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# Investment and Income Effects of Land Regularization

## The Case of Nicaragua

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In situations where tenure insecurity is pervasive (as in Nicaragua), systematic efforts of land regularization can have positive effects on productivity as well as equity.

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## Summary findings

Deininger and Chamorro use data from Nicaragua to examine the impact of the award of registered and nonregistered title on land values and on investments attached to land. They find that receipt of registered title increases land values by 30 percent and greatly increases the propensity to invest, bringing investment closer to the optimum.

Consistent with descriptive statistics indicating great demand for regularization of land rights, especially from the poor, this finding suggests that titling can have a positive distributional effect. Of overriding importance, however, are the legal validity and official recognition of the titles issued.

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This paper—a product of Rural Development, Development Research Group—is part of a larger effort in the group to explore the impact of land policies on household welfare and productivity. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Maria Fernandez, room MC3-542, telephone 202-473-3766, fax 202-522-1151, email address [mfernandez2@worldbank.org](mailto:mfernandez2@worldbank.org). Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. The authors may be contacted at [kdeininger@worldbank.org](mailto:kdeininger@worldbank.org) or [jscja,prrp@hotmail.com](mailto:jscja,prrp@hotmail.com). January 2002. (29 pages)

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# **Investment and income effects of land regularization:**

## **The case of Nicaragua**

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**Investment and income effects of land regularization:  
The case of Nicaragua**

**1. Introduction**

Access to land is of great importance for household welfare for a number of reasons -ensuring food security, providing an opportunity to make productive use of family labor, and to diversify the households' activity portfolio- especially in environments where other product and insurance markets are imperfect (de Janvry et al. 2000). Secure property rights to underpin such land access are generally considered to be a precondition for economic growth and development, for three reasons, namely (i) they provide the incentives necessary for owners to undertake land-related investments thus helping to maintain and increase sustainability of resource use and agricultural productivity; (ii) they decrease the cost of transacting land in the market, thus helping to increase allocative efficiency in the economy; and (iii) availability of formal land title increases credit supply by providing a basis for institutional lenders to actually foreclose on a property in case of default (Besley 1995; Binswanger et al. 1995; Deininger and Feder 1999). Although there is little disagreement about the importance of these factors at the conceptual level, their relative importance, the magnitude and distribution of potential benefits generated by exogenous interventions to increase tenure security as compared to the cost of establishing land rights, and the policy implications to be derived, have been the subject of much debate in the literature. In this context, three issues have been of particular interest.

The first issue relates to the benefits of more secure land tenure in an environment where credit markets do not function well. Following the seminal work by Feder et al. (1986) in Thailand which found that the benefits from land titling come about predominantly through a credit supply effect, interventions to provide land regularization and titling are now routinely justified in terms of the improved credit access they provide. However, in the majority of the situations where the issue of public interventions to enhance land tenure security is currently under discussion, credit markets do not function well. Use of land as collateral is legally prohibited in China and a number of East Asian countries (Cambodia, Laos). Foreclosure is difficult if not impossible in India and the Philippines. In many African countries, low population densities and absence of financial infrastructure imply that credit markets are underdeveloped and that land has little value as collateral. In fact, a number of studies have concluded that in

environments where, for institutional or legal reasons, credit is not readily available to agriculture, there may be little justification of public interventions to increase tenure security (Bruce and Migot Adholla 1994; Platteau 1996). This leads to the question whether, in situations where credit is unlikely to be the primary channel through which titling would affect land use, there may still be other channels through which such an intervention will have an impact.

The second issue relates to the significance of land title, and in particular the potential for reverse causality whereby, rather than increased tenure security (e.g. through award of title) causing investment, it is investment, for example in the form of tree planting, that leads to higher levels of tenure security. This key argument is that land-related investments may themselves be a means of staking claim to a plot of land and thereby enhancing the degree of tenure security (e.g. Sjaastad and Bromley 1997, Brasselle et al 1997). This could explain that possession of land title may not be equivalent to higher levels of tenure security (Wachter, 1992). If it were true, land rights would be clearly endogenous, the returns to measures that increased security of land rights found in the literature (Besley 1998; Alston et al. 1996; Lopez 1997; Hayes et al. 1997) would be biased, and contributions that are more skeptical regarding the potential impact of titling (e.g. Jansen and Roquas 1998; Atwood 1990) might be correct.

Finally, there has been concern regarding the distributional impact of land titling, an issue that depends largely on the channel through which the main effect comes about. If titling improves credit access only, it will likely be the better off who will be able to derive economic benefits from land titling (Carter and Olinto 2000). If, on the other hand, titling improves tenure security, it may provide large benefits to the poor who, without being able to rely on a formal document that is enforced by the state, are often forced to spend disproportionate amounts to counter legal challenges to their land ownership. It is well known that the added security of low-cost measures to increase tenure security is much sought after (Firmin-Sellers and Sellers 1999). Nonetheless access to land provides an important safety net in the face of incomplete food markets (Burgess 1999). Thus, especially in cases where the number of land conflicts is increasing (e.g. Andre and Platteau 1998; van Donge 1999), inability to discern a credit supply effect may not imply that measures to enhance tenure security –which may stop short of full-fledged formal title would not be useful and appropriate to enhance productivity and overall economic efficiency. By possibly precluding them from using family labor, the one resource they possess in abundance, to make productivity-enhancing investments with comparatively high economic returns. Evidence on an investment response to titling, and in particular the extent to which such titling was able to target the poor, could thus be important to provide a justification for land titling not only from an efficiency- but also from an equity perspective.

In this paper we use the example of Nicaragua to explore these issues. Nicaragua is of interest for a number of reasons. First, in different phases of its implementation, the titling program issued certificates the legal impact of which was quite different. While initially beneficiaries received only a certificate of title, subsequent changes resulted in the issuance of a legally binding registration. Second, titling was undertaken in the context of an intervention targeted at all agrarian reform beneficiaries in a given area, thus being clearly exogenous and alleviating concerns that the results of any measurement of the impact may be affected by endogeneity. Third, the data available allow us to apply econometric methodologies that are more appropriate than those that have often been used in the literature, as discussed below. Also, in view of the general lack of rural financial infrastructure and a restructuring of the financial sector in the second half of the 1990s, credit supply was unlikely to be the main route through which more secure tenure would affect economic outcomes. With a population density of 30 inhabitants per km<sup>2</sup> (90 if the Atlantic coast is excluded) Nicaragua is also relatively land abundant. Thus, as in the case of many African countries, land values as well as the likelihood to find a significant impact of titling on credit access would be lower than in densely populated areas.

The paper is structured as follows. Section two provides a more detailed review of the literature and the conceptual background underpinning efforts at land regularization as well as a brief account of the land tenure situation in Nicaragua and a description of the data underlying the analysis. Section three discusses the conceptual framework and the equations to be estimated to make inferences on the investment-effect of land title, the potential economic impact of such investment, and the extent to which land regularization increases land values for different groups in the population. Section four discusses empirical results, while section five concludes with a number of recommendations for research and policy.

