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NONTRADITIONAL CROPS AND LAND ACCUMULATION AMONG GUATEMALAN SMALLHOLDERS: IS THE IMPACT SUSTAINABLE?

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ABSTRACT

Since the late 1970s dramatic economic changes have taken place in the agricultural sector in the highlands of Guatemala. The introduction of new export crops, such as snow peas, broccoli, and miniature vegetables, has led to yet another agro-export boom. Unlike earlier booms, however, this one has included all but the smallest farmers. The high rate of smallholder participation in the boom, and the initial high profitability of nontraditional exports (NTXs), fueled initial optimism that NTX production could increase smallholders' ability to accumulate land and so decrease the highly skewed distribution of land in Guatemala, a country with one of the most unequal landholding patterns in all of Latin America.

The picture that emerges from the analysis in this paper raises serious questions about the sustainability and equity effects of NTX crop adoption among smallholders in the long run. Two main findings illustrate the problems besetting NTX crop production. First, the land accumulation rates of adopters have dropped dramatically in the 1990s. NTX crop adopters accumulated close to three times more land than non-adopters in the 1980s. Although adopters are still accumulating more land than non-adopters in the 1990s, the gap between the two groups has narrowed substantially.

Second, smaller adopters are no longer accumulating land at higher rates than their larger counterparts. In the 1980s the landholdings of smaller adopters grew significantly faster than those of the larger adopters, but this trend reversed itself in the

1990s. The advantages smallholders initially had in accumulating land may have been lost as a result of deteriorating agronomic conditions and volatile export markets.

However, given adequate policy support, smallholders could indeed improve their socioeconomic position through cultivation of NTX crops and still prove to be viable economic agents in the country's lucrative export market.

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1. ADOPTION OF NONTRADITIONAL EXPORTS AND LAND ACCUMULATION

Since the late 1970s, the highlands of Guatemala have experienced dramatic economic changes as a result of the introduction of new crops for the export market such as snow peas, broccoli, and miniature vegetables. Substantial differences seem to exist between this latest agro-export boom and all previous ones. Previous export booms have been highly exclusionary with respect to small farmers, further contributing to land concentration among large landholders. The initial high profitability of nontraditional exports (NTXs) and the apparent high participation rates of small farmers in the NTX boom have fueled optimism about the potential beneficial impact that adoption may have on these households' abilities to accumulate land. This has been heralded as an opportunity to decrease the highly skewed distribution of land in Guatemala, one of the most unequal in all of Latin America with a Gini coefficient in 1979 of 0.85 (von Braun, Hotchkiss, and Immink 1989; Barham, Carter, and Sigelko 1995).

The highlands area under study is characterized by very small landholdings: the average in our sample is 0.7 hectare of owned land per household. The argument of diseconomies of scale in NTX production has been put forth to account for the high degree of NTX adoption observed among very small landholders in the 1980s. This comparative advantage is rooted in their ability to rely on family labor, thus reducing moral hazard problems and supervision costs associated with hired labor upon which larger farmers depend more heavily (von Braun, Hotchkiss, and Immink 1989). A recent study (Barham, Carter, and Sigelko 1995) in five villages adjacent to the ones contained in our sample highlights the beneficial impact that NTX adoption has had on land accumulation patterns, particularly among smaller farmers. In spite of the optimism of these findings, a word of caution is raised in the concluding argument of Barham, Carter, and Sigelko's study as they suggest that pecuniary economies of scale (e.g., access to credit and information), and the progressively deteriorating conditions in NTX production (e.g., due to soil depletion, pest infestations, and pesticide residue problems), may be selectively more detrimental to smallholders in the long run. This raises the question of whether this experience with agro-exports in Guatemala is promoting a more or less equitable agrarian structure in the long run.

As part of the recovery effort following the 1976 earthquake that devastated the Guatemalan highlands, the internationally financed agricultural cooperative *Cuatro Pinos* was founded in 1979 with the primary objective of promoting the production of NTXs in the area by providing access to credit and technical assistance to its members. NTX adoption has created differentiated patterns of asset accumulation across different groups of farmers. The higher profitability of NTXs compared to traditional crops raises adopters' demand for high quality land (Barham, Carter, and Sigelko 1995). This should have induced non-adopters to respond to increasing land prices by selling their plots. However, small peasants in the region appear to have extremely high reservation prices for land below a minimum requirement of 4 to 5 *cuerdas* needed for subsistence purposes.[1] Furthermore, very few cases of full specialization in NTXs have been observed in the area under investigation, even during the 1980s when NTX average

[1] 1 *cuerda* = 0.11 hectare.

profitability far exceeded that of subsistence and traditional crops.[2] It has been argued that the resistance of non-adopters to sell their land, the virtual lack of NTX specialization and the unexpectedly large shares of land allocated to subsistence production (von Braun, Hotchkiss, and Immink 1989) may be caused by food market imperfections. As a result, land purchases promoted by NTXs have taken place primarily through expansion of the agricultural frontier, and very few land sales are observed.

As reported in von Braun, Hotchkiss, and Immink (1989), a minimum amount of land was necessary to adopt NTXs without putting the household's food security in jeopardy by cutting subsistence and traditional crops production excessively. However, beyond this threshold, the vast majority of peasants have initially adopted NTXs regardless of farm size. The first objective of this paper is consequently to verify whether the introduction of NTXs has induced a progressive pattern of land accumulation in the 1980s. For this purpose, we will compare, for the group of NTX adopters, the average per-year land accumulation in the preadoption period with the accumulation rates registered in the postadoption years according to the initial farm size.

