



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

## **Panel Data Evidence on the Determinants of Non-Timber Forest Products**

### **Extraction:**

### **The Case of Xate in Mexico**

Alejandro López-Feldman  
Department of Agricultural and Resource Economics,  
University of California, Davis  
feldman@primal.ucdavis.edu

*Selected Paper prepared for presentation at the American Agricultural  
Economics Association Annual Meeting, Providence, Rhode Island, July 24-27,  
2005*

#### **Abstract**

This paper examines the determinants behind households' decisions regarding non-timber forest products extraction in a setting where natural resources are common property. Data from Chiapas, Mexico, is used to estimate a selection model of xate palm (*Chamaedorea* spp.) extraction from the Selva Lacandona. Results show that individuals with low levels of human capital are more likely to extract wild xate than other individuals; the same is true for individuals from poor households.

JEL Codes: Q21, Q56 and D13

Keywords: Non-timber forest products, natural resource extraction, Chamaedorea, Mexico.

Copyright 2005 by Alejandro Lopez-Feldman. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

The data used in this research was obtained with the support of a UC MEXUS-CONACYT collaborative grant (2001 survey) and a UC MEXUS dissertation grant (2004 survey).

During the last fifteen years the commercial extraction of non-timber forest products (NTFP) from tropical forests has been considered as a strategy to promote forest conservation and at the same time alleviate poverty (Ros-Tonen, 2000; Angelsen and Wunder, 2003). This view of NTFP as a 'silver bullet' that can lead to a win-win situation is debated by studies that show that the effects of NTFP extraction on forest conservation and poverty reduction are ambiguous or even negative (Angelsen and Wunder, 2003; Browder, 1992; Lybbert et al., 2002; Wunder, 2001). In any case, it is clear that extraction of NTFP should be seen as part of a wider conservation strategy (which might include promotion of ecotourism and protected areas, among others) and not as a one-dimensional recipe to save the world's rainforest (Salafsky et al., 1993; Arnold and Ruiz-Perez, 2001).

This debate implies that the economic and biological characteristics of extractive activities need to be further analyzed before deciding if extraction of a particular set of NTFP can contribute to achieve, on a sustainable basis, conservation and poverty reduction. By explaining the economic logic behind rural households' decisions of time allocated to the extraction of NTFP, this paper attempts to shed some light on the debate.

Xate palm (*Chamaedorea* spp.), a marketable NTFP, is the product analyzed here. Xate palm leaves are used by the floral industry as a backdrop for flowers in wedding and funeral displays. They are also in demand during Easter season, particularly on Palm Sunday. The current interest of governments, non-governmental organizations, and the scientific community in the implications that extraction of xate palm leaves could have for conservation and development makes xate an ideal case study.

The main objective of this paper is to understand the determinants behind households' decisions regarding xate extraction in a setting where natural resources are common property. The interest lies mainly in answering the following questions: When all individuals in a village have access to a natural resource and extraction requires no physical capital, why do some individuals and households participate in extraction and others do not? Is there a positive relationship between poverty and xate extraction?

## **Background**

### *NTFP, Conservation, and Development*

At the end of the last century, development oriented non-governmental organizations (NGOs) became more concerned about the environment. Meanwhile, conservation organizations realized that in order to achieve their objectives they needed to look beyond plants and animals and incorporate the claims of rural poor communities into their agendas (Ruiz-Perez and Byron, 1999). As a result, both types of organizations began to work with communities to achieve conservation while increasing the income of their populations (Barham et al., 1999).

Around the same period of time, extraction of non-timber forest products as a way to conserve tropical forests gained attention. Non-timber forest products can be defined as all the biological material (other than industrial timber) extracted from forests for commercial, social, cultural or religious purposes (Wickens, 1991). The attention given to the commercial extraction of NTFP as a conservation and development strategy comes from the assumption that the forest will remain standing and relatively biologically unaffected even under sustained NTFP extraction (Neumann and Hirsch, 2000).

Some studies argued that sustainable exploitation of this 'subsidy from nature' was the most profitable and immediate way of promoting conservation and that governments and NGOs were not paying enough attention to this alternative (Hecht et al., 1988; Peters et al., 1989). Browder (1990 and 1992) responds to these claims by questioning the financial viability of extractive reserves<sup>1</sup> as well as their limited capacity to protect large forest areas. More recently, Wunder (2001) stated that there might be only a few synergies between development and forest conservation that lead to a win-win situation. According to him, from a conservation point of view it might be more effective to concentrate on the establishment and expansion of protected areas and conservation contracts than on sustainable development.

The role that NTFP extraction can actually play is case specific. As a result it has been argued that the effective implementation of conservation and development programs in rainforest areas requires an understanding of the microeconomic logic behind activity choice and resource use decisions among heterogeneous households (Coomes and Barham, 1997). Understanding how households decide their degree of involvement in extraction activities is fundamental to examine NTFP extraction as a conservation and development policy. In addition, the biological aspects of extraction should not be overlooked, in particular those related to the impacts that extraction could have on the spatial distribution and population dynamics of the resource in question as well as on the ecosystem.

Nevertheless, extraction of NTFP has rarely been studied from an integrated economic and biological perspective. Treatment of economics in the biological literature is

marginal, and economic studies of NTFP extraction usually assume that resources are abundant and that extraction has a negligible effect on their stock (Barrett and Arcese, 1998; Bluffstone, 1995; Damania et al., 2003, are some exceptions). This paper is a first step towards an integrated study of wild xate palm extraction.

### *Xate Palm*

Xate has gained the attention of national and international organizations as a possible source for promoting development and conservation. The efforts of Conservation International, US-AID and the local government to promote xate extraction in the Peten Region of Guatemala (Heinzman and Reining, 1990) are one example. More recently, the North American Commission for Environmental Cooperation began to evaluate the possibility of establishing a green market for xate under the presumption that it will lead to the conservation of forests and at the same time to the improvement of local economic conditions (Bowman, 2003; CEC, 2002). The Rainforest Alliance has also stated their interest in starting a management and marketing pilot project in Guatemala and Mexico (Rainforest Alliance 2005a).

Xate extraction is an important income generating activity for rural communities located in or around forests in these two countries (Endress et al., 2004; Sánchez-Carrillo and Valtierra-Pacheco, 2003). Mexico supplies 80% of all the world's xate and Guatemala 12% (Rainforest Alliance, 2005a). Recently, there have been some concerns about the sustainability of xate extraction from wild populations given the degree of extraction in both countries (CEC, 2002; Endress et al., 2004; Rainforest Alliance, 2005b).

In addition, and contrary to most NTFP, the impact that extraction of xate leaves has on the dynamics of xate palm populations is being studied to evaluate its implications for biological sustainability (Ackerly et al., 2003; Endress et al., 2004). These studies could provide the necessary information to incorporate the biological aspects of xate into an economic model of extraction.