## ***2. Legal environment, data, and descriptive statistics***

The impact of titling interventions can not be separated from the legal and institutional framework prevailing in a country. Thus, any effort at identifying the impact of such a measure needs to build on an understanding of the historical evolution of land relations, the way in which titles (or other documents) were awarded, and the legal significance of these certificates. In this section, we provide this legal and historical background on the situation in Nicaragua as well as the land titling intervention to be analyzed subsequently. We also describe the sample to be used and discuss descriptive statistics concerning socio-economic characteristics and agricultural productivity.

## 2.1 The legal and policy environment

In Nicaragua, a series of commodity booms in coffee, cotton, and meat, together with a set of policy distortions that encouraged the accumulation of land, gave, from the late 19<sup>th</sup> century, rise to a systematic process of land concentration (e.g. Paige 1997). This process was accentuated by land acquisition through A. Somoza, who assumed the presidency in 1936, and his family. The Sandinista revolution in 1979 unseated Somoza and distributed large tracts of lands to former workers. However, during the Sandinista period, which lasted from 1979 to 1990, and especially in its final phase, the Government distributed, through its agrarian reform program, large amounts of land it did not legally own, thereby laying the seed for continuing insecurity in the sphere of property rights.

Following the change of government in 1990, the door was opened to a flood of claims for restitution. Even though various laws aimed at setting an end to the lodging of new claims for restitution by former owners, the issue has been re-opened repeatedly, often shortly after a supposedly definitive deadline for closing the books had lapsed. As a result, a large volume of litigation ensued and tenure security was undermined not only for those directly affected by land redistribution but also for the remainder of land owners who had to live in constant fear of being subject to a claim to their land. This is illustrated by the fact that the total area currently claimed for restitution is larger than Nicaragua's total land area (Merlet and Pommier, 2000).

Distribution of land under agrarian reform, largely to ex-combatants, continued under the Government that held office in 1990-1996. Although the lands involved were largely in frontier areas, it was often not clear whether or not previous titles to the land had existed. This, together with transactions of land received through land reform, further complicated the land tenure situation. It was accompanied by farm invasions through self-styled bands of "demobilized" soldiers which were sometimes staged by indebted large farmers wanting to avoid foreclosure. There is general agreement that, in order to deal with these issues and to provide the underpinning for continued economic recovery and rural growth, improving tenure security will be mandatory from a productivity and an equity point of view. In fact, the Government's poverty reduction strategy highlights land regularization as one of the priority actions to revive economic growth and improve the livelihood of the poor (Government of Nicaragua, 2000). Nicaragua also counts with a very gender-sensitive legislation and, in order to ensure equal treatment of women, the administrative requirement to issue title jointly to husband and wife.

The importance of these issues is most strikingly illustrated by the case of cooperatives. The large majority of these cooperatives have long been disbanded and *de facto* individualized. However, inability to determine whether or not current members of the cooperatives are rightful owners of their land, together with an institutional and legal framework unable to resolve the issues, especially provision of the

legally required documentation, at the speed required, made it virtually impossible for members of cooperatives to formally make the *de jure* transition to individual land ownership. The productive inefficiency of collectives and the need to continue fighting legal battles for their land led to a precipitous economic decline of the cooperative sector and a wave of distress sales (Jonakin 1997), both of which affected primarily the poorest groups in the population. More recent case studies also illustrate that the poor spent considerable amounts of money or even had to sell portions of their lands to hire lawyers to defend their land claims in legal cases that were often of dubious nature (Merlet and Pommier, 2000).

To realize the benefits associated from better definition of property rights, various donors have provided resources for clarification of the legal framework and land titling and registration. A World-Bank project, with the general objective to carry out a rural cadastre, modernize the system of national land registry, and to regularize the situation of beneficiaries from agrarian reform under the Sandinista as well as subsequent governments, has since 1992 awarded more than 40,000 titles all over the country. With titling of the “reform sector” almost completed, policy-makers are now interested to examine not only the impact of this intervention but also to explore whether there is justification for expanding these programs, possibly in a modified form, to the “non-reform sector”, i.e. all the lands under private land ownership.

A number of design aspects of this program provide a background for an evaluation which, by assessing the impact of the past program, can help to provide an answer to this policy question. First, emphasis in this as well as most other donor-financed projects was on the “Agrarian Reform Sector”, i.e. lands that were distributed under pre- and post- 1990 agrarian reforms. Titling of these lands was almost completed during the period under concern. To the extent that wealthy land owners had already undertaken the steps necessary to formalize their land claims, this process is likely to have been well targeted towards the poor. Second, the nature of titles awarded changed significantly during the period under concern. While initially, beneficiaries received only a title certificate which fell short of full legal proof of ownership, realization of the fact that these were deficient in many respects led subsequently to official instructions to give out only titles that had also been properly registered. Supply-side variables such as shortages in staffing and availability of funds, as well as complex procedures, appear to have limited the implementation of this order on the ground. As only registered titles provide evidence that any possible claims by previous land-owners had been settled, they imply a much higher level of tenure security. Finally, the program was offered to beneficiaries free of direct cost and provided assistance to meet the indirect costs in terms of time, transportation, and the transaction costs associated with obtaining proper documentation (e.g. birth certificates and identification cards) that are still needed for participation.

## **2.2 Data sources**

We use a survey conducted by the World Bank, the University of Wisconsin, and a local NGO, between February and April of 2000. This survey contains, in addition to standard household characteristics, information on income sources, an elaborate section on agricultural production, a land inventory and land acquisition history, as well as a history of land-related investments and questions on the participation in and perception of the titling program. The sample consists of four different groups of rural producers, namely (i) a nationally representative sample of producers in the private sector; (ii) beneficiaries from the government's titling program; (iii) land-poor rural households who rely to a significant extent on rural labor and land rental markets; (iv) and recent entrants in the land purchase or rental market. The detailed construction of the sample is explained below.

The basis for this survey is a nationally representative area-sample of 1360 farmers who were first surveyed in 1996 by the Nicaraguan Ministry of Agriculture and Forestry (MAGFOR) in collaboration with FAO. As the number of titling beneficiaries in this group would have been too small to make inferences on the impact of titling, we complement the sample with 461 households who were sampled randomly from a list of beneficiaries who participated in the Government's land titling program between 1994 and 1997. To compensate for the absence of landless and poor households in this sample (which is based on area rather than households), we added 372 rural households with very little or no land who were sampled randomly from a rural household panel first surveyed by FIDEG, a local NGO, in 1996. Finally, 282 of the panel households who had been included in the 1996 MAGFOR/FAO survey were no longer present at the plot they had cultivated in 1996. These were replaced with the household who was farming the land under question at the time of the survey in order to obtain information on the characteristics of land buyers and/or renters who recently entered the land market. Taken together, these 4 groups provide a comprehensive picture of the rural sector in Nicaragua.

## **2.3 Descriptive statistics**

Using the data to generate descriptive statistics by group points towards large differences in income sources and levels as well as access to basic infrastructure. Total farm area varies considerably and is strongly positively correlated with levels of household welfare, even though land productivity varies inversely with holding size, being highest for the smallest producers. The impact, as well as the recent acceleration, of the governments' land titling programs is clearly visible from the data and socio-economic characteristics. The data also point to the fact that land regularization programs have benefited the poor. More importantly, producers express a clear desire for clarification of land tenure status through registration, implying that the programs may be associated with tangible economic benefits.