In recent years, NTX yields have registered a consistent drop across all the communities surveyed. Among the emerging agronomic difficulties observed are the dramatic increase in pest problems and pesticide resistance build-up, and the rising pressure on scarce land, resulting in accelerated soil degradation. In addition, the increasingly costly input packages and the prohibitive cost of pesticide residue spot

[2] von Braun, Hotchkiss, and Immink (1989) report that in 1985, net returns per unit of labor in snow peas were about twice as high as for maize and 60 percent higher than for traditional vegetables.

checks have reduced the profitability of NTX production. Furthermore, increasing price uncertainty and frequent temporary import bans into the United States for Guatemalan snow peas due to pesticide residues are among the market risks facing NTX growers in the 1990s. These factors are unlikely to affect all rural households in an equal manner, creating, over time, biases capable of offsetting the apparent initial competitiveness of small farmers in growing NTXs. The changing profitability of NTX production over time and the differential ability of producers to face up to rising costs and risks are expected to have a differentiated impact on adopters' ability to accumulate land. We will test for these propositions by estimating, for NTX adopters, a second system of equations to compare the accumulation rates in the 1980s with those in the 1990s.

The analysis is based on data collected in 1994 in collaboration with the Institute of Nutrition of Central America and Panama (INCAP) in six rural communities in the central highlands of Guatemala. Recall information on annual land transactions since the year of household formation through 1994 was obtained to reconstruct each household's history of land accumulation. Recall data on the household's NTX adoption history were also collected.

The remainder of this paper is organized as follows. In Section 2, we use descriptive statistics to characterize the NTX adoption in Guatemala and introduce a number of stylized facts about land accumulation that will be used in formulating working hypotheses. In Section 3, we outline the econometric strategy for the analysis and engage in a number of preliminary tests regarding time period, selectivity, and cooperative membership effects on accumulation. In Section 4, we specify and estimate the land accumulation equations. The results of the estimations are used in Section 5 to simulate the land accumulation trajectories. Finally, Section 6 extracts from the findings policy implications for the NTX strategy in Guatemala.

2. NONTRADITIONAL AGRO-EXPORTS AND LAND ACCUMULATION PATTERNS: DESCRIPTIVE STATISTICS

We look first at descriptive statistics to establish some of the regularities in the patterns of land accumulation by NTX adoption status, size of landholding, and time periods.[3]

Table 1 reports descriptive statistics of the sample by NTX adoption status. Adopters' better land endowment in 1994 appears to be the result of both better initial endowments as well as higher land accumulation rates in the 1980s following NTX adoption.

Land accumulation was clearly affected by NTX adoption. Table 2a reports the average levels of per-year land accumulation for three different periods by adoption status. The three periods of analysis refer to (1) the pre-adoption period, which includes the interval of time between the year of household formation and 1979, the first possible year of adoption, for both adopters and non-adopters (2) the 1980s adoption period, which spans from the year of adoption to 1990 for adopters, and from 1979 to 1990 for non-adopters; and (3) the 1990s adoption period, which includes all years of NTX

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[3] The values for the 1979-90 interval were computed as weighted averages of the (complete) four-year moving averages forming the period. The 1990 figures were computed as the average of all (complete) four-year moving average values relative to the years 1991-94.

cultivation since 1991 for adopters and the 1991-1994 period for non-adopters. No significant difference is observed in the accumulation rates of adopters versus non-adopters in the preadoption period, suggesting that there was no preexisting heterogeneity between the two groups. By contrast, in the 1980s, adopters accumulated land at rates close to three times as high as non-adopters. In the 1990s, adopters still accumulated land at higher rates compared to non-adopters, but at lower rates than in the 1980s.

Land accumulation was affected by farm size. Table 2b reports the accumulation rates by categories of landholding measured as the amount of land owned at the beginning of each period. Peasants with less than 4.5 *cuerdas* were accumulating more than those in the largest farm size class both in the 1980s. However, in the 1990s, the trend appears to have reversed, with larger landholders accumulating at higher rates. These contrasted trends can also be seen in Figure 1. The data thus suggest that a phase of progressive land accumulation in the 1980s was followed by a regressive phase in the 1990s, particularly for smaller landholders.

There is a clear contrast in the pace of land accumulation between the 1980s and the 1990s (Figure 2). In the first decade, using a four-year moving average, the percentage of households with positive land accumulation was increasing, rising from 32 percent in 1981-84 to a peak of 52 percent in 1988-91. Subsequently, this percentage has been falling, dropping to 42 percent in 1991-94. There is also a change in the average number of *cuerdas* that were acquired or sold each year (Table 3a). It declined from 0.91 *cuerdas* in 1979-90 to 0.79 *cuerdas* in 1991-94. These patterns of accumulation highlight a distressing scenario, with fewer adopters accumulating in the 1990s (compared to the late 1980s) and, on average, accumulating less (compared to the 1980s).

Finally, in Tables 3b and 3c we compare the group of adopters with positive 1990 land accumulation, with the group exhibiting no accumulation. In the 1990s, the former group accumulated, on average, 0.79 *cuerdas* per year, a rate almost 50 percent higher than the one registered by this same group of households in the 1980s. In the 1980s, this same group was, on average, accumulating at a rate almost double the one registered by households with zero accumulation in the 1990s, while the two groups had been accumulating at similar rates in the pre-adoption period.

3. ECONOMETRIC STRATEGY AND PRELIMINARY TESTS

LAND ACCUMULATION EQUATIONS

The main objective of this paper is to test whether NTX adoption, with its higher returns, has induced a structural change in households' land accumulation trajectories over time and across farm-size categories. To test for the presence of structural changes in accumulation induced by NTX adoption in the 1980s, and the sustainability of these trends in the 1990s, we estimate two separate equations each using switching regression techniques. In the first regression (model 2), we compare the accumulation rates of NTX adopters in the pre-adoption and the 1980 adoption periods. The second equation (model 3) will be estimated to compare the accumulation rates in the 1980s and 1990s of the same group of adopters. The period dummy variable is allowed to interact with some of the independent variables to test for changes in effects of other characteristics, such as farm size, across periods.