### **Data and Field Site**

The data used here come from two household surveys applied in Frontera Corozal, Mexico, during the years 2001 and 2004.<sup>2</sup> In the first survey 100 randomly selected households were interviewed; these households were visited again during the summer of 2004.<sup>3</sup> Frontera Corozal is a village in the Selva Lacandona in the Mexican state of Chiapas. The Selva Lacandona is a tropical forest characterized by its importance in terms of biodiversity (it encompasses the Montes Azules UNESCO Biosphere Reserve) as well as by its archeological and cultural richness (SEMARNAP, 1996).

Xate is the most important NTFP in the region in terms of its contribution to cash income for the household (Vásquez-Sánchez et al., 1992). In Frontera Corozal, community members have exclusive rights to extract natural resources from the contiguous rainforest; nevertheless, there are no community rules on how these resources, including xate, should be managed (Sánchez-Carrillo and Valtierra- Pacheco, 2003; Tejeda, 2004). Xate can therefore be considered as an unmanaged common property resource. The term common property resource, as employed here, refers to a resource that is owned by a well-defined group whose members have the right to use the resource

and to exclude non-members from using it (Ciriacy-Wantrup and Bishop, 1975; Ostrom, 1990).

There are no contracts involved in xate extraction in Frontera Corozal. When the regional buyer is interested in purchasing xate a public announcement over the town's loudspeaker is made with several days notice. Households then decide whether they wish to participate or not and how much time they will allocate to the activity.

The state of xate in Frontera Corozal has been characterized as one of deterioration of the wild populations (Sánchez-Carrilo and Valtierra Pacheco, 2003; Tejeda, 2004). As an example of this Sánchez-Carrilo and Valtierra Pacheco discuss how hours of work per day in xate extraction increased from 1996 to 2001 while productivity per day went down. As figure 1 shows, this is consistent with the perceptions of those interviewed in the 2004 survey.

Unfortunately, there is no systematic information about how wild xate around Frontera Corozal has actually changed over time. It is important to clarify that the information needed includes the change over time in the availability of marketable xate leaves and not only the change in the stock of xate palms. This distinction is crucial since the extractor's situation is affected by changes in the amount of marketable leaves available and not necessarily by changes in the stock of xate palms. As has been shown by Endress et al. (2004), it is possible that xate extraction will lead to a situation in which the leaves produced by the palm are shrinking, thus becoming valueless for extractors even when the stock of palms is not decreasing, or at least not decreasing in an important way.



Figure 2 shows how participation in xate extraction has evolved over time during the period 1976-2004 for the members of the households interviewed in 2004. The trend reflects a notorious decrease in the number of individuals participating in xate extraction from wild populations during the last five years. The main reasons for this decrease in participation are xate scarcity, migration and the fear of snakebites (see figure 3).

Although in this paper I focus on the extraction of wild xate, it is important to mention that cultivation of xate has been increasing during the last years in Frontera Corozal. From August 2001 to August 2004 the number of hectares of xate cultivated by the households in the sample went from 24.75 to 44.25. In the same period the number of households that cultivated xate in their land went from 9 to 12. Finally, while the total number of days worked in wild xate extraction by the households in the sample decreased from 2,514 in 2001 to 1,707 in 2004, the number of days worked in cultivated xate extraction grew from 21 to 205.

Table 1 presents the variables that are included in the econometric model.<sup>4</sup> The information is divided in individual and household characteristics to emphasize that both will affect households' labor allocation decisions. Special interest lies in variables capturing the human capital of individuals and households, as well as in variables that proxy for wealth and physical capital of the household.

The individual's education is expected to negatively affect participation in xate extraction as well as days of work in xate because the marginal value of educated labor is likely to be higher in other activities (e.g., off-farm work) than in xate extraction. A similar reasoning is true for average education of other family members, except that in this case

the expected effect of education is due to a higher return in activities that potentially involve more than one member of the family (e.g., agriculture and family businesses).

Xate extraction in the rainforest is a physically demanding activity that involves walking long distances; it is therefore expected to see an inverted-U relationship between xate extraction and age. Although participation of women in xate is higher than in other activities (e.g., agricultural employment), it is still the case that extraction is an activity dominated by men; a positive relationship between the variable sex (1=male) is expected in both participation and days of xate work. The effect that the number of adults and the number of children in the household has on xate extraction is not clear ex-ante.

Wealth and physical capital variables are included to allow for the possibility of liquidity constraints that prevent individuals that belong to poorly endowed households from participating in more productive activities. The justification for this is that access to credit might be limited and dependent on endowments or might be inexistent, in which case individuals have to rely on self-financing their productive activities. The variables included to capture this are cattle holdings, land, a dummy variable for ownership of a car or a boat, and an index of family wealth. The index is constructed from dwelling characteristics and ownership of durable goods using principal components analysis following Filmer and Pritchett (2001). The index of wealth and the other three variables are expected to have a negative effect on xate extraction.

A dummy variable, "Tradition", which takes the value of one when the parents of the household head and/or the parents of the spouse have ever participated in the extraction of non-timber forest products, is included as an exclusion restriction in the

estimation of the participation equation. A year dummy and a variable that captures the number of other members in the household that extract xate are also included in the econometric estimation.

## Methods

### *Theory*

The economic analysis of xate extraction followed here is based on the household farm model. Households are assumed to maximize utility subject to an endogenous budget constraint that depends on their labor allocation decisions. For ease of notation it is assumed that in each household ( $i$ ) there are two working individuals ( $j = 1, 2$ ). Nothing is lost at this stage by making this assumption compared to a more general case with  $J$  individuals per-household. Without loss of generality only agricultural production, off-farm wage labor, and xate extraction are considered in the model as productive uses of labor, even though in practice individuals have a broader set of options to choose from. To simplify notation the household subscript  $i$  is omitted whenever it is possible.

The model is set up as a multi-period problem in which in principle households maximize utility over time. The objective of this is to have a model that is consistent with the econometric estimation of the determinants of labor supply. In addition, by allowing the inclusion of feedbacks between the resource stock and households' extraction decisions, the model could also serve as the theoretical base for a bioeconomic model. Households solve the following problem:

$$Max \sum_{t=0}^{\infty} \beta^t \cdot U(C_t^{ag}, C_t^M, l_{1t}, l_{2t}; F_t) \quad (a)$$

$$\begin{aligned}
s.t \quad & p_t^{ag} C_t^{ag} + p_t^M C_t^M = p_t^{ag} q_t^{ag} + p_t^x (q_{1t}^x + q_{2t}^x) + w(L_{1t}^w + L_{2t}^w) + E_t \\
& T = L_{1t}^{ag} + L_{1t}^w + L_{1t}^x + l_{1t} \\
& T = L_{2t}^{ag} + L_{2t}^w + L_{2t}^x + l_{2t} \\
& q_t^{ag} = q_t^{ag} (L_{1t}^{ag}, L_{2t}^{ag}; \mathbf{A}_t) \\
& q_{jt}^x = q_{jt}^x (L_{jt}^x; X_t, \boldsymbol{\theta}_{jt})
\end{aligned}$$

The details of the model are as follows:

