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Investment and credit effects of land titling and registration: evidence from Nicaragua*

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Abstract

This paper analyzes the importance of legal property documents in providing tenure security, enhancing agricultural investment incentives and easing access to credit. While theory predicts that better property rights on land can increase investment through increased security, enhanced trade opportunities and increased collateral value of land, the presence and size of these effects depend crucially on whether those rights are properly enforced. In Nicaragua, a troubled history of land expropriation and invasion has undermined the credibility of the legal property regime. The variation in legal ownership status due to a land titling and regularization programme is studied to identify the effects of legal ownership documents. Possession of a registered document is found to increase the probability of carrying out land-attached investments by 35%. No difference is found in the effect of public deeds and agrarian reform titles provided they are both registered and we find no strong evidence of a credit supply link, thus suggesting security of tenure as the channel through which formal land ownership has an effect on investment.

Keywords: Property rights, investment, land reform, Nicaragua, land ownership.

JEL classification: D23, O13, Q15, K11.

1 Introduction

Institutions and their evolution play a key role in shaping the environment in which economic agents interact, and because property relations are the backbone of the economic structure of society (Bardhan, 1989), the codification and enforcement of property rights are considered as important preconditions for economic growth and development. In agrarian societies land is not only an essential factor of production and thereby the main means for households to generate a livelihood, it is often also the main means of wealth accumulation and transfer. As such, it determines not only a household's ability to produce, but also their social and economic status and even their collective identity (Deininger and Feder, 1998).

Moreover, at the aggregate level, the distribution of property rights in land and its evolution is closely linked to the evolution of power relations, technological change and population pressure (Binswanger, Deininger and Feder, 1995). Differences in systemic property rights security have been posited to

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cause or at least be associated with aggregate economic performance (see North (1981) for a historical perspective).

Secure, alienable and verifiable property rights to land are regarded as crucial because they have a profound effect on the incentives and constraints faced by agents, and thereby on the working of markets for land and capital (Feder and Feeny, 1991). Security provides agents with the incentives to use land efficiently and to invest in its future productivity, especially when property rights can be bequeathed. Alienable and verifiable property rights decrease the costs of transacting land in the market by decreasing informational asymmetries. They do so in part by granting land and alternate, formal existence (de Soto, 2000). Thus the market for land can be expected to allocate the asset more efficiently. Finally, by allowing lenders to foreclose, it allows the use of land as collateral and increases credit supply.

There is little discrepancy on the theoretical underpinnings of these mechanisms. However, they rely on strong assumptions about the property rights system: it should be able to define, document, record and enforce property rights and changes in property rights in a way that is transparent and accessible. Moreover, the latter two mechanisms assume that land, credit and other factor markets function well.

While care should be exercised not to identify documented land tenure with secure land tenure, land documentation, titling and registration programmes have become a widely used instrument in the endeavour to publicly provide secure tenure, especially in less developed countries. However, in many developing countries, public property systems and particularly land administration institutions such as cadastres and public registries are imperfect and mistrusted. Moreover, informational asymmetries and transactions costs are likely to make markets function less than fully efficiently and credit markets are underdeveloped. It is therefore not self-evident that titling and registration can provide tenure security or any other benefit to beneficiaries. Because of this, there has been much debate on the relative benefits and costs of reform aiming to enhance land tenure security by providing legal guarantees of property, as well as the distributional effects of such policies, especially when they are designed to replace customary property rights regimes (Platteau, 2000).

The large number of policy interventions spurred a substantial literature concerned with the effects of tenure security and titling programmes on various economic outcomes, with special emphasis on investment and access to credit.¹ Since the work of Besley (1995), particular attention has been devoted to the possible endogeneity of property rights and tenure security with respect to investment, in particular to the fact that visible investment, such as tree planting, can grant tenure security. This mechanism would tend to bias estimated effects upwards, which Besley (1995) finds in one of the regions studied. Other economic studies having explicitly acknowledged the possible endogeneity of land rights include Carter, Wiebe and Blarel (1994) for Kenya; Alston, Libecap and Schneider (1996) for Brazil; Brasselle, Gaspart and Platteau (2002) for Burkina Faso and Deininger, Jin, Adenew, Gebre-Selassie and Nega (2003) for Ethiopia. Results from these exercises do suggest that, especially in Africa, a large proportion of investment is carried out in order to increase security.

However, another mechanism proposed by Besley (1998) has received less attention. When titling and registration programmes are on demand rather than compulsory or area-based, the decision to seek title and register it is endogenous and an observed positive effect could be picking up unobserved characteristics which are correlated with this decision, such as the greater entrepreneurship or better financial means of the household.

The aim of this paper is to assess the impact of legal documents certifying ownership of land in Nicaragua on investment, while attempting to shed some light on the mechanisms at work and to examine the potential endogeneity of legal status in more detail than has been done in the past.

We must stress at this point the distinction between property rights and property *documents*, which are the focus of this paper. Formal property documents are proof that the property rights of an

¹See Besley (1998) for a survey of the literature and Deininger (2003) for a survey of the more recent literature with an emphasis on policy lessons and interventions.

individual are backed by the powers of the state, at least in theory. There is not necessarily a one-to-one correspondence between formal property documents and tenure security. While conditional on enforcement by the police and the judicial system, property documents should grant secure property rights, they are by no means a necessary condition. On the one hand, the law in Nicaragua and most countries – both developing and industrialised – will recognise and protect some forms of tenure - such as long standing possession - even if they are not backed by a formal document². On the other hand, tenure security may be achieved via informal channels of definition and enforcement.

A history of land reforms, with varying motives and legal underpinnings, has created a complex structure of land rights in Nicaragua, both in its legal foundations and on the field. The corresponding episodes of land expropriation by the state and the use of land grabs as a means of access to land by various segments of the population have severely increased tenure insecurity and have also severely undermined the strength and credibility of the property rights system itself, especially land administration institutions³. In this context, Nicaragua undertook a large titling programme to regularize the situation of beneficiaries of the successive waves of land reform. Due to the especially acute institutional problems in Nicaragua, we view this as a particularly stiff test of the theoretical mechanisms posited in the literature.

Additionally, the on-demand nature of the Nicaraguan titling programme and the declarative nature of the Nicaraguan Public Registry mean that there is a potential problem of endogeneity of the registration status of plots.

Previous studies of the Nicaraguan case include those of Foltz, Larson and Lopez (2000) who study the North-western region of Nicaragua and find no significant effect of land titles on investment other than trees; Broegaard, Heltberg and Malchow-Møller (2002) estimate a joint model for several outcomes to find that perennial crop adoption and tenure security are positively affected by titles, but that wealth is a major determinant of security; they consider explicitly the potential endogeneity of tenure security but not that of the legal status of land. Finally, Deininger and Chamorro (2004) find large effects of receipt of registered titles on land values and investment although they do not consider the potential endogeneity of these.⁴

The remainder of this paper is organized as follows: section 2 presents the theoretical underpinnings of the “investment effect” of legal ownership, as well as more extensive details on the property regime in Nicaragua and the data used, section 3 presents basic results, while section 4 deals with econometric issues arising from the main results, including endogeneity of the main independent variable describing legal status. Section 5 looks at the impact of ownership documents on credit supply as a potential mechanism for the investment effect and section 6 summarises and concludes.

2 Background and data

2.1 Investment effects of land property documentation: theoretical background

While viewed in most of the literature as a proxy for tenure security, legal ownership status has received more attention on its own right as a consequence of de Soto’s (2000) influential book, which puts the property system at the centre of the process of capital creation.

We view formal land property, meaning land ownership which is sanctioned by a property title or deed which is recognised by the state, as essentially formalising property rights, i.e. creating a formal

²Nicaragua, Civil Code Art. 1732 to 1740.

³Land administration institutions comprise the Public Registries and the Cadastre, but property rights institutions also include those institutions granting property rights (the executive) and protecting them (the police, the judiciary).

⁴This paper was only known to me in its working paper version (Deininger and Chamorro, 2002) while work was carried out for the present paper.

representation of the ownership of various property rights over a plot of land, including ownership, usufruct and alienability, among others.⁵ It has to be recognised that this formalisation often comes at the price of the standardisation of those rights. Less common forms of economic organisation or land ownership, such as those used by indigenous communities that follow customary laws, can thereby find themselves at odds with the prevailing formal legal edifice. This type of transition has been widely studied in the case of several African countries (Bruce and Migot-Adholla, 1993) but customary land tenure regimes remain understudied in Latin America and our data does not allow us to fill this gap.

This formal representation of land rights is then recognised by the state and (eventually) by society at large as part of the social contract. Essentially, the title functions like a contract between the holder and the state, with the latter pledging to recognise the former's property rights and protect them, including from confiscation by the state itself.⁶

The need for land administration institutions arises from the need to verify that the set of titles in the economy form a coherent whole. On the one hand, rights over a plot can potentially coexist if they refer to different forms of property right. On the other hand, it is necessary that the information contained in different titles coincides with respect to the physical boundaries over which the rights are defined, as well as the limits of those rights. The two most relevant institutions are the Cadastre, whose role is to associate titles to geographic boundaries of plots as described by maps, and the Public Registry, whose role is to record the titles or transfer deeds held over each plot.⁷ Registration provides an extra layer of security to the title holder as it guarantees that no other (registered) title exists that contradicts his or her rights. In essence, it makes the contract between the title holder and the state verifiable by a third party.

We can now give the main theoretical predictions of the effect of having a property document from this point of view⁸:

1. Insofar as it enhances land tenure security, an ownership document decreases the probability of unwanted expropriation or confiscation and provides incentives for investment in land-attached capital, as the full return from this investment is reaped by the owner.
2. Insofar as it expresses the *relevant* economic characteristics of the land in a way that is standardised (and hence understandable) and verifiable and provided property rights are alienable, possession of a title decreases the transactions costs faced by the owner when alienating all (selling) or part (renting out, mortgaging, etc...) of his or her property rights. This in turn implies that the owner of the plot is able to increase the value of the land or alternatively to recoup the value of any investment at the time of the sale, thereby increasing the returns from investment.⁹
3. Provided possession of a title increases security or decreases the cost of verifying the information contained in the title or has otherwise an effect on the value of land, a formal title that represents alienable rights will increase the collateral value of land. Besley (1995) and Feder, Onchan, Chalamwong and Hongladarom (1988) explain this in slightly different ways, the former by a decrease in the rate of interest due to the higher expected value of the collateral, the latter through the relaxation of a credit rationing constraint, but the essential argument is unchanged: the household now faces greater supply at a given interest rate.

⁵Property rights over land often overlap even when no conflict is present. For example, most governments reserve themselves property rights over underground natural resources.

⁶Throughout this paper, we distinguish between expropriation (forced sale to the state) and confiscation (appropriation by the state). This distinction is often overlooked in the economic literature but is central to the legal issues surrounding property in Nicaragua.

⁷Background on land institutions draws on Deininger (2003), Dekker (2003) and, for the case of Nicaragua, World Bank (2003).

⁸See Besley (1995) for example, for a formalisation of some of these effects.

⁹Notice that this is true for a *given* degree of security (as measured by the probability per period of losing the land). In theory different degrees of transactability would have different effects.

While much of the attention received by titling programmes in the earlier literature was aimed at the last effect (the “credit supply” or “collateral” effect) prompted in particular by the findings of Feder et al. (1988), who find the credit channel to be at the source of the effect in Thailand, and by the arguments in de Soto (2000), it is clear from the above that even if the credit effect is not present, then an increase in land-attached or land-related investment (an “investment effect”) may still exist: as the expected return from land-attached increases, the household will reallocate resources from other assets (e.g. cattle but also other capital goods) towards land as well as land-attached assets, such as improvements on land (irrigation, fences, etc.), as described formally by Carter and Olinto (2003). However, in this case, while it is clear that the land owner is better off with the title, a measurement of land-attached investment constitutes an overestimation of the welfare effect of the titling intervention.

Land titling is usually viewed as increasing security of tenure for land owners¹⁰. In fact, whether security increases depends crucially on whether the formalised rights have an informal correspondence; in other words, if there exist informal mechanisms that protect property rights or if there is no threat on property rights, then we would not expect titling to increase tenure security, and if formal rights are not protected and enforced by the police or the courts, we would not expect titling to change tenure security either.

On the other hand, whether security is increased or not, formalisation of property rights will have the effect of reducing informational asymmetries on the ownership status of the plot of land. This means that the trade opportunities are likely to increase, as trade with individuals who are not members of the same community is made less costly. It also means that, because asymmetries are reduced between borrowers and lenders, the collateral value of land will increase, thereby increasing the amount of credit available.

Given the two effects above, one would also expect the formalization of property to increase the market price of land, as it now incorporates a premium due to the increase in the credit ration (or a decrease in the borrowing rate) that is associated to it, as well as a premium due to the enhanced liquidity of the plot in case of trade. This increase of value may reinforce the credit effect if it exists. The increase in land values is empirically confirmed for the Nicaraguan case by Deininger and Chamorro (2004).

The pattern of land distribution and population management during the colonial period and the dominance of *haciendas* that followed in Nicaragua, as in most of Latin America (see Binswanger et al. (1995) for a detailed account of the emergence of property rights) seriously weakened indigenous customary forms of land ownership or restricted them to areas where indigenous people were concentrated. However this is not to say that local networks are weak. They remain “an indispensable day-to-day reference for economic and social interaction in the local territory” (Bastiaensen, 1997) and often hold the key to “access to government and outside markets”. Therefore, even if social networks do not shape property rights, they may still shape the way these rights are enforced.

Overall, we would expect formal titles to increase tenure security, but ultimately this is not necessary for them to have an effect on investment. If they do increase tenure security, then all the theoretical arguments above point to an unambiguous increase in productive investment.

