Does Natural Resource Extraction Mitigate Poverty and Inequality? Evidence from Rural México

Alejandro López-Feldman*
Jorge Mora
J. Edward Taylor

Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Long Beach, California, July 23-26, 2006

An extended version of this paper will appear in *Environment and Development Economics*.

---

* Corresponding author, email: feldman@primal.ucdavis.edu
The authors are, respectively, Post-Doctoral Fellow at the Center for U.S.-Mexican Studies, University of California, San Diego; Post-Doctoral Fellow, Economic Studies Center, El Colegio de México; and Professor, Department of Agricultural and Resource Economics, University of California, Davis. Taylor is a member of the Giannini Foundation of Agricultural Economics. Critical financial support was provided at various stages of this research by the William and Flora Hewlett Foundation, the Fulbright program, México's Consejo Nacional de Ciencia y Tecnología (CONACYT), the U.S. Department of Agriculture (USDA/NRI), the University of California Institute for México and the United States (UCMEXUS) and the Institute of International Education's *Programa Regional de Becas de Posgrado en Ciencias Sociales* (funded by the Ford Foundation, the William and Flora Hewlett Foundations and the MacArthur Foundation).

Does Natural Resource Extraction Mitigate Poverty and Inequality?
Evidence from Rural México

I. Introduction

The potential importance of natural resources in rural household livelihoods has long been recognized (Cavendish, 1999; Sunderlin et al., 2003). In many cases households living in natural resource rich environments are poor, particularly in developing countries, and although natural resources may prevent or reduce poverty, the dependence on them can also perpetuate poverty. The evidence that exists to date, mostly from studies of forests and poverty, is inconclusive (Angelsen and Wunder, 2003; Wunder, 2001).

Quantitative studies of the relationship between natural resources, poverty and inequality are scarce (see Cavendish, 1999; Reddy and Chakravarty, 1999; Fisher, 2004; and, Mahapatra et al., 2005). In this paper we examine distributional and poverty effects of natural resource extraction at the national, regional and community level. In particular we analyze how poverty and inequality change if income from natural resources is not considered when calculating total household income. The marginal impact that a change in price (or in availability) of resources has on inequality is also described using Gini decomposition techniques. Finally, with information from a community in the Lacandona Rainforest (Selva Lacandona) and by using simulation analysis, the short-run poverty effects of changes in the price of a specific non-timber forest product (the xate palm) are evaluated.

II. Data and Methods

Data for this research are from the México National Rural Household Survey (Encuesta Nacional a Hogares Rurales de México, or ENHRUM) and from a household survey in the Selva Lacandona. Both surveys provide detailed data on assets, socio-demographic characteristics, production and income sources. The ENHRUM surveyed a nationally representative sample of rural households in

January and February 2003. The present research uses the México sample as well as the sub-sample for the South-Southeast region. We decided to analyze this region because of its importance in terms of natural resources availability and because it is where the community that serves as our case study is localized.

The Selva Lacandona survey was implemented in Frontera Corozal, Chiapas in August 2001; the sample includes 98 randomly selected households that represent more than 10% of the total community population. Data from these surveys make it possible to quantify natural resource extraction at the household level, as well as to test for influences of this activity on rural households' total income, on income inequality, and on poverty.

The welfare measure used in this research is per capita net income. The poverty line used is the one calculated by the Mexican government as the monthly per capita income necessary to purchase a basic basket of food in rural areas; 495 pesos of 2002 (SEDESOL 2002).

Poverty Measures

To measure poverty and the impacts of natural resource income in poverty we use three variants of the Foster-Greer-Thorbecke (1984) poverty index. The FGT index is calculated using the formula:

$$FGT(\alpha) = \frac{1}{N}\sum_{i=1}^{N} I\left(1-\frac{y_i}{z}\right)^{\alpha} \tag{1}$$

where $I = 1$ if $y_i \leq z$ and zero otherwise. Per capita income is represented by y_i, z is the poverty line, N is the population size and α is a weighting parameter.

