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Abstract

While there is a consensus in Nicaragua that the security of property rights is a fundamental constraint to the long run development of the agricultural sector, there has been little empirical analysis to date of the relationship between land rights and rural economic activity. Using household level data collected between December, 1997–April, 1998 within the regions of Leon and Chinandega (known administratively as Region II), this paper investigates the relationship between rural land rights and agricultural credit, investment, and rural incomes (on farm and off farm). Results indicate total credit received was significantly and negatively related to female-headed households and households with no documented form of land rights. While there is no significant relationship in the data between investment (defined as either total investment or just agricultural investment) and land rights and household characteristics, tenure status is significantly related to the number of trees on the property (a form of long-term land investment). Results indicate that off-farm income is significantly and positively related to the education level of household heads and the lack of any form of documented land rights. Farm income, defined for the purposes of this study as gross agricultural revenues, is shown to be increasing in the degree of tenure security, the education of the household head, farm size, and individual operation, and decreasing in the years since acquiring the property. In sum, these results indicate that improved clarity and enforcement of rural property structures can have a positive impact on rural credit access and farm profitability.

Keywords: land tenure, rural credit, agricultural production, Nicaragua

JEL codes: Q15, Q12, O13

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1. INTRODUCTION

Nicaragua's development history has created a complex structure of rural land rights. In just this century, this history has included a period of dispossession and consolidation during the Somoza era prior to 1979, expropriation and redistribution during the Sandinista agrarian reforms in the 1980s, confusion and conflict during and after the Sandinista defeat in 1990, and renewed reform efforts after 1992. As a result of a struggling rural economy, a major concern among policymakers, international donors, and the Nicaraguan population at large is the revitalization of the agricultural sector. There is a growing consensus, not surprisingly, that improved clarity and enforcement of property rights (in land as well as other assets) remains a key constraint to investment, production, and the long run growth of the economy. Thus, resolving the land tenure situation is viewed as a pre-condition to spur investment and productivity. Despite this apparent consensus, current empirical analysis on Nicaragua has not yet established the potentially negative impacts on agriculture of the current property rights structure. Based on data collected from Region II in Nicaragua, this paper addresses this void in the literature by estimating the impacts of existing land tenure arrangements on rural credit, agricultural investment, and on- and off-farm incomes.

A long history of economic analysis has sought to understand and estimate the links between insecure forms of land ownership and credit access, investment, and agricultural production (yields, productivity, incomes). Economic theory suggests that insecure land rights cause market imperfections and increase the risks associated with farming through the threat of dispossession. Unclear property rights slows the development of credit and land markets thereby reducing investment and restricting the movement of land to more productive uses (either by other farmers or by moving it to non-farm uses). The increased risks from insecure property rights also creates shorter planning horizons that reduce incentives for investments in land management, productive assets, and new technologies. As a result, the combination of these factors conspires to reduce

agricultural production in a static sense and reduces productivity growth over time (Feder, 1987; Feder and Onchan, 1987; Place and Hazell, 1993; Roth, Cochrane, and Kisamba-Mugerwa, 1994; Roth, Unruh, and Barrows, 1994; Lopez, 1995; Hayes, Roth, and Zepeda, 1997; Place and Migot-Adholla, 1998).[1]

While the basic economic logic is clear, the available empirical evidence has produced somewhat mixed results on the relationships between tenure, credit, investment, and agricultural production. In Asia, for example, Feder and Onchan (1987) find that tenure security is important for access to formal market credit and investments in land (bunding and stump removal) in two regions in Thailand, although such a relationship did not hold in the region with a well established informal credit market. They do not, however, include any analysis of agricultural productivity (e.g., yields, revenues, or profits). In Africa, while Carter, Wiebe, and Blarel (1991) found no significant relationship between land titles and output, income, and profits per hectare in Kenya, a study in the same country by Place and Migot-Adholla (1998) find a weak relationship between registration, titles, perceived land rights of farmers, credit used and crop yields. In the neighboring country of Uganda, Roth, Cochrane, and Ksamba-Mugerwa (1994) find a significant relationship between registration and investment in agriculture. A similar study in the Gambia by Hayes, Roth, and Zepeda (1997) finds that tenure security has a significant positive effect on long-term investments (i.e. at least one or more trees on the plot), which in turn has a positive impact on yields.

As Lopez (1995) notes, the effects of land tenure and tenure security on credit, investment, and agricultural production seems to have received less attention in Latin America, and Central America in particular, than in Africa or Asia. The existing literature from Central America finds almost no significant links between the presence of titles and credit, investment, and productivity. For example, in a study of farmers with and without title in one region of Honduras, Lopez (1995)

1 Common theoretical models (e.g. Feder and Onchan, 1987; Feder and Feeney, 1993) show that tenure insecurity can reduce borrowing, investment, and productivity. Tenure insecurity also leaves farmers without a collateralizable asset, which reduces their ability to borrow money.

concludes that titles do not affect productivity. This finding is consistent with Montaner-Larson (1995), who also concludes that giving titles to small coffee farms on State-owned land in Honduras did not affect credit access, technical efficiency, or input use.

