

The Impact of Land Rights on Rural Investments - Evidence from Nicaragua

Abstract

While there is a general consensus that the security of property rights is a fundamental condition for the long run development of the agricultural sector in developing countries, there has been relatively little empirical analysis to date of the relationship between property rights and economic activity attached to land in Latin America. This thesis examines the impact of land rights on rural investments in Nicaragua. The country is of interest as its troubled history of land expropriation and lack of enforcement of property rights severely has undermined the credibility of the legal property rights system. Two hypotheses are presented in order to test the relationship between secure land titles and rural investments and a third hypothesis is presented in order to test the credit supply effect. The results indicate that land titles can have a major impact on tenure security and investment. Possession of a secure title is found to increase the value of land-attached investments by 86.1% and the probability of carrying out such investments increase by 64.7%. Descriptive analysis of the credit supply effect also indicates that the possession of a secure land title increases access to credit since producers with secure titles have a higher proportion of received credit compared to producers without such titles. Ownership rights seem to be of most importance for access to formal credit as producers with secure documents have significantly better access to credit from private banks compared to other producers.

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Presentation: May 23, 2005
10.15-12.00 in room 349

Acknowledgements

First of all we would like to express our gratitude to Melinda Cuéllar, Executive Director of Fondeagro, for generously letting us work with the study at Fondeagro's office in Matagalpa. We would also like to thank all personnel at Fondeagro for their great assistance in practical matters during our stay in Nicaragua. We are particularly grateful to Patricia Salazar de Lanzas at Fondeagro for her encouragement and interest in our work. Without her assistance it would have been difficult to carry out interviews with farmers in the Jinotega region in a professional way. The assistance from Elisabeth Rizo at Fondeagro during the interviews is also greatly appreciated. Moreover, Walter Lopez at Fondeagro is gratefully acknowledged for making important estimations of the values of the different investments analyzed in this paper.

We express our greatest appreciation to INEC in Managua for providing the data. Additionally, financial support from Sida through the SMR fund is gratefully acknowledged. We would also like to give special thanks to Associate Professor Per-Olov Edlund, Daniel Ferreira, and Assistant Professor Renée Adams at the Stockholm School of Economics, and Mirja Sjöblom for valuable comments and guidance in econometric issues. Lastly, our gratitude goes to our academic supervisor Professor Erik Berglöv at the Stockholm School of Economics for guidance and support in theoretical issues.

List of Abbreviations

GDP	Gross domestic product
IDB	Inter-American Development Bank
INEC	Instituto Nacional de Estadísticas y Censos
INVUR	Instituto de la Vivienda Urbana y Rural
NGO	Non governmental organization
MAGFOR	Ministerio Agro cultural y Forestal
Mzs	Manzana, 1 mzs = 0.7 ha
OLS	Ordinary least squares
OTR	Oficina de Titulación Rural
SAR	Sandinista Agrarian Reform
Sida	The Swedish International Development Cooperation Agency
SMR	Svenska missionsrådet

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1. Introduction

...in all countries where there is tolerable security [of property], every man of common understanding will endeavour to employ whatever [capital] stock he can command. ...A man must be perfectly crazy who, where there is tolerable security [of property], does not employ all the [capital] stock which he commands. ...In those unfortunate countries...where men are continually afraid of the violence of their superiors, they frequently bury and conceal a great part of their [capital] stock...in case of their being threatened with any of those disasters to which they consider themselves as at all times exposed. (Adam Smith 1776)

The quotation by Adam Smith points to the fact that the influence of institutions on economic activity was realized centuries ago. In our days there is still little doubt that institutions and their evolution play an important role for economic development through the incentives and disincentives they create. The academy has actually seen a recent upsurge in the economic discourse regarding the fundamental influence of property rights. Several authors and discussants continue to claim that property rights form the backbone of the economic structure of society and that the enforcement of a well functioning property rights system becomes critical for economic activity. Intellectuals like Hernando de Soto on the one hand argue that the majority of the population in non-western countries is incapable of injecting life into their assets and make them generate capital because they do not have access to a formal property rights system¹. In most western countries on the other hand, property rights are both well defined and exclusive, in the sense that no other than the legitimate owner can lay claim to the property and people know where the decision-making authority is². Further on, property rights are secure for long and indefinite periods and investors do not have to fear that the state or someone else will expropriate their property. Investors are in other words able to take a long-term view, knowing that they, and no one else, will be around to reap the rewards for long-run success. In less developed countries however, institutions are not working as smoothly and the lack of enforcement of property rights threaten to scare investors away, limit access to credit and complicate efficient allocation of land.

