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The Role of Tenure Security and Private Time Preference in Neotropical Deforestation

Ricardo Godoy, Marc Jacobson, Joel De Castro, Vianca Aliaga, Julio Romero, and Allison Davis

ABSTRACT. A survey of 209 Chimane Amerindian households in 18 villages in the Bolivian rain forest was done to examine the role of tenure security and private time preference on the clearance of old-growth forest. Results of Tobit regressions suggest that conflict with abutters was associated with more deforestation, but the average impatience of the household heads was associated with less deforestation. Results suggest that governments should protect the land rights of indigenous people if they wish to enhance conservation. Results cast doubts on the idea that high private time preference increases the depletion of natural resources. (JEL Q23, 013)

I. INTRODUCTION

Economic theory suggests that insecure rights of ownership to land (Bohn and Deacon 1996) and high private discount rates should increase deforestation if: (i) forests are managed communally or as an open-access resource and (ii) the clearance of old-growth forest is a first step in claiming rights of private ownership to land. But quantitative evidence for how insecurity of land tenure affects tropical deforestation is scant and contradictory, and evidence for how private valuations of the future affect deforestation does not exist.

In this article we take a first step in filling these gaps by presenting the analysis of a recent household survey and experimental study among Chimane Amerindians in the Bolivian rain forest. In the survey we collected demographic and socioeconomic information to assess the effect of tenure security and private discount rates on the clearance of old-growth rain forest. We focus on the cutting of old-growth rain forest because it contains more biological diversity than secondary-growth forest (Frumhoff

1995; Saldarriaga et al. 1985; Lawrence, Leighton, and Peart 1995), though secondary-growth forest can also be rich in species (Finegan 1996; Silver, Brown, and Lugo 1996; Denevan 1992).

The study is novel in two ways. First, unlike many previous quantitative studies of deforestation (e.g., Bohn and Deacon 1996; Deacon 1994; Southgate, Sierra, and Brown 1991) we use primary information, which allows us to assess the effect of variables which are hard to control when using secondary information. Second, we test for the first time the hypothesized positive link between private discount rates and deforestation.

The choice of the Chimane to study these topics is ideal for two reasons. First, the Chimane manage natural resources communally but have faced growing encroachment from loggers and cattle ranchers since the 1970s. Second, villages and households display much variance in the amount of encroachment they face and in their participation in the market.

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II. THE ROLE OF TENURE SECURITY AND PRIVATE TIME PREFERENCE IN DEFORESTATION

Tenure

Inspired by research on the benefits of tenure security on farm productivity (Binswanger, Deininger, and Feder 1993; Alston, Libecap, and Schneider 1996), researchers have started to use household surveys to measure the effects of security of land tenure on deforestation. So far research has produced contradictory results. López (1993a, 1993b) found that communal land tenure in Africa caused too much clearance relative to the social optimum. In Ecuador titling reduced clearance (Pichón, Vosti, and Witcover 1994; Pichón 1996). In Peru, Bedoya (1987) found that squatters deforested twice as much as legal owners. But elsewhere Bedoya (1991) and others show that tenure security only changes the way people use the forest and not the total area of forest they clear. In the Ecuadorian and Peruvian Amazon, titles induced people to clear forests to plant trees rather than to plant annuals but did not change the size of the area they cleared (Bedoya 1991; Southgate 1990). The effect of titling on deforestation shrinks once researchers control for the shorter residence duration of squatters (Bedoya 1995). Household surveys in Brazil show that titling is insufficient to lower itinerancy and encroachment (Almeida and Campari 1994).

Comparisons of nations and counties have produced more support for the idea that tenure insecurity increases deforestation. International comparisons show that political instability is associated with more deforestation (Bohn and Deacon 1996; Deacon 1994). Using information from 11 counties in eastern Ecuador, Southgate, Sierra, and Brown (1991) found that tenure security lowered forest clearance.

In frontier regions with muddled property rights to land, competition between indigenous people and abutters over the ownership of natural resources should increase forest clearance. If villagers perceive that outsiders will take over lands, villagers may feel the

need to cut forest to gain a first toehold on lands before others do so. Abutters may also induce greater clearance for reasons unrelated to ownership insecurity. For instance, abutters may increase demand for food crops. Although abutters may induce indigenous people to cut more forest, they may also reduce incentives to clear forest. Abutters provide indigenous people with goods and services, such as employment, medical care, new farm technologies, and informal credit. The net effect on deforestation of these opposing tendencies is unclear. For instance, by hiring workers abutters lure villagers away from the forest; but by creating competition over the ownership of land and by increasing demand for food crops abutters increase deforestation.

