness. For example, Luecke et al. (1993) state that when there is a full moon in Utah, lake fishes stay in deeper areas to hide from detection of potential predators. However, the most supported hypothesis is that lunar phases affect fish behavior by migration patterns and reproduction cycles.[10] Some biologists argue that the reason for such patterns is

them too, but information on the origin of the fish was not available for these markets.

[8] They did not keep track of prices for other types of Indian fish because according to Mercabarna, the volume of trade was not significant enough. However, since frozen calamari is the most traded species, if we were to calculate a price Index, it would get the largest weight.

[9] Sources: US Energy Information Administration (fuel prices) and International Monetary Fund (Consumer Price Index and Exchange Rate).

[10] Some examples are: Robertson et al. (1990), Tesch (1989), Barlow et al. (1986), Hastings (1981), Entright (1975), and Zucker (1978).

the existence of positive externalities in breeding and egg protection when fish synchronize their reproduction cycles, which happen to follow lunar periods. Thus, given the evidence of the relation between lunar phases and catches, our last piece of information corresponds to the lunar cycles within the period of study, January 2000 to July 2007.

3 Descriptive Statistics

Table 1 depicts boat-owners' descriptive statistics. On average, boat-owners are forty years old, have approximately 5.5 years of education, and live in households with a total of five family members. Since all are married, one of their family members is their wife. In most cases, the other relatives are children, but some boat-owners have extended family members living with them, such as in-laws, parents, or siblings. In all households, the boat-owner's earnings are the main source of income. However, there is usually another family member who works as well, such as a child or a woman manufacturing items sold at an informal market.

As we can see in Table 1, the boat-owners' daily gross average earnings are 1,080 Rupees. Since the survey includes a few questions about the amount of their daily expenses on kerosene, and laborers' wages, we can get a rough estimate of their net daily income, 310 Rupees, which is approximately 6.5 US $. In addition to such costs, boat-owners have to pay commissions on their catches to the society or auctioneers as well as eventual boat, motor, and net repairs. Hence, there may be days when they do not catch enough to cover costs. In fact, the variance of average daily earnings is almost as large as average earnings which shows the risk boat-owners face every day when deciding to go to sea. Since fishing is an onerous activity, boat-owners work an average of approximately four days a week.[11]

Since the sensitivity of participation to earnings also depends on income, we would like to get an idea of the extent to which boat-owners might be financially challenged. Their average savings[12] are low. To put it in perspective, their average savings of 2,840 Rupees is lower than the average earnings from twelve days of work.

Table 2 shows descriptive statistics for the variables that may affect boat-owners' value of catches. As we can see, during 2001-2007 the average price at which frozen Indian calamari is traded at the Spanish market stays stable around 3 Euros per kilogram.

During our period of interest, the Real Exchange Rate (RER) Rupee/Euro is 56 Rupees on average.[13] Finally, the real price at which a gallon of kerosene is exchanged in the Port of Singapore

[11] Since fishermen are Catholic, they do not work on Sundays, and thus Sundays are not included in the analysis.

[12] Savings are the total value of bank deposits, cash at home, jewellery and other forms of savings.

[13] RER=$e_{r/e}$*(P_e/P_i), where P_e and P_i are the Current Price Indexes (CPI) in Europe and India respectively. RER and kerosene prices use 2007 as base year. Sources: International Monetary Fund (CPI), European Central Bank (ER) and US Energy Information Administration (Kerosene prices).

– the main center of fuel exports to the rest of Asia – is approximately 61 Rupees (1.2 US dollars) per gallon, and unlike the price of calamari, it fluctuates considerably, with a variance of 20.

Since we expect the days around the start of a lunar phase to be the ones that have a greater impact on fish abundance, we created dummies that include the day when the cycle starts, as well as two or three days before and after. Changing this definition does not significantly alter any result.

4 Empirical Strategy

To asses the extent to which boat-owners intertemporally substitute labor for leisure when earnings are temporarily higher, we are interested in estimating the following participation equation:

$$\begin{aligned} y_{it} &= 1(y_{it}^* > 0), \\ y_{it}^* &= \alpha \ln(w_{it}^e) + \beta \ln(\sum_{p=1}^{7} w_{it-p}) - \theta_i - X_{it}\gamma + e_{it}, \end{aligned} \tag{1}$$

where y_{it} is a dummy equal to one if boat-owner i goes fishing at date t. The second equation states that y_{it}^* is the difference between the gross gains (w_{it}^e) and the opportunity cost of going fishing plus an independent random shock e_{it}. The opportunity cost is made up of three components: the sum of the value of catches in the seven prior days, a boat-owner individual effect θ_i ,[14] and time-variant opportunity cost shifters X_{it}.[15]

Note also that X_{it} includes a proxy for effort (dummies for the number of consecutive days worked during the previous week).[16] Given the physical intensity of their work, boat-owners might be less likely to work when they have been working during the previous days. Thus, because earnings and days worked are positively related, omitting this set of controls could lead to a spurious finding of negative participation elasticities.[17]

To test whether boat-owners only substitute labor for leisure when earnings are higher (intertemporal substitution) or whether they are also less likely to work when they have high recent earnings (reference-dependent preferences), we need consistent estimates of α and β. If $\alpha > 0$ and $\beta = 0$, then boat-owners' behavior is consistent with short-term intertemporal substitution.