Before estimating these land accumulation equations, there are several preliminary tests that need to be performed to eliminate potential biases in their estimation. This includes (1) a test of time effects to assess whether accumulation in the three periods was associated to factors other than NTX adoption; (2) a test of selectivity bias to assess whether adopters differ from non-adopters with respect to nonobservable characteristics which, in turn, may affect land accumulation beyond the role of adoption; and (3) a test of selectivity bias associated with cooperative membership.

TEST OF PERIOD EFFECTS

A point of concern in assessing the true effect of NTX adoption on land accumulation is the possible presence of factors directly related to the periods in question other than adoption per se. Thus, before estimating the two equations for adopters, we must account for this possibility. For this purpose, we construct a counterfactual on the non-adopters, and estimate the same systems of regressions for this control group. If any period-specific factor other than adoption is responsible for the structural changes in the accumulation rates, we should observe it among non-adopters as well. Coefficients on the time dummies in the control group equations not significantly different than zero will support the view that non-adopters are accumulating at comparable rates across periods. In such case, the equivalent coefficient in the adopters' estimation will reflect the true effect of NTX adoption.

The test for structural changes across periods can be performed by using a Tobit regression model as follows:

$$\left.\begin{array}{l} \Delta L_i = a_0 + a_1' Z_i + D_i[b_0 + b_1' Z_i] + n_i, \quad \text{with} \quad n_i \approx N(0, s^2 e^{d' w_i}) \\ \text{where :} \\ \quad D_i = 0 \quad \text{if observation } i \text{ refers to the first period, and} \\ \quad D_i = 1 \quad \text{otherwise.} \end{array}\right\} \text{(models 2 and 3)}$$

The *Z*s are variables that characterize the household—including age and square of age of household head to account for the life-cycle stage, and initial land endowment, and regional effects. Because of the high degree of censoring of the left-hand-side variable in this and the other land accumulation equations, all the land accumulation regressions are estimated as Tobits.[4]

Another problem that emerges from analyzing censored data is the presence of heteroscedastic errors. If heteroscedasticity exists and is ignored, maximum likelihood (ML) estimates are inconsistent. As reported in Maddala (1983, 182), "It is more practicable to make some reasonable assumption about the nature of heteroscedasticity and estimate the model than just to say that the ML estimates are inconsistent if heteroscedasticity is ignored." Following this advice, we introduce multiplicative heteroscedastic errors of the form $s_i^2 = s^2 e^{d' w_i}$, where *w* is a vector of household

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[4] The data also contained very few observations with negative accumulation that were censored to zero.

characteristics. Likelihood ratio tests are performed to confirm the presence of heteroscedasticity.[5]

There is no reason to believe that all coefficients must be different across periods, and hence some elements of b_1 may be set equal to zero.

Partial results of the estimation of models 2 and 3 for non-adopters are reported in Table 4**.** The “basic” model used in these equations includes no interactive term, i.e., all b_1 are set equal to zero. The coefficient b_0 on the time dummy for non-adopters is not significantly different from zero, confirming that households in this group were accumulating at comparable rates in the 1980s compared to the pre-1979 period and also in the 1990s compared to the 1980s. This excludes the possibility that some time-related unaccounted variables other than NTX adoption may have been responsible for a structural change in accumulation patterns. By contrast, NTX adopters were accumulating land at a higher rate after adoption, in the 1980s, than in the pre-adoption period. In the 1990s, however, the trend is dramatically reversed.

SELECTIVITY EFFECTS: ADOPTERS VERSUS NON-ADOPTERS

In evaluating the true impact of adoption on land accumulation trends over time, we must account for a possible preexisting heterogeneity between adopters and non-adopters due to unobservable characteristics such as farming skills and entrepreneurship not directly accounted for in the regressions. These factors are likely to affect

[5] The LR statistic is distributed as a chi-square with degrees of freedom equal to the number of variables included in the heteroscedasticity specification.

profitability at the household level with potential consequences on the household's ability to accumulate assets. It may have been the case that a self-selection process was at play, with only the most skilled farmers entering NTX production (Maxwell and Fernando 1989). In this case, the net effect on accumulation induced by adoption must be disentangled from the effect due to these unobservable idiosyncratic characteristics. We accomplish this task by estimating a first regression model (model 1) that compares land accumulation in the pre-adoption period for both adopters and non-adopters. Adoption not yet being a possibility in this pre-adoption period, any difference between the two groups will reflect characteristics innate to the two groups or acquired prior to adoption.

We estimate an equation on the annual rates of land accumulation in the pre-adoption period for both adopters and non-adopters. Since the conditions for accumulation in the 1980s are likely to be different for adopters and non-adopters, we compare accumulation rates prior to 1979, the first year of potential adoption. The variable NTX reflects whether the household will ever adopt or not:

$$\Delta L_i = a_0 + a_1' Z_i + b_0 NTX + n_i, \text{ with } n_i \approx N(0, s^2 e^{d' w_i}). \qquad \text{(model 1)}$$

A significant coefficient on the NTX variable will reveal the presence of preexisting heterogeneity in unobservable characteristics between the two groups.

Table 5 gives estimates of the accumulation rates in the pre-1979 period for both non-adopters and future adopters. The main result upon which we wish to draw attention is related to the estimated coefficient of future NTX adoption. On the basis of the estimates, we cannot reject the hypothesis of homogeneity in unobservable characteristics between adopters and non-adopters that are assumed to have an impact on the groups' ability to accumulate land. Therefore, we can analyze the effect of adoption by contrasting adopters and non-adopters without incurring the risk of introducing selectivity bias.

COOPERATIVE MEMBERSHIP EFFECTS

A final concern in estimating the land accumulation equations relates to the cooperative membership variable. The coefficient on this variable will overestimate the true effect of membership on the accumulation phenomenon if a self-selectivity process was at play when joining the cooperative, with only farmers with certain features entering the cooperative. Also, a hidden selection process may have been implemented by the cooperative when accepting members. Both situations will cause a selectivity bias if some unobservable characteristics that contributed to the decision to join the cooperative are also among the determinants of land accumulation. To estimate the true treatment effect of membership status on the land accumulation process, we must disentangle these two phenomena. We will do it in both models, but using different approaches.