While most of the above studies used simple measures of tenure security, there are many facets to tenure security not easily captured in a simple binary relationship stating tenure status including different rules on sales, transfer, and use rights. Using data from Ghana, for example, Besley (1995) demonstrates farm productivity differences from incentive effects of use, transfer, and full sales rights. The difference in incentives from distinct land tenure rules becomes especially important when considering the effects of land distribution programs, such as those in Nicaragua. Some observers of land reform programs that gave land as a grant to beneficiaries (See: Deininger, 1998) suggest productivity will be lower on land reform parcels even controlling for tenure insecurity. The idea is that land reform beneficiaries can include: people not experienced with farming, people who are more interested in holding land for speculation than farming, and people who for whatever reason are unlikely to invest in farming. In such circumstances, these people will have lower productivity, invest less, and be more likely to work off-farm where they have greater skills. Nicaragua, with its history of on-again off-again land reform, presents the picture of land reform insecurity. It thus represents an ideal location to investigate the incentive effects of land reform programs.

The rest of the paper is organized as follows. Section 2 provides a brief summary of the rural land tenure situation in Nicaragua. Section 3 presents the basic economic theory and outlines the econometric models for the analysis. Section 4 provides an overview of the data used for this analysis. Section 5 presents and discusses the empirical results. Section 6 concludes with a summary of the main results and recommendations for future analysis.

2. BACKGROUND ON TITLES AND LAND RIGHTS IN RURAL NICARAGUA

Beginning in the 1980s, the Sandinista government through various agrarian reform programs promoted collective ownership and operation of agricultural enterprises, especially for small- and medium-size farms. The sources of land were primarily public-owned properties but also included expropriated and abandoned land (Decrees 3 and 38) and indigenous community land. According to the Office of Rural Titling (1999), 3.3 million manzanas were distributed to Nicaraguan citizens via agrarian reform programs between 1980 and 1998, corresponding to approximately 40% of all agricultural land. Of the 51,680 titles granted as part of these processes, approximately 10% were granted as collective titles to production cooperatives. Because each collective title was granted to several individuals, however, approximately 45% of the land reform beneficiaries received some form of collective title.

During the 1990s, with the governments of Violeta Chamorro and subsequently Arnoldo Aleman, the agrarian reform programs continued to grant collective titles to landless peasants and ex-combatants, often organized in cooperatives. Since, in many cases, the government has not properly measured or registered many of these properties and/or properties have also been claimed by those from whom they were expropriated, these reforms have often exacerbated the insecurity of land property rights. Currently, many small and medium-sized farms do not have access to formal credit from private banks and technical assistance, in spite of having a legal document granted by the Institute of Agrarian Reform (INRA). With restricted credit access, the concern is that such farmers are less likely to invest or may put less effort into agricultural production than those with full and complete individual property rights.

Figure 1 summarizes the complicated structure of the land titling process in Nicaragua. For the most part, the current land title situation on any piece of land depends on how the land was obtained (e.g., purchased on the open market, received from the government as part of a land reform program, or taken over in a land invasion). Individual titles to property have been properly

measured, legalized, and registered in the national Office of Rural Titling. This type of title ("full title") gives the right to sell at will and full rights of collateralization thereby improving credit access with private banks. For the most part, these individually titled (measured, legalized, and registered) properties have been obtained through purchase or inheritance. Aside from these individual titles, Figure 1 identifies three additional types of tenure that grant varying combinations of rights: "INRA titles", given to land reform beneficiaries either as an individual or as a collective; indigenous community lands, which have rules and laws different from the national government; and ejidos, which are usually farms around a city or town limits. Land ownership documentation in the last two categories may include some formal or informal evidence of possession or a local government document, although rarely a full title. Despite the many land reforms a number of land parcels remain in the most insecure situation in which they have no title or supporting legal documents.

With the political and economic changes that have occurred in the Nicaragua since the 1980s, and the substantial amount of land reform (INRA) titles granted to groups, there has been growing demands to convert group titles to individual titles. The problem of converting such group titles to individuals titles appears to be most prevalent among small and medium-size farms (BID-TechnoServe, 1998). This process of full legalization of individual titles requires a great deal of expense on the part of the government and land owners since it involves resolution of conflicts of multiple ownership, adequate measurement of the property in question, registration, and legalization. This research can provide some answers as to whether such expense in creating full individual titles for land-reform beneficiaries and cooperatives is warranted.

3. ECONOMIC THEORY AND ECONOMETRIC SPECIFICATION

The empirical literature on land tenure begins with a simultaneous equation model based on an underlying household optimization problem where households make credit, investment, on- and off-farm time allocations, and agricultural production decisions (See: Feder and Onchan, 1987; Feder

and Feeney; 1993; Place and Hazell, 1993). In this model production (Y), credit used (C), and investments (K) are endogenous variables that depend on a set of exogenous variables (H and M) associated with household and farm characteristics. Depending upon the empirical situation, tenure status or some measure of security (T) may be exogenous or endogenous in the model.

Some studies (e.g., Place and Migot-Adholla, 1998; Carter and Olinto, 1996) account for the potential endogeneity of land titling decisions. For example, if households receive land under one form of tenure but then change their tenure status over time, for example, because they have an incentive to seek better tenure status on more productive lands, it would be appropriate to include tenure status as an endogenous variable in the structural model (e.g., as outlined in Place and Migot-Adholla, 1997). If the endogeneity of tenure was ignored, any correlation between tenure status and productivity would be spurious (Lopez, 1995).