Private Time Preference

The social and the economic covariates of private time preferences have received little attention, particularly in non-Western cultures (Pender 1993; Loewenstein 1992). We know of no empirical study of how private time preferences shape the use of natural resources.

High private time preference should increase deforestation if people can claim land without large investments after they have cleared the forest. But high private time preference could also lower deforestation if people perceive they could lose their investments in land development. This line of reasoning fits with the recent finding and model of Bohn and Deacon (1996). Although not dealing explicitly with private time preference, Bohn and Deacon found that political instability had mixed effects on the extraction of natural resources. It increased forest clearance, but it reduced investments in oil exploration and production because firms feared losing the large investments typically needed to prospect for minerals.

In sum, the empirical evidence plus a bit of hard reasoning suggests that insecurity of tenure over land and high private discount rates could produce mixed effects on forest clearance. We next examine the empirical evidence.

III. THE CHIMANE

The Chimane Amerindians number 5,709 people and live in the plains and in the rain forests of the department of Beni, Bolivia (Censo Indígena 1994–95). The Chimane are culturally representative of other Amerindian populations in the Amazon. Like their brethren elsewhere in Amazônia, the Chimane rely on shifting swidden cultivation along river banks, and also hunt, fish, and collect wild plants from the forest. But the Chimane are one of the three largest lowland groups in Bolivia's rain forest, and they display the most variance in integration to the market. The Chimane contain relatively unacculturated groups of nomadic swidden cultivators as well as sedentary, well-educated groups who earn most of their income from wage labor rather than from forest-based activities.

The Chimane avoided contact with outsiders until the late nineteenth century (Norden-skiold 1924, 12; Castillo 1988), but by the early twentieth century they had started to pan gold, extract quinine, tap rubber, sell rice, and work as laborers for cattle ranchers and loggers (Piland 1991; Chicchón 1992).

Encroachment was moderate until the 1950s but rose during the 1960s and 1970s. During that time the Bolivian government encouraged smallholders from the highlands to settle in the lowlands to relieve population pressure and to deflect the need for land reform in the densest areas of the country (Riester 1993). By 1966 the government classified the Chimane as an endangered ethnic group, and by the late 1970s it had granted the Chimane title to their land (Castillo 1988). These measures have been insufficient to stop outsiders from moving in (Riester 1993).

Communal titling has not been enough to stop encroachment for two reasons. First, loggers and cattle ranchers have used force and political leverage in courts to plunder resources from the Chimane. Second, unclear communal property rights to natural resources among the Chimanes themselves create a legal vacuum which abutters exploit. The central government of Bolivia granted the Chimane communal title to their lands, but Chimane disagree about how to appor-

tion between villages and the umbrella government for all Chimane (Consejo Chimane) the proceeds from the sale of logs from the Chimane territory. The Consejo Chimane signs timber contracts with loggers on behalf of all Chimane, but villagers have been known to confiscate logs from logging companies and demand payment for trees cut in village commons because they do not perceive they receive adequate compensation from the Consejo Chimane. To avoid conflict with villagers, loggers sometimes deal directly with villagers and sidestep the Consejo Chimane.

Rights of usufruct and ownership to forests are changing as lands become scarce owing to encroachment and to the growth of the Chimane population. Access to old-growth rain forests to hunt or to farm is open to any Chimane (Godoy et al. 1996). In remote settlements Chimane use fallow and old-growth rain forests freely, but in settlements closer to roads and to towns Chimane have started to fence plots; in those settlements, fallow forests belong to those who first clear plots.

Economic relations with abutters vary. Loggers, cattle ranchers, smallholders, and one oil firm that recently moved into the territory give Chimane medicines and work and, to a lesser extent, credit and farm inputs in exchange for game meat, crops, and construction materials. The information in Table 1 shows that loggers provided Chimane with the most goods and services; loggers supplied 18 percent of the households interviewed with medicines and 33 percent with employment. Eight percent of the households received free medicine from the oil company. Smallholders and cattle ranchers gave the Chimane fewer services. Besides supplying goods and services, abutters buy crops and nontimber forest goods from the Chimane.