One very important caveat to all the above is the existence of sometimes significant costs of accessing legal recognition of ownership or maintaining an up-to-date legal document. Obtaining and registering a transfer deed or a property title necessitates the services of several professionals, including at least a notary and probably also recognised measuring services. Registering a property title or deed often implies recognising liability for land taxes when they exist, or income and capital gains taxes in other cases. Therefore, while we would expect benefits to greatly outweigh costs at least in the long run, titling and/or registration can entail a substantial cost for the agent, the titling agency or the state. In turn, this means that when the decision to seek title or registration is left to the household, the household is left to weigh costs and benefits, something that begs the question of the endogeneity of legal land

¹⁰We do not consider the effect land titling can have on security of tenure for households renting land.

status. Because the costs have been widely overlooked in the literature, this source of endogeneity has in turn received less attention than it warrants.

2.2 Background: the land property regime in Nicaragua

The stability of the land property regime in Nicaragua has suffered greatly due to the historical circumstances in which it was developed. The purpose of this section is to illustrate, based on historical developments, the current status of property rights in the country, with special emphasis on land property.

Nicaragua has known, since the early 1970s, three waves of land reform, significantly altering the property landscape:

- The land reform under the Somoza regime: although on paper a land reform, the main drive of land policy under the regime of Anastasio Somoza was the extension of the agricultural frontier. In fact a very large fraction of land given out during the 1970s was at the agricultural frontier (towards the east of the country, gaining terrain on the tropical forest). Overall, however, the Somoza regime, together with a series of commodity booms in coffee, cotton and meat, gave rise to a process of land concentrations. The Somoza land reform had as one of its main objectives to reduce the pressure on land in the fertile and more productive Pacific strip of the country, in order to ease the process of land concentration.
- Land reform under the Sandinista regime (1979 - 1990): After the overthrow of Somoza in 1979 the government distributed large tracts of land to former agricultural workers, organizing many of them into collectivist cooperatives or state farms¹¹. Towards the end of the period, and under pressure due to the *contra* antirevolutionary war, the land reform started granting land to individuals or in cooperative regimes that permitted wider individual rights¹². In 1988, 48% of the country's arable land was held under the various (individual, collective and state) forms of land reform ownership according to Wheelock (1990).
- Following the change in government after the 1990 elections, two major events took place. On the basis of peace agreements, the government continued redistributing land to ex-combatants (both *ex-contras* and members of the downsized Sandinista army and security forces). This was largely done under cooperative arrangements¹³ with the use of land bought purposefully and the inclusion of ex-combatants as priority beneficiaries in the privatisation of large state farms, although overall most of the land distribution was carried out in frontier areas. Secondly, the change of government opened the door to a flood of claims for restitution of land expropriated during the Sandinista regime. This led to an enormous volume of litigation, much of which was not yet resolved at the end of the 1990s and is one of the main causes of Nicaragua's galloping internal debt.

The lack of proper legal documentation of land transfers, especially but not exclusively during the Sandinista land reform, and the existence of allocations of plots over which the State had no legal right have severely undermined the credibility and integrity of the property rights regime. This is illustrated by two facts: the total surface area claimed for restitution in 2000 was larger than the total land area of Nicaragua¹⁴ and the emergence of self-proclaimed ex-combatant bands (*desmovilizados*) who carried

¹¹The production of commodities benefiting from larger returns to scale in production, such as sugarcane, coffee and meat, was organised in large state conglomerates.

¹²An example of this were the *cooperativas de surco muerto* (dead furrow cooperatives) where the land was farmed individually but no fences could be put up to signal the separation, in principle to allow for the use of machinery; the unused furrows used to mark those limits gave the name to the cooperatives.

¹³An infamous example in Rio Blanco, where a cooperative was handed out to members of both groups, resulted in a series of violent, even armed conflicts, for the control of land (Merlet and Pommier, 2000).

¹⁴See, for example, Merlet and Pommier (2000).

out land invasions both in land redistributed during the Sandinista land reform and in privately held land.

Finally, a great number of cooperatives created during the Sandinista period were *de facto* disbanded and the property individualised. While there were about 3600 cooperatives registered at the end of the Sandinista period, only 610 agricultural enterprises defined themselves as cooperatives in 2000 (INEC, 2002). The inability to determine the rightful owners of the land and the requirements of the legal and institutional setup to make the legal transition to individual property made it virtually impossible for members of cooperatives to make this transition within the boundaries of the law.

The conjunction of unclear property claims due to the unsettled legal framework and the tightening of the credit markets, mainly because of the tightening of the eligibility conditions for official development credit and then the disappearance of the official development credit agency (BANADES), led to the decline of the cooperative sector and a wave of distress sales (Jonakin, 1996).

As a result of the troubled history of land in Nicaragua, numerous types of documents proving possession or property rights exist, with varying degrees of acceptability and legal backing. The most relevant legal point is the importance of title registration under Nicaraguan law: only a title which is registered can be used to prove property when faced with a claim by a third party, as only registration ensures that conflicts with previous land owners have been settled or that a transfer has been properly carried out. In the case of land reform beneficiaries, the legal mechanism requires that land be first acquired by the state (by payment of a compensation to the former owner) and only then titled in the name of the land reform beneficiary.

Although a description of all the possible legal documents that can be used to prove ownership and their legal support is beyond the scope of this paper, we can classify them as follows:

1. No title: a relatively large number of plots in Nicaragua (14% of the plots in our sample received no document at all at the time of acquisition) are believed to have no written property title either formal or informal;
2. Informal documents: usually in the form of a transfer deed that is not public (*Carta de compra-venta*) or a Certificate of possession (*Constancia de posesión*);
3. Transitory documents: administrative documents given out as part of the land reform process (*Constancia de asignación* or *Título provisional*);
4. Supplementary titles: a special type of title issued from positive prescription that grants property rights only so far as they are unopposed;
5. Agrarian reform titles: both during the Sandinista land reform and throughout most of the 1990s land regularization programme, these titles, which are administrative rather than judicial documents, were given out. They carry a series of restrictions, most noticeably limitations on validity if dated from the transition period (February-April 1990), and a five-year moratorium on sales¹⁵;
6. Public deed: a well-defined full property title documenting a land transaction.

Throughout the 1990s the government of Nicaragua, backed by a number of donors¹⁶, put emphasis on land rights regularisation, especially of land affected by the successive waves of land reform. The scale of the programme is remarkable: between 1992 and 2002 the government of Nicaragua issued close

¹⁵Law 278 of 1997, the current legislation on land property rights, substantially relaxes this condition as it allows mortgages on agrarian reform land as well as sales under certain conditions.

¹⁶Under the umbrella programme PNCTR (*Programa Nacional de Catastro, Titulación y Registro* - National Programme of Cadastre, Titling and Registration) the government has carried out titling and land administration modernisation initiatives.

to 40,000 titles all over the country. While administrative records could include several titles given to the same person or group of people, this can be compared to the nearly 200,000 farms counted in the recent Agricultural Census (INEC, 2002).

Because the titling programme acts administratively rather than through the judicial system, the type of title granted is an agrarian reform title (registered or unregistered) rather than a public deed (which would be a notary's document certifying a transfer¹⁷). From a legal point of view, this is the consequence of the view that land is allocated and granted by the state rather than sold.

The type of document held is one of the two main institutional restrictions on registration. Informal and transitory titles cannot be registered, except in special cases in which possession rights can be registered¹⁸ and even then, only possession rights and rights over improvements will be registered. The last three types of title can be registered as long as the chain of title is preserved¹⁹. Agrarian reform titles are subject to a number of restrictions of validity and transactability, following the laws enacted during the second half of the 1990s²⁰ to protect property rights and to counteract abuses committed, especially during the transition period.

Many agrarian reform titles need to be ratified and cannot be registered unless any previous conflict has been resolved, and in particular unless any claim originating from pre-reform owners has been settled. Because of this, even agrarian reform titles granted after 1991, which in theory need not be ratified and for which the state should have carried out any necessary conflict resolution, are likely to induce mistrust on the part of buyers and lenders especially if they are not registered. An important part of the evaluation of the validity of the legal edifice and the effects of the titling intervention therefore lies on the perceived differences between the two main types of full ownership documents.

The second restriction on registration is that either no previous registration exists for the property or that the title is a transfer deed from the previous owner. Because agrarian reform titles constitute a transfer from the state, this implies that the state must have had ownership of the plot, which in turn can be impeded by the existence of a restitution claim on the plot. Hence the resolution (or lack thereof) of restitution or compensation claims by former owners whose lands were confiscated without compensation and outside the prevailing legal framework during the land reform (generally known as *confiscados*) or the coexistence of agrarian reform titles can impede registration.

While initially, reform beneficiaries received documentation short of a full registered title and were expected to seek registration, the official guidelines were changed mid-way into the process to effectively hand out only titles that had been properly registered²¹. In practice, many titles were given out without having been properly registered first even after this date, while some titles received prior to this date had been registered. That guidelines were changed illustrates the importance of registration, but we would not expect this change in regulation to be the only (or the major) source of variation in registration status. However, due to the declarative nature of the Nicaraguan property registry, this point is important in providing exogenous variation in registration status. If one could expect well-established farmers to have taken action to register titles, the grant of already registered titles will serve to identify the effect of titling coupled with registration.

Finally, even when registration or titling is possible, the costs associated with either or both can be substantial. A study of legalisation and registration costs (PAT-MAGFOR, 2001) found that indirect

¹⁷And therefore would entail *buying* land from the state.

¹⁸Possession rights can be registered via the use of a Supplementary Title. In the departments of Jinotega and Matalgalpa, Public Registries also contain specific books to register possession rights, which are used to prove ownership on *improvements* on land and can be used to prove length of possession.

¹⁹During the transition period between the February 1990 elections and the effective change of government in April 1990, legislation was enacted that forced inscription even when the chain of title was not respected. The result of this was to lower the security granted by registration of Agrarian reform titles altogether as many were registered without preserving the chain of title and such registrations can, in principle, be challenged by previous owners or the State.

²⁰Laws 209 and 278 require the revision of a substantial number of property titles and create mechanisms for automatic devolution to the state of properties failing the revision process.

²¹Implementation of these guidelines seems however to have been hampered by shortages in staffing and funds.

costs (transport, food, opportunity costs) can be of the order of magnitude of the monthly average agricultural wage (approximately C\$ 620)²² in remote areas . Legal costs are of the same order of magnitude although they depend crucially on the type of title and are much higher when acquisition of the title requires a court order, such as the supplementary title. The most important cost, however, is a transmission tax of 1% of the fiscal value of the land and any buildings or improvements²³, which has to be paid before registration or, in the case of bequests, before judicial execution of the will. Tying this tax to registration significantly increases the cost of registration for properties that have been bought or inherited: the average land value in our sample is C\$ 81,364, therefore this represents almost a twofold increase in costs for land bought or inherited.

Despite its importance in property law, the Nicaraguan Property Registry is obsolete, severely underfunded and mistrusted although great efforts have been made since the change of power in 1992 to improve it (see Trackman, Fisher and Salas (1999) and Merlet and Pommier (2000) for details of both the main problems faced by the Public Registry and recent improvements). This makes a test of the importance of titling and registration all the more stringent in the case of Nicaragua as perceived benefits from titling and registration could very well be extremely low if there is distrust in either Land Administration institutions or the judiciary.

2.3 Data sources and descriptive statistics

The main data source is the *Estudio de las Dinámicas de la Economía Rural* (Study of Rural Economy Dynamics), a survey conducted by the World Bank, the University of Wisconsin and FIDEG, a local NGO, between February and April 2000. This survey contains information on household characteristics as well as information on income sources (both agricultural and non-agricultural), a detailed log of land holdings and transactions and information on investments in land. The survey also has detailed information on credit activity, including not only credit used but also denied requests and a subjective self-assessment of creditworthiness²⁴.

The sample for this survey was constructed using a 1996 nationally area-representative survey of 1360 farmers carried out by the Agriculture ministry (MAGFOR). This sample was then complemented by three other categories: (i) 461 households drawn randomly from the list of beneficiaries of the governmental titling programme, (ii) 372 rural households with little or no land, (iii) 282 of the households of the original sample were no longer cultivating the plot they were cultivating in 1996 and were replaced by the households who were farming the land at the time of the survey.

The presence of these categories ensures that the sample provides a representative picture of the Nicaraguan agricultural landscape, and is representative at the level of the main agro-climatic regions: the fertile Pacific strip, the hilly Northern region and the Centre of the country²⁵. The data covers 3212 plots distributed over 126 municipalities within 17 departments which can be grouped into 9 larger regions.

However, the sub-samples do not share the same structure below the macro-regional level, with categories (i) and (ii) being stratified further at the departmental level. Further details on how the samples were constructed can be found in the appendix.

Tables (A1) and (A2) (also in the appendix) present household and plot level summary statistics for the sample and each of the sub-samples. It can be seen that the sub-samples are markedly different not only in terms of land holdings but also in the form of land ownership as well as land use: while most land held by titling programme beneficiaries is used for seasonal crops, well-established farmers and land buyers devote a large proportion of land to pastures. On average, well-established farmers and land buyers are richer than the other two groups and titling program beneficiaries are richer than

²²1 córdoba (C\$) = 13.5 US\$ approx. at the time of the survey.

²³This tax has since been raised to 4%.

²⁴i.e.: the answer to the question “would you have been granted credit had you requested it”.

²⁵The Atlantic regions are not represented due to the difficulty of access and low population density.

the land poor. However the wealth of the first two groups is held in notably different ways. While established farmers hold higher value machinery and cattle, land buyers hold more land and are more heavily indebted. Several explanations could account for this: many purchases may have been made for extensive cattle farming, which requires less agricultural machinery but substantial initial investment. Another possibility is that the lack of depth of the land mortgage market even for relatively well-off households pushes them to finance the land purchases at least in part by selling or not buying mobile capital assets²⁶ as in the mechanism proposed by Carter and Olinto (2003).