## **Socio-economic characteristics of sample households**

Table 1 reports descriptive statistics for socio-economic characteristics at the national level (column 1) and disaggregated by the different groups discussed earlier (columns 2 to 5). The data highlight that the rural households in the sample are large (with 9 members on average) and have relatively low levels of access to infrastructure such as electricity (43%) housing (63% have a dirt floor and 52% clay or wood walls). Most of them obtain their main livelihood from agricultural activities. Distances to infrastructure are considerable, with the average producer being located 82 km from the next paved road and 58 km from the next NGO.

Annual per capita income, which is constructed by adding agricultural profits, agricultural wages, non-agricultural wages and profits, and non-earned income, in the sample is slightly below US \$ 400, close to the one dollar a day poverty line. Disaggregation of household income reveals that about 60% comes from an own farm enterprise - either crop (25%) or in livestock farming (35%). As one would expect in a relatively land abundant environment, there is little agricultural wage employment; total wage employment accounts for less than 5% of household income. It is noteworthy, however, that profits from non-agricultural enterprises contribute far more (25%) to households' income than does non-agricultural wage income (9%). One explanation for this could be that, presumably due to the existence of entry barriers to own enterprise formation, households who need to rely on wage employment will obtain only low levels of return to their human capital, as was found in Colombia (Deininger and Olinto 2001). Not surprisingly, land and livestock are the two main forms of wealth, each making up almost 40% of total household assets. Agricultural machinery (16%), land-attached investments (5%), and non-farm business assets (2.5%) occupy less important places in the ranking of households' asset endowments.

Comparing the different groups introduced earlier, we find that land buyers and established producers are, with per capita incomes of C\$6,690 and C\$ 4,740, clearly better off than landless and beneficiaries from the titling program whose per capita income is consistently below C\$ 2,000 (with an exchange rate of 12 C\$ to one US\$ at the time of the survey). In addition to the magnitude, there are also marked changes in the composition of income over time. Households who have access to land obtain on average 60% of their income from agricultural self-employment. By contrast, the landless obtain less than 15% of their income from agriculture, rely on wages for almost 60% of their income, and receive the remainder through self employment. Interestingly, agricultural wages, most of them derived from precarious day labor on a seasonal basis, contribute, with 33%, more to the income of this group than either non-agricultural self or wage employment (26% and 23%, respectively), indicating that they have to depend on the marginal and volatile wage labor market in rural areas. Titling beneficiaries differ from the rest in having a low level of agricultural income as well as a relatively stronger emphasis on crops as compared to livestock. Land

buyers earn high levels of non-agricultural profits and high levels of livestock profits, suggesting that at least some of them are relatively affluent non-agricultural businessmen and cattle ranchers who buy land and expand into livestock largely for non-economic reasons.

Endowments of both assets and human capital also differ between the groups. Titling beneficiaries and landless households own, with C\$ 85,000 and 15,000 significantly lower levels of assets than the other two groups (C\$ 209,000 and 268,000). Also, even though general human capital endowments are very low in general, their human capital endowment is significantly lower with the household head having 1.77 and 2.25 years of education, as compared to 2.60 and 3.36 for established producers and land buyers, respectively. Although titling beneficiaries own considerable amounts of land, its location far from infrastructure, with almost 150 km to the next road and 100 km to the next NGO, confirms the notion that land reform, and subsequent titling efforts, were focussed mainly on economically less valuable frontier land. By comparison, land poor households are closer to infrastructure but lack assets. We note that participation in social organizations such as NGOs and churches has increased since 1990; this could be a sign that this type of organizations has started substituting for formal government structures.

### **Agricultural productivity**

As profits from agriculture and livestock-related activities make up almost two thirds of the average sample households' income, more attention to the specific aspect is warranted. The top panel of table 2 illustrates that mean operated and owned area amounted to 48 and 46.6 manzanas (mzs; 1 mz. = 0.7 ha), respectively. Slightly less than one third of the owned area (13.5 mzs) was cultivated with annual or perennial crops including fruit trees and home gardens, about two thirds (27 mzs) were devoted to pasture, and the remainder (6 mzs) was under fallow or forest. About 20% of households relied on land rental markets to rent in land and 8% rented out land. The median profit per mz was C\$ 310. With land prices of about C\$ 3,000 per mz, this would imply a rate of capitalization of slightly less than 10%.

Differentiating among the sub-groups of the sample introduced earlier reveals considerable variation across those. During the reference period for the survey, mean operated area was 92 mzs for land buyers but only 3 mzs for land scarce households. Nonetheless, mean cultivated area was between 13 and 16 mzs for all groups except the land scarce households. Adjustments are made largely in terms of pasture land. Established producers and land buyers use the large majority of their lands for livestock and only between 15% and 30% for crop production. The opposite is true for participants in the titling program and land-poor households who devote between two thirds and 71% of owned land area to crops rather than livestock.

Figures on median profits per manzana, which are less sensitive to outliers than means, indicate that land scarce households are, with a profit of C\$ 523 per mz. the most productive, followed by established producers (C\$ 357), land buyers (C\$ 282), and beneficiaries from the titling program (C\$ 191). The dispersion of this variable is highest within the group of land scarce producers, followed by titling beneficiaries, established producers and land buyers. This suggests that, at the margin, increasing the land endowment of land scarce households, could have a large impact on overall productivity. Indeed, we note that the distribution of operated land is not only slightly more equal than the distribution of owned land but also that rental markets allow almost half of the 447 households in the sample who do not own any land to get access to land for agricultural production. This points towards an equalizing impact of the land rental market. The hypothesis that the rental market transfers land to more productive producers receives support from the observation that land-scarce household rely disproportionately on rental markets - almost 40% rent in land, allowing to increase the average ownership endowment by almost 50%. This could suggest that land rental market have an important role to play to allow poor producers get access to productive resources, an issue that is left for future research.

The second panel of table 2 provides information on households' tenure status. We note that, in general, and not surprisingly in view of the earlier discussion of Nicaragua's land titling program, the level of registration is quite high. 63% of producers have at least one formally registered plot, 34% an agrarian reform title and only 11% and 3.4%, respectively, an informal document or no document. This is in line with other sources which indicate that between 10% and 25% of the land area -generally the most controversial and difficult ones- suffer from remaining tenure insecurity (Merlet and Pommier 2000). Differentiating among groups points towards marked differences, especially regarding the titling program. About 80% of established producers, 70% of land scarce households, and 65% of land buyers but only 16% of titling program participants have a formally registered document. In turn, almost 90% of titling participants have an agrarian reform title but no fully registered document, compared to less than 20% for all of the other groups with the exception of land buyers. The high share of agrarian reform titles held by land buyers could indicate that many of these bought land from participants in the titling program. Examining this in more detail transcends the scope of this paper but would be very worthwhile to find out more about the impact of titling on land sales market transactions.

