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Investment and equity effects of land regularisation: the case of Nicaragua[☆]

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Abstract

We use data from Nicaragua to examine the impact of award of registered and non-registered title on land values and changes in land-attached investment. Registration, acquisition through purchase, and agrarian reform title all are associated with significant increases in the value of plots. Receipt of *registered* title is found to increase land values by 30% and at the same time greatly increase the propensity to invest, bringing such investment closer to the optimum. In line with descriptive statistics indicating great demand for land right regularisation especially from the poor, this suggests that titling can have a positive distributional effect. At the same time, the legal validity and official recognition of the titles issued appears to be of great importance.
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1. Introduction

Access to land is of great importance for household welfare for a number of reasons—ensuring food

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security, providing an opportunity to make productive use of family labour and to diversify the households' activity portfolio—especially in environments where other product and insurance markets are imperfect (de Janvry et al., 2000; Burgess, 2000). Secure property rights for 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; (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, 2001). 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 from exogenous interventions to increase tenure security as compared to their cost, and the ensuing policy implications, have been the subject of much debate in the literature. 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 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 regularisation and titling are now routinely justified in terms of the improved credit access they provide. However, in many situations where the issue of public interventions to enhance land tenure security is under discussion, credit markets do, for a number of reasons, not function well. Use of land as collateral is still very difficult in China and a number of East Asian countries such as Cambodia and 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 there are other benefits from providing tenure security in situations where credit may not be the primary channel through which titling has an impact.

A 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. The 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), especially in situations where 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 or if there is high risk, only the better off may derive economic benefits from land titling (Carter and Olinto, 2003; Zimmerman and Carter, 1999). 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). 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.

We explore these issues using the example of Nicaragua, which is of interest for three reasons, namely: (i) the different forms of documents awarded over time; (ii) the exogenous nature of the titling effort which helps to alleviate concerns about endogeneity; (iii) availability of data for multiple plots per household allowing us to use fixed effect techniques. Section 2 provides a review of the literature and the conceptual background underpinning efforts at land regularisation as well as a brief account of the land tenure situation in Nicaragua and the data underlying the analysis. Section 3 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 regularisation increases land values for different groups in the population. Section 4 discusses empirical results, while Section 5 concludes with a number of recommendations for research and policy.

2. Legal environment, data and descriptive statistics

The impact of titling interventions is linked to the prevailing legal and institutional framework and efforts to identify the impact of such measures needs to build on an understanding of the historical evolution of land relations, the way in which titles (or other documents) were awarded, and their legal significance. In this section, we provide background for Nicaragua. 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 19th century, rise to a systematic process of land concentration (e.g. Paige, 1997). While governments following the Sandinista revolution in 1979 distributed large tracts of lands to former workers, much of this land was not legally owned by government, causing overlapping claims that led to high insecurity of property rights after the change of government in 1990. Even though legislation was soon passed to increase the security of property rights for actual occupants,[1] institutional obstacles slowed down implementation and redistribution of land to demobilised soldiers in frontier areas led to a large volume of restitution claims, the current volume of which actually exceeds the total size of Nicaragua's land area (Merlet and Pommier, 2000).

Litigation about restitution undermined tenure security on a broader base, far beyond those who benefited from land redistribution. Especially in co-operatives, tenure insecurity and the emergence of multiple spurious claims led to a wave of distress sales (Jonakin, 1996), negatively affecting the poor. To deal with this, various donors including the World Bank, sup-

ported land titling and registration programs. Below, we evaluate the impact of one of these interventions, the titling program advanced by the World Bank. It is useful to mention a number of characteristics of this program, namely: (i) its limitation to lands distributed under the Sandinista reforms; (ii) the nature of titles awarded changed during the period under concern, shifting from a title certificate which fell short of full legal proof of ownership towards titles that had also been properly registered; (iii) the fact that the program was offered to beneficiaries free of direct cost and with assistance to meet the indirect costs involved.

2.2. Data sources and computation of key variables

We use a survey conducted by the World Bank, the University of Wisconsin, and FIDEG, a local NGO, between February and April of 2000. 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 labour and land rental markets; (iv) recent entrants in the land purchase or rental market.