Table [1] presents summary statistics on plot-level tenure types. Over 10% of the sample has no title or a very insecure type of title (the first four categories). Public deeds are the most common type of title, held for 58% of the plots, while about 30% of the sample plots are held with agrarian reform titles. While the categories do not exactly match, recent data from the National Agricultural Census find that 56% of land owned is held with public deeds and only 10% with agrarian reform titles, although a further 18% are reported as “owners without a public deed” and 15% as “in legalisation process”, both of which would include a number of agrarian reform titles. The lack of tenure security and the diversity of tenure regimes are quantitatively large problems in Nicaragua.

Table [2] presents summary data on the investments considered. These are land-attached investments such as sheds, silos, stables, wells and processing facilities (in particular coffee processing facilities). The main dependent variable of interest is a dummy variable that takes a value of 1 if any of these investments was carried out between 1996 and 1999. We also form groups of investments according to whether they are specific to cattle farming or not. This table shows that these investments, while large and relatively capital intensive, are not reserved for a wealthy minority, as they existed in a third of plots sampled at the time of the survey, and the dependent variable mean (the proportion of plots invested in during the period of interest) is 0.11. Two main considerations directed the choice of investments to be included. The first one is due to limitations of the data: for these investments, we have data on stocks in 1990, 1996 and 1999. For other types of investment, such as fences, terraces and manure applications which have also been examined in the literature, we can only know when investment last took place. Because those types of investment require substantial reinvestment, the lack of data on stocks would be a hindrance. The second consideration is that, because we do not observe the cost of the investment in labour or capital, we are forced to aggregate investments that are potentially very different. The class of investments chosen, namely production buildings, share basic physical characteristics and all require substantial capital. While concerns still arise from pooling investments of varying costs, we expect this to reduce the potential impact of outliers in the data. Finally, while we have data on 1990 stocks, we choose investment between 1996 and 1999 because by 1996, 77% of property documents for which we have a date of emission were already emitted, while that figure is only 46% for 1990, not surprisingly given the large titling effort.

3 Basic results

We begin by analysing the direct effect of property documents on investment. We consider the following general specification:

$$I_{p,h,t} - I_{p,h,t-1} = \alpha + \beta \mathbf{X}_{p,h,t} + \gamma \mathbf{Z}_{p,h} + \delta \mathbf{H}_{h,t} + \varepsilon_{p,h,t} \quad (1)$$

Where I represents investments present in plot p owned by household h at time t , the \mathbf{X} 's are plot level variables representing tenure status at time t , the \mathbf{Z} 's are other plot characteristics, and the \mathbf{H} 's are household level variables.

²⁶ Finally, measurement error in the machinery value variable cannot be ruled out. The absence of detailed price data means that machinery quality and depreciation are not accounted for. This could entail a significant overvaluation of longer-serving machinery.

Because the investments considered are immobile long-term investments, security of tenure, insofar as it determines the horizon of the producer, is a key determinant of their expected return.

The dependent variables of interest are dummy variables for each of the types of document in the sample. The first three – possessory note or certificate (*constancia de asignación / posesión*), private sale document (*carta de compra/venta*) and provisional title – are not sufficient to prove ownership rights but can be used to prove possession, while the remaining documents are property documents: public deeds (*escritura pública*) and agrarian reform titles are full property documents that can be registered provided the title is deemed acceptable and no conflicting registry entry exists. Communal and indigenous titles are specific to indigenous communities and are in principle full property documents. Supplementary titles and most judicial documents (these include court orders, will executions and powers of attorney) are full property documents in that they document ownership but are subject to limitations with respect to either registration or the protection offered by registration. The omitted category is “no document”. A dummy variable representing the registration status is also added. All legal status data is contemporaneous (2000) data.

We use a linear specification for ease of interpretation of the coefficients, in particular for comparison with subsequent specifications where household fixed effects are used²⁷. In anticipation of the potential omitted variables problem, we adopt, throughout this section, a sparse-to-saturated approach to model selection, with each set of regressions testing for the importance of a particular aspect of land ownership.

Table [3] presents results of linear regressions of this specification stripped down to the bare essentials, including only property document data and registration status. A preliminary regression (not reported) of investment on title types only shows no association between the type of title and the investment variable. Column (1) presents the basic specification with only document type and status dummies, while columns (2) and (3) add respectively regional and municipal fixed effects. Errors are heteroskedasticity robust and clustered at the municipal level for all but column (1) and for the remainder of the paper. Errors are in fact likely to exhibit heteroskedasticity and to be correlated within municipalities due, on the one hand, to the differing size of areas covered by municipalities, and on the other hand to non-linear effects of unobserved institutional factors that would leave a common residue in the error term.

Only the coefficient on registration status is significant at the 5% level or better in all specifications, and the order of magnitude of the coefficient is robust to the inclusion of municipal fixed effects (which to a certain extent will capture major differences in land use and land quality, as well as local institutions). The slight increase in the point estimate of the coefficient is indicative of the fact that the original result is not led by large differences in registration that can be attributed to recent settlement or average land quality. The size of the coefficient (0.043) is remarkable given that the average of the dependent variable is only 0.12, so registration is associated with an increase in the probability to invest of over one third (35%) of the average sample probability.

Of the remaining coefficients, the large negative coefficient on indigenous titles is noteworthy. Both communal and indigenous titles in the sample are concentrated in the provinces of Leon and Madriz, an area where indigenous community property is known to be conflictual. However, there are very few such observations in the data set and we cannot confirm or infirm this from the results.

Column (4) replaces the registration dummy with interactions of registration with each of the documents that can be registered²⁸. Only the coefficients on registered public deeds and registered agrarian reform titles are significant among these, and only these are shown. They are not significantly different from each other (the P-value of a Wald test of equality is 0.61), and they have the same magnitude as the registration variable. Therefore we conclude that legal status does matter for investment but

²⁷A probit regression would be problematic in the inclusion of the fixed effects. Marginal effects from results of logistic regressions are very similar for the main dependent variables in the basic specifications.

²⁸Some registries do accept to include possessory documents in the registry in a separate book and there may be instances where plots are registered in the neighbouring department because of this, however the corresponding interaction terms are not significantly different from zero at conventional confidence levels if included.

only insofar as the titles are registered and that the specific type of title is not a major determinant of investment.

The failure to find any significant difference between the two main types of strong property documents, especially in their unregistered version, is somewhat surprising as we had expected to find a different effect of agrarian reform documents, generally thought of as being less reliable due to the process leading to their acquisition, and because of the restrictions on alienation they carry. More specifically, if land acquired through land reform interventions is less secure, we would expect the coefficient to be smaller – at least the uninteracted term and probably the interacted term as well – as the effect of title on security is smaller²⁹.

Because of the legal differences in the treatment of agrarian reform titles depending on whether they were granted before or after the political transition in 1990, table [4] examines the effect of acquiring land or documents after 1990. Columns (1) and (2) examine the impact of document dates; (1) includes a dummy variable for whether the document was received after 1990 and its interaction with the agrarian reform title dummy while (2) adds to that specification the length of continued possession in years. The results do not support a difference between documents even when considering the date. While reception of a document after 1990 is significant at the 5% level in column (1) and has a large coefficient, this effect is captured by length of possession so that there is no evidence that documents received after 1990 are special nor that reform documents received after 1990 are special³⁰. Some document dummies become marginally significant in columns (1) and (2) due to the correlation between the date of reception and the document type created by the titling programme, the bulk of whose actions were carried out after 1992.

Given the many missing values in the data for land title dates, columns (3) and (4) examine the impact of the date of acquisition of the plot. We again use 1990 as a possible threshold date due to the possible legal hurdles that acquisition before 1990 creates for legal tenure security and the recognition of ownership. Column (3) includes length of possession, a dummy for whether the plot was acquired through land reform, a dummy variable indicating access to the plot after 1990 and the interaction of the latter two variables. We find acquisition after 1990 to be significant at the 10% level even when controlling for length of possession, but not more so for land reform acquired plots³¹. We therefore drop the interaction term and the reform acquisition variable³². Finally, column (4) confirms the importance of having acquired land after 1990. The positive sign of this coefficient indicates that this is a security-related effect rather than an effect due to the length of possession (which would lead to a negative coefficient, as the investments considered are very durable).

Results from tables [3] and [4] suggest that, insofar as legal documents have an effect through either the provision of tenure security or the availability of formal credit, that effect is entirely borne by the registration status of the title. The fact that only registration matters is in accord with the law, which states that only registered titles offer full protection against a third party claim over land ownership. Moreover, mortgages on land need to be registered and therefore formal credit can only use land as legally backed collateral if that land is previously registered.

Table [5] presents results of the full specification. Due to the finding that the type of document is not statistically significant once registration is controlled for, the type of document dummies are omitted. Column (1) adds further plot level controls which are inherent plot characteristics (area, area squared, distance from the household's dwelling, total investment in 1990 and a set of dummy variables

²⁹Unless it is insecurity that causes investment, which we can not rule out at this stage, in which case we would expect a larger coefficient as less security prompts more investment.

³⁰There is a substantial drop in the number of observations in columns (1) and (2) of table [4] due to many missing values in the date of document variable even for documents which by their formal essence, are necessarily dated.

³¹The land reform acquisition variable is closely related to some of the document types (provisional titles and agrarian reform titles in particular) but a joint Wald test of significance cannot reject their joint irrelevance (P-value = 0.73).

³²A further regression (not reported) with the reform access variable but without the interaction also shows the former to have a coefficient that is not significantly different from zero, both on its own and jointly with the ones for reform-specific title types.

for different types of topography). Column (2) adds household controls including dummy variables for the sub-sample the household belongs to³³, the age of the head of household and its square, an indicator variable for female-headed households, the education of the household head, the number of males and females over 12³⁴ and the presence of at least one literate person in the household. Column (3) adds distance to the nearest paved road and distance to the nearest wholesaler as measures of infrastructure quality and of the geographical isolation of the household³⁵. Finally, column (4) adds a set of household wealth controls (agricultural machinery owned in 1990, ownership of a television or radio in 1996, an indicator variable for whether the household dwelling has an earth or soil floor and the total are of agricultural land owned by the parents of the household head at the time the household head started working on his own account). Column (4) is our main specification and a more detailed description of the variables used can be found in table [B3] in the appendix.

The addition of these controls does not significantly alter the coefficient of interest, which remains between 4% and 5% in magnitude and significant at the 1% level. Noteworthy coefficients on controls include the lack of significance of initial investment which we would expect to be negative due to decreasing returns to investment, and that of distance to the plot. A plot which is further away is harder to keep watch on, although the nature of the investments considered makes them hard to steal or damage, which may be the reason for the insignificant coefficient. Other coefficients have the expected signs with the exception of the (insignificant) coefficients for household composition variables: investment is more likely in larger plots (albeit less than linearly so), more likely to be carried out by a household sampled in the follow-up sample³⁶, and less likely the further a household is from a paved road. This last point seems to be closely related to later acquisition of land as the coefficient on post-1990 acquisition of land loses significance in column (3). This can be attributed to the distribution of land in the agricultural frontier to ex-combatants as part of the peace agreements (Agu-Lughod, 2000). Of the wealth controls, only TV ownership has a significant coefficient³⁷ which is somewhat surprising. The great mobility in land ownership in Nicaragua as a result of the successive waves of land reform implies that parental ownership of land is not a very good predictor of current ownership of land, which can account for the lack of explanatory power of this variable.

Our basic results show that having a formal ownership document *that is registered* is strongly linked with the propensity to invest³⁸. Moreover, this result is robust to the inclusion of a whole range of controls that co-determine the returns on investment in land. We now turn to testing the robustness of these findings.

4 Econometric concerns

This section deals with econometric issues that may limit the validity of the estimates presented in section 3. We will first present the main issues regarding measurement issues and the possibility of relevant omitted variables, move then to unobservable household heterogeneity and then turn to the problem of possible endogeneity of the main dependent variable.

³³Terms interacting the subsample dummy with registration status were also entered but found to be insignificantly different from zero and are omitted in the specification presented.

³⁴Age 12 is chosen as it is the age a child would reach at the end of primary education without repeating a year. It is also the lowest age at which significant labour activity is reported.

³⁵Unfortunately, the smallest identifiable geographical divisions are municipalities, which are too large for fixed effects to fully control for infrastructure quantity or quality.

³⁶The follow-up subsample households are richer, especially in cattle and land, and have acquired land in later years. Excluding these households does not change the coefficient on registration but weakens the coefficient on post-1990 access to land.

³⁷The large size of this coefficient is probably due to threshold effects in wealth.

³⁸In fact, adding document type dummy variables to the baseline specification does not significantly alter the results, moreover, we are still unable to reject that the effects of having a registered public deed and a registered agrarian reform document are the same (regressions not reported).

4.1 Omitted variables and unobserved characteristics

4.1.1 Controls for wealth

Because the investments considered can require substantial capital and we have argued that registration in some cases can also entail significant expenditure, the lack of significance and the small changes in the coefficient of interest after the inclusion of controls for household wealth to the baseline specification pose a problem. So far, the possibility that both registration and investment are driven by household wealth cannot be ruled out.

Table [6] tries to address this problem by adding a final set of controls for household wealth. Unfortunately, we have limited information on wealth other than land at other points in time, therefore columns (1) and (2) test two different sets of wealth controls: column (1), our baseline specification, includes only those variables that are available for a time prior to the starting point for our investment variable and substitutes own area in 1990 by the area owned by the parents at the time of emancipation. Column (2) includes as much information on current wealth as is available, lagged if possible and contemporaneous otherwise (agricultural machinery, television and radio ownership, ownership of non-agricultural land, cattle value, non-agricultural capital, own area in 1990 and an indicator variable for whether the household dwelling has an earth floor). We treat this table not so much as a test for the best set of covariates but as a test of whether registration could be found to be driving investment only because it is related to wealth. In which case we would observe a drop in the value of the coefficient on the registration variable when further controls for wealth are included as well as in its significance.