Hayes, et al. (1997) argue that it is appropriate to consider tenure as exogenous in a situation when existing tenure status depends on the form of past land acquisition, and when the tenure conferred at such times was not influenced by the household (i.e. 'factors beyond their control', p. 371). In other words, the initial type of tenure received was exogenous to the household, and households did not change their tenure status since acquisition of the property. While detailed enough information is not available in the existing data set to know precisely, existing information suggests that exogeneity of current tenure status is a reasonable assumption for the data set used in this study. The question of potential endogeneity of tenure status represents a potentially useful topic to pursue in future data collection efforts.

With tenure status (T) considered to be exogenous, the hypothesized structural model for this study takes the general form:

$$C = f(H, M, T)$$

$$K = f(H, M, C, T)$$

$$Y = f(C, K, T, H, M).$$

Note that credit and tenure status are included directly in the production structural equation. We include credit in the production equation because some portion of total credit used by farm households can include production credit to finance variable inputs. This means that households constrained in the credit market will potentially not be able to purchase all the necessary inputs, leading to lower production. We include tenure in the production equation since tenure security/status can have a direct effect on production incentives. If, for example, there is a real possibility of expropriation, households may devote fewer resources to farm production. Thus a household with insecure tenure might be expected to spend more effort working off-farm than farming.

In general, investment (K) includes a number of different forms of investment with differing time horizons (machines, land improvements, planting of perennial crops). Among these one can distinguish, as is common in the literature, between short-term ones to increase farm productivity and longer-term investments related to environmental degradation such as trees or soil conservation. Similarly, production (Y) represents a broad vector describing a variety of household production activities (off-farm income, crop and livestock yields, farm revenues, and/or farm profits).

While the above structural model identifies the specific effects of tenure on each individual market, credit, investment, and production, a reduced form model will provide the cleanest measure of the overall effects of tenure insecurity. Using the structural model as a starting point, one can substitute the credit equation into the investment equation, and then the investment and credit equation into the production equation in order to define the reduced form model as:

$$C = g(H, M, T)$$

$$K = g(H, M, T)$$

$$Y = g(H, M, T)$$

This reduced form set of equations can then be estimated individually to show the effects of land tenure insecurity on each of the relevant markets.

Econometric Specification

Based on the theoretical discussion above, the empirical version of the theoretical reduced-form model is posited as taking the following linear form:

$$C = c + c_t T + c_h H + c_m M$$

$$K = k + k_t T + k_h H + k_m M$$

$$Y = y + y_t T + y_h H + y_m M$$

where *c*, *k*, and *y*, are the parameter vectors to be estimated. The null hypothesis we are testing is that tenure has no significant effect on the dependent variables in question (i.e., c_t, k_t, and y_t are equal to zero.

As the next section describes, data for the dependent variables include a substantial number of zero values. As is common in developing countries, many households did not borrow money, make any investments, or in some locations work off-farm. In addition, as discussed below, the data for farm production also includes a significant number of zero values. This right censoring of dependent variables implies that we need an econometric approach that takes into account the zero values. A Tobit econometric approach allows such censoring of dependent variables.

For a Tobit model, a dependent variable, say investments K, can take values of zero or a

$$K = \eta' X + \varepsilon^t \quad if \quad \eta' X + \varepsilon^t \geq 0$$

$$K = 0 \quad if \quad \eta' X + \varepsilon^t < 0.$$

positive value as follows:

where X is a matrix of household and farm characteristics (H and M) which describe the potential benefits to making investments, η is a parameter vector to be estimated and ε^t is random disturbance term. One can translate this framework into a standard Tobit model by assuming that the error term,

ε^t, is distributed normally with mean zero and variance σ^2 . Using maximum likelihood estimation, the log-likelihood function for this Tobit model is:

$$\ln L = \sum_{K_i > 0} -1/2[\ln(2\pi) + \ln\sigma^2 + \frac{(K_i - \eta' X)^2}{\sigma^2}] + \sum_{K_i = 0} \ln[1 - \Phi_i(\frac{\eta' X}{\sigma})]$$

where Φ_i is the cdf of the standard normal distribution function. Here the first part of the likelihood function is essentially the classical regression model for the non-zero observations, while the second half represents the probabilities for the censored observations. The maximum likelihood estimator has the desirable properties of being both consistent and asymptotically efficient (Green, 1993).

4. THE DATA

This report uses data from a survey conducted from December 1997 to April 1998 under a BID-Technoserve project entitled PROCADAE (*Proyecto de Capacitacion para el Desarrollo Agroempresarial in Leon and Chinandega)* in the departments of Leon and Chinandega in Region II of Nicaragua. The area of study is a core agricultural area in Nicaragua, formerly known for its cotton production. The near disappearance of cotton production in the 1990s, in part due to soil exhaustion, pest problems, and market conditions, coincided with rural unemployment rising to 80%, leaving many people in extreme poverty. While particularly severe in this area, the high levels of unemployment were part of a national economic crisis in which Nicaragua digressed from a middle income to a lower income country over the past twenty years as per-capita income fell from US$ 840 in 1978 to US $340 in 1993 (Gibson, 1996).

The survey asked 685 randomly selected households questions on the type of legal document of ownership for their farms, socioeconomic characteristics, and detailed production and marketing information. For the purposes of the econometric analysis reported below, 170 households, of the

685 surveyed, were rejected from the total data set due to missing information on critical variables (size of farm, years of operation, titles, no information on credit, investment, and incomes), illogical values for some of the variables, or if the household held only urban properties. Thus, the final sample size for the analysis is 515 observations.[2] For reference, Table 1 contains a list and descriptive statistics for each of the independent and dependent variables used in this analysis. The independent variables are organized in Table 1 into three categories: tenure status, household characteristics, and location.