The 2000 survey includes a nationally representative area-sample of 1360 out of originally 1642 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 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 area rather than household-based), we add 372 rural households with little or no land sampled randomly from a rural household panel first surveyed by FIDEG, in 1996. Finally, 282 households included in the 1996 MAGFOR/FAO survey who could no longer be found were replaced by the households farming the land concerned at the time of the survey, providing information on the characteristics of land buyers and/or renters who had recently entered the land market.

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[1] This legislation implies that, once a plot is registered, the responsibility for compensating competing claimants shifts by law from the owner to the government, i.e. the owner enjoys full security of tenure knowing that, in case of conflict, the government will guarantee the title issued and, if necessary, compensate earlier land owners.

Data are available on household and farm assets owned (e.g. machinery) at different points in time and the time path of land-attached investments which include terraces, drainage works, wells, fences and storage structures. Movable and fixed assets were valued in current prices and the data on investments (or improvements) made was used to determine the value of these assets at different points in time. This provides an assessment of households' investment over different periods of time which is used to reconstruct past asset stocks and land-related investments for the regression analysis. We subtract variable costs (excluding family labour) from agricultural output to obtain a measure of the returns to fixed factors, management and household labour which is henceforth referred to as agricultural gross margin.

2.3. Descriptive statistics

2.3.1. Socio-economic characteristics

Table 1 reports descriptive statistics for socio-economic characteristics at the national level (column 1) and disaggregated by the different groups discussed earlier (columns 2–5). Households in the sample are large (with nine members on average), have limited access to infrastructure such as electricity (43%) and housing (63% have a dirt floor and 52% clay or wood walls). The main source of livelihood is agriculture and distances to infrastructure are considerable.

Annual per capita income, which is constructed by adding gross margins from agricultural and livestock production, agricultural wages, non-agricultural wages and profits, and non-earned income, is below US$ 300 and thus the US$ 1 a day poverty line in the sample. Disaggregation of household income reveals that 69% comes from own farm enterprise—either crop (25%) or livestock farming (44%). As expected under relative land abundance, agricultural wage employment is limited, accounting for only about 3% of household income. Profits from non-agricultural enterprises contribute far more (18%) to households' income than does non-agricultural wage income (8%). Land and livestock are the two main forms of wealth, each making up 38% of total household assets. Agricultural machinery (16%), land-attached investments (5%), and non-farm business assets (2.6%) are less important assets.

Land buyers and established producers are, with per capita incomes of about C$ 6400 and 4100 (at an exchange rate of C$ 12.3 to US$ 1 at the time of the survey), better off than land scarce households and titling beneficiaries who have per capita incomes of C$ 2600 and 1800, respectively. The importance of income derived from agriculture and livestock, 69% in the aggregate, varies from 33% for land scarce households to 73% for established producers. Titling beneficiaries have low levels of agricultural and overall income and rely more on crops than livestock. Land buyers receive large resources form non-agriculture or livestock, suggesting that some are affluent non-agricultural businessmen and cattle ranchers who buy land and expand into livestock production. Titling beneficiaries and land scarce households own, with C$ 85,600 and 14,700, respectively, lower levels of assets than the other two groups (C$ 209,000 and 268,900, respectively). Even though general human capital endowments are very low in general, the endowments of these groups, whose heads have less than 2 or 2.5 years of education, respectively, are much lower than for established producers or land buyers.

2.3.2. Land access and production structure

The top panel of Table 2 illustrates that mean operated and owned area amounted to 48 and 46.6 manzanas (mz; 1 mz = 0.7 ha). Mean operated area was 92 mz for land buyers but only 3 mz for land scarce households. Nineteen percentage of households relied on rental markets to rent in land and 8% rented out land. The median gross margin per mz was C$ 310. With land prices of about C$ 3000 per mz, this would imply a rate of capitalisation of slightly less than 10%. Judging by median margins, land scarce households are, with C$ 520 per mz, the most productive, followed by established producers (C$ 360), land buyers (C$ 280), and beneficiaries from the titling program (C$ 190).