When $\alpha = 0$ the formula represents the incidence or headcount of poverty, that is, the percentage of poor in the population. The poverty gap or poverty intensity is obtained when $\alpha = 1$. This measure illustrates how far below the poverty line the average poor household's income falls. Finally, when $\alpha = 2$ we have the poverty severity index, which accounts for inequality among the poor by putting greater weight to those individuals that are further away from the poverty line (Foster, et al., 1984). In our simulations of the impacts of natural resource income on poverty we use the property of the FGT index of being decomposable by income source (Reardon and Taylor, 1996).

Inequality Measures

Of the various inequality indices that satisfy the five basic properties mentioned by Ray (1998), we decided to use the Gini coefficient, which is probably the most intuitive with its neat correspondence to the Lorenz curve and easy-to-interpret decompositions of income effects.

Following Lerman and Yitzhaki (1985), the Gini coefficient for total income inequality, *G*, can be represented as:

$$G = \sum_{k=1}^{K} S_k G_k R_k \qquad (2)$$

where S_k represents the share of component k in total income, G_k is the source Gini, corresponding to the distribution of income from source k, and R_k is the Gini correlation of income from source k with the distribution of total income.

Equation (2) allows us to decompose the influence of any income component, in our case natural resources, upon total income inequality, as the product of three easily interpreted terms:

a) how important the income source is with respect to total income (S_k)

b) how equally or unequally distributed the income source is (G_k)

c) whether or not the income source is correlated with total income (R_k)

If income from natural resources is unequally distributed and flows disproportionately towards households at the top of the income distribution (R_k is positive and large), its contribution to inequality will be positive. However, if it is unequally distributed but targets poor households, income from natural resources may have an equalizing effect on the rural income distribution, and the Gini coefficient may be lower with natural resource income than without it.

Using the Gini decomposition, we can estimate the effect of small changes in natural resource income on inequality, holding income from all other sources constant. To do so we use the decomposition of the Gini coefficient by income source proposed by Lerman and Yitzhaki (1985). Consider a small change in income from source k equal to ey_k where e is close to 1, then it can be shown that the partial derivative of the Gini coefficient with respect to a percentage change e in source k is equal to:

$$\frac{\partial G}{\partial e} = S_k \left(G_k R_k - G \right) \quad (3)$$

The percentage change in inequality resulting from a small percentage change in income from source k equals the initial share of it in inequality minus the share of it in total income.

III. Empirical Analysis

The role of natural resources in poverty alleviation is analyzed from two perspectives. First we calculate the FGT measures with and without income from natural resources. This provides us with an estimate of what will happen in terms of poverty if the resource was no longer available irrespective of the cause (e.g., due to a specific policy or due to depletion). It alternatively provides us with an estimate of the magnitude by which poverty will be overstated if information from natural resource income is not included in the estimation of total income. We perform these calculations for México, the South-Southeast region and Frontera Corozal. We then concentrate on the case study of Frontera Corozal, analyzing the impacts that changes in the price of a particular non-timber forest product, xate palm, have on poverty at the community level.

We analyze the role that income derived from natural resource extraction plays in the income distribution using two strategies. The first is to calculate the Gini coefficient with and without income from natural resources. The second is to decompose inequality by income sources to obtain the percentage changes in inequality due to a percentage change in each source of income. This is done using the data at the national, regional and community levels.

Other researchers have used similar approaches to analyze the impacts of natural resource income on poverty and/or inequality; however, we do not know of any study that has applied this method to México or simulated the impacts of price changes of a particular NTFP.

Natural Resources and Poverty

The first step to simulate the impacts of natural resource income in poverty is to estimate three variants of the FGT index (for $\alpha = 0,1,2$) using equation (1) and including income from natural resources. Then we recalculate the three measures assuming that natural resource income is equal to zero.

Table 1 presents results for the poverty experiments. Increases in poverty when we do not consider income from natural resources are all significantly different from zero. Nevertheless, the effect on poverty is substantially lower for all of rural México than for the other two samples. For example, for México the FGT index with $\alpha = 2$ increases by 10.8% as a result of not considering natural resources, compared with increases of 17.1% and 18.4% for the region and community. The headcount measure shows that the number of poor will increase 2 percentage points at the national level and 3.5 percentage points in Frontera Corozal. The poverty gap measure reveals a similar pattern of greater sensitivity of poverty at the regional and community levels.