[14] Since we have an average of 1,000 observations per individual, the bias from the incidental parameters problem (Chamberlain 1980) in our probit estimates will be negligible.

[15] These include weather conditions, a full set of month-year interactions, holiday dummies, holiday interacted with the number of other income earners in the household and dummies for the day of the week and the number of consecutive days fishermen have worked in the previous week.

[16] Using alternative proxies such as dummies for which days they have been working during last week or the total number of days worked during the previous week does not significantly change any of the results.

[17] This also rules out the possibility of non-time separable utility functions, where current labor supply depends on recent labor supply decisions. Unlike in Fehr and Goette (2007), in our setup earnings and effort are not proportional to each other and in this way we can directly rule out the possibility that short-term income effects are due to non-time-separable preferences.

Another possibility is that they both tend to work when earnings are higher but also take into account recent earnings; i.e., both coefficients are different from zero ($\alpha > 0$ and $\beta < 0$). This would be consistent with reference-dependent preferences: boat-owners might work more during days of higher expected earnings to achieve their reference target, but once this goal is achieved, they may reduce their likelihood of going fishing. Under this scenario, the marginal utility of leisure increases once the income target is achieved and boat-owners work only if expected earnings are large enough. In this case, we would be interested in knowing whether the net effect on labor force participation of a temporary increase in expected earnings is on average negative or positive.

Following Oettinger (1999), we estimate the participation equation in several steps. First, we need to estimate the following gross earnings equation:

$$\ln(w_{it}) = Z_{it}\delta + \mu_i + u_{it}, \tag{2}$$

where Z_{it} includes the log of recent earnings, the log of the real kerosene price, real frozen calamari prices, the real Rupee/Euro exchange rate, phase of the moon dummies, weather conditions, a full set of month-year interactions, and dummies for day of the week and the number of consecutive days boat-owners have worked in the previous week. While boat-owner fixed effects (μ_i) capture time-invariant individual ability, the dummies for the days they have been working during the last week control for time-varying individual effects such as changes in information.

Since we only observe earnings for boat-owners who work, self-selected participation induces a correlation between the idiosyncratic errors and the explanatory variables in (2). Thus, if there exist unobserved time-varying elements that jointly affect participation and earnings, expected log earnings conditional on participation (P_{it}) are:

$$\begin{aligned} E(\ln(w_{it}) \quad &| \quad X_{it},\ \ln(\sum_{p=1}^{7} w_{it-p}), Z_{it}, \mu_i, P_{it} = 1) = Z_{it}\delta + \mu_i \\ + \ E(u_{it} \mid u_{it} + e_{it} \quad &\geq \quad X_{it}\gamma - \beta \ln(\sum_{p=1}^{7} w_{it-p}) - Z_{it}\delta + \theta_i - \mu_i). \end{aligned} \tag{3}$$

The last term represents the bias induced by self-selection, and we first need to estimate and include the selection term into the earnings equation. Following Heckman (1976), we estimate a reduced form probit excluding a set of variables from the earnings equation to identify an inverse Mills ratio. We assume that holiday dummies and the interaction of holiday with the number of income earners in the household affect opportunity costs but not earnings. According to some informal interviews with boat-owners, there is no tragedy of the commons: it is not the case that when more boat-owners go to sea, the amount of catches is lower.

In the last stage we use predicted log earnings for all boat-owners from equation (3) and

incorporate them into the structural probit equation (1) to estimate our equation of interest.[18] Standard errors are corrected for the induced sampling error arising from the introduction of an explanatory variable which is itself estimated (Murphy and Topel, 1985).

As one might expect, some variables affecting earnings in Z_{it} are opportunity cost shifters as well. Therefore, they also belong to X_{it} in equation (1). An example is rain – both boat-owners and fish may dislike rainy days. If so, on rainy days, boat-owners would be less likely to go to sea and hidden fish would be less likely to be caught. However, in order to identify our parameters of interest, we need some variables that affect participation only through earnings and that are excluded from the participation equation. We assume that the real exchange rate, the real price of frozen calamari and kerosene in Singapore, lunar phase dummies and wind direction – conditional on wind speed – meet that criteria and allow us to identify our parameters of interest in equation (1). Section 6 will discuss the validity of these exclusion restrictions.

5 Results

5.1 Reduced Form Equation

Before turning to the structural participation model of interest, Table 3 presents estimates of the reduced-form model of participation. Although this simple model does not allow us to identify our parameters of interest, it provides a preliminary idea of variables that are important for determining participation either through earnings or opportunity costs. All specifications include individual dummies, a full set of month and year interactions and dummies for the number of consecutive days they have worked within the previous seven days. Errors are clustered at the year and village levels. Columns (2) and (3) include weather controls for the years we have information, 2000 to 2006. The last column includes observations for which we have information both on weather characteristics and the price of frozen calamari, 2001 to 2006.