Information on tenure status in the second panel of Table 2 points to relatively high levels of registration. Sixty three percentage of producers have at least one formally registered plot, 34% an agrarian reform title and only 11 and 3%, respectively, an informal document or no document. Almost 80% of established producers, 70% of land scarce households, and 65% of land buyers, but only 16% of titling program

Table 1

Socio-economic characteristics of sample households in 2000, total and by sub-sample

	Total sample	Established producers	Land scarce households	Titling program participants	Land buyers
Household characteristics					
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
Infrastructure					
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
Income level and structure					
Total annual income (C$)	34500	37500	23300	16300	54000
Agricultural gross margin (C$)	23800	27500	7800	10700	32500
From crop production	8500	9100	5700	6000	10600
From livestock production	15300	18400	2000	4700	21900
Non agricultural profits (C$)	6200	5200	7600	2600	17200
Agricultural wages (C$)	1000	900	3200	1200	900
Non-agricultural wages (C$)	2900	3400	4500	1600	2200
Non-earned income (C$)	500	500	200	200	1200
Asset portfolio (C$)					
Total assets owned	163800	209400	14700	85600	268900
Land	62100	80700	4600	48500	70600
Livestock	62400	78200	5200	26600	120300
Machinery	26300	33600	2200	5400	57000
Land-related investments	8800	11100	900	4000	16000
Non-agricultural enterprise assets	4200	5800	1700	1000	5000
No. of observations	2475	1360	372	461	282

Source: Own computation from 2000 World Bank/University of Wisconsin survey. *Notes*: US$ 1 = C$ 12.3 in 2000. C$; Cordoba Oro. A household was defined to participate in church activity if this was reported for at least one member of the household. Agricultural gross margin is obtained by subtracting variable costs (excluding family labour) from agricultural output to obtain a measure of the returns to fixed factors, management and household labour. Non-agricultural profits are defined similarly for activities in commerce, service, small industry, handcrafts 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. Figures for income levels and asset values have been rounded to avoid spurious accuracy.

participants, have a formally registered document. In turn, almost 90% of titling participants have an agrarian reform title but no fully registered document. Nicaragua's legislation is considered highly gender-sensitive (Deere and Leon, 2001), although the data suggest that thus far 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

Table 2
Land access and production structure by group in 2000

	Total sample	Established producers	Land scarce households	Titling program participants	Land buyers
Land access, production structure and productivity					
Operated area (mz)	48.0	58.1	3.2	27.0	92.3
Owned area (mz)	46.7	57.1	2.2	26.9	87.3
of which cultivated (mz)	13.5	16.3	1.4	15.1	13.0
of which pasture (mz)	27.2	34.0	0.5	7.2	63.0
of which other uses (mz)	6.0	6.9	0.3	4.6	11.3
Producers renting in (%)	19	14	39	15	22
Producers renting out (%)	8	10	1	8	9
Gross margin per mz (median) (C$)	310	360	520	190	280
Titling status and type of document (%)					
No document	3	2	5	4	6
Informal document	11	11	11	8	20
Registered document	63	78	70	16	64
Agrarian reform title	34	18	15	88	27
Document individual	95	98	96	84	99
Document mancomunado	6	2	4	19	5
Title joint	5	2	3	15	4

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. Percentages may not add to 100 due to rounding. US$ 1 = C$ 12.3 in 2000 and 1 mz = 0.7 ha.

issued jointly for husband and wife (*mancomunado*), much less than one might expect, or is often asserted.[2]

2.3.3. Changes in land tenure status

At the time the survey was undertaken, the 2475 sample households owned 3649 plots. Information on changes in the legal and tenure status of individual plots, which was obtained from producers' recall, allows us 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.[3] One also notes that a large

number of plots received title during the last decade, with progress in titling accelerating markedly during the 1996–1999 period. At the same time, government efforts largely concentrated on the award of agrarian reform titles rather than full registration.[4]

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 mentioned (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.

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[2] 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, the wife had actually signed away her part of the title. As it is unlikely that a joint title will affect household behaviour unless there is awareness of its nature, this finding suggests that, unless insurance of joint titles is combined with greater efforts at dissemination and awareness building, it may have a rather limited impact on actual decisions and thus on improving women's position.