1. Households maximize the discounted value of utility over consumption of an agricultural good  $(C_t^{ag})$ , an off-farm market good  $(C_t^M)$ , and leisure  $(l_{1t}, l_{2t})$ , given a vector  $\mathbf{F}_t$  of household and individual characteristics. The utility function,  $U(C_t^{ag}, C_t^M, l_{1t}, l_{2t}; \mathbf{F}_t)$ , is assumed to be quasiconcave and strictly increasing in consumption and leisure.  $\beta$  is a discount factor.
2. Households decide how to allocate the time of their working members  $(T_1 = T_2 = T)$  across four alternatives: leisure  $(l_{jt})$ , agriculture  $(L_{jt}^{ag})$ , off-farm work  $(L_{jt}^w)$  and xate extraction  $(L_{jt}^x)$ .
3. The production function of the agricultural good is  $q_t^{ag} = q^{ag}(L_{1t}^{ag}, L_{2t}^{ag}, \mathbf{A}_t)$ , where  $\mathbf{A}_t$  is a vector of physical capital (e.g., land) and other individual and household specific characteristics. It is assumed that no labor is hired in for agriculture.  $q^{ag}(\cdot)$  is concave and non-decreasing in its arguments.
4. The amount of xate leaves that an individual can extract at a given point in time is given by  $q_{jt}^x = q^x(L_{jt}^x, X_t, \boldsymbol{\theta}_{jt})$  where  $X_t$  is the stock of xate leaves available at

time  $t$  and  $\theta_{jt}$  is a vector of parameters that capture household and individual characteristics that explain ability in xate extraction. The market price of xate is  $p^x$  and the only cost of extraction is the time involved in the activity.

5. The time path of wild xate accumulation is represented by  $X_{t+1} = f(X_t, H_t)$ ,

where  $H_t = \sum_{i=1}^N \sum_{j=1}^2 q_{jit}^x$  is the amount of xate leaves extracted by each one of the

individuals from all the households at time  $t$ .

The xate that households extract is located in a common property rainforest and there are no capital requirements to participate in the activity. In this setting of unmanaged common property, households have limited incentives to incorporate in their maximization process the effects that their current extraction decisions have in the future. The result is the same as in a situation of open-access. At each period households solve static maximization problems considering the time path of the stock of wild xate, as well as the time path of all the exogenous variables, as given and out of their control (Bluffstone, 1995; Damania et al., 2003). As a result, problem (a) simplifies to maximization of utility in a period-by-period basis. Implicitly I am also assuming that there are no savings possibilities and that physical capital is taken as given, otherwise this simplification will not be possible.

By solving the F.O.C. of problem (a) the following set of reduced form equations for labor allocation are obtained:  $L_{jit}^{ag} = L_{jit}^{ag}(\mathbf{p}_t, X_t, \mathbf{F}_{jit}, \mathbf{A}_{jit}, \boldsymbol{\theta}_{jit})$ ,

$L_{jit}^w = L_{jit}^w(p_t, X_t, F_{jit}, A_{jit}, \theta_{jit})$ ,  $L_{jit}^x = L_{jit}^x(p_t, X_t, F_{jit}, A_{jit}, \theta_{jit})$ , where

$p_t = [p_t^{ag}, p_t^M, p_t^x, w_t]$ . The last equation is the one estimated here.

### *Empirical analysis*

As a result of the economic decision of maximization by labor allocation, some households decide to allocate labor from all or some of its members to xate extraction while others decide not to participate in the activity. This implies that the sub-sample of xate extractors is a self-selected sample in the sense that we observe days of xate work only for those that decide to participate. According to Vella (1998) if the unobservable factors determining inclusion in the sub-sample are correlated with the unobservables influencing the variable of primary interest, in this case days of work, there could be selection bias.

The econometric analysis that follows is based on the selection or type two tobit model, which explicitly accounts for selectivity. Under this model, in a first step (eq. 1) household  $i$  decides whether or not to allocate labor from individual  $j$  to xate extraction, then in the second step (eq. 2) determines how much labor from  $j$ , if any, will be allocated to xate extraction. The first step can be seen as comparing the shadow wage from xate labor to the shadow wage of other activities to decide if participation increases utility or not. Formally the econometric model is:

$$d_{jit}^{x*} = \delta + z_{jit}'\psi_z + s_{jit}'\psi_s + \varsigma \tau_t + v_{jit} \quad (1)$$

$$L_{jit}^{x*} = \alpha + z_{jit}'\beta_z + s_{jit}'\beta_s + \gamma \tau_t + u_{jit} \quad (2)$$

where  $L_{jit}^{x*}$  and  $d_{jit}^{x*}$  are latent variables. Vectors  $z_{jit}$  and  $s_{jit}$  include, respectively, the household and individual information contained in  $A$ ,  $F$ , and  $\theta$ . The superscripts in the vectors of exogenous variables emphasize that the two equations will not necessarily include the same variables. In particular, for correct identification there must be at least one variable in the selection model regressors (equation 1), that is not included in the second equation (Wooldridge, 2002).

When the same variables are included in both equations identification rests solely on the nonlinearity of the inverse Mills ratio calculation, which can lead to inflated standard errors and unreliable estimates of the parameters (Vella, 1998). In this study the exclusion restriction is a dummy variable (Tradition, see above) which is assumed to affect the probability of participation in xate extraction via a family acquired taste or ability for extractive activities. On the other hand, it is assumed that this family history of extraction does not affect the number of days that an individual participates in extraction once the influence in the probability of participation is accounted for. This is admittedly not a perfect exclusion restriction, if there exist such a thing, but is a defensible one that proves to work reasonably well for this data set.

It is important to notice that prices ( $p_t$ ) and the stock of xate ( $X_t$ ) are not included in the equations to be estimated, although they were part of the reduced form equations derived before. This is a consequence of the fact that the data available comes from a single village and prices do not vary across individuals during the same period of time. The same is true for wild xate stock that is extracted from common property. A

dummy variable ( $\tau = 1$  if  $t = 2004$ ) is included in the estimation to indirectly account for changes in prices and xate over time. Unfortunately, this procedure does not allow me to disentangle the effects of changes in prices from those of changes in xate stock or other variables that are constant across individuals but that change over time (e.g., weather).

Instead of observing the latent variables  $(d_{jit}^{x*}, L_{jit}^{x*})$  what we observe is a binary variable  $d_{jit}^x$  for the household decision of participating or not in xate extraction, and  $L_{jit}^x$  for the positive number of days of participation in the activity. Omitting the subscripts, this is equivalent to:

$$d^x = \begin{cases} 1 & \text{if } d^{x*} > 0, \\ 0 & \text{if } d^{x*} \leq 0, \end{cases} \quad (3)$$

$$L^x = \begin{cases} L^{x*} & \text{if } d^x = 1, \\ 0 & \text{if } d^x = 0. \end{cases} \quad (4)$$

Following Cameron and Trivedi (2005) the model defined by equations (1)-(4) is estimated by the Heckman two-step estimator. The first step requires the estimation of equation (4) using a probit model to obtain the inverse Mills ratio. In the second step this ratio is included as an extra regressor in an ordinary least squares regression of equation (5) that uses only information for the censored sample.