While the values of cattle and non-agricultural capital as well as the variable for total owned area have large and significant coefficients, the coefficient of interest is not much affected. Had the measured effect been due to mismeasurement of wealth, we would expect to see a much greater change in the coefficient on registration.

Given the relatively small change in the coefficient, we prefer our baseline allocation, as contemporaneous wealth variables are clearly very likely to be endogenous to the investment decision and therefore likely to have biased coefficients and to bias other coefficients in the regression. It not unlikely that investment drives wealth or the allocation of wealth. Even in the most favourable case, we would expect the distribution of wealth between land-attached investment and other forms to be jointly determined with the level of land-attached investment.

With the preceding caveat, it is noteworthy that the coefficient on the value of cattle is much larger than that on other forms of asset ownership. While this could be due to the fact that cattle is often used in rural Nicaragua as a store of wealth, we also interpret it as a warning with regard to the measurement of the dependent variable, which puts more emphasis on cattle-related investment.

4.1.2 Controlling for main land use

We have very little information on the quality of land, which could be related to the expected return on investment and thereby to the propensity to invest. In particular, we decided not to include information about the main use of land (for seasonal, perennial crops or pastures) as, while it could provide some information about the inherent productivity of land, the decision is likely to be endogenous.

As a robustness check, the regressions reported in table [7] run the baseline specification on different sub-samples according to the main use of land as reported by the household³⁹. A reported use of “seasonal crops” is compatible with the existence of cattle or permanent crops, and we therefore use the same definition of the dependent variable. However, in the case of perennial crops and pastures, this is less likely, and we therefore run the baseline specification for cattle-specific improvements (cattle sheds, forage silos, etc) in the case of pastures and non-cattle specific improvements in the case of perennial cultures.

³⁹ As it is common practice in Nicaragua to associate perennial cultures (particularly coffee and fruit) with seasonal cultures (typically maize and beans), the classification may be somewhat imprecise.

Hence, columns (1), (2) and (3) report the baseline regression for plots with seasonal crops, perennials and pastures respectively, while column (4) reports results for non cattle-specific improvements in plots with perennial crops and column (5) reports results for cattle-specific investments in pasture plots.

The main results are unchanged, although they are much weaker in the case of perennial cultures. One reason for this is the fact that the main non cattle-specific investments (silos, irrigation) are less likely to be useful for the most common perennial crops (coffee and fruit) while coffee-specific installations need not be on the same plot as the coffee trees. However, even in the case of perennial crops, registration status remains significant and the point estimate stable.

4.1.3 Cattle-specific investments

A concern arising from our earlier robustness checks for the importance of wealth controls is that we may be capturing mostly an effect of investment in cattle-related installations, and therefore a greater propensity of cattle farmers to register their land. One possible cause of this is the fact that most cattle farming in Nicaragua is extensive, therefore making it more costly to watch over the land when the cattle herd is elsewhere.

To alleviate this concern, we split the sample in two sub-samples according to whether the household owns any cattle or not, and we regress separately non cattle-specific investments for households with no cattle (column 1) and cattle-specific investments for households with cattle (column 2), as well as for the whole sample (in column 3, for comparison purposes).

The results are encouraging. While we do find that part of the results are carried by cattle-specific investments, as shown by the strong coefficient for registration in column 2, the results of column 1 show that registration also matters for non cattle-specific investment. In fact, the coefficients are of very similar magnitude, suggesting that registration matters equally for the relevant investment regardless of whether it is cattle related or not⁴⁰.

4.2 Unobserved household heterogeneity

The main concern in estimation of (1) is the existence of unobservable household level variables – such as entrepreneurship or legal sophistication, or better measures of wealth or income – that are not included in the estimated regression but may be correlated with both registration status and the decision to invest. Failure to include them will make the estimates inconsistent. For this reason we run the same specification with the inclusion of household fixed effects. The estimated equation is therefore:

$$I_{p,h,t} - I_{p,h,t-1} = \beta \mathbf{X}_{p,h,t} + \gamma \mathbf{Z}_{p,h} + \alpha_h + \varepsilon_{p,h,t} \quad (2)$$

The inclusion of household fixed effects means that the estimation relies exclusively on within-household variation. For this reason, only households with more than one plot of land are included⁴¹. It should be noted that this has the effect of reducing variation in the data because fewer plots are considered and only within-household variation is taken into account; moreover, the equation is now estimated for households owning more than one plot only, which may systematically differ from households with only one plot.

Table [9] summarises the amount of within-household variation in both the dependent variable and the main independent variable. This constitutes a stiff test of the association between registration and investment. While our sample only drops to 1916 plots, there is within-household variation in registration for 691 of them, variation in investment for 454 of them, and only 52 households (176 plots) have variation in both investment and registration. On top of this, plots owned by households with

⁴⁰Not surprisingly, a regression of cattle-related investments for households with no cattle does not provide any useful information (not reported).

⁴¹The inclusion of all households would, of course, not alter parameter estimates. It would, however, alter the variance estimates, given that these allow for clustering at the municipality level.

more than one plot are 3 percentage points less likely to receive investment (significant at the 1% level) and 5 percentage points less likely to be registered.

If a household owns several plots, the presence of household fixed effects dilutes the credit effect mentioned above. Indeed, if the credit effect is the force driving an increase in investment, then own plot characteristics will also matter insofar as they enhance the household creditworthiness. However, if the increase in investment can be attributed to household-level effects, such as an increase in available resources (funds and/or time) which are then invested equally among plots, we would not expect to find an effect in this specification (Besley, 1995). Finding an effect in this specification does not preclude the existence of a credit effect, it would only indicate how the extra available funds are allocated.

Results are reported in table [10] along with the full specification (1) ran over the same households, for comparison purposes (in column (1)). Column (2) uses the same sample as column (1), while columns (3) and (4) use the full sample of households with more than one plot⁴². The point estimate of the coefficient of interest increases slightly but the coefficient is less precisely estimated. The statistical significance of the coefficient is reduced, especially when we allow for correlation between errors within municipalities, although it remains significant at the 10% level throughout.

Overall, results from this specification are somewhat supportive of the basic results. The inclusion of household fixed effects captures much of the variation in the dependent variable as showed by the R^2 of the fixed effects regressions ($R^2 = 0.47$), suggesting that household effects not present in the original model are important in the investment decision.

At the same time, the lack of significance of the included regressors points to the fact that important determinants of investment at the plot level (in particular a measure of the quality of land) are not included, which casts some doubts on the validity of the estimates. Column (4) includes variables describing the mode of access to the plot and finds that within a household, receipt of a plot via land reform makes it substantially less likely to receive investment, although this effect is cancelled out by a registered title; having bought the plot, however, makes it no more or less likely to receive investment than having inherited it (the omitted category).

4.3 Endogeneity

While household the household fixed effects specification can control for any unobserved household characteristic that affects all plots in the same way, there is still the possibility that registration is endogenous, in the sense that it is correlated with the error of the regression. We now turn to concerns about the endogeneity of legal ownership documents, and registration in particular.

Endogeneity of land property rights is a matter that was largely ignored in the literature dealing with investment effects of tenure security until the work of Besley (1995). The main argument is that past investments may enhance land tenure security; if land holders own the improvements they make on land, they may claim to own the land by virtue of this. This argument relates to the essence of property rights themselves, by relying on the idea that individuals create property rights by “mixing” their labour with a given object. Moreover, such rights are legally recognised in many countries – at least to some extent – including Nicaragua.

In effect, adverse possession can be used as the basis for prescription of the owner’s property rights and therefore as a means of access to property rights which are formally recognised (a mechanism known as “positive prescription” in Nicaraguan law). In turn, visible investments in land could be used to prove possession itself and therefore be used as a basis to obtain formal property rights. There are two distinct reasons why this mechanism, in our opinion, is not a major concern. Firstly, despite widespread speculation in Nicaraguan media of the massive use (and misuse) of positive prescription, the type of title which sanctions it is hardly present in our data set⁴³. Secondly, the time frame involved in the

⁴²The difference between the samples is the existence of missing data which would exclude some households from the baseline specification.

⁴³Land held with a *título supletorio* (supplementary title) represents less than 1% of the plots in the sample.

judicial mechanism (10 years' continued possession) is considerably larger than the one we examine (investment within 3 years of the survey). Because of these two facts, we are relatively safe from such reverse causation concerns.

Unfortunately, this does not mean that we are free from endogeneity concerns altogether. Beneficiaries of the governmental titling programme may have received titles that were registered or unregistered, with registration depending on a number of factors which are largely exogenous to the household's investment decision, such as the presence of an unsettled claim from a previous owner or administrative competence on the part of the titling officer. However, the nature of the registry is declarative, which means that, in general, registration is a decision of the household. This means that households that received a title that could be registered but was not, may have decided to register it later and even that an individual may obtain a title so as to register his or her property rights.

In the case of plots which were inherited or bought, registering the transfer deed (in the latter case) or updating registry information (in the former) is solely a decision of the household and is likely to be led by the relative costs and benefits provided by registration, including any anticipated increase in the expected return on investment.

A first answer to this is to carry out the main regression only for the plots participating in the legalisation process⁴⁴, as there is likely to be substantial variation in registration at the reception of the document due to factors that are exogenous to the household's decision. This is done in Table [11]. The main independent variable is also changed to be not current registration, which is potentially endogenous, but a dummy indicating whether the plot was registered at the time it was titled (self-reported). This variable potentially depends on the specific procedures put in place by the programme at the time and therefore exogenous to the investment decision. Both the baseline specification with household controls and a household fixed-effects specification are presented and results are mildly supportive of our basic specification, although the drop in sample size is very large, especially in the case of the fixed effects specification.

Moreover, using correct registration at receipt of title as an instrument for current registration results in a coefficient that is of roughly the same magnitude (0.074) but no longer significant (P-value = 0.18), despite the strong first stage regression (the t-statistic for the excluded instrument is 13.18 even with municipal fixed effects). Overall, restricting attention to titling beneficiaries has the effect of reducing the variation in the sample and weakens the results.

The contamination of the registration status can be addressed if we believe that the type of title is exogenous to the investment decision. Because only certain types of title can be registered, the type of document held is an important predictor of the registration decision. Moreover, as per our discussion in section 2, the type of title, and more generally the tenure status (especially whether the owner is a land reform beneficiary or not) are crucial determinants of not only the possibility of registration, but its cost when it is possible. However, since what brings about investment is not so much the title itself but whether this title is registered, as suggested by the basic results presented above, document types are natural instruments for registration status in the investment equation.

Which document is held depends essentially on the tenure of land before it was acquired and on how it was acquired. Land reform beneficiaries receive land reform titles or provisional titles if the legality of the land allocation has not yet been verified. Inherited land retains the original document, although if that is an informal document, steps can be taken to acquire a public deed. If land is bought, the original type of document is also retained, although it is less likely to be an agrarian reform title due to limitations on its sale.

Because registration is declarative, we are particularly concerned with the endogeneity of the registration decision. However, it is also possible for the document held to be endogenous itself, particularly in the case of land reform beneficiaries. Indeed, the titling programme was carried out "on demand"

⁴⁴We do not have, unfortunately, an indicator of participation from the sampling stages and we have to rely on self-reported data, which may not always be accurate.

rather than universally. The fact that the unit of titling was not the individual plot but rather the original estate (usually much larger than a single plot), there is the possibility that someone not actively seeking a title would receive one. However, the possibility of actively seeking a title poses a major problem. For this reason, we will use two alternative sets of instruments: current documents held and the documents held for the plots at the time of acquisition. Because this does not allow us to distinguish ex-ante between possible titling beneficiaries and other producers, we augment this set by the interaction of not having a title with the mode of access to land (inherited, bought, squatted, received as donation, received through land reform)

The relevant estimator for comparison with the results presented above is the “within” instrumental variables estimator. However, this will only control for local effects which are fixed and additive in nature. In order to make correct inference in the presence of potential correlation between errors at the local level, we present the results with standard errors corrected for clustering at the municipal level. The orthogonality conditions on the instruments are tested using the J statistic of Hansen (1982)⁴⁵.

4.3.1 Determinants of registration

As a first attempt to model the decision to register a title, we run regressions of registration status on a number of plot and household characteristics, including type of title, as well as geographic (municipal) dummies. This corresponds to the “first stage” regression of the instrumental variables estimator if it is viewed as a two-stage least squares estimator⁴⁶.

For comparison purposes, we also present results from a regression omitting document type but including dummies for the mode of access, as used, among others, by Besley (1995): the categories are inheritance (omitted), purchase, squatting, donation and land reform. Results are presented in Table [12]. All regressions share the same set of covariates of the baseline specification.

Regarding the mode of acquisition, registration is more likely if the plot was bought, inherited or acquired through land reform and less likely if it was acquired through donation or squatted⁴⁷. Overall mode of access is not a very good predictor of registration (the R-squared – including municipal dummies – is 0.25). One reason for this is that what matters is the level of formalisation. For example a sale can be carried out privately or publicly and this will lead to different transfer deeds which impacts on the possibility of registration.

Results regarding title type are as expected: registration is more likely with a public deed than with any other type of title, including an agrarian reform title (the difference is quantitatively important and significant at better than the 1% level), then with agrarian reform titles (either provisional or definitive) and finally with other types of title⁴⁸. On the whole, agrarian reform beneficiaries are less likely to register their rights than are recent buyers.

Surprisingly, apart from plot area, factors that influence the value of the land such as topography, and that we could therefore expect to increase demand for registration, do not increase the probability of registration status⁴⁹. A greater degree of literacy or education increases the chances of registration, which is a relatively heavy bureaucratic process, and so does being close to a market. This is taken as evidence that the opportunity cost of carrying out the procedure is relevant, if we assume that the distance to the local market or wholesaler is indicative of the distance to government institutions.

⁴⁵The J statistic is numerically identical to the Sargan statistic under conditional homoskedasticity but the latter is not valid for an IV regression if this assumption is violated, see Baum, Schaffer and Stillman (2003).