[3] Note that percentages do not add to 100 as households may have plots under different tenure categories. Only plots that were owned in the initial period are included.

[4] 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 fully registered during the first and the second period.

Table 3

Changes in title status by plot between 1990 and 1996, and 1996 and 1999, respectively

Document held in 1996	Document held in 1990 (between 1990 and 1996)					
	None	Unofficial document	Agrarian reform title	Full registration	Total	Percentage
None	31	1	2	3	37	2.1
Unofficial document	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
Total	236	281	206	1029	1752	100.0
Percentage	13.5	16.0	11.8	58.7	100.0	

Document held in 1999	Document held in 1996 (between 1996 and 1999)					
	None	Unofficial document	Agrarian reform title	Full registration	Total	Percentage
None	36	1	3	4	44	1.9
Unofficial document	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
Total	415	347	336	1266	2364	100.0
Percentage	17.6	14.7	14.2	53.6	100	

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

According to survey results, households clearly desire full registration rather than only award of title (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'. Only 7% indicated that they would like to have title but lacked the resources, mostly in terms of time, needed to obtain it. The situation is 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 to do so. Thirty percent of the beneficiaries indicate that there were shortcomings in the registration of the property to which they had received agrarian reform title.

Table 4

Reasons given for not obtaining title or registration, total and by sub-sample of producers

	Total sample	Established producers	Land scarce households	Titling program participants	Land buyers
Plots that have no title					
Do not know how to obtain (%)	1	1		1	2
Not worth the effort (%)	90	91	93	94	85
Worth it but lack the resources/time (%)	7	6	4	5	12
Other reasons (%)	2	2	4	1	2
No. of observations (plots)	874	454	27	179	214
Plots that are not registered					
Do not know how to obtain (%)	7	5	8	14	7
Not worth the effort (%)	5	5	8	4	6
Worth it but lack the resources/time (%)	69	73	85	74	54
Other (including no title) (%)	18	16		8	32
No. of observations (plots)	681	365	13	147	156

Source: Own computation from 2000 World Bank/University of Wisconsin survey. Percentages have been rounded to avoid spurious accuracy.

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 allow us to use evidence on labour-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. 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. Concerning land values, we are able to control for household fixed effects, in addition to tenure characteristics and observable plot characteristics such as topography, slope and distance to the homestead. This helps to deal with unobserved factors which, in a simple cross-sectional equation, can result in biased coefficients and thus an overestimate of the impact of titling. Since the fixed effect estimator also controls for household specific factors, including the impact of credit access, it allows us to obtain an estimate of the 'tenure security effect' of land registration.

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., 1986). The relationship between possession of title and higher levels of land-attached investments has repeatedly been confirmed in cross-sectional equations (see Binswanger et al., 1995). Even though numerous studies have demonstrated that land tenure has an investment-enhancing effect (Besley, 1995; Rozelle et al., 1998; Gavian and Fafchamps, 1996), failure 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 are more likely to acquire title. This would lead to an overestimate and thus limit the use of the results of such analysis predict the impact of changes in title status brought about by titling programs. Avail-

ability of data on investment before and after title 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 as dependent variable.[5]

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; 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, ΔI_i. Regressing this variable on initial title status, the change in title status during the period, and a vector of time invariant characteristics, leads to an estimate of the impact of an exogenous change in tenure status on investment. Formally, we estimate an equation of the form:

$$\Delta I_i = \alpha + \beta X_{it} + \delta Z_i + \varepsilon_i \tag{1}$$

where X_{it} is a vector of time varying characteristics (e.g. whether the plot has a title or is registered), and Z 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 two competing hypotheses that have been discussed in the literature. If producers undertake visible investments on plots the tenure of which is highly insecure as a means 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 receipt of title to have a significant impact. Empirically, we use both a zero-one dummy for whether any investment was undertaken in a probit, and the actual amount of land-related investment in a tobit specification.

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[5] Because the possibility for 'titling on demand' continued to exist especially outside the project area, we cannot completely exclude the possibility of a 'contamination' of the sample by households who choose to register their plots outside of the program. While the availability of data before and after the intervention would still imply that we arrive at an unbiased estimate of program benefits, the impact of expanding the program to other areas might be higher or lower.