The information in Table 1 also shows that Chimane had conflicts with abutters, principally with smallholders and with loggers. Conflicts arose because loggers extracted valuable timber species without paying royalties to villagers or to the Consejo Chimane. Conflicts also arose when cattle ranchers and smallholders cleared forests to put in cattle or to plant crops, or when cattle destroyed crops of the Chimane. Chimane

TABLE 1
LINKS OF CHIMANE HOUSEHOLDS TO ABUTTERS, 1995 ($n = 209$)

Type of Abutter:	Percent of Chimane Household:					Reporting Conflicts with:
	Receiving:					
	Medicines	Credit	Agri. Inputs	Work	Other	
Smallholder	3.35	0	1.44	3.35	6.62	46.46
Rancher	0.48	0.48	0.96	5.74	3.35	13.43
Logger	18.18	2.87	0.48	33.01	20.10	69.41
Oil firm	8.13	0	0.48	0.48	9.57	2.94

have been known to kill the cattle of abutters when there is not enough game meat in the village.

IV. THE SURVEY

We conducted the survey between June and August 1996, with 209 Chimane households in 18 villages. The survey was the second pilot study done as part of a forthcoming three-year study on the effects of markets on the Chimane's use of natural resources. We chose the Chimane rather than other lowland Amerindian groups in Bolivia because the Chimane contain more variance in explanatory variables (Godoy et al. 1996).

In each village we interviewed the village headmen and school teachers. From them we collected statistics on the village, such as information concerning conflict with encroachers and time to the nearest old-growth rain forest. With the help of Chimane assistants we collected demographic and socioeconomic information from the male and from the female household heads and from two randomly selected adults in the household: one male and one female. We classified as an adult any person over the age of 16. Interviews lasted 1.5–2 hours. In each village we surveyed an average of 31 percent of the population or 49 percent of the households.

In February 1997, we returned to the Chimane territory to discuss the preliminary results of the analysis with Chimanes. We asked questions such as, "Why is it that patient Chimane seem to cut more old-growth rain forest than impatient Chimanes?"¹ or, "Why is it that Chimanes with more educa-

tion seem to cut less old-growth rain forest than uneducated Chimanes?"¹ Answers to such questions elicited indigenous explanations about the path through which variables affected forest clearance.

V. THE VARIABLES: DEFINITION AND MEASUREMENT

Table 2 contains definitions and summary statistics of the variables used in the analysis. The dependent variable was the area of old-growth forest cleared by the household in 1995. To estimate the effect of tenure security and private time preference on the clearance of old-growth rain forest, we controlled for residence duration in the village, demographic and human capital characteristics, and wealth. We measured residence duration in the village and age in years. We split household size into gender and sex groups. We measured adverse shocks to the household (e.g., illness) by asking about the total number of deaths and illness in the household in 1994, the year before the forest was cut. We used height to proxy for a person's

¹ The Chimane word for patience or to be patient is *ryum'chuti* or *dyichchuti* and connotes the idea of "to be quiet," "holding," and "keeping back" for future use. Wayne Gill, a missionary who has worked with the Chimane for over 30 years, says that the idea of delaying gratification is rare among the Chimane. For instance, the Chimane are not concerned with the maintenance of modern physical assets such as bicycles. Unlike other lowland Amazonian Amerindians, the Chimane do not seem to plant many fruit trees in their gardens. For more information on the socioeconomic determinants of private time preference among the Chimane see Godoy et al. (1997).

TABLE 2
DEFINITION AND SUMMARY STATISTICS OF VARIABLES

Variable	Definition	Obs.	Mean	Std. Dev.	Min	Max
Deforest	<i>Tareas</i> of primary rain forest cut: 10 <i>tareas</i> = 1 ha	209	6.60	7.83	0	80
Resdur	Residence duration in village: years	206	18.2	16.7	0	78
Boys	# boys (<16)	209	1.63	1.51	0	8
Men	# adult men*	209	.899	.846	0	5
Women	# adult women*	209	.885	.973	0	8
Deaths	# deaths, 1994	209	.258	.672	0	4
Height	Height (cms) of household head	204	162	7.51	104	184
Age	Age in years of household head	201	34.6	13.0	17	80
Tumi-Chucua	Attended Tumi-Chucua boarding school: dummy**	208	.028	.167	0	1
Education	Maximum schooling	209	1.92	2.71	0	14
Missions	Short courses in mission school	208	1.46	3.92	0	30
Spanish	Spanish fluency**	207	.792	.406	0	1
Animals	Value of stock of animals, 1994, in <i>Bolivianos</i> ***	208	419	771	0	6789
Land	<i>Tareas</i> of secondary forest owned	203	178	385	2	4000
Parented	Parent's ed**	209	.153	.360	0	1
Forest	Minutes walking to reach closest old-growth forest	209	16.0	14.4	0	60
Distance	Km as crow flies from village to town of San Borja	209	31.7	18.3	3	82
Impatience	Average impatience of household heads: see text	196	.314	.532	0	2
Rancher	Conflict with ranchers**	209	.129	.336	0	1
Logger	Conflict with loggers**	170	.694	.462	0	1
Farmer	Conflict with smallholders**	170	.464	.500	0	1
Oil	Conflict with oil firm**	170	.029	.169	0	1