These differences are explained by the fact that in the national sample a smaller proportion of households' income is captured by natural resources than in the South-Southeast region and Frontera Corozal. This is not a surprising result considering that this region is relatively more abundant in natural resources than the country as a whole.

Simulation of Poverty and NTFP Price Changes in Frontera Corozal

For the case of Frontera Corozal we simulate the short-term impacts that changes in the price of a non-timber forest product have on poverty at the community level. Xate palm (*Chamaedorea* spp.), a marketable NTFP, is the product analyzed. 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. Xate is the most important NTFP in the Lacandona region in terms of its contribution to households' cash income (Vásquez-Sánchez et al., 1992).

Xate has gained the attention of national and international organizations as a possible source for promoting development and conservation. Recently, the North American Commission for Environmental Cooperation (CEC) 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 improve local economic conditions (Bowman, 2003; CEC, 2002).

The experiment that we undertook to evaluate the potential impacts of xate price changes in poverty was to calculate the three FGT measures for different price changes. The price decreases (25%, 50% and 100%) simulate a hypothetical situation in which the demand for xate goes down, including an extreme scenario in which no xate is demanded at all. As can be seen in figures 1.a to 1.c, the extreme case implies an increase of almost 5% in the poverty headcount measure, 11% in the poverty gap, and 18% in the severity of poverty. The simulation of price increases (25%, 50% and 100%) represents a first approach towards understanding the potential impacts that the creation of a green market for xate could have on terms of poverty alleviation. Figure 1.a shows that a 100% price increase[1] implies a 6% decrease in the headcount measure. Figures 1.b and 1.c show an 8% and 11% decrease in the poverty gap and severity measures

[1] Not too extreme considering the results of a survey that shows that Christian congregations in the US would be willing to double the price they pay for palms if they are harvested in a sustainable way (CEC, 2005).

when the price of xate doubles. The confidence bounds show that all these changes are statistically different from zero.

It is important to recognize that these results assume that households do not change their allocation of labor in response to xate price changes. That is, during the simulation exercise the intensity of xate extraction is kept constant irrespective of prices. Even though the assumption of no labor reallocation is a strong assumption, the resulting changes in poverty measures due to a price decrease can be seen as short-run upper bounds and the changes due to price increases as short-run lower bounds on poverty reductions. Another implicit assumption in this analysis is that in the short-run xate availability remains unchanged. In order to obtain long-run conclusions we need to simulate the impacts that changes in prices have not only on labor allocation and intensity of extraction but also on the stock of xate available. This is the subject of future research.

Natural Resources and Inequality

A decomposition of income inequality is provided in Table 2. This table presents the contributions of income sources to per capita total income and income inequality in our data sets. The first column, S_k, presents the share of each income source in the per capita rural income for each level of data. The contribution of income from natural resources goes from 2.3% for the country to 7.3% for the community sample.

The second column of Table 2, G_k, presents the Gini coefficient for each income source. Inequality in the distribution of natural resource income is relatively high; G_k for natural resource income is 0.80, 0.71, and 0.77 in the national, regional and community samples. These high values for the source specific Gini coefficients can be partially explained by the fact that many households do not participate in extraction, implying that many zeros are included in the source Gini calculations (the same is true for other income sources, e.g., remittances).[2]

As indicated earlier, a high income source Gini (G_k) does not necessarily imply that an income source has an unequalizing effect on total income inequality. An income source may be unequally distributed yet favor the poor. This is the case for natural resources in all of our samples. The Gini correlation between natural resources and the distribution of total per capita income (R_k) ranges from 0.11 (national sample) to 0.34 (community sample), and it is the lowest of all income sources in the national sample. At the national level, because of the low Gini correlation between natural resources and total-income rankings, the percentage contribution of this income source to inequality (0.3%) is smaller than the percentage contribution to income (2.3%). Thus, natural resources have an equalizing effect on the distribution of total rural income. A 10% increase in income from natural resources, other things being equal, reduces the Gini coefficient of total income by 0.2%, and this change is statistically significant.

Income from natural resources is also equalizing in the South-Southeast region and in Frontera Corozal; a 10 % increase in natural resource income reduces the Gini coefficient by 0.36% and 0.11%, respectively, in these two samples. The change is statistically significant at the regional level but it is not statistically different from zero in Frontera Corozal.