In addition to testing the impact of title, an economically interesting issue is whether, without or 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-maximising producers would equalise 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 gross margins from total agricultural plus livestock production (π_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:

$$\pi_i = \alpha + \delta L_i + \varepsilon_i \qquad (2)$$

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 δ 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 equalised, 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 gross margins. 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 investment, not provide us with an estimate of the net impact of such an intervention on land values and thus households' net asset positions. 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 obtain such an estimate requires 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

$$V = \sum_{t=0}^{\infty} \delta^t r_t \qquad (3)$$

where r_t is the return received in period t and $\delta = 1/(1+i)$ 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 capitalised in land values has long provided the underpinning for estimation of hedonic land price regressions of the form $V_i = f(Z)$, where 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

$$V_{ip} = \alpha_i + \beta Z_{ip} + \xi_i + \varepsilon_{ip} \qquad (4)$$

will produce biased estimates of the coefficient vector β due to correlation between the unobservable household-specific error term ξ_i and Z. Indeed, this appears to have been a problem in many cross-sectional studies of this issue. To eliminate ξ_i and thus obtain an equation that will yield unbiased estimates via ordinary least squares, we use 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 $\bar{Z}$ the mean of the associated characteristics. Then, as shown, among others by Hausmann and Taylor (1981), taking the mean over all plots owned by the household and subtracting this from the original equation produces

$$V_{ip} - \bar{V}_i = \beta(Z_{ip} - \bar{Z}_i) + \varepsilon_{ip} - \varepsilon_I \qquad (5)$$

which is an equation that will produce unbiased estimates of the β'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 exogenous. The particular attractiveness of this estimator is that, since household-specific attributes are eliminated, it provides us with an estimate of the tenure security effect of having registered title to a plot.

4. Empirical results

Applying this analytical framework to the Nicaraguan data at hand, we obtain three main results. First, the propensity to undertake largely intensive–intensive investments is increased significantly by the receipt of land title. The nature of the data allows to greatly reduce the scope of reverse causality. Comparison of returns across asset classes points to 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 increase investment and help producers to move towards a socially more optimal asset portfolio. We also find that values for registered (not merely titled) land are almost 30% higher than for land that is not. Simple award of a document is thus not equivalent to greater tenure security

(Wachter, 1992) because producers are aware of the lower tenure security associated with non-registered titles and adapt their behaviour accordingly.

4.1. Investment impact of increased tenure security

Results from the probit as well as the tobit regression equations for net investment (Eq. (1)) 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 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 awarding an agrarian reform title per se, without accompanying registration, had only a minimal impact on investment. The coefficient on this variable is small and insignificant at conventional levels 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 conclusions are confirmed by the tobit regressions in which the value of the investment is used as the dependent variable. Even though the probit regression explains more of the variation in the data than does the tobit both of them are consistent in indicating that the propensity to invest is 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 only of marginal significance.

The limited importance which beneficiaries ascribe to increased credit-market access as a consequence of registration, as well as circumstantial evidence, suggest that in Nicaragua title as a means to increase access to credit is of limited importance. Even though an in-depth study of this issue is beyond the scope of this study, we are able to conduct a simple test, based on the idea, discussed for example by Besley (1995), that a credit-market effect of land title will be