⁴⁶In the presence of heteroskedasticity the 2SLS estimator is less efficient (asymptotically) than its GMM counterpart, which takes into account the structure of the variance-covariance matrix in estimation, rather than just in the calculation of standard errors.

⁴⁷The “other” category includes especially non-legalised donations and cooperatives. Donations are the legal figure of choice for dismembering cooperatives as they do not require a transaction and reduce legal costs.

⁴⁸Indigenous community titles are excluded in these regressions.

⁴⁹The inclusion of land-use dummies shows that land used for perennial cultures is more likely to be registered. However these variables are very likely to be endogenous and are omitted.

Finally, wealth variables are not strong determinants of registration status and are therefore not reported. An optimistic interpretation of this finding would be that wealth constraints are not binding in registering titles once the cost of acquiring the title is taken into account. However this may also be a consequence of either the imperfect measurement of wealth, as most measures are self-reported, or of the fact that, since the cost of registration is for a large part fixed, wealth constraints are only important for lower income households, making the actual relationship non-linear, which would result in an underestimation of the importance of wealth.

From the perspective of the instrumental variable estimation of the investment equation, document types are important predictors of registration, and, subject to their conforming to the orthogonality conditions, appear to be good instrument candidates.

Results concerning individual documents are similar when we consider documents at acquisition, with the exception of agrarian reform titles. The effect of the titling and registration programme was expected to show on the interaction terms since having no title but being an agrarian reform beneficiary should make the individual eligible for titling, this in turn should facilitate registration. The lack of significance of the coefficient on that term casts some doubts on the power of our preferred instrument set to effectively predict programme participation and, therefore, title change. Overall, the first stage with the second set of instruments is much weaker than with current documents.

4.3.2 Instrumental variables estimates

Table [13] reports instrumental variables estimates of the investment equation for the first set of instruments. All estimates in this table are of the mean-differenced model (with means taken at the municipal level) and are therefore within municipality estimators.

Because our instruments are dummy variables, the instrumental variables estimates rely on the variation between the groups described by the instruments⁵⁰. We view our instruments as essentially determining the cost of registration for a given net benefit from investment. The coefficient therefore measures the impact of opportunity to register and is identified by variation between holders of different documents.

If, for every type of document, the decision to register depended on the prospect of future (or current) investment, the coefficient from the instrumental variable estimation would be lower than the OLS coefficient.

Column (1) reports the OLS results, while column (2) reports two-stage least squares results, column (3) reports 2SLS results with robust variance-covariance and column (4) reports the asymptotically efficient cluster-heteroskedasticity consistent GMM estimator.

The instruments are found to be orthogonal to estimation errors as we can never reject the null in a test of overidentifying restrictions even when taking into account potential error correlations within municipalities. Overall results are not greatly affected by instrumenting and the point estimate is actually larger. In fact a Durbin-Wu-Hausman test between the estimates in columns (1) and (2) cannot reject exogeneity of the registration variable, or in other words, reject that the OLS specification is correct, and therefore, more efficient. The effect of registration is therefore estimated to be of the order of 5% according to the first set of instruments.

Results for the alternative set of instruments are presented in table [14]. Results are somewhat mixed, as only the last estimator finds a significant effect of registration⁵¹. The point estimate is not affected, but the coefficient is not precisely estimated and is not found to be significantly different from zero.

⁵⁰It is indeed an efficient linear combination of pairwise between estimator, as pointed out, for example, by Angrist (1991)

⁵¹This estimator suffers from potential problems because it involves municipal mean-differencing, along with the use of an estimated clustered variance-covariance matrix at the same level to form the weighting matrix.

The lack of explanatory power of the second set of instruments in the first stage is probably the cause of the lack of significance of these results. However, the difference between the two sets of instruments suggests that while current documents contain much of the information about tenure status that makes registration matter for the investment regression, this information is not contained in the tenure status at access. This means that we should exert care not to consider tenure regime or security as fixed or predetermined.

There remains one caveat about the estimates presented that cannot be easily lifted with the results presented. While we have made every effort to estimate the effect of registration taking into account the possible endogeneity of the titling or registration decision, our estimates rely on the randomness of the distribution of titles with respect to plot-level unobservable characteristics.

4.3.3 Matching estimates of the effects of registration

The structure of the data (see appendix A) lends itself to the treatment of the titling programme and subsequent registration with the use of a control group. While the titling sub-sample was selected among beneficiaries, the particular political objectives of the programme meant that plots with insecure tenure may not have received titles, in particular of households who had not benefited from the land reform and which, while they were originally intended to benefit from the titling programme, were in practice excluded from it for the larger part due to procedural problems.

Table [15] provides propensity score matching estimates of the association between registration and investment. The matching method is kernel matching, and the propensity score is calculated with the covariates used for the baseline model, as well as for these augmented by the set of documents at acquisition of land and the mode of access to land for those plots not having a document at the time of acquisition. Estimates are presented for both models with and without municipal fixed effects in the propensity score function. The pseudo-R squared from the estimation of the propensity to register is reported as a measure of goodness of fit, and bias-corrected confidence intervals are reported.

The estimated average effects of the ‘treatment’ (registration) on the treated are consistent with our findings in parametric specifications, and actually lie on the upper end of the range described by the coefficient during the robustness tests.

Matching estimates of the effects of registration rely on the included observables to control for the endogenous variation on the observed registration status. To the extent that plot level unobservables lead registration, these estimates will be biased (they would be in particular biased upwards if higher quality land is more likely to be registered and receive investment).

5 Credit effects

Since the seminal contribution of Feder et al. (1988) who found credit supply effects to be the main mechanisms through which benefits of land titling came about in Thailand, titling and registration interventions have often been justified on credit access grounds. As has been seen earlier, these effects are neither a necessary condition for benefits, in the sense that security on its own may well be enough to increase investment and private returns, nor a sufficient condition, insofar as it is not obvious in many situations that access to capital is the main constraint faced by farmers. Other factors, such as access to technology or markets (Carter et al., 1994) may well be more important.

Moreover, given the lack of penetration of formal financial institutions in rural Nicaragua, many farmers may not have access to formal credit regardless of their formal ownership status as they are not wealthy enough to be considered profitable customers. Although the main focus of her paper is the distribution of land property rights as opposed to their definition, Bandiera (2002) finds that the wealth of farmers matters for the choice of crops when the farmer owns the land, which can be interpreted as the evidence indicative of credit rationing.

5.1 Characteristics of credit transactions

An examination of recorded credit transactions (table [16]) shows that titled land is the single most common form of collateral, as it is the form of collateral of choice in 35% of the recorded credit transactions and 60% of the transactions with formal financial intermediaries. Second and third in the list are the harvest (although this is due to semiformal and informal transactions, which is in line with a moral hazard problem either in production or in repayment incentives) and cattle. In the 2000 sample, 35% of credit transactions are secured by land, 20% by harvest and 12% by cattle. The percentages are 60%, 7% and 12% in the formal supervised sector. On the other hand, very few credit transactions are secured with untitled land (2% of transactions in the sample).

We can also notice that the length of credit depends on the source, with formal intermediaries granting mostly long-term (over 60% of loans have maturity of one year or more) credit while semiformal sources grant 57% of total loans over six months or less and less than 10% of loans with maturity of more than one year. The largest contributors (in terms of number of loans) in the semiformal sector are NGO or assistance projects and government programmes. This is important in the interpretation of a possible causal effect between land titles and investment because short-term credit (6 months and less) is more likely to be used as working capital for the purchase of inputs. Use of more or better inputs, such as seeds or fertilizer would in turn increase the return from land attached investment and land improvements. However if credit is the constraint limiting those investments, the availability of working capital will not be enough to satisfy credit needs.

Moreover, the use of land as collateral for long-term credit is restricted to private banks and to some development projects.

Credit use, especially from formal banks, is low in the sample, with only 4.2% of households receiving credit from formal, regulated sources. However, this does not preclude the existence of an important credit effect. Indeed, 28% of households use some form of credit, most from the unregulated formal sector and as can be seen in table [18], titled land is also used as a guarantee by unregulated institutions, while untitled land almost never is.

Overall, however, credit rationing does not seem to be the main constraint faced by farmers. Just under 50% of respondents say they would get credit from a regulated formal institution if they requested it, while 62% say they would get credit from an unregulated formal institution. The lack of credit use seems to be caused by the lack of investment opportunities that justify the rates charged by lending institutions or the risk of losing the collateral rather than by non-price rationing.

5.2 A test of the credit effect

As discussed, among others, by Besley (1995), if property rights bring about benefits via better access to credit markets, this effect will be household rather than plot-specific. This is because if the effect of registration is to increase the collateral value of the land, the household will still be able to choose what the extra available funds are used for. We can therefore test for credit effects by adding to the baseline regression a variable that measures the legal status of *other* plots held by the household.

Registration rather than ownership is taken as the main determinant of credit availability because mortgages need to be registered, therefore registration is a precondition for the use of land as collateral in a formal credit agreement. Moreover, we also consider the possibility that the effect of other plots' status depend on the considered plot's registration status by including an interaction term.

Two variables are used for this purpose: total land registered other than the plot and a dummy variable indicating whether there are other registered plots. Area would determine the price of the other plots and hence their collateral value, therefore it measures the increase in credit ration – if the household is credit-rationed. The dummy variable treats as identical all other plots if they are registered, and therefore will test whether there is investment displacement, given that the cost of the investments studied is independent of plot area for the large part.

The studied specification is the following

$$\Delta I_p = \beta_1 R_p + \beta_2 R_{-p} + \beta_3 R_p * R_{-p} + \delta \mathbf{X}_p + \varepsilon_{p,h,t} \quad (3)$$

Where R_p and R_{-p} represent the variables describing own and other plots respectively, \mathbf{X} represents all controls (time and household indexes have been omitted).

A pure credit effect would increase total investment, so that $\beta_2 > 0$ and $\beta_3 = 0$ (if only the sum of registration status or average registration matters).

A pure security effect would increase investment in any plot that is registered. If total investment is not otherwise constrained, this would imply $\beta_1 > 0, \beta_2 = 0$ and $\beta_3 = 0$. However, if total investment is fixed and an increase in security leads to an increase in investment in the plot with increased security, that would lead to $\beta_1 > 0, \beta_2 < 0$ and $\beta_1 + \beta_2 + \beta_3 = 0$, that is, if all plots are registered, there is no increase in investment.

Results are presented in Table [17], where columns (1) and (2) present results for other registered area and columns (3) and (4) present results using a dummy variable for other plots' registration.

While the coefficient on the variable based on area is not significantly different from when entered on its own, it is negative and significant when the interaction term is entered and has the same magnitude as the interaction term (a Wald test cannot reject that the sum is zero). Therefore there is no evidence of a credit effect from this specification: when a plot is not registered, registering another plot will tend to *decrease* investment; if a plot is registered, the area of other plots registered does not matter for investment.

The coefficient of the dummy variable when entered on its own is negative and significant and the size of the coefficient is independent of the studied plot's registration status as shown from the lack of significance of the interaction term.

Overall, results are somewhat mixed as to whether the effect of registering all plots is positive or zero. They do suggest that the effect of having another plot registered is that of displacing investment away from the studied plot and towards the other registered plot. There is, according to this test, no evidence of a credit link at work.

6 Conclusion

The evidence presented from a programme of land titling in Nicaragua suggests that land titling significantly increased land-attached investments. The absence of evidence of enhanced access to formal credit, in turn, leads us to conclude that the intervention had the effect of increasing security and that this was the main channel through which it provided benefits. The ability to observe households with multiple plots allows us to examine this channel in depth without fear of contamination by the presence of unobserved household characteristics.

We can conclude that the legal status of ownership matters for economic outcomes. In particular, beyond the perceived security granted by titles themselves, registration was found to have significant effects on land-attached investments. This is remarkable because it corresponds to differences in the (theoretical) legal protection of property rights in a society that questions openly its judicial system, where the legal edifice that underpins property rights over land is complex and often exhibits contradictory propositions, and where we would not necessarily expect producers to have a high level of legal sophistication.

We find, however, no clear indicative evidence of a credit supply link. This is not surprising given the macroeconomic conditions in Nicaragua during the period of study, in particular the application of a structural adjustment programme with the consequence of severe credit tightening (and the disappearance of several major banks, including the public development bank). Our evidence points rather to a reallocation of investment towards more secure land.

Results on the possible endogeneity of legal ownership status are mixed but they do suggest that careful attention should be paid to the evolution of legal rights. While the need to study the determinants of *de facto* property rights has been recognised in the literature, our results suggest that agents endeavour to have their rights recognised legally and that tenure forms cannot be taken as given. On the one hand, this suggests that even in situations where the legal framework is mistrusted, legal rights have value and it would be hasty to conclude that titling and registration interventions have no positive effects. On the other hand, it also means that descriptions of legal status at one point in time may not be sufficient to describe future tenure security in environments where the property regime is changing. In those situations, the determinants of the perceived validity of legal protection of property rights deserve more careful attention as they ultimately underpin the property rights system itself.

Finally, all local factors have been taken as given in this study, as in most of the literature. While the need to study the determinants of individual property rights has been recognised before, the importance of local property rights regimes means that the determinants of local arrangements also deserve further attention.

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A Data

The main data source is the *Estudio de las Dinámicas de la Economía Rural* (Study of Rural Economy Dynamics), a survey conducted by the World Bank, the University of Wisconsin and FIDEG, a local NGO between February and April 2000. The sample is constructed from three different sub-samples, whose construction is described here.