In model 2, which compares accumulation between the pre-adoption period and the 1980s, membership was not a possibility in the pre-adoption period. Therefore, the coefficient on the membership variable relative to the first period (pre-adoption) will reflect the existence of preexisting heterogeneity between future cooperative members and nonmembers. The true effect of membership status will then be equal to the difference between the effect of the membership status in the second period, i.e., in the

1980s, and the impact of the same variable in the first period. We test for it by introducing in model 2 both the membership variable as well as an interaction term between this variable and a dummy identifying the 1980s.

In model 3, we handle the cooperative membership as a classical treatment effect. For this purpose, we first estimate a Probit model on membership status. The hypothesis is that the probability of joining the cooperative is determined by the size of landholding, the year of household formation, the geographical location of the household, and the age and education of the head of household. The predictive power of the model specification is quite high, with a Zavoina and McKelvey's pseudo-R^2 = 0.84. The derived Inverse Mills Ratio (IMR) will be used in model 3 to correct for possible selection bias.

4. THE LAND ACCUMULATION EQUATIONS

SPECIFICATION OF THE EQUATIONS

Among the potential factors affecting land accumulation trajectories other than NTX adoption, we will consider a set of idiosyncratic features such as the life-cycle position of the household, its initial landholding, cooperative membership status, and local land market conditions. We introduce a quadratic specification of the life-cycle age of the household[6] to test the hypothesis that, at least in the pre-adoption period, peasant households were following a Chayanovian demographic life-cycle accumulation

[6] The variable reflects the number of years between the year of household formation and the end of the period under consideration.

trajectory. NTX adoption is likely to disrupt this pre-adoption life-cycle pattern of accumulation.

As reported by Barham, Carter, and Sigelko (1995) and supported in the descriptive statistics reported above, smallholders appear to initially accumulate at higher rates. We wish to test this assertion, as well as whether smaller landholders are able to maintain this high rate of accumulation in the long run. The amount of land owned by the household at the beginning of each period is introduced in the model for this purpose. It is plausible to assume that smaller farmers, thanks to the high profitability of NTXs in the 1980s, were initially able to accumulate at higher rates to relax their binding land constraints. The question remains whether this pattern of accumulation has been offset in the longer run by other factors operating in favor of wealthier farmers.

Membership in the cooperative is assumed to have a positive impact on land accumulation during the adoption years. Credit for land purchases was available from the cooperative, at least initially. In addition, cooperative membership may have contributed to relaxing information constraints so important in agronomically difficult types of cultivation such as NTXs and, consequently, increased the likelihood of wealth accumulation.

Furthermore, the characteristics of the local land markets, as captured by the set of village dummies, are among the potential factors affecting the household's ability to accumulate land. The assumption is that different local land market may characterize the different villages in the sample.

ACCUMULATION IN THE 1980s

In Table 7, we report the estimation of model 2 in which we test for the existence of structural changes induced by NTX adoption in the 1980s. A test for the presence of heteroscedasticity was performed. The estimated parameters of the heteroscedasticity specification used, and the value of the Likelihood Ratio test are reported at the bottom of the table. The coefficient of the period dummy is positive and strongly significant, implying a powerful net effect of 1980 NTX adoption on land accumulation patterns. Because we have seen in Table 4 that non-adopters in the 1980s are not accumulating at rates significantly different than the ones observed in the pre-1979 period, the coefficient on the period dummy in Table 7 truly reflects the impact of adoption.

As predicted, the pre-adoption accumulation trajectory follows a Chayanovian demographic life cycle. However, the pattern is reversed in the adoption period, as suggested by the opposite sign of the coefficients of the life-cycle age variables for the 1980s adoption period. In conformity with Barham, Carter, and Sigelko's (1995) findings, smaller landowners are accumulating at higher rates both in the pre-adoption and the 1980-adoption periods (the coefficient of the interactive term between the time dummy and landholding was not significantly different from zero and was dropped from the equation). Cooperative membership significantly contributed to higher accumulation rates in the 1980s. The coefficient on the interaction term reflects entirely the cooperative treatment effect, since no evidence of preexisting heterogeneity between members and nonmembers is found (see coefficient on membership variable). No significant differences in land accumulation rates emerge across villages.

ACCUMULATION IN THE 1990s

In Table 8, we present different estimations of the regression in which we compare the accumulation rates in the 1980s with those in the 1990s. One of the problems encountered with the comparison of these two periods stems from the very short period of observation for the 1990s. As land transactions are lumpy, purchases are infrequent, and many observations of zero purchase in the short period may only reflect the timing of the observation rather than a true nonpurchase. This may lead to both a gross underestimation and a large standard deviation of the acquisition rate, compared to the observations in the longer 1980s period. We correct for this by introducing the length of the period of observation as an exogenous variable.

One of the most crucial and distressing conclusion that is common to all specifications in Table 8 is the significantly lower rates of accumulation in the 1990s compared to the ones in the 1980s, as reflected in a negative and significant coefficient on the period dummy variable, hinting to the unsustainability of previous patterns of accumulation in the long run. Because we have seen in Table 4 that non-adopters in the 1990s are not accumulating at rates significantly different than the ones observed in the 1980s, this coefficient truly reflects the impact of adoption. In conformity with the results of model 2, smaller landholders are accumulating at higher rates compared to their larger counterparts in the 1980s. However, this trend appears reversed in the 1990s as reflected in a positive marginal effect of the land variable for the second period. The finding is grounds for concern about the long-run impact of NTX adoption as an instrument for wealth accumulation for less well-endowed farmers toward a more equitable distribution of assets.