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

| | Entire sample | | Restricted sample |
	Probit	Tobit	Probit
Area (mz)	0.001*** (5.60)	69.1*** (7.9)	0.001*** (5.08)
Area squared	−0.0000002*** (3.44)	−0.02*** (4.3)	−0.0000001*** (3.39)
Length of possession (years)	−0.001 (1.56)	−66.9 (1.0)	−0.001 (0.38)
Dummy for titled plot in household			−0.007 (0.34)
Received agricultural reform title after 1990	0.028 (1.18)	1766.6 (1.2)	0.052 (1.59)
Plot was registered before 1990	0.039* (1.84)	2860.3* (1.8)	0.014 (0.72)
Plot was registered after 1990	0.088*** (4.55)	7460.1*** (5.2)	
Plot under perennials	0.025 (0.88)	4290.2* (2.1)	−0.019 (0.63)
Plot under pasture	0.002 (0.13)	−317.3 (0.2)	−0.017 (0.89)
Plot under forest	−0.141*** (3.10)	−13457.5*** (2.58)	−0.118*** (2.61)
Plot under fallow	−0.122*** (2.71)	−12308.1*** (2.5)	−0.109** (2.27)
House plot	0.080** (2.33)	5455.8*** (2.3)	0.057 (1.47)
Plot undulating	0.046** (2.51)	4220.5*** (3.1)	0.054** (2.55)
Plot hilly	0.022 (1.19)	1462.5 (1.0)	0.029 (1.31)
Plot steep	0.052 (1.58)	3564.6 (1.5)	0.096** (2.55)
Log likelihood	−1454.76	−7696.6	−921.6
Pseudo-R^2	0.07	0.01	0.05
No. of observations (plots)	3217	3200	2170

Source: Own computation from 2000 World Bank/University of Wisconsin survey. *Notes*: Dependent variables are 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. 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; flat for plot topography. Regional dummies included but not reported. As explained in the text, the restricted sample drops all the registered plots in order to explore the scope for a title effect at the household level.

  * Significant at 10%.
  ** Significant at 5%.
  *** Significant at 1%.

household—rather than plot-specific.[6] To do so, we use a 'restricted sample' in which we drop all the registered plots and repeat the regression reported earlier with a dummy indicating whether or not the household owns a registered plot rather than an indicator for the registration status of a specific plot. As illustrated in Table 5, column 3, this dummy is negative rather than positive and clearly insignificant, implying that having a registered plot does not increase a household's propensity to invest on other non-registered plots. We conclude that the investment-enhancing effect of registration we identified is indeed plot-specific and does not come about through improved access to credit markets.

The signs and magnitudes of most other variables are as expected. As Table 5 illustrates, we find that the propensity to invest is higher on larger plots but

that this impact decreases with plot size (as indicated by the negative coefficient on the squared area). This is consistent with the presence of fixed setup costs for investment which would generate increasing returns to scale to investment on large plots. 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 often found for other countries, length of possession is not estimated to have a significant investment-enhancing impact. This is understandable since the main risk to land ownership is the emergence of a legal challenge by somebody who claims to have owned the land before 1979. Whether the land was received in the 1990s or the 1980s does not, in this context, seem to make a big difference in

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[6] We thank a referee for pointing this out to us.

Table 6
Pseudo-profit function

	Estimated parameter
Value of land-attached installations 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)
No. of observations	1937
R^2	0.26

Source: Own computation from 2000 World Bank/University of Wisconsin survey. *Notes*: Dependent variable is the logarithm of the gross margin from agricultural and livestock production in C$. Absolute value of robust *t*-statistics in parentheses.

   *** Significant at 1%.

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 the pseudo-profit function 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 gross margins. 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 to livestock (12%) and 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 1 year would, other things equal, increase the dependent variable by almost C$ 2500. In line with our hypothesis, marginal returns to land-attached investment are higher than those to mobile capital, shifting resources from the latter to-

wards the former would 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 emerged from the descriptive analysis. They are consistent with producers' desire for full registration of land ownership, rather than merely an agrarian reform title. In the Nicaraguan context, which can be considered representative of situations with high levels of endemic tenure insecurity, producers appear to need a legally clear title rather than an intermediate substitute to invest. 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 land price regression discussed above.

4.2. Tenure security and land values

Results for the estimation of the land price regression using OLS and fixed effects techniques, are reported in Table 7. We omit the random effects specification which is rejected by the Hausman test and can be obtained from the authors upon request. Note that the dependent variable is the logarithm of the self-assessed land price, which allows us to interpret the coefficients on independent dummy variables such as titling to be interpreted as the marginal increase in land values brought about by a change in the corresponding variable from 0 to 1. Note first that the results confirm the presence of correlation between unobservables and the right hand side variables in the regression as hypothesised earlier. Moving from the OLS to the fixed effects regression, the coefficient on the value of land improvements decreases from 6.1 to 2.3%.