The main sub-sample was constructed for a household survey carried out in 1996 by the Ministry of Agriculture (MAGFOR) and the FAO with assistance from USAID. The sample design for this survey was realised in two phases. The first phase is the method used by MAGFOR for their Agriculture and Production surveys. Each department is stratified according to the intensity of cultivation and an area-representative sample is selected using an area sample frame⁵² to yield a sample of 5600 producer units. The sample covers all departments except for the two Atlantic regions. Of those, a portion of RAAS (the western agricultural frontier) is included and only occasional observations of RAAN are included due to border issues. The household sample was selected as a second-phase sample from the 1996 Postrera/Apante survey⁵³ using the inverse of the probability of selection in the first sampling stage as the set of sampling weights except for non-agricultural land and large farms (more than 500 manzanas), which were excluded, and small farms (less than 5 manzanas), which were all included. The resulting sample can be considered a random sample of farms and comprises 1357 households.⁵⁴

The second sub-sample consists of producers having benefited from the governmental titling programme between 1994 and 1997 and the sample was constructed using the official database of beneficiaries as a sample frame. It only covers 8 of the country's 16 departments, 3 in the Pacific region (León, Chinandega and Rivas), 3 in the Northern region (Nueva Segovia, Jinotega and Matagalpa) and 2 in the Central region (Chontales and Río San Juan). The choice of departments is best seen as a stratification of the sampling carried out in order to ensure that all relevant forms of cultivation are included. This sample comprised 458 households, which were actually found and interviewed⁵⁵.

A third sub-sample of 372 rural households with little or no land was sampled from a rural household panel surveyed by FIDEG in 1996.

Finally, 289 households, which were not part of the original sampled households, were found farming the land selected in the above three samples and were surveyed as well. This includes replacement households when the original sample households were not found as well as households found farming one of several plots farmed in 1996 by the original sample household.

⁵² An area frame sample is constructed by drawing a random set of points on topographic maps for each stratum. Thus, the probability of selection within a stratum is proportional to the size of the segment or farm.

⁵³ MAGFOR's *Encuesta de Granos Básicos* (Staple Grains survey) is repeated for each agricultural season.

⁵⁴ For the construction of the MAGFOR "Basic grains" sample see Garibay and Steiner (1998). For the construction of the MAGFOR/FAO sample, see Davis, Carletto and Sil (1997).

⁵⁵ This is the same sample used by Deininger and Chamorro (2004).

TABLE 1
Descriptive statistics: tenure type - Owned plots only

	Number of plots	Sample proportion (%)
		N=3214
Type of document held		
None	61	1.9
Certificate of possession	62	1.93
Private sale document	202	6.29
Provisional title	17	0.53
Public deed	1,884	58.64
Agrarian reform title	944	29.38
Communal title	14	0.44
Supplementary title	15	0.47
Judicial document	8	0.25
Indigenous title	6	0.19
Registration status		
Registered	2237	69.75
In process of registration	294	9.17
Not registered	676	21.08
Mode of access		
Inherited	720	22
Bought	1,759	54.73
Squatted	45	1.4
Donated	83	2.58
Agrarian Reform	592	18.42
Other access	15	0.47

TABLE 2
Description of fixed investments

	Installation present		Investment 1996-1999	
	Number of plots	Proportion of plots	Number of plots	Proportion of plots
Cattle-specific investments				
Farmyard	746	23.2%	189	5.9%
Hen run	70	2.2%	24	0.7%
Farmyard (poultry)	13	0.4%	8	0.2%
Pigsty	75	2.3%	33	1.0%
Basin	252	7.8%	57	1.8%
Anti-tick basin	14	0.4%	4	0.1%
Stable/shed	16	0.5%	6	0.2%
Fodder silo	12	0.4%	0	
Cattle-specific investment	902	28.1%	282	8.8%
Non cattle-specific investments				
Depulping facility	129	4.0%	24	0.7%
Packaging facility	1	0.0%	0	
“Beneficio”*	48	1.5%	13	0.4%
Mill	57	1.8%	10	0.3%
Warehouse	108	3.4%	30	0.9%
Grain Silo	98	3.0%	41	1.3%
Oven	71	2.2%	14	0.4%
Drying yard	20	0.6%	7	0.2%
Shed	36	1.1%	18	0.6%
Irrigation well	18	0.6%	7	0.2%
Dykes or ditches	22	0.7%	4	0.1%
Irrigation pivot	3	0.1%	0	
Non-cattle specific investment	409	12.7%	138	4.3%
Fixed investment dummy	1090	33.9%	375	11.7%

Note: A “beneficio” is the set of facilities used to clean, dry and roast coffee or cocoa.

TABLE 3
Linear probability model: ownership documents only

Dependent variable: Fixed Investment 96-99 (dummy)				
	(1)	(2)	(3)	(4)
Registered	0.034 (2.35)*	0.032 (2.49)*	0.043 (3.53)**	
Registered public deed				0.055 (2.44)*
Registered agrarian reform title				0.041 (2.49)*
Certificate of possession	-0.015 (0.26)	-0.025 (0.42)	-0.009 (0.14)	0.005 (0.08)
Private sale document	0.044 (0.94)	0.032 (1.00)	0.024 (0.61)	0.023 (0.59)
Provisional title	-0.042 (0.47)	-0.063 (1.82)+	-0.024 (0.75)	-0.004 (0.11)
Public deed	0.029 (0.65)	0.022 (0.53)	0.030 (0.70)	0.017 (0.37)
Agrarian reform title	-0.030 (0.69)	-0.022 (0.55)	-0.007 (0.17)	-0.008 (0.19)
Communal title	-0.021 (0.22)	-0.008 (0.10)	-0.006 (0.06)	-0.090 (1.56)
Supplementary title	0.037 (0.40)	0.036 (0.37)	0.084 (0.83)	0.095 (0.82)
Judicial document	-0.082 (0.69)	-0.072 (1.87)+	-0.127 (1.69)+	-0.124 (1.64)
Indigenous title	-0.082 (0.60)	-0.034 (0.91)	-0.117 (2.81)**	-0.119 (2.88)**
Constant	0.082 (1.98)*	0.086 (2.32)*	0.070 (1.84)+	0.072 (1.91)+
Fixed effects	no	region	municipal	municipal
Observations	3213	3206	3206	3206
R-squared	0.01	0.03	0.08	0.08

Absolute value of t statistics in brackets

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

All regressions except (1) with standard errors clustered at municipal level (2) includes region fixed effects (3) and (4) include municipal fixed effects.

TABLE 4
Linear probability model: ownership documents and date of document/acquisition

Dependent variable: Fixed Investment 96-99 (dummy)	Date of document		Date of acquisition	
	(1)	(2)	(3)	(4)
Registered	0.048 (1.93)+	0.047 (1.93)+	0.051 (4.04)**	0.051 (4.00)**
Agrarian reform title received after 1990	-0.028 (0.97)	-0.021 (0.74)		
Document received after 1990	0.043 (2.17)*	0.031 (1.37)		
Length of possession (years)		-0.001 (0.80)	-0.000 (0.14)	-0.000 (0.25)
Plot acquired after 1990			0.042 (1.95)+	0.037 (2.04)*
Plot acquired through land reform			-0.002 (0.12)	
Plot acquired through land reform after 1990			-0.027 (0.86)	
Certificate of possession	0.150 (1.10)	0.158 (1.15)	-0.014 (0.22)	-0.011 (0.18)
Private sale document	0.237 (1.76)+	0.243 (1.77)+	0.013 (0.33)	0.016 (0.41)
Provisional title	0.244 (1.42)	0.248 (1.41)	-0.037 (1.11)	-0.033 (0.98)
Public deed	0.252 (1.91)+	0.259 (1.93)+	0.019 (0.44)	0.023 (0.53)
Agrarian reform title	0.224 (1.73)+	0.228 (1.72)+	-0.010 (0.23)	-0.014 (0.31)
Communal title	0.271 (1.48)	0.279 (1.51)	0.001 (0.01)	-0.009 (0.10)
Supplementary title	0.323 (1.92)+	0.333 (1.96)*	0.082 (0.84)	0.083 (0.84)
Judicial document	0.063 (0.36)	0.071 (0.38)	-0.129 (1.77)+	-0.127 (1.76)+
Indigenous title	0.105 (0.79)	0.111 (0.81)	-0.117 (2.53)*	-0.114 (2.49)*
Constant	-0.177 (1.32)	-0.168 (1.20)	0.058 (1.24)	0.058 (1.27)
Observations	2384	2384	3206	3206
R-squared	0.09	0.09	0.08	0.08

Robust t statistics in parentheses

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

All regressions with standard errors clustered at municipal level and municipal fixed effects.

TABLE 5
Linear probability model: Plot and household controls

Dependent variable: Fixed Investment 96-99 (dummy)	Baseline model			
	(1)	(2)	(3)	(4)
Registered	0.051 (4.57)**	0.051 (4.67)**	0.046 (4.47)**	0.047 (4.57)**
Plot acquired after 1990	0.045 (2.52)*	0.038 (2.09)*	0.036 (1.93)+	0.039 (2.07)*
Length of possession (years)	-0.000 (0.26)	0.000 (0.55)	0.000 (0.48)	0.001 (0.64)
Area	0.005 (2.48)*	0.005 (2.35)*	0.005 (2.54)*	0.006 (2.95)**
Square of area	-0.000 (1.44)	-0.000 (1.40)	-0.000 (1.71)+	-0.000 (2.14)*
Distance	-0.000 (0.06)	-0.000 (0.35)	-0.000 (0.35)	-0.000 (0.15)
Investment in 1990	0.007 (0.69)	0.005 (0.45)	0.005 (0.46)	0.005 (0.46)
Hilly	0.027 (1.43)	0.027 (1.45)	0.026 (1.42)	0.026 (1.44)
Sheer face	0.001 (0.05)	0.005 (0.28)	0.007 (0.38)	0.003 (0.17)
Slope	0.010 (0.42)	0.013 (0.54)	0.013 (0.53)	0.012 (0.51)
Other topography	-0.030 (0.38)	-0.026 (0.33)	-0.021 (0.25)	-0.029 (0.35)
FIDEG sample		-0.035 (0.88)	-0.042 (0.99)	-0.042 (0.98)
Titling sample		0.006 (0.30)	0.010 (0.52)	0.013 (0.71)
Follow-up sample		0.051 (2.65)**	0.046 (2.40)*	0.046 (2.40)*
Males over 12		-0.006 (1.45)	-0.006 (1.55)	-0.006 (1.44)
Females over 12		0.003 (0.59)	0.004 (0.82)	0.004 (0.83)
One literate in household		0.043 (2.01)*	0.045 (2.30)*	0.044 (2.22)*
Distance to wholesaler			0.000 (0.02)	-0.000 (0.07)
Distance to paved road			-0.001 (2.02)*	-0.001 (2.20)*
Had a TV in 96				-0.032 (2.60)**
Constant	0.035 (1.56)	0.049 (0.58)	0.083 (0.99)	0.090 (1.05)
Observations	3197	3197	3140	3140
R-squared	0.09	0.10	0.10	0.10

Robust t statistics in brackets

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

All regressions with standard errors clustered at municipal level

Note: OLS regressions. All regressions with municipal fixed effects. Household controls: subsample dummies, age of head, age of head squared, female head, education of head, males over 12, females over 12, literacy (at least one literate in household), TV ownership in 1996, radio ownership in 1996, other property (non-agricultural), dwelling with earth floor, distance to wholesaler. Plot controls: dummies for topographical characteristics (hilly, sloping, sheer face in plot).

TABLE 6
Linear probability model: Plot and household controls

Dependent variable: Fixed Investment 96-99 (dummy)	Baseline model	
	(1)	(2)
Registered	0.047 (4.57)**	0.044 (4.08)**
Plot acquired after 1990	0.039 (2.07)*	0.038 (2.04)*
Length of possession (years)	0.001 (0.64)	0.001 (1.09)
Area	0.006 (2.95)**	0.007 (3.83)**
Square of area	-0.000 (2.14)*	-0.000 (3.27)**
Distance	-0.000 (0.15)	-0.000 (0.23)
Investment in 1990	0.005 (0.46)	0.005 (0.50)
One literate in household	0.044 (2.22)*	0.050 (2.55)*
Distance to paved road	-0.001 (2.20)*	-0.000 (1.61)
Agricultural machinery 1990 (C\$ million)	0.005 (0.78)	0.002 (0.37)
Had a TV in 96	-0.032 (2.60)**	-0.030 (2.40)*
Has non-agricultural land		-0.012 (0.65)
Value of cattle (C\$ million)		0.164 (5.59)**
non-agricultural capital (C\$ million)		0.051 (7.01)**
Total area owned individually in 1990		-0.003 (5.35)**
Parents owned land (area)	-0.001 (1.21)	
Constant	0.090 (1.05)	0.072 (0.86)
Observations	3140	3106
R-squared	0.10	0.12

Robust t statistics in brackets

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

All regressions with standard errors clustered at municipal level

Note: OLS regressions. All regressions with municipal fixed effects. Household controls and plot controls as described. Wealth controls include TV ownership in 96, radio ownership in 96, dwelling with earth floor, capital owned, land owned in 1990.

TABLE 7
Linear probability model: Plots by main use

Dependent variable:	Fixed Investment 96-99 Plots with Seasonals	Fixed Investment 96-99 Plots with Perennials	Fixed Investment 96-99 Pasture plots	Non-cattle specific investments Plots with Perennials	Cattle-specific investments Pasture plots
Registered	0.047 (3.00)**	0.041 (0.97)	0.057 (2.28)*	0.060 (1.90)+	0.047 (2.18)*
Plot acquired after 1990	0.035 (1.33)	-0.034 (0.42)	0.070 (1.79)+	-0.006 (0.08)	0.090 (2.94)**
Length of possession	0.001 (0.93)	-0.000 (0.01)	0.001 (0.30)	0.001 (0.30)	0.001 (0.49)
Area	0.016 (2.71)**	0.033 (1.12)	0.006 (2.73)**	0.015 (0.62)	0.004 (1.72)+
Distance	-0.000 (0.31)	-0.001 (0.37)	0.000 (0.27)	-0.001 (1.09)	0.000 (0.11)
Investment in 1990	0.004 (0.42)	-0.033 (1.73)+	-0.001 (0.02)	-0.017 (0.85)	-0.009 (0.48)
One literate in household	0.052 (2.09)*	0.070 (1.10)	-0.062 (0.83)	0.073 (1.33)	-0.034 (0.51)
Distance to paved road	-0.001 (2.57)*	0.000 (0.28)	-0.001 (1.60)	0.000 (0.41)	-0.001 (2.18)*
Agricultural machinery (1990)	0.006 (0.61)	-0.076 (0.94)	0.007 (2.25)*	-0.062 (0.34)	0.010 (1.79)+
Other controls (Plots and household)	Yes	Yes	Yes	Yes	Yes
Observations	1625	359	1062	359	1062
R-squared	0.13	0.29	0.16	0.28	0.18

Robust t statistics in brackets

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

Note: OLS regressions. All regressions with standard errors clustered at municipal level. All regressions with municipal fixed effects. Household controls and plot controls as described. Wealth controls include TV ownership in 96, radio ownership in 96, dwelling with earth floor, capital owned, land owned in 1990.