Based on the survey questionnaire, four categories of title status were defined for this analysis: full title, no title, INRA title, and partial title. INRA title represents land documents given to land reform beneficiaries in all periods. The partial title category includes miscellaneous types of intermediate titles such as some evidence of possession, a city hall document, indigenous community documents, or pending title. In addition, since INRA titles can be granted to individual or to cooperatives, a dummy variable for collective production, COOP, was developed for the analysis. Thus, the combination of the variable COOP with the other tenure categories should also give a hint of incentive and insecurity problems due to collective titles.

From Table 1, of the 515 observations in the final sample, the distribution of tenure status is: 3% of the households reported having no title or other form of legal documents; 26% report having full, legal title; 61% have an INRA title, meaning their land was distributed in a land reform program; and 10% reported having temporary or pending titles. Given the geographic dispersion of the households throughout the 7 sub-regions (*municipios*) of Leon and Chinandega in Region II, we include dummy variables to capture site-specific differences across these sub-regions that could be due to market access or agro-ecology. These variables correspond to the seven municipalities in the sample: (1) Leon (the second most populated), (2) Telica, (3) Quezalguaque, (4) Chinandega (the

2 Based a some additional analysis of the complete sample of 685 and the sub-sample of 515, we have no reason to believe that using the sub-sample creates any important or systematic bias.

most populated), (5) Posoltega, (6) El Viejo (the largest in area), and (7) Puerto Morazan. Note that the first three are in the Department of Leon and the last four are in the Department of Chinandega.

The variables used to describe key household characteristics include age, sex, and years of schooling of the household head, and the number of adults in the household. Two variables describe farm specific characteristics, the number of years that the household has held the land and the size of the operated farm. For reference, a 'typical' household reports a male household head averaging 45 years of age with 4 years of schooling. Households contain on average 4 adults (defined as age > 13), farm approximately 12 manzanas of land, and have been on the land for 13 years.

Information from the survey was also used to construct the following dependent variables for the analysis: CREDIT defined as total credit received during last year, 1997; INVEST defined as total household investment expenditures (agricultural and non-agricultural related investments such as housing) during the last year; AGINVEST defined as agriculture related investments; NTREES defined as the number of trees including perennial crops on the farm[3]; OFFFARM defined as total off-farm income of the household; and REVTOTAL defined as total agricultural revenues earned during the past year, which includes both crop and livestock activities[4]. To calculate REVTOTAL, home consumption of farm products was valued at prices the household received for market sales of the product. In cases where the household consumed all it produced, the average price received for the item in the *municipio* was used as a shadow value for the item.

From Table 1, about 39% of households reported receiving some from of credit (CREDIT) during the past year, although the breakdown between credit used for investment, production (e.g.

3 The number of trees on the property can be interpreted as a measure of long term land use decisions as in Hayes, et al. (1997). While Hayes, et al. (1997) only includes a dummy variable (i.e., D = 1 if one or more trees on the plot, else D = 0), the data used here has information on tree numbers as summarized in Table 1. For reference, individual farms includes more than 25 types of trees, including forestry resources (e.g., eucalyptus) as well as fruit trees (such as lime, passion fruit, avocado, cashews, pitahaya, and tamarind).

4 Total revenue is used as a proxy for total profits since the data set has incomplete and seemingly unreliable cost data. Using the 441 observations with both revenue and cost data we found a 0.996 correlation between the total revenue variable used in the analysis and total profits (revenues minus costs).

buying seeds and fertilizers) and consumption is not known. On average across the complete sample, households received 1,231 Cordobas (approximately $123).[5] While 23% of households reported some form of investment expenditures (INVEST), only about 15% reported any agricultural investment expenditures (AGINVEST) totaling on average about 522 Cordobas. About 57% of the households reported trees on their lands (NTREES), with about 244 trees on average that either produced perennial crops or useful forestry materials.

Also from Table 1, about 50% of the household report earning off-farm income (OFFFARM) averaging about 3,200 Cordobas, while 81% reported non-zero agricultural revenues (REVTOTAL) averaging about 7,700 Cordobas. Note that during the study year of 1997 El Nino caused reduced rainfall, which given the lack of irrigation in the region, caused many crop failures. In many of these cases farmers had zero production and negative profits.

5. RESULTS AND DISCUSSION

Based on the outlined econometric model above, Tobit results for each reduced-form equation are presented in Tables 2-6. For all equations, the base case (i.e. the excluded dummy variables) is for a household with the following characteristics: full title to land;
individual producer; male household head; and located M1 (*municipio of Leon)*. For clarity of exposition we present the key hypothesis on the effects of tenure insecurity at the beginning of the discussion of each equation.

5 While the mean of CREDIT for the entire sample is 1,231 Cordobas, only 39% of the sample report receiving some form of credit. As a result, the average credit received for the subsample with positive credit is 3,156 Cordobas.