Model 3b shows that cooperative members accumulate significantly more in both periods compared to nonmembers. However, when this cooperative membership is taken into account, the farm size effect loses some significance. This is due to a strong link between farm size and membership as the cooperation especially catered to small farms in helping them increase their holdings in order to adopt NTXs. As this link did not last to the 1990s, the farm size effect on accumulation remains significant in the 1990s. In model 3c we introduce the IMR to correct for potential selectivity bias due to unobservable characteristics captured in the membership variable. The coefficient on the IMR is not significant, once again providing evidence for the absence of preexisting heterogeneity between members and nonmembers in their predisposition to accumulate land.

In model 3a, the length of the period of observation appears, as expected, positively related to land accumulation. However, as we introduce the cooperative membership variable (model 3b), the coefficient loses significance. This is due to the more important role of the cooperative in the earlier years of adoption, and hence a strong correlation between the longer period of observations (which correspond to earlier adopters), and the cooperative membership. Finally, no significant difference in the accumulation rates exists across communities.

ACCUMULATION AND DIFFERENTIATION

While adoption in the 1980s initially promoted a process of land accumulation among adopters quite widespread and evenly distributed, inequalities in land accumulation patterns within this group of peasants increased substantially in the 1990s compared to the 1980s. We argue that while NTX adoption in the 1980s stimulated a process of socioeconomic differentiation in the highlands exclusively on the basis of adoption status, the deteriorating conditions of the 1990s have fueled an additional stratification in the wealth accumulation patterns among adopters, with fewer adopters able to accumulate in the 1990s at even higher rates, and a larger portion of adopters no longer able to accumulate.

A simple test of this proposition is to verify whether the variability in land accumulation rates across households has increased over time, i.e., whether the error terms in each separate model (models 2 and 3) are related to the time dependent variable identifying the periods. A positive and significant coefficient on the time dummy variable in the heteroscedasticity specification will imply increasing inequality in the accumulation rates across adopters. Both in models 2 and 3, the coefficient is positive and strongly significant. The findings imply that NTX adoption has progressively fueled a process of increasing inequality in the accumulation patterns across households.

5. SIMULATION OF LAND ACCUMULATION TRAJECTORIES

The models estimated to explain the determinants of accumulation can be used to simulate trajectories of land accumulation for specific values of the explanatory variables. They provide a good visual summary of the results obtained in this study. We use predictions based on the conditional mean functions for the censored regression models. The predicted Tobit value for the *i*-th observation is

$$E(\Delta L_i \mid x_i, \Delta L_i \geq 0) =$$
$$\mathrm{Prob}(\Delta L_i = 0) E(\Delta L_i \mid x_i, \Delta L_i = 0) + \mathrm{Prob}(\Delta L_i > 0) E(\Delta L_i \mid x_i, \Delta L_i > 0) =$$
$$\Phi(\frac{g' x_i}{s_i}) g' x_i + s_i f(\frac{g' x_i}{s_i}),$$

where x_i are the values of the exogenous variables in the land accumulation equation for farmer *i* and b_i, the corresponding regression coefficients; s_i, the estimated standard error of the residuals; ö, the standard normal density function; and Φ, the cumulative normal.

Average predicted values are calculated by sample averaging. This means that a predicted value is calculated for each household using the above formula with all exogenous variables at their observed values except the variable for which conditional predictions are obtained, and the average of the predicted values over the sample is then calculated. The land accumulation trajectories are drawn using

$$L_t = L_0 + t\{E(\Delta L)\}.$$

Figure 3 gives the land accumulation trajectories for non-adopters and adopters, with adopters disaggregated in cooperative members and nonmembers. These trajectories were calculated with the following models:

For non-adopters:

For period 1969-79: Model 2na (basic model with period dummy = 0; results partially reported in Table 4).

For period 1979-90: Model 3na (basic model with period dummy = 0; results partially reported in Table 4).

For period 1991-94 : Model 3na (basic model with period dummy = 1; results partially reported in Table 4).

For adopters:

For period 1969-79: Model 2 for future adopters with period dummy = 0 (see Table 7).

For period 1979-90: Model 3e with period dummy = 0 (see Table 8).

For period 1991-94: Model 3e with period dummy = 1 (see Table 8).

For dropouts in period 1993-95: Model 4 with period dummy = 0 (basic model; results not reported).

The regression equation used for basic models 2na, 3na, and 4 is specified as

Annual accumulation = *f*(*age*, age^2, *initial land*, *village dummies*, *period dummy*).

The trajectories in Figure 3 show how there was a steady increase in the size of landholdings, with no significant change in the rate of land accumulation, across the three periods for non-adopters. For future adopters, land accumulation was similar to that of non-adopters before NTXs became available in 1979. For adopters, land accumulation accelerated in the 1980s compared to the pre-adoption period, but it decelerated in the 1990s. For those who dropped out of NTXs in the 1990s, accumulation stopped, making them fall behind accumulation by non-adopters and thus showing the distress caused by problems with NTX production. Among adopters, membership to the Quatro Pinos cooperative made a considerable difference on land accumulation, especially in the 1980s, with members accumulating at a much faster pace than non-adopters as the cooperative was providing advantages such as access to long-term credit for land purchases.

Figure 4 shows that annual rates of accumulation were decreasing with farm size in the 1980s. Smallholders were adopting NTXs enthusiastically and using the income to increase the size of their landholdings. This was contributing to a more egalitarian pattern of landownership. This was reversed in the 1990s, with larger farms accumulating land at a faster pace than small farms, leading to land concentration.

6. CONCLUSIONS AND RECOMMENDATIONS

After more than two decades of extensive NTX adoption in LDCs, the direction and magnitude of the impact of these programs at the household level is still the subject of debate. The aim of this paper was to contribute to this debate by investigating the long-run linkage between NTX adoption and land accumulation patterns in rural communities in the central highland of Guatemala.

In spite of the optimism that has characterized previous studies of the Guatemalan experience with NTXs (von Braun, Hotchkiss, and Immink 1989; Barham, Carter, and Sigelko 1995), we provide empirical evidence of a rather distressing scenario. In particular, the portrayal that emerges from our analysis raises some perplexities about both the sustainability and the equity implications of NTX adoption in the long run.