The probit model assumes that the error term in equation (4) is normally distributed. As explained by Wooldridge (2002), non-normality in the latent error means not only that the probit estimates will be inconsistent but also that there is a functional form



problem. Even though in many empirical studies the normality assumption is not tested, in this paper I test it following the approaches proposed by Pagan and Vella (1989) and Vella (1998) to ensure that the use of the probit model is valid for the data set analyzed.

Since there is no universally accepted goodness-of-fit measure for the probit model the area below the receiver operating characteristics (ROC) curve, as proposed by Cameron and Trivedi (2005), is used in addition to the pseudo  $R^2$ . The interpretation of this measure in simple terms is: the bigger the area under the ROC curve the better the model, in particular if this area is 1 the model is perfect; if the area is equal to 0.5 then the model has no predictive power.

The Heckman procedure might not perform well when errors are not normal (Kennedy, 2003). The normality assumption for the Heckman model is tested using the approach proposed by Vella (1998). Collinearity can explain a lot of apparent inconsistencies when estimating the Heckman model (Leung and Yu, 1996). In particular, it can explain why the coefficient of the Inverse Mills Ratio turns out to be insignificant in many empirical studies. Collinearity in the Heckman model is tested using the procedure proposed by Belsley et al. (1980).

## **Results**

Table 2 presents the results of the probit model of participation in wild xate extraction. Column 1 shows that individuals with a higher level of education are less likely to participate in xate extraction; the same is true about individuals belonging to households with a higher level of education (although the coefficient is not statistically different from zero). The wealth index, the dummy variable for capital ownership, and the amount of

cattle owned by the household, all have the expected negative impact in the probability of participation in xate extraction (the wealth index is not statistically different from zero).<sup>5</sup> These results indicate that individuals from households with relatively lower levels of human and physical capital or with less access to the latter are more likely to end up working on xate extraction.

As anticipated, a family history of participation in gathering and harvesting has a positive impact on wild xate participation. This variable could be capturing a higher marginal productivity of labor allocated to xate extraction due to familiarity with extractive activities. The negative sign of the year dummy reflects the decrease in participation that was shown in figure 2. Finally, the probability of participation follows a concave pattern with respect to age. This and the negative sign of the sex dummy are in part explained due to the fact that extracting xate from the rainforest is a physically demanding activity. Nevertheless, it has to be acknowledged that females and individuals at either end of the age distribution are less likely to participate in *any* activity.

By looking at the goodness of fit measures used here, Pseudo  $R^2$  and the area under the ROC curve, one can conclude that the probit model fits the data adequately. Furthermore, the tests of normality show that the null hypothesis of normality cannot be rejected, which also speaks in favor of the probit model.

Column 2 of table 2 shows the marginal effect that a change in an explanatory variable has in the probability of participation. As is well known, the marginal effects of non-linear models, like the probit and the Heckman models, are not constant and can be different for each observation. There are at least three ways of calculating the marginal

values of nonlinear models: using average values of the explanatory variables, calculating the marginal effect for each observation and then obtaining the average, and calculating the marginal effects for some different “typical” observations (Kennedy, 2003). The values presented in column 2 were obtained using the first method.

As an alternative way to illustrate the effect that a change in some of the explanatory variables will have on the probability of participation, figures 4 to 6 show the predicted probabilities of participation plotted against age, education and cattle holdings, respectively. Separate graphs are drawn for males and females to illustrate the differences in the magnitude of the effects across sex. Figure 4 shows how, depending on the age of the individual, the probability of participation changes, being as high as 20% (3% for females) when the individual is 36 years old. In the case of education, figure 5 shows that as education increases, the probability of participation goes down relatively fast from almost 15% for males with no schooling to less than 7% for males with 5 years of school. Finally, the effect that cattle holdings have on the probability of wild xate extraction is presented in figure 6, which shows that the probability goes from almost 10% for males that belong to households with no cattle holdings to less than 5% for those that belong to households with at least 10 animals. These figures illustrate how the marginal effects (the slopes of the curves) change depending on the particular values of the explanatory variables and therefore provide additional information to that included in the single number presented in column 2.

The results of the second step of the Heckman model are presented in table 3. As expected the signs of the coefficients of the explanatory variables are in most cases the

same as in the probit estimation (exceptions are the signs of the variables head, land, and year, but none of them is statistically different from zero). Of the variables related to human capital, to physical capital or to access to it, the only ones that are significant are education, household average education and cattle holdings. Individuals with low human capital (either own education or household education) or with low access to capital allocate more of their time to xate extraction. Males allocate considerably more time to xate extraction than females, and as was the case for the probability of participation, there is some indication that xate work is concave with respect to age.

The marginal effects of the Heckman model can be calculated with respect to the unconditional or conditional expected values. The former refers to the expected value over the whole sample while the latter refers to the value over the selected sub-sample. In the case of xate work and using the terminology presented in the theory section of this paper this refers to  $E[L^x]$  and to  $E[L^x | L^x > 0]$ , where expectation in both cases is conditional on the value of the explanatory variables. The marginal effects presented in table 3 refer to the conditional expected value, that is, with respect to expected days of xate work for those that participate in the activity.

As was done with the results of the probit model, a graphical approach is followed to present the effect that changes in age, education, and cattle holdings have on days of xate work (for those that participate). The graphs presented in figures 7 to 9 show the expected xate labor supplies as a function of age, education and cattle holdings, respectively.<sup>6</sup>

Figure 7 shows, unexpectedly, that labor allocation to xate conditional on participation is increasing with respect to age. According to this the expected value of xate labor goes from approximately 30 days for children to slightly over 70 for the elder. As expected, education has a negative effect on the supply of xate labor (see figure 8); xate work goes from over 50 days for males with no education to almost 30 for those with 9 years of education. A negative relationship is also apparent for cattle holdings (see figure 9). The results for the three graphs show that conditional on participation male and female expected labor allocation is not very different.

It is important to emphasize that the confidence intervals in the three graphs are not tight enough to guarantee that the slopes of the curves have actually the sign that they appear to have. Although this can explain the counterintuitive result for age it unfortunately also implies that with the data set at hand I cannot make any strong claims about the relationships illustrated in figures 7 to 9. A similar conclusion could be inferred from the standard errors of the marginal effects presented in column 2. Even though some of the coefficients in the second step of the Heckman model are significantly different from zero, none of the marginal effects is significant. As regrettable as this is, it clearly shows the importance not only of calculating marginal effects but also of obtaining their standard errors, a practice not very common in empirical papers that estimate nonlinear models.

The mills ratio is statistically different from zero, although weakly, indicating that selection bias is in fact an issue (see column 1). This low level of significance, as well as the wide confidence intervals in figures 7 to 9, and the high standard errors of the marginal effects in column 2, can be explained by the presence of collinearity in the explanatory

variables. Collinearity is revealed by the relatively high value of the condition number according to the criteria established by Belsley et al. (1980). Finally, the null hypothesis of normality cannot be rejected, which means that the Heckman model is adequate for the data set being analyzed.

## **Conclusion**

This paper identifies some of the basic characteristics of the individuals that participate in wild xate extraction and at the same time provides some information on the factors behind their degree of involvement in the activity. The main results show that individuals with low levels of human capital are more likely to extract wild xate than other individuals; the same is true for individuals from poor households (based on the wealth index, capital and cattle holdings).