Credit Hypothesis: Farm households without secure land tenure will receive a lower supply of credit.[6]

The results for the credit equation are reported in Table 2. The variable NOTITLE is negative and significant at the 5% level, while the variable COOP (i.e., farmers who are not individual producers) is negative and significant at the 10% level. These results provide some support to the idea that lack of secure tenure (as indicated by lack of title and some form of collective production) reduces credit access. On the other hand, there is no indication from these results that other forms of tenure status (INRA or PARTIAL) are significantly related to credit after controlling for production status (i.e. being an individual producer). Since INRA or PARTIAL title would provide a collateralizable asset for a bank, we cannot conclude that the collateral from a land title is the driving force in credit access.

The results from other variables in the credit equation indicate that credit is significantly (5% level) and negatively related to the age of the household head (AGE) and female-headed households (FEMALE), but positively and significantly (5% level) related to the number of adults in the household (ADULTS). Regarding regional differences, farmers in the *municipio* of Telica (M2) received greater amounts of credit. Since these estimates represent an equilibrium outcome of both credit supply and demand, it is not possible to determine if younger, male headed households have higher investment demands or if they receive preferential credit treatment (or both). Nonetheless, these results indicate that there are a number of possible inequities in the operation of Nicaraguan credit markets.

6 An outcome of a credit supplier's maximization problem is that, at any given interest rate, more credit will be supplied to households with greater collateralizable assets. Thus, other things equal, a household with full tenure rights to the land they farm will have more collateral than a household without secure tenure. Further, because of problems with adverse selection of potential borrowers, a lender may not be able to raise interest rates enough to compensate for a borrower having a lower level of collateral.

Investment Hypothesis: *households will make fewer investments (including environmental improvements) on pieces of land with less secure types of tenure.*

The basic logic of this hypothesis depends on two effects: an eviction effect and an asset sales value effect. Where insecure tenure implies that a farmer risks eviction, the farmer will have lower incentives to invest in long-term improvements attached to the farm. Where insecure tenure implies an inability to sell land, the value of investments cannot be recovered by the owner should he need to sell the land.[7] We estimate two types of investment models: AGINVEST defined as the cash value of capital investments such as machinery; and NTREES defined as the number of trees on the farm.

From Table 3, the results suggest that none of the potential explanatory variables are significantly related to agricultural investment expenditures during the past year except for two location variables. In short, tenure status is not significantly related to agricultural investment expenditures.[8] Since only a small number of households actually reported any agricultural investment expenditures, these results need to be interpreted with considerable caution. While they suggest that tenure status is not significantly related to agricultural investment expenditures, the investment data only includes expenditures during the past year.

From Table 4, the results suggest that tenure status is significantly related to the number of trees on the farm at a 10% confidence level. The farmers with the least number of trees had lands with NOTITLE, followed by those with PARTIAL title, and then INRA title status. This ranking lends support to the general notion that weaker forms of tenure provides a disincentive to long term

7The tenure security and investment logic depends on the situation. In some cases of insecure tenure, land based investments may increase the possibility of eviction by increasing the returns to taking eviction actions. On the other hand, for example in some parts of West Africa where communal tenure is the norm, land based investments, particularly trees, are used as means to establish tenure security.

8 For reference there is an estimation of total household investments, adding in primarily housing improvements, shows essentially the same results.

investments (of which trees on are one type), although caution is needed at this stage given the marginal significance level of the parameter estimates.

As one would expect, the size of the property (MANZANA) is positive and statistically significantly (5% level) related to the number of trees. In addition, regions M2 (Telica) and M3 (Quezalguaque) are significantly different from the control municipality (M1= Leon).

Off-Farm Income Hypothesis: *insecure tenure reduces expected returns from agriculture compared to other income possibilities, thereby inducing farm households to shift to non-agriculture sources of income.*[9]

The Tobit results for the equation explaining off-farm income of the household (OFFFARM) are provided in Table 5. From Table 5, the most insecure tenure status (NOTITLE) is significantly and positively related to off-farm income, while the other tenure categories of PARTIAL and INRA are not different from the base category (FULL title). This suggests that very insecure types of tenure can induce more off-farm work, but that moderate levels of insecurity do not. Since many observers have suggested that land reform beneficiaries are less serious farmers and tend to work off-farm more, it is particularly important that we find no significant effect of INRA titles on off-farm work. Thus, controlling for other household characteristics, land reform beneficiaries are no more likely to have significant off-farm work than farmers with secure titles who purchased their land.

The results in Table 5 also suggest that as the size of the property increases, the amount of off-farm income decreases, *ceteris paribus*. This is not surprising since larger farms are expected to absorb more of the available family labor. As could be expected, higher education levels and more adults in the household are also positively and significantly (5% level) related to off-farm income, while age of the household head is negatively related to off-farm income (10% level). As one might expect, differences in regional labor markets create significant location parameters. The location

9 This result follows from the standard household production model with tenure insecurity, e.g. Feder and Onchan, 1987.

variables M3-M6 are significantly (5% level) related to off-farm income, with three of the four *municipio* located in the region of Chinandega (M4-M6) showing a higher amount of off-farm income than those located in the region of Leon (the base of M1, M2, and M3).