Table 3 presents the Gini coefficients resulting from the simulation exercise of not considering income from natural resources. This exercise points out the importance of natural resource income in reducing rural income disparities. At the national level, the Gini coefficient increases by 2.4% when natural resource income is ignored. The effect is higher in the South-

[2] In Table 2, the Gini coefficient for family production is higher than 1.0. This does not imply perfect income inequality, but rather reflects the presence of some negative income values. Income-source Gini coefficients greater than 1.0 have been reported elsewhere in the literature (e.g., Lerman and Yitzhaki, 1985).

Southeast region; the Gini increases 4.8% when natural resource income is not considered. In Frontera Corozal it increases by 4.3%.

IV. Conclusions

Our findings highlight the importance of income from natural resource extraction in alleviating poverty and income inequality in México as well as in the resource-rich South-Southeast region and in the Lacandona Rainforest community of Frontera Corozal. Natural resource extraction is an important source of income for many rural households. Without it, many households' ability to meet their basic needs would be jeopardized.

Results from the simulation of price increases of xate in Frontera Corozal show that poverty can be reduced, at least in the short-run, via this price mechanism. Nevertheless natural resources represent both an opportunity and a challenge. One should not be overly optimistic about the potential of promoting the extraction of xate, or other natural resources, as a poverty alleviation tool before carefully considering the long-term ramifications. Sustained price increases could lead to overexploitation of the resource, leaving everyone worse off when the resource is exhausted and the income source lost.

The interrelationships between extraction decisions and the resource base as well as the circumstances surrounding price increases will determine in the end whether this perverse outcome is observed or not. They should be carefully weighed before implementing policies to achieve poverty alleviation via the promotion of natural resource extraction (e.g., the creation of green markets).

References

Angelsen, A. and Wunder, S., 2003. Exploring the Forest-Poverty Link: Key Concepts, Issues and Research Implications*,* CIFOR Occasional Paper No. 40.

Bowman, J., 2003. Unsustainable Palm Harvest Prompts Survey of Churches, The Newsletter of the North American Commission for Environmental Cooperation, Summer 2003.

Cavendish, W., 1999. Poverty, Inequality and Environmental Resources: Quantitative Analysis of Rural Households, Working Paper Series 99-9, Center for the Study of African Economies, Oxford.

CEC, 2002. In Search of a Sustainable Palm Market in North America, The Commission for Environmental Cooperation of North America.

CEC, 2005. Churches to celebrate Palm Sunday with 'eco-palm' for first time, http://www.cec.org/news

Fisher, M., 2004. Household Welfare and Forest Dependence in Southern Malawi, Environment and Development Economics 9: 135-154.

Foster, J., Greer, J., and Thorbecke, E., 1984. A Class of Decomposable Poverty Measures, Econometrica 52(3): 761-766.

Lerman,R. and Yitzhaki, S., 1985. Income Inequality Effects by Income Source: A New Approach and Applications to the United States, The Review of Economics and Statistics 67(1): 151-156.

Mahapatra, K. A., Albers, H., and Robinson, E., 2005. The Impact of NTFP Sales on Rural Households' Cash Income in Inida's Dry Deciduous Forest, Environmental Management 35(3): 258-265.

Ray, Debraj, 1998. Development Economics, Princeton: Princeton University Press.

Reardon, T. and Taylor, J.E., 1996. Agroclimatic Shock, Income Inequality, and Poverty: Evidence from Burkina Faso, *World Development 24(5): 901*-914.

Reddy, S. and Chakravarty, S., 1999. Forest Dependence and Income Distribution in a Subsistence Economy: Evidence from India, World Development 27(7): 1141-1149.

SEDESOL, 2002. Nota técnica para la medición de la pobreza con base en los resultados de la Encuesta Nacional de Ingresos y Gastos de los Hogares*,* http://www.sedesol.gob.mx/subsecretarias/prospectiva/medicion_pobreza

Sunderlin, W., Angelsen, A., and Wunder, S., 2003. Forests and Poverty Alleviation, in State of the World's Forests, Rome: FAO.

Vásquez-Sánchez, M.A., March, I.J., and Lazcano-Barrero M.A., 1992. Características Socioeconómicas de la Selva Lacandona, in M.A. Vásquez-Sanchez and Ramos, M.A., eds., Reserva de la Biósfera Montes Azules, Selva Lacandona: Investigación Para su Conservación, eds., Chiapas: Ecosfera.