One way to explain the role of human capital is by arguing that xate extraction has low returns to education. This is a consequence of the fact that xate extraction does not require any sophisticated skills, and management of the resource is not relevant given its unregulated common property nature. Therefore, it is likely that education will have relatively high returns in other activities.

Individuals that participate more in xate extraction are the ones with lower levels of physical endowments and wealth. This can be explained by arguing that the lack of liquidity or access to credit restricts them from participating in more productive self-employment activities, forcing them to rely on extraction as a second best option to allocate their time.

Although further investigation is required, these two aspects of the determinants of extraction might imply that xate extraction is good for preventing extreme poverty but not necessarily for lifting households out of poverty. If this is true, conservation and development policies based exclusively on the promotion of xate extraction might not achieve all of its objectives.

Throughout this paper I have argued that a key aspect to fully comprehend the implications of non-timber forest products extraction is to analyze the biological and economic conditions under which extraction takes place. Not doing so may compromise both development and conservation objectives.

The focus of this paper has been to obtain the determinants of participation in xate extraction. However, the basic framework to develop a bioeconomic model has been included in the setup of the theoretical model. In future work I will attempt to incorporate the biological information available into this economic analysis to achieve an understanding of the interactions between economic decisions and the state of the resource.

## Footnotes

<sup>1</sup> Roughly speaking, extractive reserves are forested areas from which inhabitants that have usufruct rights but not the right to sell or deforest the land, extract forest resources collectively managed.

<sup>2</sup> The information collected refers to the periods September 2000-August 2001 and September 2003-August 2004. For ease of exposition I will refer to the first twelve-month period as 2001 and to the second as 2004.

<sup>3</sup> During the second survey 14 households were lost from the sample, 6 due to migration and 8 because they refused to be re-interviewed. The lost households are not statistically different in observable variables from those that remained in the sample. It was decided therefore that sample bias due to attrition was not a concern, although I must admit that it is still possible that those households have different unobservable characteristics compared to those that remained in the sample. The econometric information presented in this paper comes from the 86 households that answered to both surveys.

<sup>4</sup> The sample consists of 391 individual observations for 2001 and 454 individual observations for 2004 from 86 households. All the individuals included in the sample are 10 years of age or older.

<sup>5</sup> Capital, cattle and wealth refer to values observed at the beginning of the year and are therefore considered as predetermined variables when the labor allocation decision takes place. In this way the potential endogeneity of these variables is less of an issue, and I can argue that they are in fact determinants of labor allocation and not the other way around.

<sup>6</sup> The graphs are plotted only over the range of values of the independent variable relevant for those that do participate in the activity and not over the whole range of possible values.



## References

- Ackerly, D., N. Anten, M. Martinez-Ramos, and T. Fransen. 2003. "Sustainable Harvesting of Xate Leaves at The Individual and Population Level." Working Paper.
- Angelsen, A., and S. Wunder. 2003. "Exploring the Forest-Poverty Link: Key Concepts, Issues and Research Implications." CIFOR Occasional Paper No. 40.
- Arnold, J., and M. Ruiz-Perez. 2001. "Can Non-Timber Forest Products Match Tropical Forest Conservation and Development Objectives?" *Ecological Economics*. 39: 437-447.
- Belsley, D., E. Kuh, and R. Welsch. 1980. *Regression Diagnostics*. Wiley.
- Barrett, C., and P. Arcese. 1998. "Wildlife Harvest in Integrated Conservation and Development Projects: Linking Harvest to Household Demand, Agricultural Production, and Environmental Shocks in the Serengeti." *Land Economics*. 74(4): 449-465.
- Barham, B., O. Coomes, and Y. Takasaki. 1999. "Rain Forest Livelihoods: Income Generation, Household Wealth and Forest Use." *Unasylva*. 198 (50): 34- 42.
- Bluffstone, R. 1995. "The effect of Labor Market Performance on Deforestation in Developing Countries under Open Access: An Example from Rural Nepal." *Journal of Environmental Economics and Management*. 29: 42-63.
- Bowman, J. 2003. "Unsustainable Palm Harvest Prompts Survey of Churches." *Trio*. The Newsletter of the North American Commission for Environmental Cooperation, Summer 2003.
- Browder, J. 1990. "Extractive Reserves Will not Save the Tropics." *BioScience*. 40(9): 626.

- \_\_\_\_\_. 1992. "The Limits of Extractivism: Tropical Forest Strategies Beyond Extractive Reserves." *BioScience*. 42(3): 174-184.
- Cameron, C., and P. Trivedi. Forthcoming. *Microeconometrics: Methods and Applications*. Forthcoming. Cambridge University Press.
- CEC 2002. *In Search of a Sustainable Palm Market in North America*. The Commission for Environmental Cooperation of North America.
- Coomes, O., and B. Barham. 1997. "Rain Forest Extraction and Conservation in Amazonia." *The Geographical Journal*. 163(2): 180-188.
- Ciriacy-Wantrup, S.V., and R. Bishop. 1975. "Common Property as a Concept in Natural Resources Policy." *Natural Resources Journal*. 15: 713-727.
- Damania, R., R. Stringer, K. Karanth, and B. Stith. 2003. "The Economics of Protecting Tiger Populations: Linking Household Behavior to Poaching and Prey Depletion." *Land Economics*. 79 (2): 198-216
- Endress, D., D. Gorchov, M. Peterson, and E. Serrano. 2004. "Harvest of the Palm *Chamaedorea radicalis*, its Effects on Leaf Production, and Implications for Sustainable Management." *Conservation Biology*. 18(3): 822-830.
- Filmer, D., and L. Pritchett. (2001). "Estimating Wealth Effects without Expenditure Data or Tears: An Application to Educational Enrollments in States of India." *Demography*. 38(1): 115-132.
- Hecht, S., A Anderson, and P. May. 1988. "The Subsidy from Nature: Shifting Cultivation, Successional Palm Forests, and Rural Development." *Human Organization*. 47(1): 25-34.

- Heinzman, R., and C. Reining. 1990. "Sustained Rural Development. Extractive Forest Reserves in the Northern Peten of Guatemala." TRI Working Paper # 37.
- Kennedy, P. 2003. *Guide to Econometrics*. 5<sup>th</sup> edition. The MIT Press.
- Leung, S.F., and S. Yu. 1996. "On the choice between sample selection and two-part models." *Journal of Econometrics*. 72: 197-229.
- Lybbert, T., C. Barrett, and H. Narjisse. 2002. "Market-Based Conservation and Local Benefits: The Case of Argan Oil in Morocco." *Ecological Economics*. 41: 125-144.
- Neumann, R., and E. Hirsch. 2000. "Commercialization of Non-Timber Forest Products: Review and Analysis of Research." CIFOR.
- Ostrom, E. 1990. *Governing the Commons*. Cambridge University Press.
- Pagan, A., and F. Vella. 1989. "Diagnostic Test for Models Based on Individual Data: A Survey." *Journal of Applied Econometrics*, 4(S) pp. S29-S59.
- Peters, C., A. Gentry, and R. Mendelsohn. 1989. "Valuation of an Amazonian Rainforest." *Nature*. 339: 655-656.
- Rainforest Alliance. 2005a. "Rainforest Alliance Projects in Mexico" [on line]. Available at <http://www.rainforest-alliance.org/locations/mexico/ra.html>
- Rainforest Alliance. 2005b. "Reliable Sources: Environmentally Sound and Socially Just Harvesting of Non-Timber Forest Products: Certified Chico Initiative at the Rainforest Alliance" [on line]. Available at <http://www.rainforest-alliance.org/programs/profiles/forestry-chico-initiative.html>