* Excludes the male and the female household heads.

** Dummy variable. Name of dummy variable equals one.

*** One U.S. dollar = 5.05 *Bolivianos* (bo).

long-term stock of health and estimated the body mass index (kg/mt^2) to estimate present undernutrition. Besides health, we included five variables to measure human capital: regular education in village schools, short courses in the mission school, education in the missionary boarding school of Tumi-Chucua, knowledge of Spanish, and parental education. Wealth was proxied by the value of animals owned in 1994.

Private Time Preference

About 20 minutes into the interview, we asked the interviewee roughly the following question: "We realize you may be getting tired from answering questions. We would like to give you a rest. Would you like to have one candy now or two candies at the

end of the interview?" If the interviewee wanted the candy now, we asked a second question: "Would you like to have one candy now or three candies at the end of the interview?" Depending on the person's response, we delivered the candies on the spot or at the end of the interview. We did not ask hypothetical questions (e.g., Barsky et al. 1995) because they may not elicit with accuracy the value a person places on the future (Bohm 1994).

Answers to the question on time preference were coded in the following ordinal categories: 0 (patient), 1 (average impatience), and 2 (impatient). We labeled patient those subjects who said they would wait and take two candies at the end of the interview, impatient those subjects who wanted one candy immediately irrespective of the size of later

rewards, and average those subjects who opted to wait until the end of the interview, but only after we had raised the reward from two to three candies. In the regressions presented later we use the average impatience of the male and the female household heads as an explanatory variable because decisions of how much forest to cut rest with both of them.

We chose candy rather than money, clothing, or other goods to measure impatience for several reasons. First, we had to carry the rewards to villages, often on foot and sometimes far away. It was difficult to take bulky or heavy goods. Second, the use of money is not generalized in remote Chimane villages and raised the possibility of theft. Third, the use of other light, portable items such as cigarettes or coca leaves raised ethical issues. For all these reasons—costs, ethics, security—we opted to use candy.

The choice of food to measure impatience is consistent with the work of social psychologists who have found that people's preference for food is strong and mirrors closely their ability to delay gratification or to make impulsive choices (e.g., Mischel, Shoda, and Rodríguez 1989; Kirby and Herrnstein 1995; Kirby and Marakovic 1996). However, the choice of candy to measure time preference over a short time may not capture with accuracy time preference or commitment for economic investments which take place over a longer stretch of time, such as forest clearance.

Tenure Insecurity and Village Variables

To measure tenure insecurity, we coded for conflicts in the village with cattle ranchers, loggers, smallholders, and the oil firm. To control for village fixed effects we included town-to-village distance and the availability of old-growth forest, proxied by the minutes it took to walk from the center of the village to the closest old-growth forest.

We use a Tobit model because the dependent variable was censored at zero; 61 households or 29 percent of the sample did not cut old-growth rain forest. Just as wealth may increase deforestation, so too deforestation may allow households to gain access to mod-

ern technologies to increase forest clearance. We did not have good instrumental variables for wealth to control for endogeneity or reverse causality.

VI. RESULTS

Table 3 contains the regression results. We have split the discussion of results into three parts. We first discuss the basic model, which contains the explanatory variables held constant to examine the effects of private time preference and tenure insecurity on deforestation. We next add the variable for household impatience to the basic model. Last, we add variables that capture conflict with smallholders, cattle ranchers, oil firm, and loggers.

The Basic Model

The results shown in the first column of Table 3 suggest that the number of boys and deaths in the household increase deforestation, but the number of adult men lowers clearance. Residence duration in the village bore a positive link to deforestation. All human capital variables lowered deforestation in part because they ease the migration of labor out of swidden agriculture, but only regular schooling was a statistically significant hurdle of deforestation. Schooling allows Amerindian households to intensify agriculture, particularly along river banks, and to find employment outside the village. In so doing, education curbs the clearance of old-growth rain forest (Godoy, Groff, and O'Neill 1997).