Wunder, S., 2001. Poverty Alleviation and Tropical Forests – What Scope for Synergies?, World Development 29 (11): 1817-1833.

Table 1. FGT Index With and Without Income from Natural Resources (NR)

Index	México	South-Southeast Region	Frontera Corozal
FGT (0)			
Without NR	0.446	0.717	0.810
With NR	0.428	0.686	0.775
Difference	0.018	0.031	0.035
	(0.015, 0.022)	(0.023, 0.040)	(0.020, 0.054)
FGT (1)			
Without NR	0.257	0.406	0.389
With NR	0.235	0.364	0.350
Difference	0.022	0.042	0.039
	(0.020, 0.023)	(0.037, 0.046)	(0.034, 0.046)
FGT (2)			
Without NR	0.205	0.288	0.219
With NR	0.185	0.246	0.185
Difference	0.020	0.042	0.034
	(0.019, 0.022)	(0.037, 0.046)	(0.028, 0.040)
N =	7047	1515	559

Note: All measures use household per capita income attributed to individuals and are calculated on an individual basis. 95% bootstrapped percentile confidence intervals in parentheses.

Table 2. Gini Decomposition by Income Source

Income Source	Share in Total Income (S_k)	Income Source Gini (G_k)	Gini Correlation with Total Income Rankings (R_k)	Share in Total-Income Inequality	% Change in Gini from a 10% Change in Income Source
México					
Family production	0.265	1.015	0.786	0.357	0.92 (0.70, 1.21)
Wages	0.541	0.667	0.804	0.491	-0.51 (-0.75, -0.23)
Natural resources	0.023	0.803	0.109	0.003	-0.20 (-0.23, -0.18)
Government Transfers	0.044	0.766	0.236	0.013	-0.30 (-0.35, -0.26)
Remittances	0.127	0.927	0.681	0.135	0.08 (-0.05, 0.24)
Total income		0.592			
N = 7047 individuals					
South-Southeast Region					
Family production	0.293	0.992	0.799	0.418	1.26 (0.62, 2.02)
Wages	0.442	0.672	0.766	0.411	-0.32 (-0.99,0.44)
Natural resources	0.062	0.711	0.326	0.026	-0.36 (-0.45, -0.28)
Government Transfers	0.099	0.587	0.178	0.019	-0.80 (-0.98, -0.62)
Remittances	0.104	0.937	0.722	0.127	0.23 (-0.06, 0.57)
Total income		0.555			
N = 1515 individuals					
Frontera Corozal					
Family production	0.343	0.552	0.769	0.479	1.36 (0.48, 2.79)
Wages	0.296	0.628	0.585	0.359	0.63 (-0.80, 1.55)
Natural resources	0.073	0.772	0.335	0.062	-0.11(-0.55, 0.32)
Government Transfers	0.273	0.295	0.377	0.100	-1.73 (-2.21, -1.03)
Remittances	0.015	0.971	-0.014	-0.001	-0.15 (-0.60, 0.31)
Total income		0.304			
N = 559 individuals					

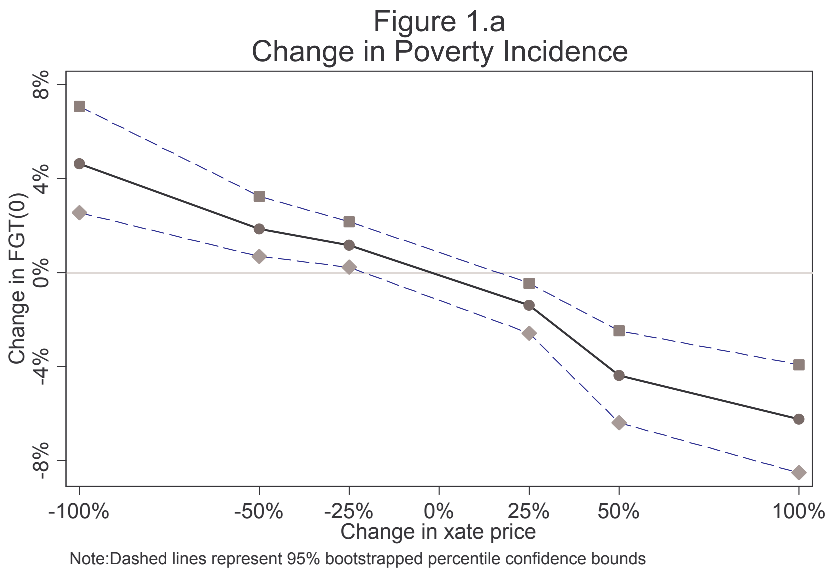
Note: All measures use household per capita income attributed to individuals and are calculated on an individual basis. 95% bootstrapped percentile confidence intervals in parentheses.