This suggests that more productive households are more likely to undertake land improvements. As it cannot distinguish between the two effects, estimation via OLS would result in serious overestimation

Table 7

Land price regressions at the plot level with and without household fixed effects

	Ordinary least squares	Household fixed effects
Area (mz)	0.011*** (18.91)	0.007*** (10.38)
Area squared	−0.000001*** (12.39)	−0.0000003*** (7.19)
Value of improvements (log)	0.061*** (9.00)	0.023*** (2.97)
Length of possession in years	0.004* (1.68)	0.013*** (3.31)
Plot is registered	0.372*** (5.80)	0.294*** (3.21)
Plot has been purchased	0.001 (0.01)	0.281*** (2.68)
Plot has been occupied	0.048 (0.35)	0.119 (0.55)
Plot acquired through agricultural reform before 1990	0.293 (0.98)	−0.531 (1.02)
Plot acquired through agricultural reform after 1990	0.040 (0.37)	0.442** (2.44)
Pre-1990 agrarian reform and agricultural reform title	−0.532* (1.70)	1.107** (2.05)
Plot is undulating	0.168** (2.38)	0.139 (1.25)
Plot is hilly	0.071 (0.97)	0.216+ (1.69)
Plot is steep	−0.109 (0.91)	−0.031 (0.15)
Plot used for perennials	0.538*** (4.80)	0.004 (0.03)
Plot used for pasture	0.436*** (6.44)	0.128 (1.43)
Plot used for forest	−0.008 (0.04)	0.131 (0.71)
Plot is in fallow	−0.288 (1.61)	−0.614*** (2.62)
House plot	−0.635*** (4.60)	−0.388** (2.46)
Constant	8.964*** (93.18)	8.989*** (63.08)
No. of observations	3062	3062
R^2	0.26	0.17
No. of households	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 C$. Region dummies included but not reported. Absolute value of robust *t*-statistics in parentheses.

  * Significant at 10%.

  ** Significant at 5%.

  *** Significant at 1%.

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 Z and the household specific elements of the error term. The χ^2 statistic of 129.9 leads to a clear rejection of the hypothesis of no correlation between Z and ξ, 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 with this, registration

of a plot results in a quantum jump in tenure security. Using the point estimate for the impact of possession, 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 has a high payoff. However, by awarding predominantly agrarian reform titles that stopped far short of full registration, considerable and relatively immediate benefits have been foregone. Our analysis suggests that avoiding this shortcoming and providing fully registered title could greatly enhance the economic benefits to be expected from 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. On 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 decentralisation 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; (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, allays 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 to devote sufficient attention for 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 maximise 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 titling and registration on land values, together with the descriptive evidence suggesting that this activity has benefited those who were less well off, would imply 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 labour-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 (Deininger and Binswanger, 1999; Deininger, 2003).

Finally, while we found clear benefits of enhanced tenure security due to titling plus registration, there may be scope for studying in more detail other channels, such as activity in land markets and the associated credit supply that might help 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 suggests that titling has not increased beneficiaries' access to formal credit, something that is not surprising in view of the fact that during the period under concern several lending institutions were closed down. 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.

References

Alston, L.J., Libecap, G.D., Schneider, R., 1996. The Determinants and Impact of Property Rights Land Titles on the Brazilian Frontier. Oxford University Press, Oxford. J. Law Econ. Org. 12 (1) pp. 25–61.

Atwood, D.A., 1990. Land registration in Africa: the impact on agricultural production. World Dev. 18, 659–671.

Besley, T., 1998. Investment incentives and property rights. In: Newman, P. (Ed.), The New Palgrave Dictionary of Economics and the Law. Macmillan, London, pp. 359–365.

Besley, T., 1995. Property rights and investment incentives: theory and evidence from Ghana. J. Polit. Econ. 103 (5), 903–937.

Binswanger, H.P., Deininger, K., Feder, G., 1995. Power, distortions, revolt and reform in agricultural land relations. In: Behrman, J., Srinivasan, T.N. (Eds.), Handbook of Development Economics, vol. III, Elsevier, North Holland.