- Ruiz-Perez, M., and N. Byron. 1999. "A Methodology to Analyze Divergent Case Studies of Non-Timber Forest Products and Their Development Potential." *Forest Science*. 45(1): 1-14.
- Ros-Tonen, M. 2000. "The role of non-timber forest products in sustainable tropical forest management." *Holz als Roh- und Werkstoff* 58: 162-201.
- Salafsky, N., B. Dugelby, and J. Terborgh. 1993. "Can Extractive Reserves Save the Rain Forest? An Ecological and Socioeconomic Comparison of Nontimber Forest Product Extraction Systems in Petén, Guatemala, and West Kalimantan, Indonesia." *Conservation Biology*. 7(1): 39-52.
- Sánchez-Carrillo D., and E. Valtierra-Pacheco. 2003. "Social Organization for the Exploitation of Camedor Palms (*Chamaedorea* spp.) in the Lacandona Rainforest, Chiapas." *Agrociencia*. 37: 545-552.
- SEMARNAP. 1996. *Program de áreas naturales protegidas de México 1995-2000*. SEMARNAP, México.
- Tejeda Cruz C. 2004. "Apropiación territorial y aprovechamiento de recursos forestales en la comunidad Frontera Corozal, Selva Lacandona, Chiapas, México." Paper presented at the 10<sup>th</sup> congress of the International Association for the Study of Common Property.
- Vásquez-Sánchez, M.A., I.J. March, and M. Lazcano-Barrero. 1992. "Características Socioeconómicas de la Selva Lacandona." In Vásquez-Sanchez, M.A., and M.A. Ramos, eds. *Reserva de la Biósfera Montes Azules, Selva Lacandona: Investigación Para su Conservación*. Ecosfera

- Vella, F. 1998. "Estimating Models with Sample Selection Bias: A Survey." *The Journal of Human Resources*. 33(1): 127-169.
- Wickens, G. 1991. "Management issues for development of non-timber forest products." *UNASYLVA*. 42 (165):3-8.
- Wooldridge, J. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA. MIT Press.
- Wunder, S. 2001. "Poverty Alleviation and Tropical Forests – What Scope for Synergies?" *World Development*. 29 (11): 1817-1833.

Figure 1

Scarcity Perception

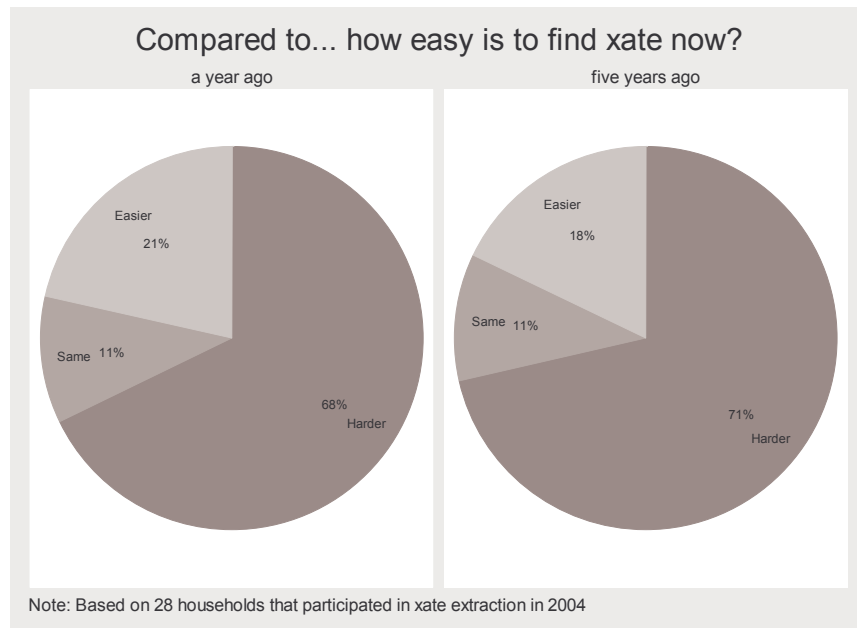


Figure 2

Evolution of Individual Participation in Wild Xate Extraction

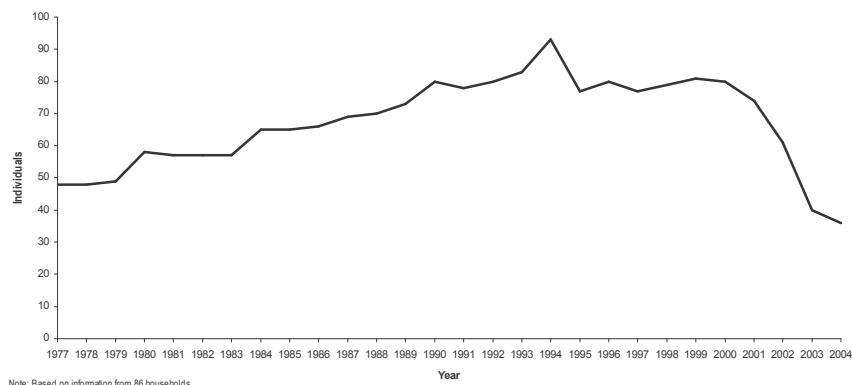
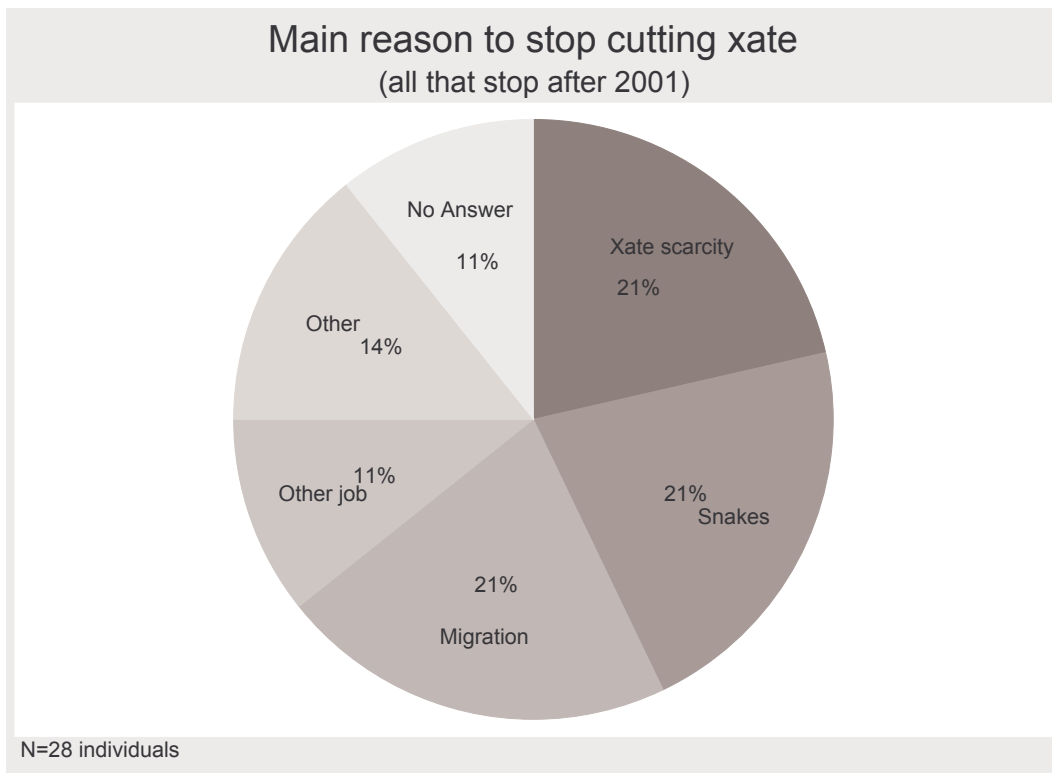