The agrarian sector is typically of major importance in developing countries. Agriculture constitutes a large part of GDP in these countries and provides the majority of the working population with employment³. Secure property rights that underpin access to land are generally considered to be a precondition for increased productivity in this sector and for land-related investments to take place. The existence of dysfunctional and inefficient property rights systems in rural land markets therefore raises a number of highly contentious questions with respect to investment, such as; would land owners invest more in their land if they possessed legally secure land titles? Would a transformation to a more secure property rights system enhance investments in land? If so, through which channels do property rights affect rural investments?

¹ De Soto 2000, pp. 222-223.

² Perkins 2001, p.185.

³ Lundahl 1992, p. 116.

1.1 Case Study of Nicaragua

In this thesis Nicaragua is used as a case to explore the impact of land rights on investments attached to land. It is of interest to study the impact of land rights in Nicaragua for several reasons. First, a turbulent history of land reforms initiated with different motives and legal underpinnings has created a complex and dysfunctional property rights system. The last three decades have seen episodes of land expropriation by the state and the use of land invasions as a means of access to land, which has created widespread tenure insecurity and undermined the credibility of the property rights system.

Second, Nicaragua is a relatively land abundant country where the agricultural sector stands for about 30 percent of total GDP, 65 percent of export earnings, and 40 percent of total employment⁴. Agriculture's role in the economic development of the country is therefore central and to increase the productivity of land more investment is needed.

Third, Nicaragua is the poorest country in the region after Haiti. With a GDP per capita of 473 US dollars in year 2000⁵ the country is economically far behind its neighbour Costa Rica and the lack of productivity in all sectors of the country is evident. More investment is thus not only necessary to increase the productivity of the agricultural sector, but also to increase the growth of the entire economy.

Lastly, Nicaragua is of interest since several studies have assessed the economic effects of land titling in Africa and Asia but only a few studies have rigorously explored the subject in Latin America.

1.2 Purpose

The purpose of the study is to investigate if Nicaraguan producers in possession of land titles that certify well-defined, transferable, and secure property rights invest more in their land compared to producers with less secure titles⁶. Two different models are used to study the impact of secure land titles on rural investments. In addition, the importance of the possession of secure land titles to receive credit from different credit sources will be investigated. This link between credit and property rights is called the credit supply effect and it is one of the channels through which property rights are believed to enhance investments⁷.

⁴ Nicaragua Land Policy and Administration 2003, p. 9.

⁵ www.ui.se.

⁶ There is an important distinction between property rights and formal land titles in the sense that the latter is a proof that the former is backed by the powers of the state (at least in theory). At this point it is therefore necessary to stress that the correspondence between secure ownership and formal titles depends on the enforcement of property rights by the police and judicial system. See section 4.5 for further discussion.

⁷ See section 4.3 for further discussion of the credit effect.

1.3 Outline

The remainder of the thesis is structured as follows: chapter 2 describes how the field study was conducted. This chapter also presents a short description on practical problems and limitations faced at place. Chapter 3 illustrates important sequences in the historical development of property rights in Nicaragua as well as the present institutional context in this field. Chapter 4 gives an update on the relevant theory and how it will be applied. A review of previous research is also presented. Chapter 5 provides a brief overview of the data underlying the analysis. Chapter 6 consists of the analytical part where hypotheses are tested on the data set and the empirical results are discussed. Chapter 7 brings up econometric concerns regarding the regression analysis and discusses the validity of the results. The analysis continues in chapter 8 where the credit effect is examined. Chapter 9 discusses the empirical results from the regression models and provides the most important findings of the study. Lastly, chapter 10 gives suggestions for future research.

2. Approaching the Problem at Hand

The findings in this thesis are based on a field study conducted in Nicaragua in the summer of 2004. Preparations in Sweden before the trip consisted of applying for scholarships and establishing contacts in Nicaragua. At place in Nicaragua Fondeagro assisted the authors with many practical matters, such as the provision of drivers, interpreters, and valuable contacts. Fondeagro is a Swedish development project that works on rural development in the Jinotega region in Nicaragua. The main goal is to reduce poverty in assigned areas through micro credit schemes, technical assistance and land titling projects.

In order to investigate the effect of land rights on rural investments the authors have made use of statistics from a census that covers agricultural information on a national level. The statistics are studied by two regression models that test the hypotheses derived from previous research. The credit supply effect from land rights is also studied by descriptive analysis. In addition to the statistical and descriptive analysis a more qualitative analytical framework based on semi structural interviews with producers and qualitative interviews with different organizations and institutions has been applied. The interviews were conducted in order to get an understanding of the Nicaraguan context and to facilitate the analysis of the data set. They should thus be regarded as a complement to the econometric study.