In all specifications, the logarithm of recent value of earnings (catches) is significant and positively related to the likelihood of participation. Since earnings are serially correlated, recent earnings are a proxy for expected earnings. Thus, at first glance, it seems as if boat-owners are more likely to work when earnings are higher, which is consistent with intertemporal substitution.

Turning to the variables that will be excluded from the participation equation and that are used to identify the coefficients in the structural participation model, only wind direction in the last two specifications is significant. Nevertheless, all these variables (exchange rate, price of calamari, phases of the Moon and wind direction) are jointly significant in all specifications with an F-statistic of 8, 7 and 6.7 respectively.

[18] Table A1 in the Appendix summarizes the included and excluded variables in the earnings and participation equations.

As expected, since a higher exchange rate leads to higher earnings, the probability of working is increasing with the exchange rate. Similarly, in column (3) we observe that the higher the price of frozen calamari, the higher is the likelihood of participation, a pattern that seems to coincide with intertemporal substitution.

Surprisingly, the coefficient of the log of price of kerosene is positive. We would expect that if boat-owners take into account the price of kerosene as a determinant of net earnings, they should be less likely to participate when prices are higher. Although the coefficient is not significant, we will discuss the validity of the exclusion of this and other variables from the participation equation in Section 6.

If we take a look at the factors affecting the quantity of the catch, we see that compared to a full moon phase, boat-owners tend to participate more in the days around the last and first quarters of the lunar phase. However, none of these estimates is significantly different from zero.

In the specifications with weather controls in columns 2 and 3, we observe that participation is lower when the wind blows in the northeast direction. While it is plausible that rainy or windy conditions directly affect both boat-owners' participation and earnings, it seems less likely that wind direction (conditional on rainfall and wind speed) influences the utility of going fishing.

Boat-owners are more likely to go to sea on Mondays than on any other day of the week. Since work is physically demanding and the boat-owners rest on Sundays, it seems reasonable that they will be most likely to work on Mondays when they are well-rested. After Mondays, boat-owners are more likely to work on Saturdays than in any other day of the week, following the previous argument, perhaps because they will be resting the day after.

Finally, consistent with their religion, boat-owners tend to rest during Catholic holidays. Sundays are not included in the regressions. In addition to Sundays and Catholic holidays, fishermen, and only fishermen, have the tradition of not working on the first Friday of every month. Moreover, boat-owners from households with more income earners are less likely to work during a holiday. This variable may capture the fact that families have less need for the head of household to work when there are other sources of income available.

5.2 Earnings Equation

Table 4 shows the results for the selection-corrected log-earnings equation (3) that we use to predict expected earnings for all boat-owners. All columns include boat-owners' dummies, year and month dummies, month-year interactions, and dummies for the number of days worked consecutively in the previous week. Columns (2) and (3) only include observations for which we have information on wind direction, total rainfall and average wind speed. The last column only includes observations for which we have information on the price of frozen calamari and weather characteristics. The set

of variables that will be excluded from the structural participation equation is: the real exchange rate, the real price of kerosene, and lunar phases for all columns together with wind direction in columns (2) and (3) and the price of frozen calamari in column (3).

As we discussed earlier, we can see how earnings are serially correlated, since the recent cumulative value of catches is a good predictor of present earnings. Consistently, earnings are significantly higher when the real exchange rate is higher. Although not significant, the signs of the coefficients on the prices of kerosene and frozen calamari are as expected.

In all specifications, earnings are lower during a Full Moon compared to the rest of the lunar cycle. Moreover, in the specifications with meteorological controls (last two columns), the significance of these dummies decreases. This can be due to the link between lunar phases and to tides, since tides are also closely related to wind speed. Thus, the disutility of going fishing might be affected by lunar phases if boat-owners prefer to fish under particular tide and weather conditions. Therefore, we will devote a later section to discussing the validity of the exclusion of lunar phases and other variables from the earnings equation.

Meteorological variables also affect earnings of boat-owners; average wind speed, rain and northeast wind direction adversely affect value of catches. Since identification in the participation equation comes from the excluded variables (exchange rate, log prices of kerosene and frozen calamari, lunar phases and wind direction northeast), we include the results of an F-test for the excluded instruments. Our F-statistic is in all specifications higher than ten, which is the minimum recommended to obtain reliable estimates (Stock Wright, and Yogo 2002).

Surprisingly, earnings are significantly higher on Wednesdays and Mondays than Saturdays (omitted category). This could reflect variations either in the catch or in prices. Although there is no evidence of a daily price effect, we cannot absolutely rule this possibility out. Variations in the catch could reflect increasing fatigue over the week or a tragedy of the commons. However, as we have mentioned before, according to boat-owners, expected earnings do not depend on the total number of fishermen who work in a particular day.

Finally, as expected, in all cases the estimated Rho coefficient on the Inverse Mills-ratio (identified by the variables being a holiday and the number of income-earners in the household interacted with being a holiday) is positive, which means that there is positive selection into participation when earnings are temporarily higher.