Brasselle, A.S., Gaspart, F., Platteau, J.P., 1997. Land tenure security and investment incentives: some further puzzling evidence from Burkina Faso. CRED, Namur, Belgium.

Bruce, J.W., Migot-Adholla, S., 1994. Searching for Land Tenure Security in Africa. Kendall Hunt Publishing Company, Dubuque, IA.

Burgess, R., 2000. Land, Welfare and Efficiency in Rural China. London School of Economics, London (mimeo).

Carter, M.R., Olinto, P., 2003. Getting institutions "Right" for whom? Credit constraints and the impact of property rights on the quantity and composition of investment. Am. J. Agric. Econ. 85 (1), 173–186.

de Janvry, A., Platteau, J.P., Gordillo, G., Sadoulet, E., 2000. Access to Land and Land Policy Reforms. Oxford University Press, Oxford and New York.

Deere, C., Leon, M., 2001. Empowering Women: Land and Property Rights in Latin America. University of Pittsburg Press, Pittsburg.

Deininger, K., 2003. Land policies for growth and poverty reduction World Bank Policy Research Report series. World Bank and Oxford University Press, Washington, D.C., Oxford, and New York.

Deininger, K., Feder, G., 2001. Land institutions and land markets. In: Gardner, B., Raussser, G. (Eds.), Handbook of Agricultural Economics. Elsevier, North Holland, pp. 287–330.

Deininger, K., Binswanger, H., 1999. The evolution of the World Bank's land policy: principles, experience, and future challenges. World Bank Res. Observ. 14 (2), 247–276.

Feder, G., Onchan, T., Chalamwong, Y., Hangladoran, C., 1986. Land Policies and Farm Productivity in Thailand. John Hopkins University Press, Baltimore, MD.

Firmin-Sellers, K., Sellers, P., 1999. Expected failures and unexpected successes of land titling in Africa. World Dev. 27 (7), 1115–1128.

Gavian, S., Fafchamps, M., 1996. Land tenure and allocative efficiency in Niger. Am. J. Agric. Econ. 78, 460–471.

Hausmann, J.A., Taylor, W., 1981. Panel data and unobservable individual effects. Econometrica 49, 1377–1399.

Hayes, J., Roth, M., Zepeda, L., 1997. Tenure security, investment and productivity in gambian agriculture: a generalized probit analysis. Am. J. Agric. Econ. 79 (2), 369–382.

Jansen, K., Roquas, E., 1998. Modernizing insecurity: the land titling project in Honduras. Dev. Change 29, 81–106.

Jonakin, J., 1996. The impact of structural adjustment and property rights conflicts on Nicaraguan agrarian reform beneficiaries. World Dev. 24 (7), 1179–1191.

Lopez, R., 1997. Land Titles and Farm Productivity in Honduras. World Bank, Washington, DC (mimeo).

Merlet, M., Pommier, D., 2000. Estudios sobre tenencia de la tierra. Nicaragua. Managua, Nicaragua IRAM (Institut de Recherches et d'Applications des Méthodes de Développement).

Paige, J.M., 1997. Coffee and Power Revolution and the Rise of Democracy in Central America. Harvard University Press, Cambridge, MA.

Platteau, J.P., 1996. The evolutionary theory of land rights as applied to sub-Saharan Africa: a critical assessment. Dev. Change 27, 29–86.

Rosen, S., 1974. Hedonic prices and implicit markets: product differentiation in pure competition. J. Polit. Econ. 82 (1), 34–55.

Rozelle, S., Guo, L., Brandt, L., 1998. Land tenure, property rights, and productivity in China's agricultural sector. Agric. Econ. 19 (2), 63–71.

Sjaastad, E., Bromley, D., 1997. Indigenous land rights in sub-Saharan Africa: appropriation, security and investment demand. World Dev. 25 (4), 549–562.

Wachter, D., 1992. Farmland Degradation in Developing Countries: The Role of Property Rights and an Assessment of Land Titling as a Policy Intervention, LTC Paper 145. Land Tenure Center, University of Wisconsin, Madison.

Zimmerman, F.J., Carter, M., 1999. A dynamic option value for institutional change: marketable property rights in the Sahel. Am. J. Agric. Econ. 81 (2), 467–478.