Farm Productivity Hypothesis: *farm households with insecure tenure will have lower productivity than household with more secure tenure.*

The results of the Tobit model explaining total agricultural revenues (a proxy for income) is provided in Table 6. Of the reduced-form equations presented in Tables 2-6, the results explaining agricultural revenues present the strongest evidence for the theory outlined in Section 3. The tenure variables show a significant negative effect of tenure status on agricultural revenues. This negative effect follows neatly along the degrees of insecurity: with NOTITLE having the lowest productivity (10% significance), PARTIAL title having the next lowest (5% significance), and finally INRA title (5% significance). After controlling for tenure status, the variable on group production (COOP) is negatively and significantly (10% level) related to agricultural revenues. Thus, these results indicate that group production may lower revenues even after controlling for tenure status.

The parameter estimates for tenure status reported in Table 6, as well as being statistically significant and negative for less secure forms of tenure, also have empirically significant magnitudes. The marginal effects, corrected for right-censoring and evaluated at sample averages for exogenous variables, show substantial reductions in agricultural revenues across tenure categories. For example, while the sample average for agricultural revenues was 7,725 Cordobas, the results show that: households with NOTITLE earn 4,900 Cordobas less than the base case (full title); households with PARTIAL title earn 3,524 Cordobas less; and households with INRA title earn 2,900 Cordobas less. Thus, the tenure insecurity relationship with agricultural revenues is both statistically significant and empirically important.

The parameter estimates for the other variables in the revenue equation conform broadly to a general model of farm production. Farm size is positively and significantly (5% level) related to

revenues. Among other household variables, the parameter for education level of the household head (EDUC) is positively and significantly (10% level) related to agricultural revenues, suggesting a positive return to households of higher education levels both on and off the farm. The number of years on the property (YEARS) is significantly and negatively (5% level) related to revenues, which may indicate some link between past land use, soil quality, and current productivity.

Note also that the other household variables (the number of adults, female headed households, and age of the household head) are not significantly related to productivity. Comparing the results for ADULTS between Table 5 for off-farm income and Table 6 for agricultural revenues, these indicate adequately functioning rural labor markets. For most farm households excess labor seems to be allocated to off-farm activities, a notion strengthened by the positive relationship between farm-size and farm revenues. Comparing the results from the credit equation, Table 2, and the agricultural revenues equation, Table 6, one finds that the poor position of female headed households in the credit market does not translate immediately into lower productivity. Since lower credit levels may take a few years to show up in lower productivity, one should be cautious of drawing strong conclusions from this.

6. CONCLUSIONS

This investigation provides a first empirical test of the hypothesis that insecure property rights present a fundamental constraint to the long run development of the agricultural sector in Nicaragua. The empirical analysis of the relationship between land rights and agricultural credit, investment, and rural incomes (on farm and off farm) has demonstrated some significant effects. Clear evidence shows that agricultural production increases with increasing levels of tenure security and that cooperative farming has deleterious incentive effects. Investments in trees on agricultural lands follows a similar pattern, suggesting that tenure insecurity can effect the environmental

viability of agricultural production. With the previous history of environmental degradation in Nicaragua's Region II, this suggests some long-term consequences to current land tenure problems.

The results presented here also demonstrate some of the successes and pitfalls from land reform programs. For example, land reform beneficiaries operating on individual farms were more successful farmers than farmers with less secure types of tenure and were no more inclined to work off farm than a household with full title. On the other hand, their farms did not approach the productivity of farms with full title, suggesting a great deal of room for improvement in incentives and possible extension efforts. Finally, the research on the credit market, while not showing any clear relationship to land tenure, do give rise for some concern since total credit received was significantly lower for female headed households. Since our production equations suggest that female headed households have effectively the same revenues, this, at a minimum, is suggestive of an imperfectly operating credit market.

From a policy perspective, this research has pointed to a number of places in which the operation of rural factor markets can be improved. Clarification of property rights in rural Nicaragua does seem like a worthwhile intervention. It will improve the incentives for farmers, leading to higher revenues and may lead to more environmentally friendly production methods. Some attention should be accorded to ensuring that female headed households get sufficient access to credit markets. Since a great deal of the credit supplied to the households in this area came from non-governmental organizations rather than banks, one might insist that they re-target some of their credit supply to female headed households. Finally the research provides some lessons for future land reform programs, for example, by suggesting that a lack of commitment to farming (as perhaps evidenced by off-farm work) may be less of a problem for land reform beneficiaries than imperfect property rights.

Since the results in this paper represent a first empirical analysis, a number of issues remain in identifying the effects of insecure property rights in Nicaragua. Future research, based for

example on more years of data, can take advantage of the original structural model to identify the specific effects of tenure insecurity on each individual market. Such a panel data-set might also be able to investigate whether tenure status is endogenous to land productivity or quality. Also possible with more data would be the identification of the differing incentives in different types of land reform leases.