Figure 3



**Table 1. Descriptive Statistics**

Variable	Description	Mean	(s.e.)
Dependent Variables	Dxate	1= Participates in wild xate extraction	0.118
	Xatewk	Days of work in xate extraction	4.791 (18.185)
Individual Characteristics	Head	1= Individual is head of household	0.204
	Sex	1= Male	0.525
	Age	Age in years	27.221 (14.982)
	Educ	Years of education	5.013 (3.525)
	Otxateros	Number of xateros in household in addition to individual	0.444 (0.856)
Household Characteristics	Hheduc	Average education of other household members	4.337 (1.725)
	Adults	Number of adults in the household	5.825 (2.525)
	Child	Number of children in the household	1.717 (1.328)
	Land	Hectares of land (at beginning of the period)	46.618 (20.335)
	Capital	1= Owns a car or a boat (at beginning of the period)	0.119
	Cattle	Number of animals owned (at beginning of the period)	3.896 (10.845)
	Index	Household wealth index (Principal Components Analysis)	0.462 (1.352)
	Tradition	1= Parents of household head and/or spouse have a history of non-timber forest products extraction	0.461
	Year	1= 2004	0.537
	N	Pooled observations	845



**Table 2. Probit Results**

Dependent Variable:	Dxate	
	Coefficient	Marginal Effect
Head	0.264 [0.333]	0.017 [0.027]
Sex	1.063*** [0.303]	0.064*** [0.019]
Age	0.156*** [0.040]	0.002*** [0.001]
Age <sup>2</sup>	-0.002*** [0.001]	
Educ	-0.081*** [0.031]	-0.004*** [0.002]
Otxateros	0.562*** [0.085]	0.031*** [0.009]
Hheduc	-0.115 [0.081]	-0.006 [0.005]
Adults	-0.084 [0.052]	-0.005 [0.003]
Child	-0.013 [0.062]	-0.001 [0.003]
Land	0.004 [0.004]	0.0002 [0.0002]
Capital	-0.748* [0.454]	-0.025* [0.011]
Cattle	-0.041*** [0.016]	-0.002*** [0.001]
Index	-0.026 [0.068]	-0.001 [0.004]
Year	-0.259** [0.121]	-0.015** [0.008]
Tradition	0.420** [0.191]	0.025** [0.012]
Constant	-3.653*** [0.680]	-0.204*** [0.055]
Observations	845	
Pseudo R <sup>2</sup>	0.376	
Area under ROC curve	0.905	
P & V normality test	P>Chi <sup>2</sup> =0.843	
P normality test		
Skewness	P>F=0.956	
Kurtosis	P>F=0.938	

Cluster robust standard errors in brackets

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

**Table 3. Heckman Second Step Results**

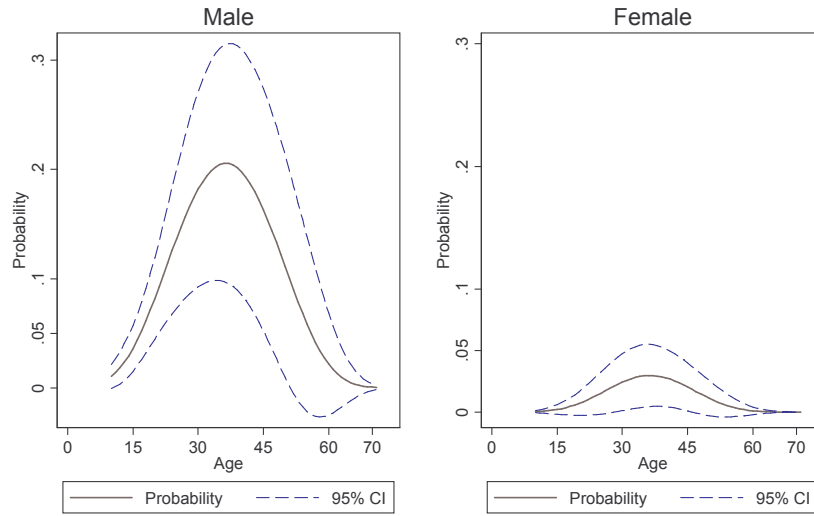
Dependent Variable:	Xatewk	
	Coefficient	Marginal Effect
Head	-6.102 [19.286]	-18.897 [26.227]
Sex	55.239* [29.759]	3.773 [44.723]
Age	7.921* [4.352]	0.587 [0.964]
Age <sup>2</sup>	-0.100* [0.061]	
Educ	-5.810** [2.892]	-1.877 [3.963]
Otxateros	21.400 [13.228]	-5.810 [21.021]
Hheduc	-9.117* [4.798]	-3.571 [6.957]
Adults	-0.923 [4.773]	3.160 [5.867]
Child	-5.953 [3.858]	-5.331 [4.940]
Land	-0.122 [0.254]	-0.305 [0.598]
Capital	-5.247 [37.352]	30.969 [48.21]
Cattle	-3.073* [1.894]	-1.110 [2.344]
Index	-4.464 [3.839]	-3.181 [5.211]
Year	6.369 [10.289]	18.899 [13.901]
Constant	-151.982 [107.490]	
Mills Ratio	54.705* [31.66]	
Observations	845	
P normality test	P>F=0.755	
Condition number	148.76	