5.3 Participation Equation and Elasticities

Let us turn to Table 5, which depicts results for our main model of interest: a structural participation probit (equation (1)). The set of excluded variables from the participation equation is the exchange rate, price of kerosene, phases of the moon dummies and a dummy for the wind blowing

in a northeast direction in the columns that include meteorological variables, (3) - (6). These columns also include predicted value of earnings derived from a model that includes weather characteristics (specification 2 from Table 4). The last two specifications include the price of frozen calamari as an explanatory variable in the earnings equation (specification 3 from Table 4).

Focusing on our two main coefficients of interest, we see that, consistent with intertemporal substitution, coefficients on the predicted logarithm of earnings are positive and significant in all specifications. The rest of the coefficients (not reported) behave in a similar fashion to the ones reported in the reduced form equations from Table 1.

The bottom panel of Table 5 reports uncompensated elasticities evaluated at boat-owners' average characteristics as well as the mean of individual elasticities. We should focus on the mean of individual elasticities, given that the inclusion of dummy variables in the regression complicates the interpretation of an individual having mean dummy characteristics.

All elasticties are significantly different from zero and range between 0.19 and 0.62. Moreover, elasticities are severely downwardly biased when we omit recent earnings, a variable that, as we have seen before, is significant and positively correlated with expected earnings.

Coefficients for the logarithm of the value of recent earnings in columns (2), (4), and (6) are negative and significantly different from zero. In particular, they imply that an increase in earnings of ten percent decreases the likelihood of participation by approximately 0.6 percentage points. Hence, the magnitude of this effect is very small compared to expected earnings elasticities. It implies that in order to offset the positive effect of an increase in expected earnings, the increase in recent earnings should be at least ten times larger than the increase in expected earnings. Thus, although we can reject that the coefficient on recent income is zero its magnitude is small.

As discussed in Section 4, a positive coefficient on expected earnings together with a negative sign on recent earnings implies that boat-owners tend to work when expected earnings are higher but are less likely to work when recent earnings are higher, i.e. $\alpha > 0$ and $\beta < 0$. This result is consistent with the hypothesis that boat-owners have reference-dependent preferences. However short-term income effects are not very large.

It is important to note that unlike most of the literature, our elasticities are calculated with respect to gross earnings. We cannot directly calculate net earnings elasticities since we do not have information on daily expenses on kerosene, laborers and other repairs. Nevertheless, if we assume that gross earnings are proportional to net earnings, elasticities for net earnings should be similar to those presented. Another alternative is to assume that costs are a fixed amount regardless of earnings and to use the survey information on the cost of kerosene and laborers to get a rough estimate of the net earnings elasticity. On average, gross earnings and costs are 1,000

and 700 Rupees respectively. For example, suppose gross earnings increase ten percent (100), then, this implies that net earnings increase 33% (300 to 400 Rupees); and the gross earnings elasticity of 0.57 implies a net earnings elasticity of 0.19. Since the average participation rate is 0.72, this change would increase the likelihood of participation to 0.75.

Although this might seem like a small change, we should consider the fact that the variance of earnings is very high (900). This implies that if gross earnings increase one standard deviation from the mean, which implies an increase in net earnings of 900 Rupees, the likelihood of participation would increase by approximately 50 percent. As discussed before for gross income, the corresponding effects on participation from recent net income would also be a tenth of the substitution effect. Therefore, although we find evidence supporting reference-dependent preferences, short-term income effects are small relative to substitution effects.

5.4 Preferences or Liquidity Constraints?

Negative coefficients on recent earnings can reflect reference-dependent preferences, as well as liquidity constraints. Since we examine individuals from a developing country, they are more likely to be liquidity constrained.

Liquidity constraints come in two forms: credit constraints and an absence of a savings technology. If boat-owners are not able to borrow enough from the society or their middlemen to smooth consumption when recent earnings have been low, then they might have to work more days to achieve a minimum level of consumption. This could be particularly true for boat-owners who are close to living at a subsistence level. Furthermore, if boat-owners lack a safe way to save to smooth consumption when recent earnings have been high, they will not be able to store extra income for future consumption even if expected earnings are high. If that is the case, then we might have mistakenly concluded that boat-owners' labor supply is driven by preferences.

In Table 6 we will test this hypothesis. In the first three columns, we include interaction terms of the log of recent and log of the expected earnings with the log of total savings, and the log of assets, as well as a variable that is equal to one if the household had an income shock that forced it to cut meals during 2006 respectively.[19]

If it is true that credit constraints are driving our results, we should expect elasticities to be higher and the coefficient on recent earnings to be lower in absolute value when there is less of a liquidity constraint. Thus, in the first two columns, the coefficients on the interaction terms should be positive, i.e. the higher are assets or savings, the less is credit constrained, and thus the higher should be the effect on expected earnings and the lower (in absolute value) should be the

[19] Since these variables do not vary (or are missing) between both surveys in 2005 and 2007, their direct effects are captured by the boat-owners' fixed effects.

coefficient on recent cumulative earnings. In a similar fashion, since cutting a meal acts as a proxy for being credit constrained, we should expect the opposite sign for the interactions between the dummy variable for cutting a meal and log earnings and log of recent earnings.