A highly gender-sensitive legislation has generally been identified as one of the great advantages of Nicaragua as compared to other countries (Deere and Leon, 2000). While this would lead us to expect a high level of joint titles, the data suggest that, at least in the perception of survey respondents, joint titling has been of limited relevance. In the sample as a whole, only between 5% and 6% of households reported to have a document issued jointly for husband and wife (*mancomunado*) or a plot to which title was held

jointly. Even for the sub-sample of participants who participated in recent titling efforts, this number is less than 20% - very small compared to claims that about 80% of titles were issued jointly. One possible explanation for this is that respondents may not have been aware of the exact nature of the documents. A second possibility that is supported to some extent by anecdotal evidence is that even though titles were given to husband and wife jointly but that the wife had actually signed away their part of the title. Part of this low percentage may be due to the constraints imposed by the survey which did not allow for physical inspection of households' documents by the enumerator and identification of which of the two possibilities pertain would be of great interest. Nonetheless, as it is unlikely that a joint title will affect household behavior unless there is awareness of its nature, this finding suggests that, unless they are combined with greater efforts at dissemination and awareness building, issuance of joint titles may have a rather limited impact on actual decisions and thus have limited impact on improving women's position. More detailed research on this issue would be of great interest.

### **Changes in land tenure status and the demand for titling and registration**

At the time the survey was undertaken, the 2475 sample households owned 3659 plots. Information on changes in the legal and tenure status of individual plots, which was obtained from producers' recall, allows to construct the transition matrices presented in table 3. These matrices, for the 1990-1996 and the 1996-1999 periods, illustrate that, during the last decade, the status of ownership has changed for a significant number of plots. To interpret them, note that the percentages do not add up to 100 as households may have plots under different tenure categories and that only plots that were owned in the initial period are included. With regards to the titling program, one notes that a large number of plots received title during the last decade and that the progress of titling programs accelerated markedly during the 1996-99 period.

At the same time, table 3 illustrates that, somewhat surprisingly, government efforts largely concentrated on the award of agrarian reform titles rather than full registration. To demonstrate this, note that the number of plots with agrarian reform title more than doubled in both periods, from 206 to 419 between 1990 and 1996, and from 336 to 690 between 1996 and 1999. By comparison, only 121 and 166 plots, respectively, were registered during the first and the second period. This suggests that registration was either associated high transaction costs, e.g. in the form of complicated pre-requisites and procedures, and distances to registry offices or that the public sector was initially unable to fulfill its mandate of giving fully registered titles.

To ascertain whether these programs were perceived to be associated with any benefits, households who had received title were asked whether they felt to have benefited from this event and, if yes, what the character of these benefits was. The data (not reported separately) indicate that the majority of program

participants (77%) perceived the program to have had a beneficial impact. Elimination of tenure insecurity was clearly the most important benefit (88%), with credit access a distant third (2.5%). This provides a first indication that titling may have been associated with economic benefits through increased tenure security and investment demand rather than credit supply.

What are the mechanisms through which the benefits from titling come about? According to survey results, households' demand for registration is clearly higher than that for title only (table 4). Of the 874 households who owned at least one plot without title, more than 90% indicated that the reason for not obtaining a formal title was that it was "not worth the effort" and only 7% that they would like to have title but lacked the resources, mostly in terms of time, needed to obtain it. The situation is completely opposite for registration – of the 559 households who fulfilled the pre-conditions for registration of their plots (i.e. who had a title), 84% indicated that having their plot registered would be desirable but that they lacked the resources for doing so. In addition to signaling strong demand for tenure security, this suggests that, in the context of Nicaragua, policy initiatives which fail to award full registration may fall short of both beneficiaries' expectations and economic necessities. Thus, while titling seems to have clearly responded to a demand for greater tenure security from producers, the strategy of giving title without full registration appears to have fallen short by what was desired by most producers.

The notion of incomplete government efforts is supported by the fact that, while virtually all beneficiaries were satisfied with the technical and legal aspects of the processes adopted, 30% indicate that there were shortcomings in the registration of the property to which they had received agrarian reform title. This suggests that, in the context of rural Nicaragua, land rights regularization has significant welfare effects. It also highlights that, in an environment where most large producers had already obtained title on their own initiative, awarding certificates to small producers could benefit the less well off. In the next section we will analyze in detail the economic impact titling and registration. We will do so by exploring whether greater security of individual land ownership will be associated with higher levels of investment, the extent to which such investment is economically and socially beneficial, and whether greater land tenure security will affect land values.

### **3. Analytical framework**

In this section we introduce the framework for analysis of investment effects, the extent to which tenure insecurity may result in a socially sub-optimal asset portfolio, and the impact of tenure security on land values. The data at hand are well suited to this task. In terms of investment we can use actual evidence on largely labor-intensive land related investment before and after the intervention for beneficiaries and non-

beneficiaries, thus providing an estimate of the impact of titling on this type of investment rather than just correlations with little indication of causality. Availability of production data allows us to make inferences on the extent to which any tendency towards increased investment, which may have resulted from the land titling effort, helped to counteract previous under-investment. With regard to land values, we are able to control for household fixed effects, in addition to tenure characteristics, for observable plot characteristics such as topography, slope, and distance to the homestead, thereby eliminating unobserved factors that may, in a simple cross-sectional equation, easily result in biased coefficients which would overestimate the impact of titling.

### 3.1 Titling and land-related investment

The notion that the greater tenure security accorded by possession of registered land title will be associated with higher levels of investment is a key element in the literature (e.g. Feder et al. 1988). The relationship between possession of title and higher levels of land-attached investments has repeatedly been confirmed in cross-sectional equations (see Binswanger, Deininger, and Feder 1995). Even though numerous studies have demonstrated that land tenure has an investment-enhancing effect (Besley 1985, Rozelle et al. 1998; Gavian and Fafchamps 1996), the inability to control for unobservable households-specific characteristics may, however, have resulted in biased coefficients. For example, it is likely that producers with better access to credit or infrastructure were more likely to acquire title. This would lead to an overestimate and thus limit the ability to use the results of such analysis to extrapolate on the impact of changes in title status brought about by titling programs. Availability of data on investment before and after title was received at the plot level allows us to deal with this concern by using the difference in investment levels rather than the simple amount of investment.

In other words, we use the monetary value of all the land-attached investments that were available in 1990 and 1999. These include irrigation facilities; processing and storage structures such as sheds, silos, warehouses and coffee processing plants; and livestock structures such as stables, silos, and fencing. Subtracting the value of such investments in 1990 from what was available in 1999 allows to construct the net investment on plot  $i$   $\Delta I_i$ . Regressing this variable on initial title status, the change in title status during the period, and a vector of time invariant characteristics, helps to obtain an estimate of the impact of an exogenous change in tenure status on investment. Formally, we estimate an equation of the form

$$\Delta I_i = \alpha + \beta X_{it} + \delta Z_i + \varepsilon_i$$

where  $X_{it}$  is a vector of time varying characteristics (e.g. whether the plot has a title or is registered), and  $Z$  is a vector of time invariant characteristics such as soil quality and other physio-geographic plot features. Note in particular that this specification allows us to test empirically between two competing

hypotheses that have been discussed in the literature. If producers undertake highly visible investments on plots the tenure of which is highly insecure as a way of establishing claims to ownership, we would expect a significant coefficient on agrarian reform title (or on initial levels of investment). Alternatively, if award of title causes investment, we would expect significance of the receipt of title. Empirically, we use both a zero-one dummy for whether any investment was undertaken in a probit as well as the actual amount of land-related investment in a tobit specification.