Cluster robust standard errors in brackets

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

**Figure 4**

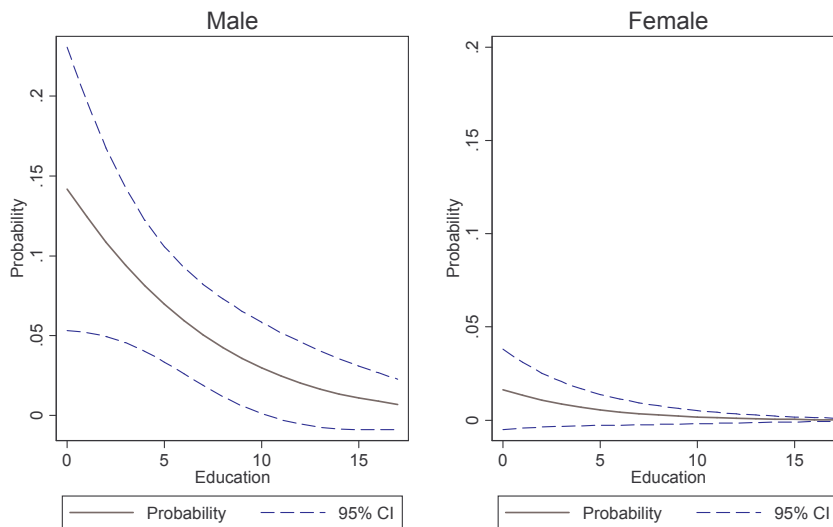
**Predicted Probability of Participation in Xate Extraction**



Note: All variables except Age are set at mean values

**Figure 5**

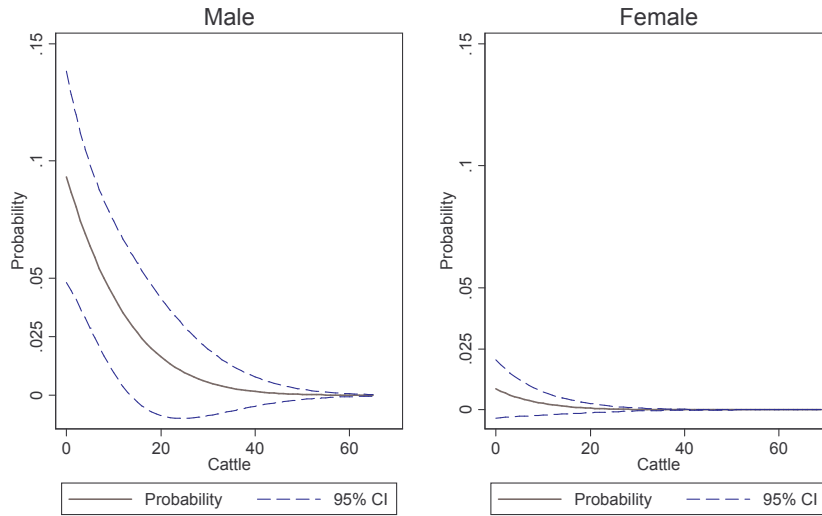
**Predicted Probability of Participation in Xate Extraction**



Note: All variables except Education are set at mean values

**Figure 6**

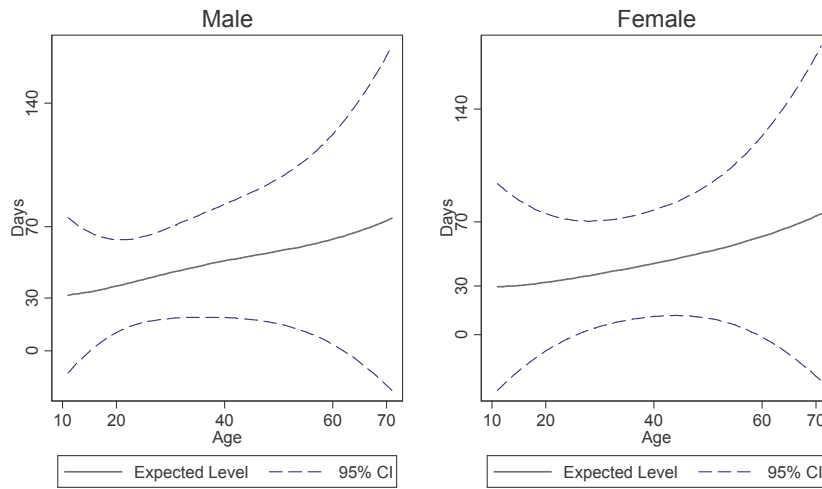
**Predicted Probability of Participation in Xate Extraction**



Note: All variables except Cattle are set at mean values

**Figure 7**

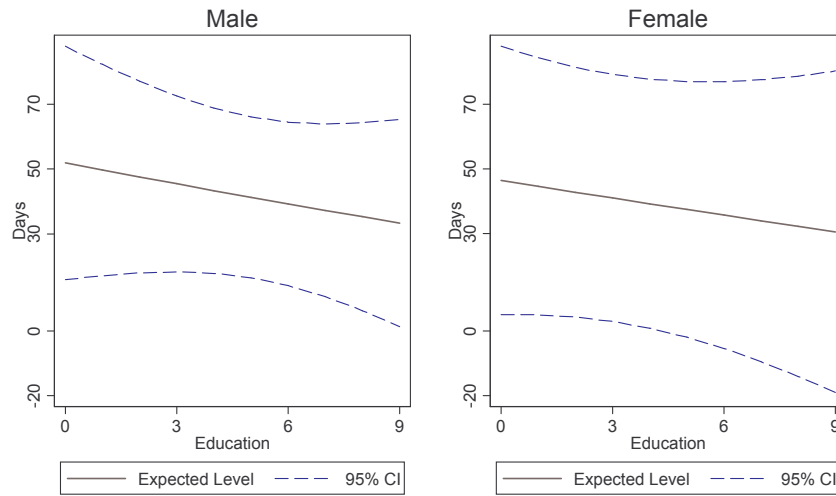
**Expected Level of Xate Work for Xateros**  
 $E[Lx|Lx>0]$



Note: All variables except Age are set at mean values

**Figure 8**

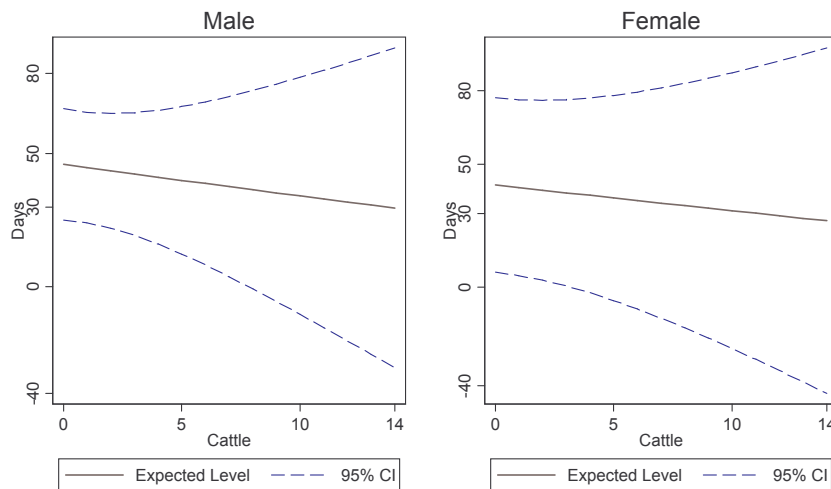
Expected Level of Xate Work for Xateros  
 $E[Lx|Lx>0]$



Note: All variables except Education are set at mean values

**Figure 9**

Expected Level of Xate Work for Xateros  
 $E[Lx|Lx>0]$



Note: All variables except Cattle are set at mean values