The results in the first three columns of Table 6 do not find consistent evidence of liquidity constraints driving our results. All coefficients (and marginal effects) are almost zero and insignificant. Moreover, none of the specifications have both of the signs of the variables of interest as expected and out of the six coefficients, only half have the excepted sign (interactions of assets and savings with recent earnings and having cut a meal with expected earnings).

In conclusion, we do not find any consistent evidence of credit constraints driving our estimates and thus, reference-dependent preferences might be more likely to explain our results. Nevertheless, we cannot completely dismiss the possibility that the boat-owners are equally being credit constrained and that the variance of savings (4,400) and assets (7,360) is not high enough to distinguish between unconstrained and constrained boat-owners in our sample.

6 Robustness Checks

We argued that phases of the moon are related to fish availability. Nevertheless, we have also posed the possibility that moon cycles are linked to night brightness. Thus, if boat-owners prefer to fish during nights with better visibility conditions, lunar phases will not satisfy the exclusion restriction. Moreover, the phase of the moon is related to the variation in the difference between high and low sea tides. Every day, there are two high tides and two low tides. When the moon is full or new, high tides are very high and low tides are very low while this difference decreases during quarter moons. Therefore, sea conditions might also affect the disutility of going fishing if boat-owners prefer not to sail under cycles with a higher sea tide variance. In Table 7 we check the validity of the exclusion restriction for the lunar dummies in the following two ways. First, we exclude lunar phases as an explanatory variable for earnings (column 1); second, we include lunar phase dummies in the participation and earnings equations (column 2) and compare both estimates with ones in Table 5. We can see that the F-statistic on the joint significance of the excluded variables is still larger than ten. Moreover, in both specifications, estimates are very similar to the ones in Table 5 and estimated elasticities are even larger.

Another excluded variable that may be problematic is the price of kerosene. More specifically, boat-owners may use kerosene for purposes other than fishing. We address this possibility in columns 3 and 4 in Table 7. Column 3 reports participation equation coefficients without including kerosene prices as an explanatory variable for earnings while column 4 includes it in the participation equation. Again, F-statistics are still higher than ten and results are not too different

from the ones in Table 5.

One may also argue that when the wind blows northeast, this may be linked to other meteorological characteristics affecting participation for which we have not accounted. Columns 5 and 6 show specifications without wind as an explanatory variable for earnings and including it in both participations and earnings equations, respectively. As before, the F-statistic of the remaining excluded variables is higher than ten, and although estimated elasticities are smaller than in Table 5, the main conclusions do not change.

Finally, Columns 7 and 8 show specifications that exclude environmental characteristics and prices from the participation equation, respectively. While in these cases F-tests are not as conclusive as we would like, we see that, overall, coefficient estimates are robust to the choice of excluded variables, which supports the overall choice of excluded variables.

7 Discussion

The study of labor supply is a fundamental pillar in labor economics. In this paper, we use daily data on Indian boat-owners' participation and value of catches to estimate participation elasticities conditional on effort, individual effects and recent earnings.

According to our results, we find evidence that Indian boat-owners have reference-dependent preferences. That is, these workers take into account recent earnings, as well as expected earnings, in their daily labor supply decisions. However, compared to participation elasticities, the effects of recent earnings are small. We argue that these short-term income effects seem not to be driven by credit constraints.

Our results have two implications for labor supply analysis. First, our uniquely large panel allows us to estimate a participation equation conditional on expected earnings, recent earnings, effort, and individual effects. We show that, although short-term income effects are small, labor supply models should include recent earnings conditional on recent hours or days worked as an explanatory variable. Since recent earnings are positively correlated with expected earnings and negatively related to the probability of participation, omitting this variable yields severely downwardly biased elasticity estimates. Thus, labor supply models should account for the existence of reference-dependent preferences in estimating intertemporal elasticities.

Second, this paper links labor economics to the development literature supporting evidence of workers having reference-dependent preferences by finding evidence of reference-dependent preferences among workers in a non-service sector of a developing country.

References

Barlow R., B.Maureen K. Powers, H. H., and L. Kass (1986): "Migration of Limulus for Mating: Relation to Lunar Phase, Tide Height and Sunlight," *Biological Bulletin*, 171(2), 310–329.

Basu, K. (1992): "Limited liability and the existence of share tenancy," *Journal of Development Economics*, 38, 203–220.

Blundell, R., and T. E. MaCurdy (1999): *Labor Supply: A review of alternative approaches. Handbook of Labor Economics*. Amsterdam, New York and Oxford. Elsevier Science.

Camerer, C., L. Babcock, G. Loewenstein, and R.Thaler (1997): "Labor Supply of New York City Cabdrivers: One Day at a Time," *Quarterly Journal of Economics*, 112(2), 407–441.