In particular, we wish to emphasize three main findings

1. One first point of concern relates to the sustainability of NTX policies as documented in the dramatic drop in accumulation rates exhibited by adopters in the 1990s. Adopters accumulated substantially more land than non-adopters in the 1980s. But, while they are still accumulating more than non-adopters in the 1990s, the gap between the two groups is narrower in the 1990s than in the 1980s.
2. Fewer adopters are accumulating positive amounts of land in the 1990s (compared to the second half of the 1980s), but those who do are, on average, accumulating at higher rates than in the preceding periods. In view of Guatemala's past experiences with highly exclusionary export booms, the outcome causes concern about the degree of concentration of the land accumulation process promoted by NTX adoption in the 1990s. The higher levels of accumulation exhibited in the 1990s by few adopters and the smaller number of

adopters still accumulating is the result of a process of escalating differentiation among adopters based on their differential capacities to accumulate wealth.

3. In accordance with Barham, Carter, and Sigelko (1995), we also find evidence that smaller adopters were accumulating at significantly higher rates than their larger counterparts, both in the pre-adoption period and in the 1980s. However, the direction of the bias appears to be reversed in the 1990s, with larger landholders accumulating at higher rates. The advantage initially exhibited by smaller farmers in accumulating land may have been lost as a result of the increasingly deteriorating conditions under which NTXs are produced, which are likely to have been most taxing on less-endowed farmers.

On the basis of this evidence, a word of caution is warranted regarding the potential of NTXs as an instrument of rural development. NTXs exhibited great promise in the 1980s as a means to reduce the strong dualistic structure of Guatemalan agriculture. While the widespread diffusion of NTXs among all farm size classes initially fueled optimism, it has now become a matter of serious concern, in view of the worsening conditions that appear to have followed NTX adoption.

One of the central tenets behind the promotion of input-intensive NTXs in LDCs was to encourage rural development through a more efficient use of the locally available resources, i.e., land and labor. Paradoxically, the crisis of NTXs in the 1990s appears to be a direct consequence of the overexploitation of these resources. In the period preceding the introduction of NTXs, the inadequate land base of the vast majority of households was already heavily cultivated with subsistence and traditional crops. Family members were overburdened with low productivity but indispensable tasks. In many instances, NTX adoption contributed in the long run to putting an additional strain on the households' limited resources. A successful and sustainable NTX policy calls for a more comprehensive approach to prevent this. Well-functioning food markets are a precondition to allow a reduction of land allocated to subsistence crops. Crop insurance, consumption credit, and other risk-coping instruments must be promoted to allow taking greater risks in growing NTXs and reduce the need to grow traditional crops as a risk management strategy for consumption smoothing. Furthermore, long-term rural credit programs can facilitate land purchases. All this would ultimately release pressure over scarce land resources and reduce the likelihood of the recurrence of similar crises.

In conclusion, the problems associated with this latest agro-export boom seem to have occurred as a result of the indiscriminate diffusion of these new crops regardless of individual farmer's suitability to grow them. The choice for policymakers is obvious. They can either accept the fact that NTXs may not be suited to small farmers and focus on a more accommodated group of participants; or, alternatively, they can provide more adequate support in the form of crop insurance and access to credit and information to the poorest peasants so they can successfully improve their socioeconomic position through NTX cultivation and capitalize the gains to increase the size of their landholdings.

TABLES

Table 1—Descriptive statistics, by nontraditional export adoption status

	All	Non-adopters	Adopters[a]
Number of observations	182	64	126
Farm size	5.3	2.8	6.6
1979 landholdings	3.7	2.4	4.2
1994 landholdings	6.5	3.5	8.2

[a] Only includes households who adopted for more than two years.

Table 2a—Average annual land accumulation, by adoption status (in *cuerdas*)

	All	Non-adopters	Adopters
<1979	0.20	0.18	0.21
1979-1990	0.24	0.11	0.30
1991-1994	0.17	0.08	0.22

Table 2b—Average annual land accumulation, by initial size of landholding

	Landholdings (*cuerdas*)[a]	
	[0 - 4.5]	> 4.5
<1979	0.22	0.05[b]
1979-1990	0.23	0.19
1991-1994	0.15	0.19

[a] Landholdings at beginning of each period.
[b] Low number of observations.

Table 3a—Average annual land accumulation (positive accumulation rates in each period only)

	Percent > 0	Average accumulation
<1979	47	0.42
1979-1990	43	0.91
1991-1994	42	0.79

Table 3b—Average annual land accumulation for adopters with positive 1990 accumulation

	Percent > 0	Average accumulation
<1979	44	0.18
1979-1990	63	0.55
1991-1994	100	0.79

Table 3c—Average annual land accumulation for adopters with zero 1990 accumulation

	Percent > 0	Average accumulation
<1979	51	0.23
1979-1990	32	0.30
1991-1994	0	0.00

Table 4—Partial results on period dummy coefficients[a]

	Non-adopters	Adopters
	n(model 2na) = 67 n(model 3na) = 96	n(model 2) = 201 n(model 3) = 207
Model 2	0.02 (0.1)	0.14 (1.7)
Model 3	-0.36 (-1.5)	-0.60 (-3.0)

[a] Using the basic model specified as:

Annual accumulation = f(age, age^2, initial land, village dummies, period dummy).
Period dummies are 1980s in model 2 and 1990s in model 3.
Values in parentheses are Z-statistics.

n = number of observations.