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Tables and Figures

TABLE 1. VARIABLE DEFINITIONS AND DESCRIPTIVE STATISTICS

Variable	Definition	Mean	Std.	Minimum	Maximum
Tenure Variables (T in theoretical model)					
NOTITLE	no title to property	0.03		0	1
PARTIAL	title in process	0.10		0	1
INRA	INRA title	0.61		0	1
FULL	full title	0.26		0	1
COOP	not an individual producer	0.57		0	1
Household Variables (H in theoretical model)					
FEMALE	female hh head	0.16		0	1
AGE	age of hh head	45.83	13.48	4	93
EDUC	education of hh	4.15	3.01	1	15
ADULTS	adults age > 13	3.72	1.95	1	13
MANZANA	farm size in manzanas	11.80	15.28	0.25	130
YEARS	years held property	13.02	9.23	1	60
Location Variables (M in theoretical model)					
M1	Leon	0.37		0	1
M2	Telica	0.21		0	1
M3	Quezalguaque	0.07		0	1
M4	Chinandega	0.07		0	1
M5	Posoltega	0.04		0	1
M6	El Viejo	0.04		0	1
M7	Puerto Morazon	0.21		0	1
Dependent Variables (C, K, and Y in theoretical model)					
C	credit > 0	0.39		0	1
CREDIT	credit used	1231	3205	0	30300
I	investment > 0	0.24		0	1
INVEST	total investment	1052	3508	0	32000
AI	ag. investment > 0	0.15		0	1
AGINVEST	ag. investment	522	2137	0	29000
NT	trees on property >0	0.57		0	1
NTREES	number of trees	244	1339	0	20000
OF	off-farm income > 0	0.51		0	1
OFFFARM	off-farm income	3240	6060	0	61920
RT	ag. revenues > 0	0.82		0	1
REVTOTAL	total ag. revenues	7725	13849	0	128299

TABLE 2. TOBIT RESULTS EXPLAINING AMOUNT OF CREDIT RECEIVED DURING PAST YEAR (IN CORDOBAS)

Variable	Coefficient	std. error	z=b/s.e.
Constant	-281.7740	1641.8	-0.172
NOTITLE	-7192.711	3116.6	-2.308**
PARTIAL	143.9587	1161.0	0.124
INRA	-479.2502	781.04	-0.614
COOP	-1243.921	707.15	-1.759*
AGE	-65.15500	27.533	-2.366**
EDUC	76.24914	106.44	0.716
ADULTS	381.8856	164.47	2.322**
FEMALE	-3671.361	1019.2	-3.602**
MANZANA	-16.12913	23.628	-0.683
YEARS	21.08066	37.899	0.556
M2	2162.461	858.37	2.519 **
M3	1642.084	1309.7	1.254
M4	778.9069	1359.2	0.573
M5	-1533.934	2128.2	-0.721
M6	-183.9366	1882.8	-0.098
M7	731.3911	961.40	0.761
σ	5839.089	318.42	18.338

* = 10% significance level
** = 5% significance level

TABLE 3. TOBIT RESULTS EXPLAINING AMOUNT OF AGRICULTURAL INVESTMENTS MADE DURING PAST YEAR (IN CORDOBAS)

Variable	Coefficient	std. error	z=b/s.e.
Constant	-8336.783	2708.1	
NOTITLE	1342.154	2809.1	0.478
PARTIAL	877.1597	1792.0	0.489
INRA	-909.8395	1336.5	-0.681
COOP	-952.8151	1151.3	-0.828
AGE	-17.52691	42.789	-0.410
EDUC	229.7112	156.55	1.467
ADULTS	-215.2921	279.27	-0.771
FEMALE	400.6313	1296.9	0.309
MANZANA	28.44072	32.312	0.880
YEARS	22.12245	59.742	0.370
M2	1318.717	1359.1	0.970
M3	-1592.956	2589.3	-0.615
M4	-23478.44	0.22177E+06	-0.106
M5	14537.48	2327.1	6.247**
M6	4767.192	2457.6	1.940
M7	3450.233	1453.8	2.373**
σ	6762.949	622.79 1	0.859

* = 10% significance level
** = 5% significance level

TABLE 4. TOBIT RESULTS EXPLAINING NUMBER OF TREES ON THE FARM

Variable	Coefficient	std. error	z=b/s.e.
Constant	-145.3512	456.92	-0.318
NOTITLE	-1027.596	593.05	-1.733*
PARTIAL	-556.8957	328.12	-1.697*
INRA	-403.2681	218.17	-1.848*
COOP	111.2552	194.26	0.573
AGE	-6.372219	7.6087	-0.837
EDUC	-4.769703	29.324	-0.163
ADULTS	54.62025	47.317	1.154
FEMALE	-422.4196	262.22	-1.611
MANZANA	21.76036	5.7631	3.776**
YEARS	-13.87287	10.690	-1.298
M2	475.5584	240.93	1.974**
M3	-1110.876	438.16	-2.535**
M4	449.0218	342.74	1.310
M5	-7727.586	85715.	-0.090
M6	531.9569	472.09	1.127
M7	-0.01536	264.15	0.000
σ	1750.942	73.518	23.817

* = 10% significance level
** = 5% significance level

TABLE 5. TOBIT RESULTS EXPLAINING TOTAL OFF-FARM INCOME DURING PAST YEAR (IN CORDOBAS)

Variable	Coefficient	std. error	z=b/s.e.
Constant	-2488.790	2348.7	-1.060
NOTITLE	6007.843	2484.6	2.418**
PARTIAL	1161.118	1678.7	0.692
INRA	-809.5816	1152.3	-0.703
COOP	-396.2516	999.27	-0.397
AGE	-67.61851	38.675	-1.748*
EDUC	573.8749	145.28	3.950**
ADULTS	499.9895	242.57	2.061**
FEMALE	1377.244	1216.2	1.132
MANZANA	-102.4486	37.012	-2.768**
YEARS	70.51989	53.488	1.318
M2	7.614079	1276.0	0.006
M3	-6527.432	2430.6	-2.686**
M4	7784.839	1734.9	4.487 **
M5	10160.67	2396.8	4.239**
M6	7337.731	2409.6	3.045**
M7	1607.167	1321.0	1.217
σ	8769.642	410.92	21.342