Chamberlain, G. (1980): "Analysis of Covariance with Qualitative Data," *Review of Economic Studies*, 47, 225–38.

Chou, Y. K. (2002): "Testing Alternative Models of Labour Supply: Evidence from Taxi Drivers in Singapore," *Singapore Economic Review*, 47(1), 14–47.

Crawford, V. P., and J. Meng (2009): "New York City Cabdrivers' Labor Supply Revisited: Reference-Dependent Preferences with Rational-Expectations Targets for Hours and Income," Working Paper.

Dickens, W. T., and S. J.Lundberg (1993): "Hours, Restrictions and Labor Supply," *International Economic Review*, 34(1), 169–92.

Doran, K. B. (2009): "Reference Points, Expectations, and Heterogeneous Daily Labor Supply," Working Paper.

Entright, J. (1975): *Orientation in time: endogenous clocks, Physiological Mechanisms, Vol II, part 2*. Kinne, Wiley and Sons, London.

Farber, H. S. (2005): "Is Tomorrow another day? The Labor Supply of New York City Cab Drivers," *Journal of Political Economy*, 113(1), 42–82.

——— (2008): "Reference-Dependent Preferences and Labor Supply," *American Economic Review*, 98(3), 1069–82.

Fehr, E., and L. Goette (2007): "Do Workers Work more if Wages are High? Evidence from a Randomized Field Experiment," *American Economic Review*, 97(1), 298–317.

Hastings, M. (1981): "Semi-Lunar Variations of Endogenous Circa-Tidal Rhythms of Activity and Respiration in the Isopod Eurydice pulchra," *Marine Ecology. Progress series*, 4, 85–90.

Heckman, J. J. (1976): "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models," *Ann. Econ. and Soc. Measurement*, 5, 475–492.

Kahn, S., and K. Lang (1991): "The Effect of Hours Constraints on Labor Supply Estimates," *Review of Economics and Statistics*, 79(4), 605–11.

Kahneman, D., and A. Tversky (2000): *Choices, Values and Frames*. Cambridge, New York and Melbourne. Cambridge University Press.

Luecke, C., and W. A.Wurtsbaugh (1993): "Effects of Moonlight and Daylight on Hydroacoustic Estimates of Pelagic Fish Abundance," *Transactions of the American Fisheries Society*, 122, 112–120.

Murphy, K., and R. Topel (1985): "Estimation and inference in two-step econometric models," *Journal of Business and Economic Statistics*, 3(4), 370–379.

Oettinger, G. S. (1999): "An Empirical Analysis of the Daily Labor Supply of Stadium Vendors," *Journal of Political Economy*, 107(2), 360–92.

Platteau, J., and J. Nugent (1992): "Share contracts and their rationale: lessons from marine fishing," *Journal of Development Studies*, 28, 386–422.

Robertson, D. R., C. W. Petersen, and J. D. Brawn (1990): "Lunar Reproductive Cycles of Benthic-Brooding Reef Fishes: Reflections of Larval Biology or Adult Biology," *Ecological Monographs*, 60(3), 311–329.

Smith, M. (2002): "Two Econometric Approaches for Predicting the Spatial Behavior of Renewable Resource Harvesters," *Land Economics*, 78(4), 522–538.

Smith, M., and J. Wilen (2005): "Heterogeneous and Correlated Risk Preferences and Behavior of Commercial Fishermen: The Perfect Storm Dilemma," *The Journal of Risk and Uncertainty*, 31(1), 53–71.

Stock, J. H., J. H. Wright, and M. Yogo (2002): "A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments," *Journal of Business and Economic Statistics*, 20(4), 518–529.

Tesch, F.-W. (1989): "Changes in swimming depth and direction of silver eels (Anguilla anguilla L.) from the continental shelf to the deep sea," *Aquatic Living Resources*, 2, 9–20.

Watson, R., and D. Pauly (2001): "Systematic distortions in world fisheries catch, trends," *Nature*, 414.

Zucker, N. (1978): "Monthly Reproductive Cycles in Three Sympatric Hood building Tropical Fiddler Crabs (Genus Uca)," *Biology Bulletin*, 155, 410–424.

Appendix: Tables

Table 1: Boat-Owner's Characteristics

Age	40.16
	(9.43)
Total family members	4.93
	(1.57)
Number of income earners	2.164
	(1.32)
Number of children	2.46
	(1.57)
Years of education	5.469
	(2.23)
Savings in Rupees	2,840
	(4,385)
Daily participation	0.72
	(0.46)
Daily value of catches	1,080
	(902)
Average daily costs in kerosene and laborers	770
	(245)
N	279

Savings, earnings, and costs are in 2007 Rupees

Table 2: Determinants of Boat-Owner's Earnings

Price of frozen calamari from India (Euro per Kilogram)	3.03
	(0.39)
Real exchange rate Rupee-Euro	56.43
	(5.3)
Price of kerosene in Rupees per gallon	61.23
	(20.6)
Proportion of days of the month within a lunar cycle	0.24
	(0.4)
T	2,796
Rainfall in millimeters	1.2
	(5.8)
Average wind speed in Km./hour	13.7
	(6)
Wind direction Northeast	0.13
	(0.34)
T	2,557

Prices are in real terms calculated with base year 2007.
Price of kerosene in Singapore port..