TABLE 8
Linear probability model: Different types of investment - regressions according to cattle ownership

Dependent variable:	Non-cattle specific investments Households with no cattle	Cattle-specific investments All households	Cattle specific investment dummy Households with cattle
Registered	0.023 (2.06)*	0.025 (2.64)**	0.036 (2.52)*
Plot acquired after 1990	-0.004 (0.16)	0.036 (2.60)**	0.049 (2.86)**
Length of possession (years)	-0.000 (0.11)	0.000 (0.01)	0.000 (0.13)
Area	0.034 (2.72)**	0.003 (1.80)+	0.003 (1.37)
Distance	-0.001 (1.55)	-0.000 (0.11)	-0.000 (0.09)
Investment in 1990	-0.017 (1.86)+	-0.002 (0.29)	-0.003 (0.30)
Distance to wholesaler	-0.001 (2.77)**	0.000 (0.61)	0.000 (0.52)
Distance to paved road	-0.001 (3.47)**	-0.000 (1.37)	-0.001 (1.56)
Agricultural machinery 1990 (C\$ millions)	0.005 (1.72)+	0.006 (1.14)	0.009 (0.83)
Constant	-0.072 (1.00)	0.082 (0.92)	0.153 (1.19)
Plot controls	Yes	Yes	Yes
Household composition	Yes	Yes	Yes
Household asset controls	Yes	Yes	Yes
Observations	766	3140	2374
R-squared	0.25	0.10	0.12

Robust t statistics in parentheses

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

Note: OLS regressions. All regressions with standard errors clustered at municipal level. All regressions with municipal fixed effects. Household controls and plot controls as described. Wealth controls include TV ownership in 96, radio ownership in 96, dwelling with earth floor, capital owned, land owned in 1990.

TABLE 9
Intrahousehold variation in investment and registration

	Number of plots	Number of households
Registration		
All plots in household	1906	1336
None	612	466
Some but not all	691	224
Investment		
All plots in household	200	188
None	2560	1681
Some but not all	454	157
Variation in registration and investment	176	52
Total	3209	2026

TABLE 10
Linear probability model: household fixed effects

Dependent variable: Fixed Investment 96-99 (dummy) Sample: households with more than one plot	Household controls	Household fixed effects	Household fixed effects	Household fixed effects
	(1)	(2)	(3)	(4)
Registered	0.047 (4.27)**	0.067 (2.69)**	0.062 (1.90)+	0.061 (1.88)+
Plot acquired through land reform				-0.071 (2.04)*
Bought				-0.031 (0.88)
Plot acquired after 1990	0.025 (1.00)	0.037 (1.17)	0.037 (0.87)	0.031 (0.73)
Length of possession (years)	0.001 (0.66)	0.002 (1.61)	0.003 (1.11)	0.002 (0.94)
Area	0.004 (1.97)*	0.006 (2.34)*	0.006 (1.64)	0.006 (1.65)+
Square of area	-0.000 (1.06)	-0.000 (1.77)+	-0.000 (1.46)	-0.000 (1.46)
Distance	0.000 (0.94)	-0.000 (0.12)	-0.000 (0.13)	-0.000 (0.06)
Investment in 1990	0.008 (0.51)	0.024 (1.81)+	0.023 (1.07)	0.023 (1.08)
Distance to paved road	-0.001 (2.00)*			
Agricultural machinery 1990 (million CS)	-0.002 (0.65)			
Had a TV in 96	-0.038 (2.33)*			
Dwelling floor earth	-0.030 (1.57)			
Parents owned land (area)	-0.001 (1.07)			
Fixed effects	municipal	household	household	household
Constant	0.065 (0.57)	-0.018 (0.46)	-0.015 (0.24)	0.026 (0.39)
Observations	1894	1894	1916	1916
R-squared	0.15	0.46	0.47	0.47

Robust t statistics in brackets

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

Note: OLS regressions. (1) with municipal fixed effects and errors robust to intra-municipal error correlation, controls for age of head, age of head squared, female head, education of head, males over 12, females over 12, literacy (at least one literate in household), TV ownership, radio ownership, other property, dwelling with earth floor. (2) to (4) with household fixed effects. (2) with robust standard errors. (3) and (4) with cluster effects-robust standard errors. All include dummies for topographical characteristics (hilly, sloping, sheer face in plot).

TABLE 11
Investment Linear probability model: Legalized plots

Dependent variable: Fixed Investment 96-99 Sample: Legalized plots only	(1) Household controls	(2) Household fixed effects
Correctly registered	0.047 (1.86)+	0.105 (4.39)**
Plot acquired through land reform	-0.029 (0.74)	-0.120 (2.81)**
Bought	0.055 (1.23)	0.177 (0.74)
Plot acquired after 1990	0.022 (0.45)	0.076 (0.91)
Length of possession (years)	-0.000 (0.08)	0.005 (0.64)
Area	0.020 (1.59)	-0.020 (0.45)
Square of area	0.000 (0.45)	0.004 (0.60)
Distance	0.000 (0.75)	-0.001 (0.20)
Investment in 1990	-0.002 (0.06)	0.017 (0.31)
Constant	0.083 (0.54)	-0.090 (0.41)
Household controls	Yes	.
Observations	534	267
R-squared	0.24	0.63

Robust t statistics in parentheses

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

All regressions with standard errors clustered at municipal level

Note: Regressions only for legalized plots. Column (1) includes controls also for age of head, age of head squared, education of head, presence of one literate person in household, TV and radio ownership, whether the dwelling has a soil floor. Column (2) includes household fixed effects.

TABLE 12
First stage regressions of registration status

Dependent variable: plot is registered	Mode of access (1)	Current document (2)	Document at acquisition Augmented (3) (4)	
Mode of access:				
Bought	0.006 (0.23)			
Squatted	-0.476 (4.60)**			
Donated	-0.256 (3.89)**			
Agrarian Reform	-0.039 (0.86)			
Other access	-0.214 (1.39)			
Document type:				
Certificate of possession		0.230 (3.53)**	0.035 (0.61)	-0.029 (0.41)
Private sale document		-0.051 (0.91)	-0.115 (1.65)+	-0.181 (2.40)*
Provisional title		0.440 (2.85)**	0.411 (4.51)**	0.348 (2.83)**
Public deed		0.707 (15.33)**	0.288 (6.05)**	0.220 (3.58)**
Agrarian reform title		0.485 (8.62)**	0.026 (0.44)	-0.039 (0.56)
Communal title		0.301 (2.26)*	0.078 (0.70)	0.006 (0.05)
Supplementary title		0.202 (1.26)	-0.024 (0.12)	-0.094 (0.48)
Judicial document		-0.206 (2.89)**	-0.732 (6.68)**	-0.802 (6.49)**
None * Bought				-0.115 (1.51)
None * Squatted				-0.527 (5.39)**
None * Donated				-0.234 (3.07)**
None * Land reform				0.009 (0.12)
None * Other access				-0.445 (2.10)*
Plot acquired after 1990	-0.026 (0.74)	-0.052 (1.41)	-0.046 (1.42)	-0.037 (1.20)
Length of possession (years)	0.004 (3.20)**	0.003 (2.21)*	0.004 (2.79)**	0.004 (3.40)**
Female Head	-0.030 (0.95)	-0.037 (1.31)	-0.059 (1.78)+	-0.064 (1.98)*
Education of Head	0.021 (3.17)**	0.015 (2.58)**	0.017 (2.42)*	0.017 (2.56)*
One literate in household	0.089 (2.10)*	0.089 (2.18)*	0.073 (1.82)+	0.080 (1.94)+
Distance to wholesaler	-0.001 (2.07)*	-0.001 (2.35)*	-0.001 (2.18)*	-0.001 (2.26)*
Constant	0.481 (4.18)**	-0.098 (0.81)	0.274 (2.30)*	0.341 (2.69)**
Observations	3133	3133	3133	3133
R-squared	0.25	0.41	0.31	0.32
Partial R-squared of instruments		0.23	0.10	0.11

Robust t statistics in parentheses

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

Note: OLS regressions. All with municipal fixed effects and standard errors robust to clustering at the municipal level. Other controls include topographical dummies, age of head, subsample fixed effects, number of adults males and females in the household, tv ownership, radio ownership, earth floor in dwelling.

TABLE 13
Investment - Instrumental Variables Results

Dependent variable: Fixed Investment 96-99	(1)	(2)	(3)	(4)
	Mean-differenced OLS	Mean differenced 2SLS	Mean differenced 2SLS, robust VarCov	Cluster- heteroskedasticity consistent GMM
Registered	0.047 (3.45)**	0.062 (2.22)*	0.062 (2.25)*	0.047 (1.86)+
Plot acquired after 1990	0.039 (2.23)*	0.039 (2.26)*	0.039 (2.12)*	0.033 (1.94)+
Length of possession	0.001 (0.70)	0.001 (0.62)	0.001 (0.58)	0.000 (0.36)
Area	0.005 (4.32)**	0.005 (4.21)**	0.005 (2.90)**	0.004 (2.74)**
Area squared	-0.000 (2.07)*	-0.000 (2.00)*	-0.000 (2.06)*	-0.000 (1.96)+
Distance	-0.000 (0.17)	-0.000 (0.17)	-0.000 (0.20)	0.000 (0.50)
Investment in 1990	0.005 (0.71)	0.005 (0.70)	0.005 (0.49)	-0.002 (0.22)
One literate in household	0.046 (1.72)+	0.044 (1.67)+	0.044 (2.33)*	0.039 (2.23)*
Distance to paved road	-0.000 (1.98)*	-0.000 (1.96)*	-0.000 (2.30)*	-0.001 (2.98)**
Agricultural machinery (1990)	0.004 (0.62)	0.005 (0.64)	0.005 (0.80)	0.008 (1.48)
Owned TV in 96	-0.032 (2.09)*	-0.033 (2.14)*	-0.033 (2.63)**	-0.036 (3.22)**
Dwelling with earth floor	-0.021 (1.59)	-0.021 (1.57)	-0.021 (1.62)	-0.024 (2.04)*
Parents owned area	-0.001 (1.82)+	-0.001 (1.83)+	-0.001 (1.22)	-0.001 (1.01)
Constant	0.008 (1.39)	0.008 (1.40)	0.008 (3.66)**	0.009 (4.31)**
Observations	3133	3133	3133	3133
R-squared	0.03			
Overid test statistic		Sargan = 6.483	Hansen J = 9.198	Hansen J = 9.198
P-value		0.485	0.239	0.239

Robust t statistics in parentheses

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

Note: all regressions include controls for age of head, female head, education of head, tv and radio ownership as well as dummies for topographical characteristics (hilly, sloping, sheer face in plot) as described for the baseline specification.

TABLE 14
Investment - Instrumental Variables Results - Alternative Instrument set

Dependent variable: Fixed Investment 96-99	(1) Mean-differenced 2SLS	(2) Mean-differenced 2SLS, robust VarCov	(3) Cluster- heteroskedasticity consistent GMM
Registered	0.050 (1.23)	0.050 (1.26)	0.076 (2.33)*
Plot acquired after 1990	0.039 (2.24)*	0.039 (2.13)*	0.025 (1.64)
Length of possession	0.001 (0.68)	0.001 (0.62)	-0.000 (0.12)
Area	0.005 (4.23)**	0.005 (2.92)**	0.005 (2.93)**
Area squared	-0.000 (2.04)*	-0.000 (2.15)*	-0.000 (2.18)*
Distance	-0.000 (0.17)	-0.000 (0.20)	0.000 (0.48)
Investment in 1990	0.005 (0.71)	0.005 (0.50)	0.002 (0.31)
One literate in household	0.045 (1.70)+	0.045 (2.29)*	0.033 (2.01)*
Distance to paved road	-0.000 (1.98)*	-0.000 (2.34)*	-0.001 (3.33)**
Agricultural machinery (1990)	0.005 (0.62)	0.005 (0.77)	0.007 (1.59)
Owned TV in 96	-0.032 (2.09)*	-0.032 (2.62)**	-0.036 (3.17)**
Dwelling with earth floor	-0.021 (1.59)	-0.021 (1.67)+	-0.026 (2.30)*
Parents owned area	-0.001 (1.83)+	-0.001 (1.22)	-0.000 (0.93)
Constant	0.008 (1.40)	0.008 (3.68)**	0.007 (4.62)**
Observations	3133	3133	3133
R-squared	0.04		
Overid test statistic	Sargan = 7.421	Hansen J = 7.582	Hansen J = 7.582
P-value	0.829	0.817	0.817

Robust t statistics in parentheses in (2) and (3). Absolute values of t statistics in (1)

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

Note: all regressions include controls for age of head, female head, education of head, tv and radio ownership as well as dummies for topographical characteristics (hilly, sloping, sheer face in plot) as described for the baseline specification.