Table 3. Gini Coefficients With and Without Income from Natural Resources (NR)

Index	México	South-Southeast Region	Frontera Corozal
Gini without NR	0.606	0.583	0.317
Gini with NR	0.592	0.555	0.304
Difference	0.014	0.028	0.013
	(0.013, 0.015)	(0.025, 0.031)	(0.007, 0.021)
N =	7047	1515	559

Note: All measures use household per capita income attributed to individuals and are calculated on an individual basis. 95% bootstrapped percentile confidence intervals in parentheses.

Figure 1. Percentage Changes in Poverty



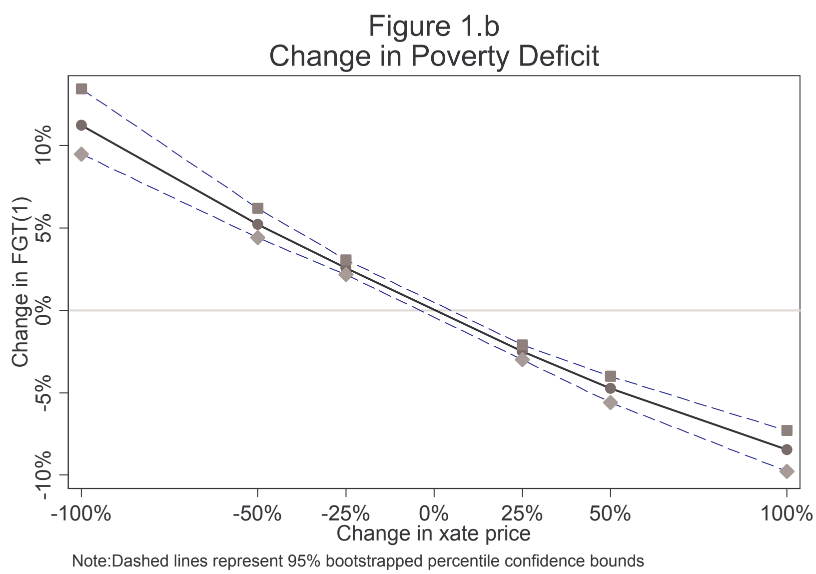
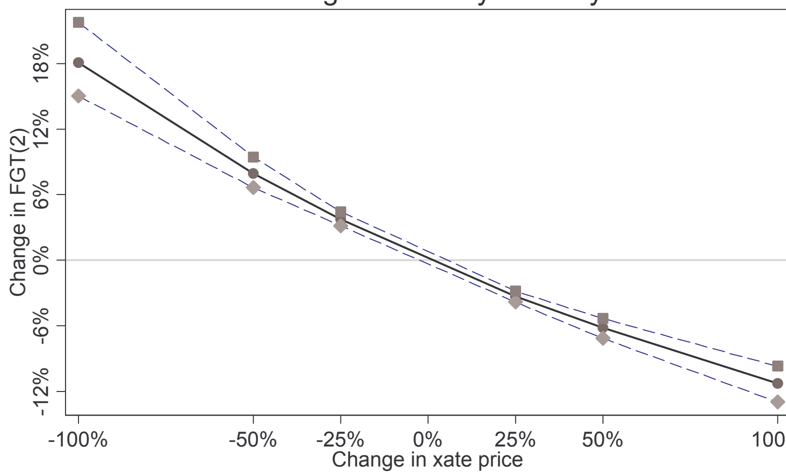


Figure 1.c
Change in Poverty Severity



Note:Dashed lines represent 95% bootstrapped percentile confidence bounds