Table 5—Tobit specification of land accumulation prior to 1979 (model 1)

	Coefficient	Z-statistics
Number of observations	110	
Constant	-0.55	-2
Age of household head at end of period	0.07	2.6
Age of household **2	-0.002	-2.3
Initial land owned at year of household formation	-0.04	-2.2
Village dummies		
Pachali	-0.30	-1.3
San Jose Pacul	0.06	0.3
Santa Maria Cauque	-0.08	-0.5
San Mateo Milpas Altas	-0.32	-1
El Rejon	-0.01	-0.1
NTX adoption	0.1	0.7
Heteroscedasticity specification		
Age of household head at year of household formation	-0.04	-20
Heteroscedasticity test: Likelihood Ratio statistic = 6.9		

Table 6—Tobit specification of land accumulation in preadoption period and 1980s, by adopters only (model 2)

	Coefficient	Z-statistics
Number of observations	169	
Constant	-0.26	-1.1
Household characteristics (*Z*)		
Age of household at end of each period	0.09	2.5
Age of household **2	-0.003	-2.2
Landholdings at beginning of each period (*cuerdas*)	-0.06	-3.1
Cooperative membership	-0.06	-0.7
Village dummies		
Pachali	0.18	1.4
San Jose Pacul	0.005	0.1
Santa Maria Cauque	-0.17	-2.0
San Mateo Milpas Altas	-0.21	-1.5
El Rejon	-0.17	-1.7
Period dummy (*D*)	1.1	2.8
Household characteristics in the 1980s (*DZ*)		
Period dummy*Age household	-0.18	-3.3
Period dummy*(Age household**2)	0.006	3.0
Period dummy*Cooperative membership	0.4	2.1
Heteroscedasticity specification		
Initial landholdings	0.05	2.0
Length of adoption	-0.08	
Log-likelihood	-94	
Heteroscedasticity test: Likelihood Ratio statistic = 31.6		

Table 7—Tobit specification of land accumulation in the 1980s and 1990s, by adopters only (model 3)

Models	3a	3b	3c
Number of observations	207	172	172
Constant	0.45	0.39	0.33
	(1.8)	(0.9)	(0.8)
Household characteristics (*Z*)			
Age household at end of each period	-0.06	-0.09	-0.09
	(-2.2)	(-2.2)	(-2.2)
Age household **2	0.001	0.002	0.002
	(1.9)	(1.9)	(2.0)
Landholdings at beginning of period (in *cuerdas*)	-0.027	-0.026	-0.026
	(-1.7)	(-1.2)	(-1.2)
Cooperative membership		0.65	0.73
		(2.1)	(1.9)
Inverse Mills Ratio (IMR)			-0.09
			(-0.3)
Village dummies			
Pachali	0.30	0.21	0.19
	(1.5)	(1.1)	(0.9)
San Jose Pacul	0.11	0.11	0.10
	(0.6)	(0.6)	(0.5)
Santa Maria Cauque	-0.23	-0.16	-0.15
	(-1.4)	(-0.8)	(-0.8)
San Mateo Milpas Altas	0.24	0.3	0.3
	(1.2)	(1.3)	(1.3)
El Rejon	0.10	-0.05	0.05
	(0.5)	(-0.3)	(0.2)
Length of observation period	0.05	0.09	0.07
	(2.4)	(0.4)	(0.3)
Period dummy (*D*)	-1.41	-0.72	-0.71
	(-3.0)	(-2.9)	(-2.9)
Household characteristics in the 1990s (*DZ*)			
Period dummy*Initial owned land	.19	.045	.045
	(1.6)	(1.5)	(1.5)
Period dummy*Initial owned land**2	–.009		
	(-1.4)		
Heteroscedasticity specification			
Period dummy	1.08	0.81	0.81
	(5.3)	(3.6)	(3.5)
Length of observation period	-0.07	-0.04	-0.04
	(-2.5)	(-1.1)	(-1.1)
Cooperative membership		–0.28	–0.27
		(-0.9)	(–0.8)
Log likelihood	-172	-134	-135
LR heteroscedasticity test (chi-square)	38.2	11.1	20.8

Note: Values in parentheses are Z-statistics.

FIGURES

Figure 1—Per-year land accumulation, by 1979 farm size

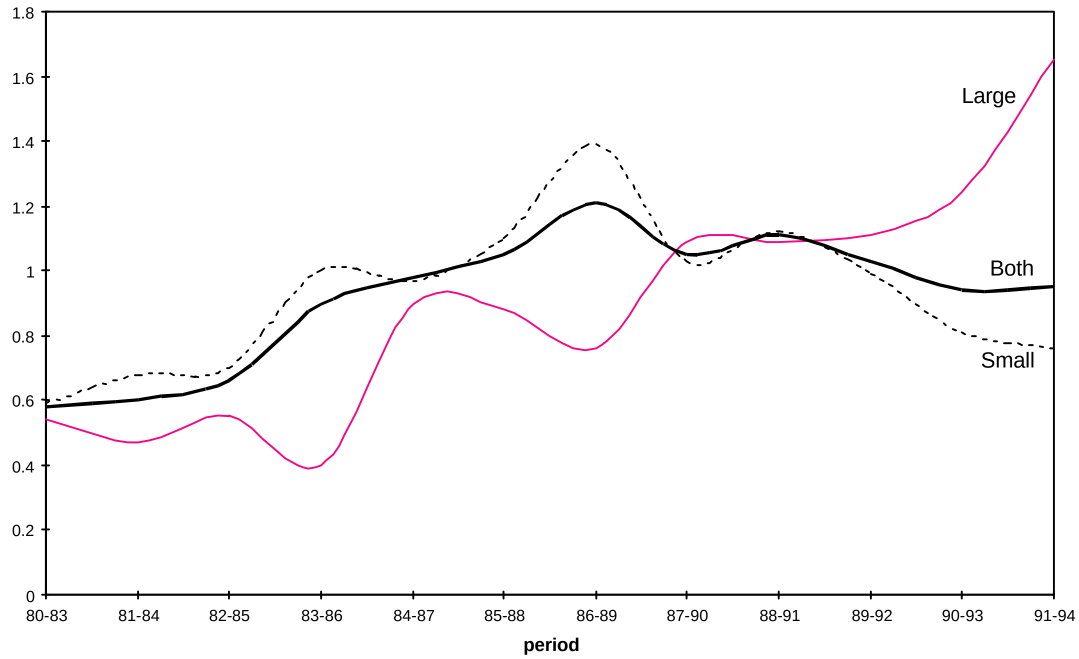


Figure 2—Percentage of households with positive accumulation (four-year moving average, adopters only)