TABLE 15

Propensity score matching estimates of the effect of registration on investment

Model covariates	N (Common support)	ATT	Bias-corrected 95% confidence interval*	Logit pseudo-R
Baseline model, no fixed effects	3,124	0.042	0.015	0.102
Baseline model, fixed effects	3,011	0.070	0.041	0.203
Augmented model	3,117	0.037	0.006	0.220
Augmented model, fixed effects	2,933	0.062	0.028	0.304
Unmatched	3207	0.046	P-value	0.000

*Bias-corrected confidence intervals calculated with N=200 bootstrap sample replications.

Type of collateral required, by credit source

	Formal		Total Formal	Semiformal (unregulated institutional credit)					Total semiformal
	Private Bank	Credit Cooperative		Producer cooperative	Informal bank	Caja rural	NGO or Project	Government program	
Titled land	51	13	64	13	15	5	32	4	69
Untitled land	5	0	5	1	0	0	1	0	2
Housing	4	5	9	7	3	4	2	2	18
Harvest	5	3	8	20	6	1	19	15	61
Cattle	6	7	13	11	4	2	15	0	32
Vehicles/machinery	2	0	2	2	2	0	0	0	4
Third party	0	1	1	3	3	0	8	12	26
Group guarantee	0	1	1	2	2	0	9	8	21
None	0	1	1	0	0	0	0	0	0
Other	2	1	3	1	7	0	16	3	27
Total	75	32	107	60	42	12	102	44	260

	Informal						total informal	Total
	Trade credit	Wholesaler	Money-lender	Other farmer	Family & Friends	Other		
Titled land	2	12	1	0	0	1	16	149
Untitled land	0	1	0	0	0	1	2	9
Housing	1	0	3	0	0	0	4	31
Harvest	1	15	0	1	1	0	18	87
Cattle	2	0	4	1	0	1	8	53
Vehicles/machinery	0	0	1	0	0	1	2	8
Third party	0	1	1	0	0	1	3	30
Group guarantee	1	0	0	0	0	0	1	23
None	0	0	0	0	0	0	0	1
Other	2	1	2	0	1	0	6	36
Total	9	30	12	2	2	5	60	427

TABLE 16

TABLE 17
Effect of other plots' registration status - credit effect test

Dependent variable: Fixed Investment 96-99	Other area		Other plots (dummy)	
	(1)	(2)	(3)	(4)
Registered	0.047 (4.57)**	0.042 (3.91)**	0.054 (5.13)**	0.058 (3.71)**
Other registered area	-0.000 (0.03)	-0.001 (3.33)**		
Registered x Other area registered		0.002 (4.15)**		
Other registered plots (d)			-0.061 (4.44)**	-0.054 (2.71)**
Registered x Other registered (d)				-0.011 (0.46)
Plot acquired after 1990	0.039 (2.07)*	0.039 (2.09)*	0.044 (2.27)*	0.044 (2.26)*
Length of possession (years)	0.001 (0.64)	0.001 (0.63)	0.001 (0.61)	0.001 (0.61)
Area	0.006 (2.95)**	0.005 (2.93)**	0.006 (2.97)**	0.006 (2.99)**
Investment in 1990	0.005 (0.46)	0.004 (0.43)	0.002 (0.23)	0.002 (0.23)
Plot and Household controls as in baseline model				
Constant	0.090 (1.05)	0.092 (1.07)	0.080 (0.94)	0.079 (0.94)
Observations	3140	3140	3140	3140
R-squared	0.10	0.10	0.11	0.11
P-value of test on other+interaction		0.686		0.000
P-value of test on register+other+interaction				0.684

Robust t statistics in parentheses

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

Note: all regressions include controls for age of head, female head, education of head, tv and radio ownership, parental owned area, area and area squared as well as dummies for topographical characteristics (hilly, sloping, sheer face in plot) as described for baseline specification.

TABLE A1
Household summary statistics

Number of households	WHOLE SAMPLE		MAGFOR		FIDEG		TITULACION		FOLLOW-UP	
	2475		1357		371		458		289	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Total area owned (mzs.)	46.65	(143.03)	57.08	(125.71)	2.21	(11.40)	26.97	(36.95)	85.91	(306.20)
registered	38.06	(135.94)	47.72	(113.95)	1.94	(10.89)	17.95	(30.48)	70.96	(303.53)
untitled	0.28	(3.97)	0.30	(4.88)	0.02	(0.24)	0.34	(2.88)	0.39	(3.10)
with escritura	34.57	(136.98)	46.89	(118.35)	1.87	(10.84)	4.19	(15.38)	66.82	(300.19)
with AR title	8.36	(32.37)	5.86	(32.06)	0.27	(3.70)	21.87	(34.53)	9.09	(43.00)
with provisional title	0.72	(11.96)	0.74	(11.69)	0.03	(0.24)	0.36	(2.90)	2.06	(23.88)
with informal title	0.64	(9.51)	0.94	(12.36)	0.03	(0.34)	0.12	(1.17)	0.84	(7.31)
Total value of land ('000 C\$)	101.48	(349.52)	132.89	(410.49)	5.44	(22.30)	59.92	(281.13)	143.17	(330.12)
Machinery value 1990 ('000 C\$)	35.30	(586)	56.67	(784)	0.14	(2)	14.88	(141)	12.51	(131)
Machinery value 1997 ('000 C\$)	32.32	(415)	49.76	(550)	0.31	(2)	16.45	(143)	16.72	(133)
Total savings ('000 C\$)	4.21	(21)	4.97	(22)	0.84	(2)	3.47	(24)	6.14	(25)
Non-agricultural capital ('000 C\$)	4.17	(102)	5.82	(137)	1.64	(11)	0.91	(5)	4.84	(22)
Value of cattle ('000 C\$)	44.03	(137)	55.00	(124)	3.20	(13)	17.62	(43)	86.84	(285)
Value of minor livestock ('000 C\$)	1.05	(2)	1.22	(2)	0.50	(1)	0.85	(1)	1.29	(2)
Literacy	0.64	(0.29)	0.67	(0.28)	0.65	(0.27)	0.54	(0.31)	0.68	(0.28)
Average age	27.81	(12.19)	29.79	(12.59)	24.85	(10.52)	25.45	(11.06)	26.03	(12.32)
Number of males over 12	2.35	(1.39)	2.50	(1.44)	2.12	(1.34)	2.16	(1.26)	2.20	(1.37)
Number of females over 12	2.07	(1.21)	2.17	(1.22)	2.05	(1.26)	1.89	(1.12)	1.90	(1.16)
Female head of household	0.12	(0.33)	0.12	(0.33)	0.15	(0.36)	0.12	(0.32)	0.11	(0.31)
TV ownership	0.34	(0.47)	0.35	(0.48)	0.40	(0.49)	0.26	(0.44)	0.38	(0.49)
Radio ownership	0.84	(0.36)	0.85	(0.35)	0.79	(0.41)	0.83	(0.38)	0.88	(0.32)
Ownership of other property	0.14	(0.35)	0.18	(0.38)	0.04	(0.19)	0.09	(0.29)	0.21	(0.41)
Housing with soil floor	0.63	(0.48)	0.57	(0.50)	0.68	(0.47)	0.78	(0.41)	0.57	(0.50)
Debt	1,163	(16,729)	1,199	(16,793)	66	(687)	1,397	(23,570)	2,033	(13,851)
Arrears dummy	0.02	(0.15)	0.02	(0.14)	0.01	(0.10)	0.03	(0.18)	0.02	(0.15)
Access to formal credit (subjective)	0.50	(0.50)	0.61	(0.49)	0.19	(0.39)	0.40	(0.49)	0.55	(0.50)
Access to semiformal credit (subjective)	0.62	(0.48)	0.72	(0.45)	0.31	(0.46)	0.56	(0.50)	0.71	(0.46)

TABLE A2
Plot level summary statistics (owned plots only)

N	WHOLE SAMPLE		MAGFOR		FIDEG		TITULACION		FOLLOW-UP	
	3212		1960		87		637		528	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Area	35.91	(84.94)	39.50	(73.46)	9.41	(20.31)	19.33	(28.66)	47.02	(149.15)
Distance from house	5.40	(26.40)	5.39	(29.27)	2.45	(6.00)	1.91	(4.72)	10.18	(31.51)
Time since acquisition	13.82	(11.24)	16.53	(11.74)	15.10	(11.43)	11.25	(8.74)	6.63	(7.48)
Bought (d)	0.55	(0.50)	0.57	(0.49)	0.51	(0.50)	0.29	(0.46)	0.79	(0.41)
No document	0.02	(0.13)	0.01	(0.12)	0.06	(0.24)	0.03	(0.17)	0.02	(0.13)
Certificate of possession	0.02	(0.14)	0.02	(0.14)	0.05	(0.21)	0.02	(0.12)	0.02	(0.14)
Private sale document	0.06	(0.24)	0.06	(0.23)	0.05	(0.21)	0.03	(0.17)	0.12	(0.32)
Provisional title	0.01	(0.07)	0.00	(0.06)	0.01	(0.11)	0.00	(0.07)	0.01	(0.11)
Public deed	0.59	(0.49)	0.76	(0.43)	0.70	(0.46)	0.12	(0.33)	0.50	(0.50)
Agrarian reform title	0.29	(0.46)	0.14	(0.34)	0.14	(0.35)	0.79	(0.41)	0.30	(0.46)
Communal title	0.00	(0.07)	0.00	(0.06)	0.00	(0.00)	0.01	(0.09)	0.01	(0.08)
Supplementary title	0.00	(0.07)	0.01	(0.07)	0.00	(0.00)	0.00	(0.04)	0.01	(0.08)
Registered	0.70	(0.46)	0.77	(0.42)	0.76	(0.43)	0.56	(0.50)	0.58	(0.49)
In registration process	0.09	(0.29)	0.04	(0.21)	0.09	(0.29)	0.22	(0.42)	0.11	(0.32)
Plot flat	0.35	(0.48)	0.30	(0.46)	0.56	(0.50)	0.45	(0.50)	0.41	(0.49)
Plot undulated	0.32	(0.46)	0.35	(0.48)	0.25	(0.44)	0.21	(0.41)	0.31	(0.46)
Plot hilly	0.26	(0.44)	0.29	(0.45)	0.09	(0.29)	0.25	(0.44)	0.22	(0.42)
Plot steep	0.06	(0.24)	0.05	(0.23)	0.09	(0.29)	0.09	(0.29)	0.05	(0.22)
Seasonal crops	0.45	(0.50)	0.44	(0.50)	0.43	(0.50)	0.59	(0.49)	0.35	(0.48)
Permanent crops	0.08	(0.26)	0.09	(0.29)	0.10	(0.31)	0.03	(0.17)	0.07	(0.26)
Pasture	0.29	(0.45)	0.31	(0.46)	0.13	(0.33)	0.16	(0.36)	0.40	(0.49)
Forest	0.02	(0.15)	0.01	(0.10)	0.03	(0.18)	0.05	(0.22)	0.03	(0.17)
Fallow	0.03	(0.16)	0.02	(0.15)	0.01	(0.11)	0.04	(0.19)	0.03	(0.17)
House plot	0.05	(0.22)	0.04	(0.19)	0.24	(0.43)	0.08	(0.26)	0.04	(0.19)
Fruit	0.00	(0.04)	0.00	(0.05)	0.00	(0.00)	0.00	(0.00)	0.00	(0.06)
Conflict (d)	0.02	(0.12)	0.01	(0.11)	0.03	(0.18)	0.03	(0.17)	0.01	(0.11)
Value (C\$)	81,341	(244,489)	96,183	(259,323)	27,285	(39,453)	43,837	(239,300)	80,656	(202,945)
Investment 90-99 (d)	0.17	(0.37)	0.19	(0.39)	0.02	(0.15)	0.16	(0.37)	0.21	(0.41)
Investment 96-99 (d)	0.10	(0.30)	0.11	(0.32)	0.01	(0.11)	0.07	(0.26)	0.16	(0.36)

TABLE A3
List of covariates in baseline specification and dependent variables

Variable	Description
Dependent variables	
Fixed investment 96-99	Dummy for investment carried out.
Fixed investment 96-99 (cattle)	" - cattle specific
Fixed investment 96-99 (non-cattle)	" - non cattle-specific
Plot level covariates	
Variables of interest	
Registered	Whether the title to the plot is in the Public Registry
Title type dummies	No title (omitted), certificate of possession , private document, provisional title, public deed, agrarian reform document, communal title, supplementary title, judicial document, indigenous peoples' title
Controls in Baseline specification	
Length of possession	Years since acquisition
Area	Area of plot (unit is 10 mzs.)
Square of area	Square of area of plot
Distance	Distance from dwelling to plot (km)
Investment in 1990	Summation of considered fixed investment in 1990
Topographical dummies	Flat (omitted), hilly, sheer face in plot, sloping, other
Plot acquired after 1990	Dummy. 1 if plot was acquired after the end of 1990
Household level controls	
Controls in Baseline specification	
Subsample dummies	MAGFOR(omitted) , FIDEG, Titling, Follow-up
Age of Head	in years
Age of Head squared	
Female Head	dummy for female head of household (self-declared)
Education of Head	Categorical variable: highest achieved schooling level
Males over 12	Number of males over 12
Females over 12	Number of females over 12
One literate in household	At least one person in the household can read and write (dummy)
Distance to wholesaler	Distance to nearest wholesaler (in km)
Distance to paved road	Distance to nearest paved road (in km)
Agricultural machinery 1990	Agricultural mobile capital owned in 1990 (in million C\$)
Had a TV in 96	Dummy variable
Had a radio in 96	Dummy variable
Dwelling floor earth	Dummy. 1 if the household dwelling's floor is earth/soil
Has non-agricultural land	Dummy. 1 if the household owns at least one non-agricultural property
Land owned by parents (area)	Area owned by parents of head at emancipation
Other variables used	
Value of cattle (C\$ million)	Value of owned cattle (million C\$)
non-agricultural capital (C\$ million)	Value of owned non-agricultural business assets (million C\$)
Total area owned individually in 1990	Agricultural land area owned in 1990 (excludes cooperative land)