Table 3: Reduced Form Participation Equation Probit

y=Pr(participation)	(1)	(2)	(3)
Log (Last 7 days value of catches)	0.0755***	0.0726***	0.0746***
	(0.0093)	(0.0097)	(0.0106)
Log (Real exchange rate Rupee/Euro)	1.314	1.277	1.382
	(0.894)	(0.947)	(1.088)
Log (Kerosene price)	0.0955	0.130	0.0673
	(0.168)	(0.169)	(0.188)
Log (Price of calamari)			0.166
			(0.150)
First Quarter Moon	0.0143	0.0107	0.00375
	(0.0183)	(0.0190)	(0.0201)
New Moon	-0.0211	-0.0212	-0.0176
	(0.0237)	(0.0241)	(0.0264)
Last Quarter Moon	0.0167	0.00930	0.00183
	(0.0212)	(0.0222)	(0.0225)
Wind direction Northeast		-0.0850***	-0.0911***
		(0.0311)	(0.0314)
Average wind speed (Km. per hour)		-0.00152	-0.00194
		(0.00144)	(0.00157)
Total rainfall in millimeters		-0.00477***	-0.00442**
		(0.00160)	(0.00172)
First Friday of the month	-0.466***	-0.410**	-0.423**
	(0.155)	(0.169)	(0.178)
Catholic holiday	-0.659***	-0.563***	-0.546***
	(0.107)	(0.108)	(0.114)
Holiday*Num. income-earners	-0.0973***	-0.103***	-0.107***
	(0.0158)	(0.0160)	(0.0170)
Monday	0.0270	0.0316*	0.0272
	(0.0172)	(0.0171)	(0.0180)
Tuesday	-0.113***	-0.107***	-0.108***
	(0.0249)	(0.0266)	(0.0285)
Wednesday	-0.156***	-0.146***	-0.142***
	(0.0263)	(0.0272)	(0.0288)
Thursday	-0.175***	-0.167***	-0.167***
	(0.0244)	(0.0254)	(0.0269)
Friday	-0.223***	-0.222***	-0.222***
	(0.0210)	(0.0221)	(0.0237)
Observations	288,587	261,118	240,493
Mean Participation	0.72	0.71	0.71
	(0.44)	(0.45)	(0.54)

Regressions include: Full set of month and year interactions, dummies for the number of consecutive days worked and boat-owner dummies.
Errors are clustered at the year and village levels.
All prices are in real terms with base year 2007.
The income-earners variable includes all income-earners in the household.

Table 4: Log Earnings Equation

y=log(value of catches)	(1)	(2)	(3)
Log (Last 7 days value of catches)	0.164***	0.158***	0.154***
	(0.0197)	(0.0198)	(0.0206)
Log (Real exchange rate Rupee/Euro)	0.728**	0.816**	0.835**
	(0.357)	(0.373)	(0.421)
Log (Kerosene price)	-0.0648	-0.0943	-0.0795
	(0.0651)	(0.0639)	(0.0700)
Log (Price of calamari)			0.0388
			(0.0589)
First Quarter Moon	0.0155**	0.0115	0.0139
	(0.00729)	(0.00790)	(0.00848)
New Moon	0.00827	0.00820	0.00878
	(0.00770)	(0.00837)	(0.00918)
Last Quarter Moon	0.0197*	0.0218*	0.0250*
	(0.0115)	(0.0123)	(0.0132)
Wind direction Northeast		-0.0257*	-0.0255*
		(0.0137)	(0.0143)
Average wind speed (Km. per hour)		-0.00103*	-0.00112*
		(0.000613)	(0.000666)
Total rainfall in millimeters		-0.000196	-0.000245
		(0.000471)	(0.000510)
Rho	0.06***	0.05***	0.05***
	(0.016)	(0.02)	(0.02)
Observations	209,884	187,184	172,428
F-Excluded Instruments	12.5	21.48	14.20

Regressions include: Full set of month and year interactions, dummies for the number of consecutive days worked and boat-owner dummies.
Errors are clustered at the year and village levels.
All prices are in real terms with base year 2007.