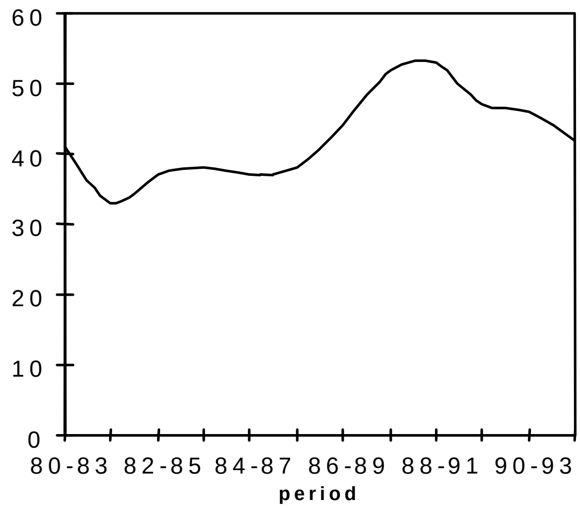


Figure 3—Land accumulation trajectories

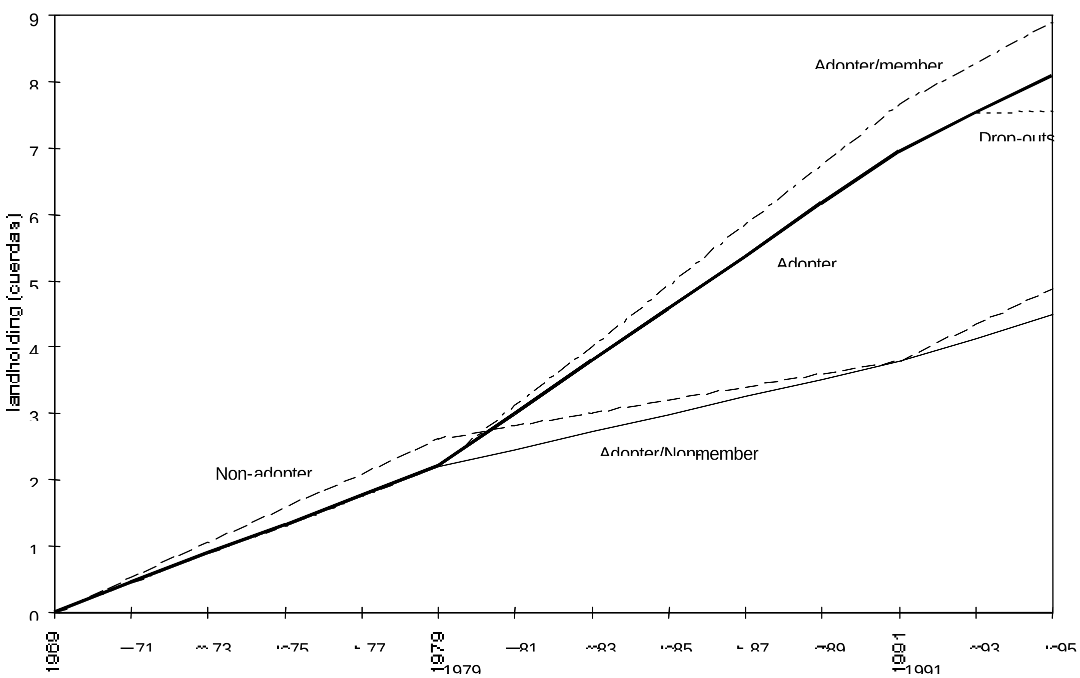
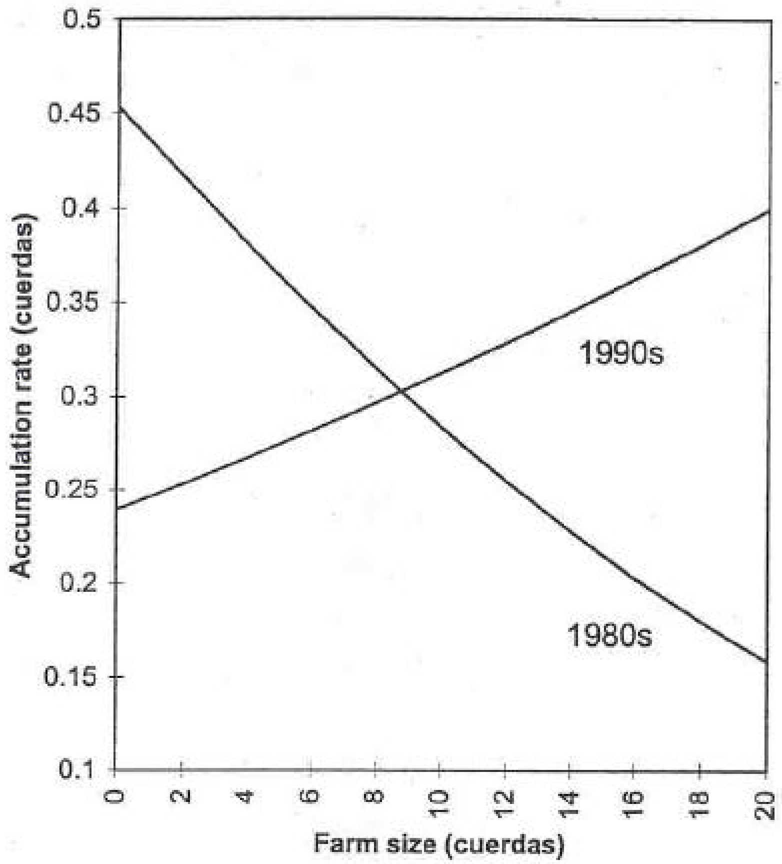


Figure 4—Per-year land accumulation, by farm size (NTX adopters)



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