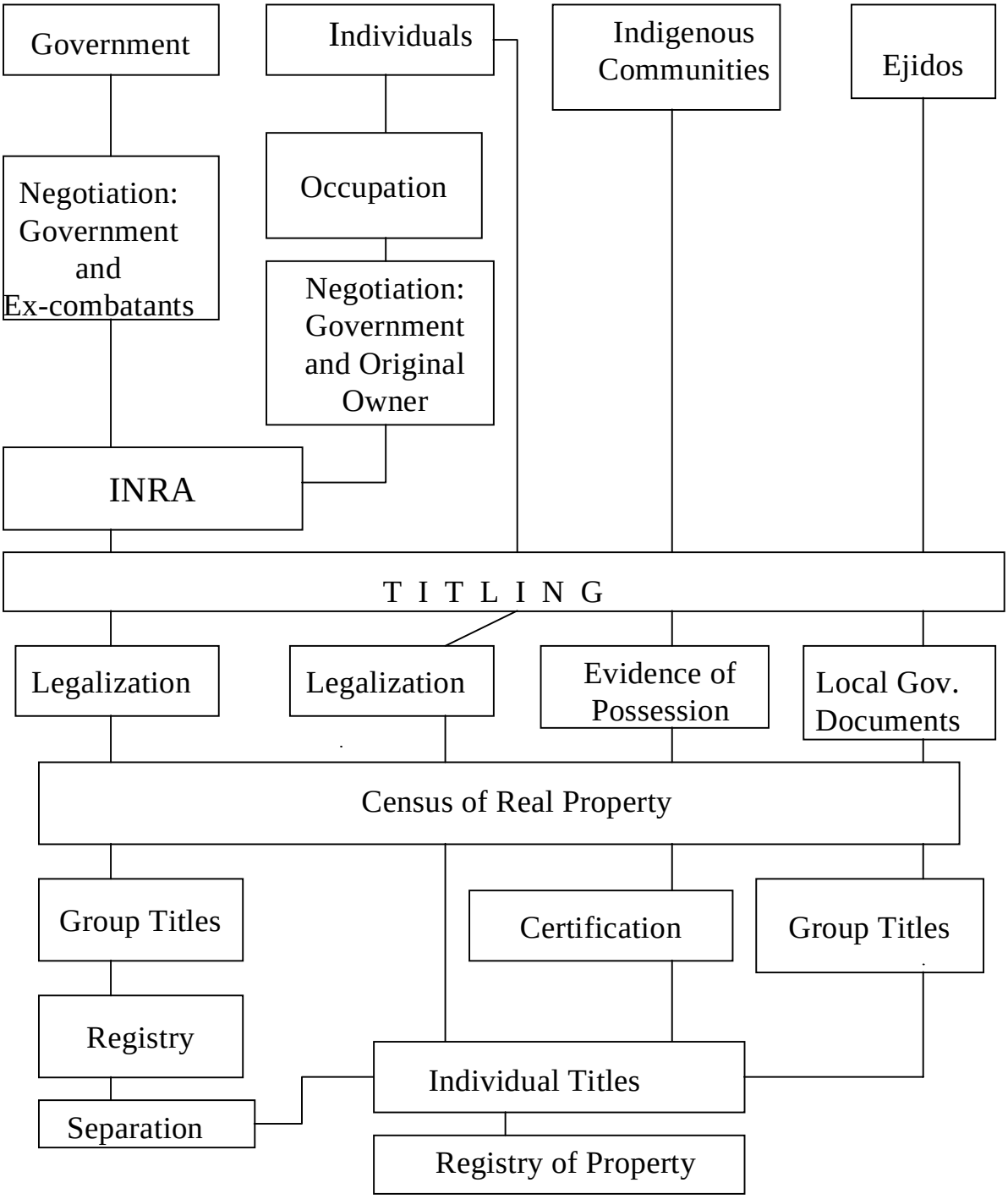
* = 10% significance level
** = 5% significance level

TABLE 6. TOBIT RESULTS EXPLAINING TOTAL AGRICULTURAL REVENUES (CROPS AND LIVESTOCK) DURING PAST YEAR (IN CORDOBAS)

Variable	Coefficient	std. error	z=b/s.e.
Constant	7714.618	3173.1	2.431
NOTITLE	-7248.775	3886.9	-1.865*
PARTIAL	-5226.019	2332.6	-2.240**
INRA	-4301.011	1533.0	-2.806**
COOP	-2502.439	1360.9	-1.839*
AGE	-31.34738	52.117	-0.601
EDUC	373.0579	203.93	1.829*
ADULTS	283.4472	326.26	0.869
FEMALE	-2425.975	1729.1	-1.403
MANZANA	177.6022	41.965	4.232**
YEARS	-152.9456	73.480	-2.081**
M2	2082.980	1711.6	1.217
M3	1757.588	2599.0	0.676
M4	1206.000	2509.3	0.481
M5	40498.580	3516.3	11.518**
M6	5380.978	3436.3	1.566
M7	-384.2936	1847.8	-0.208
σ	13186.75	462.28	28.525

* = 10% significance level
** = 5% significance level

Figure 1: Rural Land Titling Process in Nicaragua



Source: Adapted from the PL-480 Nicaragua Proposal