In addition to testing the impact of title, an economically interesting issue is whether, before the receipt of title, the level and composition of investment had, in some sense, been sub-optimal. In this case one could argue that the increased tenure security may have allowed producers to move closer to the optimum level of investment and/or a more balanced asset portfolio. To examine this issue, we use the fact that investment decisions by rational profit-maximizing producers would equalize marginal returns, properly adjusted for the risk of loss of the asset, across moveable and land-attached assets. One reason for observed returns to these two classes of assets to be systematically different from each other would then be that producers attach a higher risk of asset loss to one category than to the other. If there are systematic differences in the security of property rights to mobile and immobile assets, returns to immobile assets should be consistently higher than those for mobile ones (e.g. livestock and machinery) to compensate for the higher risk of asset loss involved.

To explore this empirically, we regress household  $i$ 's profits from total agricultural plus livestock production  $\pi_i$  on a vector  $L_i$  of endowments and exogenous characteristics (including regional dummies) and a standard error term, in a "pseudo-profit function" of the form

$$\pi_i = \alpha + \delta L_i + \varepsilon_i$$

Note that  $L_i$  includes land-attached investments and moveable assets, in addition to households' level of education and that we omit prices which are captured by regional dummies. In this case, the coefficients  $\delta$  provide the return on various fixed factors such as education and different types of assets included on the right hand side. If returns across different types of assets were equalized, it would be impossible to reject the hypothesis that, for any two of the elements  $k$  and  $l$  included in the vector  $L_i$ ,  $\delta_k = \delta_l$ . The ability to reject this hypothesis, on the other hand, would imply that shifting investment from one class of assets to the other would result in an increase of total profits. Thus, if titling increases the scope for land-attached investments, measures to increase producers' tenure security could result in increased agricultural profits and higher overall productivity in the economy.

### 3.2 Titling and land values

Even if one finds a positive impact of land tenure security on investment, this will, without strong assumptions on the benefits from such investments, not provide us with an estimate of the net impact of such an intervention on land values and thus households' net asset position. This figure is of interest to obtain an idea of the impact of such a program on household welfare and thus the maximum cost for such a program from a social point of view as well as possible cost recovery measures. To get such an estimate will require an examination of the extent to which, over and above any potential impact on investment and the value of land attached assets, possession of title will also increase land values.

To provide the background for analysis, note that the value  $V$  of any asset such as land equals the discounted net present value of cash flows generated by this asset.

$$V = \sum_{t=0}^{\infty} \delta^t r_t$$

where  $r_t$  is the return received in period  $t$  and  $\delta = \frac{1}{1+i}$  is the discount factor with  $i$  being the opportunity cost of capital. The notion that all factors that can possibly affect the expected stream of returns to land will be capitalized in land values has long provided the underpinning for estimation of hedonic land price regressions of the form  $V_i = f(\mathbf{Z})$  where  $\mathbf{Z}$  is a vector of exogenously given quality characteristics (e.g. Rosen 1974). Availability of self-reported land values for each of the plots under consideration makes it easy to implement this methodology. However, while this methodology is appropriate in cases where quality characteristics are exogenous, problems may arise if land values are also affected by unobservable household characteristics. Consider the discount rate  $i$  which may be household specific, depending on whether or not the household has access to capital at the market interest rate. If, as is commonly assumed, poor households have higher discount rates and are less likely to be titled, the coefficients from a simple hedonic regression may be biased. Formally, let  $i$  denote households and  $p$  plots within the household. In this case, estimation of

$$V_{ip} = \alpha_i + \beta \mathbf{Z}_{ip} + \xi_i + \varepsilon_{ip}$$

will produce biased estimates of the coefficient vector  $\beta$  because of correlation between the unobservable household-specific error term  $\xi_i$  and  $\mathbf{Z}$ . Indeed, this appears to have been a problem in many cross-sectional studies of this issue. To eliminate  $\xi_i$  and thus obtain an equation that will yield unbiased estimates via ordinary least squares, we make use of the availability of information on multiple plots per household to estimate a fixed effect household-level regression. Let  $\bar{V}$  be the mean value of all plots for any given household and  $\bar{\mathbf{Z}}$  the mean of the associated characteristics. Then, as shown, among others by

Hausman and Taylor (1981), taking the mean over all plots owned by the household and subtracting this from the original equation produces

$$V_{ip} - \bar{V}_i = \beta (Z_{ip} - \bar{Z}_i) + \varepsilon_{ip} - \varepsilon_i$$

which is an equation that will produce unbiased estimates of the  $\beta$ 's, which are the main parameters of interest in the above equation. Elements included in the vector  $Z$  are exogenously given physical land characteristics such as the topography, land attached investments, the type of land use, area and length of possession, and the titling status which, as discussed above, can also be considered to be exogenous.

#### **4. Empirical results**

Applying this analytical framework to the Nicaraguan data at hand, we obtain three main results. First, the propensity to undertake largely labor-intensive investments is increased significantly by the receipt of land title and the nature of the data allows to virtually exclude the possibility of reverse causality. Second, comparison of returns across asset classes points towards significantly higher returns (28%) for assets attached to land as compared to moveable assets (3%) and livestock (11%). This suggests that award of title would not only increase investment but also help producers to move towards an asset portfolio that would be socially more optimal. Finally, we find that values for land that is registered (but not merely titled) are almost 30% higher than for land that is not. This implies not only that programs to improve tenure security can have a significant impact but also that the legal nature of the documents being awarded clearly matters. Simple award of a document is thus not equivalent to greater tenure security (Wachter, 1992) and producers are well aware of the much lower tenure security conveyed by non-registered titles and adapt their behavior accordingly.

##### **4.1 Investment impact of increased tenure security**

Results from the probit as well as tobit regression equations for net investment are presented in table 5. Since the main form of intervention was to either award agrarian reform title or full registration, we use a probit equation with a zero-one dummy for whether an investment had taken place, and a tobit with the actual amount of investment. The Huber-White heteroskedasticity-consistent estimator is used throughout. The probit equation illustrates that full registration of a plot after 1990 had a very significant investment-enhancing impact; according to the regression results it increased the propensity to invest by between 8% and 9% (figures in column 1 of table 5 are marginal probabilities). It also highlights that award of agrarian reform title per se, without accompanying registration, had only minimal impact on investment. The coefficient on this variable is small (increasing the marginal propensity of undertaking

investment by between 1.2% and 2.8% in the regressions without and with regional dummies, respectively) and insignificant at any conventional level of significance. Finally, the propensity to undertake land-related investment on plots that had been registered before 1990 was still higher by about 4% than on the rest, pointing towards a continuing beneficial impact of registration on investment.

These broad conclusions are confirmed by the tobit regressions where, instead of a zero/one indicator, the value of the investment is used as the dependent variable. The propensity to make investments emerges as significantly higher on plots that were registered after 1990 whereas receipt of agrarian reform title during the same period did not have any perceptible impact. Registration before 1990 is, as in the probit equation, of lesser impact and of marginal significance.