The Role of Private Time Preference

The results shown in the second column of Table 3 suggest that impatient heads of households cleared less old-growth rain forest than patient couples; the relation was statistically significant at less than the 5 percent level. Patient Chimanese seem to specialize in farming in old-growth rain forest and impatient Chimanese seem to specialize in wage labor and in farming in secondary rain forest, which is easier and faster to cut than old-growth rain forest. In contrast to farming,

TABLE 3
DETERMINANTS OF OLD-GROWTH RAIN FOREST CLEARANCE BY CHIMANE

Variable	[1]		[2]		[3]	
	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error
Resdur	.133	.054**	.127	.055**	.171	.057***
Boys	.916	.486*	1.13	.495**	.519	.478
Men	-3.11	1.03***	-3.3	1.03***	-2.45	1.086**
Women	.106	.752	.378	.750	1.49	1.045
Deaths	3.44	1.06***	3.62	1.08***	4.41	1.072***
Height	.099	.094	.094	.095	.143	.088*
Age	-.516	.341	.600	.364*	.558	.346
Age2	-.006	.003	-.007	.004*	-.007	.004**
Tumi-Chucua	-8.64	6.22	-10.0	6.14*	-7.02	6.47
Education	-.749	.449*	-.540	.463	-.856	.483*
Missions	-.420	.393	.411	.392	-.736	.416*
Spanish	-3.06	2.17	-3.18	2.19	-5.72	2.17***
Animal	.0007	.0009	.0006	.0009	-.001	.001
Land	-.002	.001	-.003	.001	-.002	.001
Parented	3.19	2.08*	2.96	2.12	4.86	2.17**
Forest	-.034	.064	-.0002	.064	-.080	.140
Distance	.055	.054	.082	.055	-.089	.067
Impatience			-2.86	1.31**	-1.05	1.257
Conflict:						
Rancher					7.23	2.61***
Logger					.201	2.47
Farmer					1.81	1.97
Oil					-2.30	7.31
Observations	185		174		139	
Left censored	50		48		24	
Uncensored	135		126		115	
Pseudo R ²	5.7		6.5		7.5	

Notes: dependent variable is area of old-growth rain forest cleared in 1995 in *tareas* (10 *tareas* = 1 hectare). *, **, and *** significant at $\leq 1\%$, $\leq 5\%$, and $\leq 10\%$, respectively. *F*-test for joint significance of conflict variables = 1.76 percent.

which requires waiting a long time to obtain rewards, rural wage labor results in rewards at the end of each day. This may be why patient and impatient Chimane drift to or seek different occupations or, perhaps, why different occupations breed different valuations of the future.

The Role of Tenure Security

The results of the third column of Table 3 suggest that abutters had mixed effects on forest clearance. Conflict with cattle ranchers, loggers, and smallholders seemed to increase deforestation, but only conflict with ranchers was a statistically significant cause of old-growth rain forest clearance. The presence of the oil firm seemed to be as-

sociated with less forest clearance, but the statistical relation was weak. An *F*-test for the joint significance of all four conflict variables showed they were statistically significant at the 1.76 percent level.

VII. CONCLUSIONS

The small size of the sample and endogeneity should make one cautious about reading too much into the results of this case study. The results, tentative though they may be, point to two tentative conclusions.

In a recent paper based on an international comparison of nations, Bohn and Deacon (1996) found that political instability increased ownership insecurity and deforestation. The results of the household survey

among the Chimane supports that conclusion. Although abutters provide villagers with many goods and services, they also usurp land and natural resources and, in so doing, may raise uncertainty over ownership and induce greater cutting of old-growth rain forest by the Chimanes themselves. On a more applied front, the results suggest that the Bolivian government, international donors, and conservation agencies ought to defend the land rights of indigenous people with more vigor if they wish to enhance conservation.

The results of the study raise doubts about the common idea that high private discount rates necessarily increase deforestation in a village economy. In a village economy where patient and impatient people can seek occupations which differ in their payback periods, and where different types of work, in turn, shape people's appreciation of the future, high private discount rates may have a small or even beneficial effect on the amount of old-growth rain forest cleared. Impatient people may be less willing to invest time in clearing old-growth rain forests and, instead, may be more willing to seek wage labor where rewards come at the end of each day. Patient people may find it more attractive to invest in clearing old-growth forests and waiting until their efforts bear fruit.

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