Table 5: Structural Participation Equation Probit

y=Pr(participation)	(1)	(2)	(3)	(4)	(5)	(6)
Predicted log (earnings)	0.462***	1.459***	0.464***	1.388***	0.489***	1.260***
	(0.0159)	(0.240)	(0.0169)	(0.203)	(0.0178)	(0.212)
Log (Last 7 days value of catches)		-0.165***		-0.147***		-0.120***
		(0.0395)		(0.0323)		(0.0330)
Observations	288,587	288,587	261,118	261,118	240,493	240,493
Mean participation	0.72	0.72	0.72	0.72	0.71	0.71
	(0.44)	(0.44)	(0.44)	(0.44)	(0.45)	(0.45)
Mean of ind. part. elasticities	0.19	0.59	0.19	0.57	0.2	0.51
	(0.03)	(0.1)	(0.03)	(0.1)	(0.04)	(0.09)
Elasticity at mean chara.	0.2	0.62	0.21	0.61	0.22	0.56
	(0.06)	(0.1)	(0.01)	(0.1)	(0.01)	(0.1)

Regressions include: Average wind speed, total rainfall, day of the week dummies, full set of month and year interactions, dummies for the number of consecutive days worked, being a holiday, being a holiday interacted with the number of income-earners in the household, and boat-owner dummies. Errors are corrected for the inclusion of a variable that it is itself estimated (Murphy-Topel, 1985)

Table 6: Liquidity Constraints

y=Pr(participation)	**Savings**	**Assets**	**Cut Meal**
	(1)	(2)	(3)
Predicted l(earnings)	1.399***	1.391***	1.393***
	(0.204)	(0.203)	(0.203)
Log (Last 7 days value of catches)	-0.143***	-0.145***	-0.144***
	(0.0325)	(0.0324)	(0.0323)
Savings*Predicted l(earnings)*10-5	-0.4540		
	(0.513)		
Savings*Log (Last 7 days value of catches)*10-5	-0.2100		
	(0.131)		
Assets*Predicted log (earnings)*10-5		-0.072	
		(0.18)	
Assets*Log (Last 7 days value of catches)*10-5		-0.01	
		(0.04)	
Cut meal*Predicted log (earnings)			-0.0518
			(0.0396)
Cut meal*Log (Last 7 days value of catches)			-0.0146
			(0.0097)
Observations	261,118	261,118	261,118
Mean participation	0.72	0.72	0.72
	(0.44)	(0.44)	(0.44)
Mean of ind. part. elasticities	0.57	0.57	0.57
	(0.1)	(0.1)	(0.1)
Elasticity at mean chara.	0.62	0.62	0.62
	(0.09)	(0.09)	(0.09)

Regressions include: Average wind speed, total rainfall, day of the week dummies, full set of month-year interactions, dummies for the number of consecutive days worked, being a holiday, being a holiday interacted with the number of income-earners in the household, and boat-owner dummies.
Errors corrected for the inclusion of an itself estimated variable (Murphy-Topel, 1985).

Table 7: Participation Equation and Elasticities: Alternative Specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Predicted log (earnings)	1.792***	1.793***	1.606***	1.543***	0.942***	0.969***	1.530***	1.173***
	(0.251)	(0.251)	(0.212)	(0.208)	(0.224)	(0.225)	(0.283)	(0.300)
Log (Last 7 days value of catches)	-0.211***	-0.211***	-0.182***	-0.172***	-0.0766**	-0.0810**	-0.170***	-0.113**
	(0.0398)	(0.0398)	(0.0336)	(0.0330)	(0.0356)	(0.0357)	(0.0449)	(0.0475)
Mean of ind. part elasticities	0.73	0.73	0.66	0.63	0.4	0.4	0.63	0.48
	(0.12)	(0.12)	(0.12)	(0.11)	(0.07)	(0.07)	(0.1)	(0.08)
Elasticity at mean chara.	0.79	0.79	0.71	0.68	0.42	0.43	0.68	0.52
	(0.11)	(0.11)	(0.09)	(0.09)	(0.1)	(0.1)	(0.12)	(0.13)
Observations	261,118	261,118	261,118	261,118	261,118	261,118	261,118	261,118
Included in the log-earnings equation:								
Phase of the Moon dummies		√	√	√	√	√	√	
Wind direction northeast	√	√	√	√		√	√	
Log (Real Exchange rate Rupee/Euro)	√	√	√	√	√	√		√
Log (Kerosene price)	√	√		√	√	√		√
Included in participation equation:								
Phase of the Moon dummies		√						
Wind direction northeast						√		
Log (Kerosene price)				√				
F-Excluded instruments	15.41	16.24	15.12	15.73	21.12	20.75	5.7	12.72

Regressions include: Average wind speed, total rainfall, day of the week dummies, full set of month and year interactions, dummies for the number of consecutive days worked, being a holiday,being a holiday interacted with the number of income-earners in the household, and boat-owner dummies.Errors are corrected for the inclusion of a variable that it is itself estimated (Murphy-Topel, 1985).

Table 8: Identification: Summary of variables included in each of the regressions

	Earnings Equations	Participation Equations
Log (Real exchange rate Rupee/Euro)	√	
Log (Kerosene price)	√	
Log (Price of calamari)	√	
Phases of the Moon dummies	√	
Wind direction Northeast	√	
Holiday dummies		√
Holiday*Num. income-earners		√
Log (Last 7 days value of catches)	√	√
Average wind speed (Km. per hour)	√	√
Total rainfall in milimiters	√	√
Day of the week dummies	√	√
Dummies for the number of days worked during the previous days	√	√
Full set of month-year interactions	√	√
Individual dummies	√	√