The signs and magnitudes of most other variables are as expected (table 5). We find that the propensity to invest is higher on larger plots but that this impact decreases in size (as indicated by the negative coefficient on the squared area). This is consistent with the presence of fixed setup cost for investment which would generate increasing returns to scale to investment on large fields. Other things equal, investment is more likely to occur on house plots, on undulating plots, and on those that already had some perennials initially. While plots under forest or fallow are less likely to receive investment, there is no difference between plots planted to annuals (the excluded category in the regression) and those under pasture. Also, and contrary to what is generally found for other countries, length of possession is not estimated to have a significant investment-enhancing impact. This can be explained by the fact that, in the context of Nicaragua, the main risk to land ownership is the emergence of a legal challenge to land ownership by somebody who claims to have owned the land before 1979. Whether somebody received the land in the 1990s or the 1980s did, in this context, not seem to make a big difference in terms of tenure security. Similarly, our results do not support the hypothesis of a reverse causality according to which investment would be undertaken to increase tenure security rather than being the consequence of a higher level of tenure security. To further test for this possibility, we included the level of pre-existing investment which consistently remained insignificant (not reported). Greater land tenure security therefore appears to lead to higher levels of investment rather than the other way round.

To examine the economic impact of such investment, we turn to estimation of a pseudo-profit function as discussed above. As the dependent variable is in logs, the coefficients on different types of assets can be interpreted as these assets' marginal contribution to profits. A summary of results is displayed in table 6. One notes that, with a point estimate of about 29%, returns to land-attached investments are the highest, followed by returns on livestock (12%) and those on machinery (3%). The hypotheses of equality of returns between land-attached investments and livestock, as well as land-attached investment and machinery, can be rejected at the 10% and 1% levels of confidence, respectively by using standard t tests.

Note also that education has a large and highly significant impact – increasing educational levels by one year would, other things equal, increase profits by almost C\$ 2,500. In line with our hypothesis, marginal returns to land-attached investment are higher than those to mobile capital, shifting resources from the latter towards the former will increase overall economic efficiency. This suggests that, in addition to enhancing overall levels of investment, the higher level of tenure security brought about by land titling in Nicaragua will also lead to a more optimal balance in the mix of investment between moveable and attached goods.

Taken together, these two results provide a strong justification for programs of titling and registration from an economic perspective, supporting what had already emerged from the descriptive analysis. In addition, they are consistent with producers' desire for full registration of land ownership, rather than merely award of an agrarian reform title, as evidenced earlier in the descriptive analysis. In the Nicaraguan context, which can be taken to be representative of situations with high levels of endemic tenure insecurity, producers need a legally clear title rather than an intermediate substitute. Only having a legally valid title seems to prompt them to increase their level of investment. This suggests that, by falling short of full registration, the government's program may have foregone considerable gains in terms of investment and the higher levels of production and welfare this would have implied. To examine the extent to which such lack of investment was sub-optimal from an economic perspective, we turn to the results from the land price regression as discussed earlier.

#### **4.2 Tenure security and land values**

Results for the estimation of the land price regression using OLS, as well as random effects and fixed effects techniques, are reported in table 7. Note first that the results empirically confirm that presence of correlation between unobservables and the right hand side variables in the regression. Moving from the OLS to the fixed effects regression, the coefficient on the value of land improvements decreases continuously, from 6.1% in the OLS regression to 2.3% in the equation with household fixed effects. This suggests that more productive households are more likely to undertake land improvements. As it can not distinguish between the two effects, estimation via OLS would result in serious overestimation of the impact of such investment. The same is true for land registration, the coefficient of which decreases from 37% to 29% as one moves from OLS to fixed effects. Indeed, performing a Hausman test confirms the presence of correlation between  $\mathbf{Z}$  and the household specific elements of the error term; the  $\chi^2$  statistic of 129.9 leads to a clear rejection of the hypothesis of no correlation between  $\mathbf{Z}$  and  $\xi$ , thus indicating that the fixed effect estimates are more appropriate. In interpreting the results, we will therefore focus on these coefficients.

Concerning the impact of titling and registration, we find that both formal and informal rights enhance land values. The regression suggests that rights of possession, as embodied in length of time during which the plot had been cultivated, provide a marginal increase in tenure security whereby each additional year the plot has been held by the current owner increases land values by 1.3%. Compared to this, registration of a plot signifies a quantum jump in tenure security. Using the point estimate for the impact of possession, one notes that registration would increase land values by about 30%, equivalent to more than 20 years of continuous possession. In addition, having purchased a plot is estimated to increase land values by 28%, most likely because presence of a sales receipt allows land owners to better defend themselves against challenges to the legitimacy of claims to their land. In this context, it is of interest to note that the value of plots that were acquired through agrarian reform varies systematically with the regime under which such acquisition took place. The (insignificant) coefficient on the dummy for receipt of agrarian reform lands before 1990 under the Sandinista regime suggests that, other things equal, those lands are worth less than those received under agrarian reform efforts afterwards. By comparison, lands obtained under agrarian reform after 1990 are more valuable than those informally occupied (the omitted category). Award of an agrarian reform title to a plot that had been received before 1990 can, according to the regression estimate, more than double its value. Over and above the impact of title, neither topography nor land use (which is, of course, endogenous at least to some degree), are estimated to have a strong impact on land values.

These results suggest not only that the titling effort had a perceptible economic impact but also that, by initially focusing on “agrarian reform” lands, the government has identified areas where increasing tenure security had a high payoff. However, by awarding in the great majority only agrarian reform titles that stopped far short from full registration, considerable and relatively immediate benefits were foregone. Our analysis suggests that avoiding this shortcoming and providing fully registered title can greatly enhance the economic benefits to be expected from the current land titling efforts. Indeed, the Government has recently made plans to systematically register all plots that have undergone the titling process. Given that most of the land owners who remain under insecure tenure are precarious small producers, doing so could, by increasing the value of the land endowment of the poor, also have a large and beneficial impact on equity. From a policy perspective, this would imply that even a program that combined land titling with a way of recovering some of the cost of such an investment, e.g. in the form of land taxes, would be unlikely to have adverse effects on equity. To the contrary, by increasing the revenue base of local governments and accountability for the use of tax revenues at this level, such a step could possibly make an important contribution to the process of decentralization and local governance.

## 5. Conclusion

Evidence from a program for land titling and registration from Nicaragua's agrarian reform sector indicates that this program managed to target the poor and, to the extent that it was properly implemented, also (i) resulted in a significant increase in tenure security and land-attached investments; (ii) shifted investment towards land-related items with high economic returns which were previously discriminated against; and (iii) caused an appreciable increase in land prices. The fact that the program was targeted towards the agrarian reform sector and that changes in the design, in particular the shift from awarding only agrarian reform titles to full registration, were made exogenously, allows to allay fears of endogeneity and reverse causality that typically plague evaluations of land titling programs. Availability of information on a large and nationally representative control group of non-beneficiaries outside the reform sector, together with the ability to compare land values of multiple plots within the same households, allow us not only to control for unobservable variables that might result in biased coefficients but also to empirically demonstrate that such bias does indeed exist. This indicates that, in an environment where tenure insecurity is high and endemic, a systematic program of land titling can provide significant economic benefits to the poor. We conclude by highlighting a number of implications for policy as well as research.

A first conclusion is that the legal validity of the titles distributed under a titling program clearly matters. The ability to discern a clear investment and land price effect suggests that there may be a wider range of situations with endemic insecurity where interventions to enhance tenure security, if building on a clear legal basis, can be justified. At the same time, the fact that even in Nicaragua, the majority of the titles received was not properly registered suggests that, in many cases, the failure to find a significant impact of titling in the literature may be due to the fact that the legal value of the documents awarded may have been deficient or doubtful. This highlights the need that sufficient attention be devoted to ensuring the legal validity of certificates to be distributed, especially in view of the fact that implementing agencies, as well as international donors, often may have a strong preference to maximize the number of certificates issued, rather than their quality, to demonstrate high levels of accomplishment. Whether, in specific settings, the failure to detect an impact of titling programs may be due to the fact that the certificates issued were of limited legal validity, is an interesting proposition that might be explored further.

Second, the effect of land title on land values, together with the descriptive evidence suggesting that titling has benefited those who were less well off, suggests that, by giving the poor more secure property rights to assets which they already own, titling could help improve the distribution of assets and economic opportunities. Observing such an effect in a relatively land abundant environment where credit is of limited importance and most of the investments considered are highly labor-intensive suggests that the

investment effect of more secure land title may be important in its own right. Identifying cost-effective ways to enhance producers' tenure security may thus be important even where credit markets are absent or not functioning well.

Finally, while we found clear benefits from titling, there may be scope for studying in more detail other channels, such as activity in land markets and the associated credit supply that might be of relevance to increase the impact of such interventions. Descriptive evidence from the survey suggests that, thus far, the award of title failed to reverse a decline in land market activity that started with the weakening of property rights in the aftermath of the Sandinista revolution. Also, descriptive evidence does not suggest that titling has, in a period when several lending institutions were closed down, increased beneficiaries' access to formal credit. Exploring the reasons underlying these phenomena, as well as ways to overcome them in the context of a broader land and rural development policy that contains titling as one element would be a worthwhile topic for future research.

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**Table 1: Socio-economic characteristics of sample households in 2000, total and by sub-sample**

	Total Sample	Established Producers	Land scarce households	Titling prog. Participants	Land buyers
<b>Household Characteristics</b>					
No. of household members	9.03	9.18	8.94	9.05	8.44
Mean age	27.80	29.79	24.82	25.40	26.06
Female headed household	12%	12%	15%	12%	11%
Head's education (years)	2.48	2.60	2.25	1.77	3.36
Parents in agriculture	86%	90%	60%	90%	91%
Access to piped water	73%	70%	94%	65%	72%
Access to electricity	43%	42%	53%	33%	48%
Dirt floor	63%	57%	68%	79%	57%
Clay or wood walls	52%	50%	52%	63%	45%
Had TV in 1996	23%	24%	24%	18%	27%
Had radio in 1996	79%	82%	70%	76%	86%
<b>Infrastructure</b>					
Distance to paved road (km)	82	75	31	149	75
Distance to NGO (km)	58	51	36	100	52
Participation in churches	11%	14%	11%	4%	6%
Participation in NGO	4%	4%	2%	7%	5%
<b>Income level and structure</b>					
Total annual income (C\$)	34,523	37,466	23,349	16,296	53,997
Agricultural profits (C\$)	23,846	27,543	7,773	10,665	32,485
from crop production	8,525	9,141	5,731	5,983	10,579
from livestock production	15,322	18,402	2,042	4,682	21,906
Non agricultural profits (C\$)	6,228	5,167	7,590	2,618	17,206
Agricultural wages (C\$)	1,043	876	3,225	1,231	916
Non-agricultural wages (C\$)	2,915	3,419	4,525	1,571	2,206
Non-earned income (C\$)	490	460	236	211	1,184
<b>Asset portfolio (C\$)</b>					
Total assets owned	163,812	209,421	14,680	85,573	268,923
Land	62,122	80,743	4,633	48,524	70,607
Livestock	62,381	78,195	5,195	26,578	120,298
Machinery	26,307	33,596	2,246	5,436	57,013
Land-related investments	8,782	11,060	877	3,993	16,049
Non-agric. enterprise assets	4,220	5,826	1,729	1,041	4,958
No. of observations	2475	1360	372	461	282

**Source:** Own computation from 2000 World Bank/University of Wisconsin survey.

**Notes:** 1US\$=12.3 C\$ in 2000

A household was defined to participate in church activity if this was reported for at least one member of the household.

Agricultural profits are defined as the difference between the total value of production and total costs for the entire year (\*\* explain).

Non-agricultural profits are defined similarly for activities in commerce, service, small industry, handicrafts, and food processing.

Agricultural wages correspond to earnings in money or kind received for activities outside the farm.

Non-earned income includes income from remittances, interest, and pensions.

The value of assets in the portfolio are self reported for a large number of categories (\*\* give for both agricultural and non-agricultural).

Non agricultural enterprise assets corresponds to facilities located in urban areas

**Table 2: Land access and production structure by group in 2000**

	Total Sample	Established Producers	Land scarce households	Titling prog. Participants	Land buyers
<b>Land access, production structure, and productivity</b>					
Operated area (Mzs.)	47.98	58.14	3.17	27.03	92.33
Owned area (Mzs.)	46.65	57.07	2.20	26.90	87.32
of which cultivated (Mzs.)	13.45	16.26	1.43	15.10	13.02
of which pasture (Mzs.)	27.24	33.95	0.52	7.16	62.97
of which other uses (Mzs.)	5.97	6.86	0.26	4.64	11.34
Producers renting in	19.1%	14.4%	39.2%	14.8%	22.3%
Producers renting out	7.9%	9.9%	0.8%	7.6%	8.5%
Profit per mz. (median) C\$	310.49	357.11	522.75	190.50	282.47
<b>Titling status and type of document</b>					
No document	3.4%	2.4%	5.4%	4.4%	5.5%
Informal document	11.1%	10.5%	10.8%	7.9%	20.0%
Registered document	63.0%	78.3%	70.3%	16.2%	64.3%
Agrarian reform title	33.7%	17.8%	14.9%	87.7%	26.7%
Document individual	95.0%	98.3%	96.2%	83.6%	98.5%
Document mancomunado	6.0%	1.8%	3.8%	18.6%	5.1%
Title joint	4.9%	1.7%	2.7%	15.1%	3.9%

**Source:** Own computation from 2000 World Bank/University of Wisconsin survey.

**Notes:** The types of document may sum up to more than 100% due to ownership of multiple plots within the same household.  
 1US\$=12.3 C\$ in 2000  
 1 mz. = 0.7 ha

**Table 3: Changes in title status by plot between 1990 and 1996 and 1996 and 1999, respectively**

<i>Between 1990 and 1996</i>						
Document held in 1996	Document held in 1990				Total	Percentage
	None	Unofficial Document	Agrarian Reform Title	Full registration		
None	31	1	2	3	37	2.1%
Unofficial Doc.	22	92	21	11	146	8.3%
Agrarian Reform Title	170	91	139	19	419	23.9%
Full registration	13	97	44	996	1150	65.6%
<b>Total</b>	<b>236</b>	<b>281</b>	<b>206</b>	<b>1029</b>	<b>1752</b>	<b>100.0%</b>
<b>Percentage</b>	<b>13.5%</b>	<b>16.0%</b>	<b>11.8%</b>	<b>58.7%</b>	<b>100.0%</b>	

  

<i>Between 1996 and 1999</i>						
Document held in 1999	Document held in 1996				Total	Percentage
	None	Unofficial Document	Agrarian Reform Title	Full registration		
None	36	1	3	4	44	1.9%
Unofficial Doc.	36	116	31	15	198	8.4%
Agrarian Reform Title	324	121	220	25	690	29.2%
Full registration	19	109	82	1222	1432	60.6%
<b>Total</b>	<b>415</b>	<b>347</b>	<b>336</b>	<b>1266</b>	<b>2364</b>	<b>100.0%</b>
<b>Percentage</b>	<b>17.6%</b>	<b>14.7%</b>	<b>14.2%</b>	<b>53.6%</b>	<b>100%</b>	

**Source:** Own computation from 2000 World Bank/University of Wisconsin survey.

**Note:** The number of observations included in each of the transition matrices is lower than the total number of plots (3649) because changes are observed only for plots that had been held already in the initial period (i.e. 1990 or 1996). \*\* give the number of plots in each of the cases.

**Table 4: Reasons given for not obtaining title or registration (in percentages), total and by sub-sample of producers**

<i>Plots that have no title</i>					
	Total Sample	Established Producers	Land scarce Households	Titling prog. Participants	Land buyers
Don't know how to get	0.92 (%)	0.66(%)	--	0.56(%)	1.87(%)
Not worth the effort	90.37(%)	91.41(%)	92.59(%)	93.85(%)	84.58(%)
Worth it but lack the resources/time	7.21(%)	6.17(%)	3.7(%)	5.03(%)	11.68(%)
Other reasons	1.60(%)	1.76(%)	3.70(%)	0.56(%)	1.87(%)
No. of Observations (plots)	874	454	27	179	214
<i>Plots that are not registered</i>					
	Total Sample	Established Producers	Land scarce households	Titling prog. Participants	Land buyers
Don't know how to get	7.34(%)	4.93(%)	7.69(%)	13.61(%)	7.05(%)
Not worth the effort	5.29(%)	5.21(%)	7.69(%)	4.08(%)	6.41(%)
Lack the resources/time	69.45(%)	73.43(%)	84.61(%)	74.15(%)	54.48(%)
Other (incl. no title)	17.92(%)	16.44(%)	--	8.16(%)	32.05(%)
No. of Observations (plots)	681	365	13	147	156

Source: Own computation from 2000 World Bank/University of Wisconsin survey.

**Table 5: Probability of having made land-attached investments between 1990 and 1999**

	Model	
	Probit	Tobit
Area (mzs.)	0.001*** (5.60)	69.1*** (7.9)
Area squared	-0.0000002*** (3.44)	-0.02*** (4.3)
Length of possession (years)	-0.001 (1.56)	-66.9 (1.0)
Received agrarian reform title after 1990	0.028 (1.18)	1766.6 (1.2)
Plot was registered before 1990	0.039* (1.84)	2860.3* (1.8)
Plot was registered after 1990	0.088*** (4.55)	7460.1*** (5.2)
Plot under perennials	0.025 (0.88)	4290.2* (2.1)
Plot under pasture	0.002 (0.13)	-317.3 (0.2)
Plot under forest	-0.141*** (3.10)	-13457.5*** (2.58)
Plot under fallow	-0.122*** (2.71)	-12308.1*** (2.5)
House plot	0.080** (2.33)	5455.8*** (2.3)
Plot undulating	0.046** (2.51)	4220.5*** (3.1)
Plot hilly	0.022 (1.19)	1462.5 (1.0)
Plot steep	0.052 (1.58)	3564.6 (1.5)
Log likelihood	-1454.76	-7696.6
Pseudo R2	0.0710	0.01
No. of observations (plots)	3217	3200

**Source:** Own computation from 2000 World Bank/University of Wisconsin survey.

**Notes:** Dependent variables are a dummy variables for whether or not investment had been made during the period for the Probit model and the value of the land attached investment for the Tobit model.

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

For Probit model: coefficients correspond to marginal probabilities at the mean values

For Tobit model: coefficients correspond to marginal effects for C\$ invested

Robust z-statistics in parentheses for Probit, t-statistics for Tobit

Omitted categories are no document for type of title; plot under annuals for current use of plot; and flat for plot topography.

Regional dummies included but not reported.

**Table 6: Pseudo-profit Function**

	Estimated Parameter
Value of land attached instalations in 1999 (log)	0.287*** (3.49)
Value of assets in 1997 (log)	0.028*** (3.28)
Total Livestock value (log)	0.118*** (16.10)
Level of Education (years completed)	2487.3*** (4.92)
Value of Land (log)	0.019*** (2.94)
Constant	2.657 (0.00)
Number of observations	1937
R-squared	0.26

Source: Own computation from 2000 World Bank/University of Wisconsin survey.

Notes: Dependent variables are profits in C\$

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

Absolute value of robust t -statistics in parentheses.

**Table 7: Land price regressions at the plot level with and without household fixed effects**

	<i>Technique</i>		
	Ordinary Least Squares	Random effects	Household fixed effects
Area	0.011*** (18.91)	0.009*** (17.76)	0.007*** (10.38)
Area squared	-0.000001*** (12.39)	-0.0000002*** (12.00)	-0.0000003*** (7.19)
Value of improvements (log)	0.061*** (9.00)	0.047*** (7.83)	0.023*** (2.97)
Length of possession in years	0.004* (1.68)	0.005** (2.08)	0.013*** (3.31)
Plot is registered	0.372*** (5.80)	0.331*** (5.31)	0.294*** (3.21)
Plot has been purchased	0.001 (0.01)	0.104 (1.51)	0.281*** (2.68)
Plot has been occupied	0.048 (0.35)	0.085 (0.62)	0.119 (0.55)
Plot acquired through ag. Reform before 1990	0.293 (0.98)	0.209 (0.70)	-0.531 (1.02)
Plot acquired through ag. Reform after 1990	0.040 (0.37)	0.201* (1.86)	0.442** (2.44)
Pre-1990 agrarian reform and agr. Reform title	-0.532* (1.70)	-0.204 (0.65)	1.107** (2.05)
Plot is undulating	0.168** (2.38)	0.127* (1.78)	0.139 (1.25)
Plot is hilly	0.071 (0.97)	0.064 (0.84)	0.216+ (1.69)
Plot is steep	-0.109 (0.91)	-0.161 (1.30)	-0.031 (0.15)
Plot used for perennials	0.538*** (4.80)	0.392*** (3.65)	0.004 (0.03)
Plot used for pasture	0.436*** (6.44)	0.368*** (5.68)	0.128 (1.43)
Plot used for forest	-0.008 (0.04)	0.109 (0.67)	0.131 (0.71)
Plot is in fallow	-0.288 (1.61)	-0.335** (2.00)	-0.614*** (2.62)
House plot	-0.635*** (4.60)	-0.580*** (4.78)	-0.388** (2.46)
Constant	8.964*** (93.18)	9.042*** (92.79)	8.989*** (63.08)
Number of observations	3062	3062	3062
R-squared	0.26	0.20	0.17
Number of households	1926	1926	1926

**Source:** Own computation from 2000 World Bank/University of Wisconsin survey.

**Notes:** Dependent variables is the self-reported selling price of the land in CS

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

Region dummies included but not reported. Absolute value of robust t-statistics in parentheses.



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