2.1 The Interviews

2.1.1 Interviews with Producers in the Jinotega Region

The authors collected primary data from 35 interviews conducted in the Jinotega region in July 2004⁸. The questionnaires prepared for these interviews were semi structured, which means that they follow a predefined pattern and at the same they provide more

⁸ See reference list for a full account of the conducted interviews.

flexibility than structured interviews⁹. The main reason why semi structural interviews have been used is to get a deeper understanding of how producers individually look upon the issue of tenure security as well as to enable relevant comparisons between them.

The sample of farmers interviewed was chosen to represent different categories of producers with respect to land titles, income, land size and agricultural activity. All of the interviewed producers live in the department of Jinotega, in the municipalities Wiwilí or el Cuá. The Jinotega region was mainly chosen as a base for the interviews because it is a proper area to study the effects of tenure insecurity. A large part of the producers in this zone lack legal titles and strikingly many of them only have a handwritten or unregistered piece of paper to prove their ownership. Even producers that do not have anything but a word of mouth to prove that they own the land were encountered. Out of the 4000 producers who live in el Cuá only 39 % possess some kind of title and 45% do not possess any legal title at all¹⁰. A second reason for choosing this region is that Fondeagro is involved in the process of legalizing titles of producers in Jinotega, and by keeping a good record of the land owners they could assist us in the process of selecting a representative sample of producers.

The interviews were divided into two excursions, the first one to el Cuá and the second one to Wiwilí. El Cuá is a relatively accessible area, reachable through a paved road during the largest part of the trip. Wiwilí on the other hand, is a very difficult area to access since the only road available is a seven hour long mud way. By conducting the interviews in two separate municipalities the authors were able to broaden the sample and find out if the producers thought differently about the importance of legal titles.

2.1.2 Interviews with Different Organizations

In order to get a deeper understanding of the structure of the property rights system and the institutional context in Nicaragua the authors also conducted qualitative interviews with people from micro credit foundations, governmental institutions, and international organizations. In total eleven persons with knowledge of the institutional and economic context of the country were interviewed¹¹. They were asked broad questions that allowed them to talk freely about the subject. The comments of these persons have been particularly valuable when the regression models were constructed and the results from the regressions were interpreted.

2.2 *The Agricultural Census*

The statistics used in this thesis is based on the Census of 2001 conducted by INEC, the national institute for statistics and census, and the World Bank in 2001. It is an agricultural census that contains nation-wide information from the agricultural sector in Nicaragua. The general objective of the census is to enable implementation of programs and political decisions that would benefit producers in the Nicaraguan countryside.

⁹ Lundahl & Skärvad 1982, p. 73.

¹⁰ Fondo de Desarrollo Agropecuario 2002, p. 6.

¹¹ See reference list for a full account of the conducted interviews.

Nationally it is also regarded as an important database that provides data for different investigations and studies of the agricultural sector¹².

2.3 Problems and Limitations

2.3.1 Limitations Regarding Interviews with Producers

As the agricultural census is based on nation-wide information, the regression analysis is used to study the economic effects of land rights in the entire country. It would have been desirable to conduct interviews in different parts of the country with producers from several regions to match the database and to avoid possible bias. However, this was unfortunately not realistic within the scope of this study. In order to limit the extent of the problem the interviews were conducted with producers at different levels of wealth and from different municipalities in the Jinotega region. Moreover, it should be emphasized that the interviews are mainly used as a complement to the statistics.

It can also be argued that the presence of personnel from Fondeagro at the interviews could have influenced the answers of the respondents since some of them were beneficiaries from the Fondeagro's micro credit program. Despite the risk of biased answers the authors thought it was more important to be assisted by people up to date with the topic who could make sure no important information was missed out due to linguistic difficulties.

2.3.2 Limitations and Advantages with the Agricultural Census

Like many other developing countries, Nicaragua does not have a tradition of collecting data, which makes it very hard to find good quality data for specific purposes. Large surveys are carried out either by INEC or international organizations such as the World Bank and the IDB. These surveys are often used for economic research both within and outside the country, and are generally regarded as trustworthy. However, large surveys of this kind often lack specific and detailed information that could be of value. In our case, the use of the census is limited as it has not been constructed to provide specific data for studies that investigate the impact of land rights on investments. Detailed information about investments, land rights and factors that are thought to affect investments are not consistently included in the data set. In order to limit the problem with insufficient data the authors have used approximations and additional computations as a complement to the data.

Apart from the problem with the general structure of the data, there are several advantages with the census. As far as the authors know it is the largest nation-wide census in Nicaragua used for investigating the effects of land rights on investments. The fact that the census so far has been unexplored with respect to the subject at issue enhances the significance of the findings and reduces the risk of replicating the work of other studies. Moreover, the large number of observations in the data set makes it possible to apply the results on the country as a whole and reduces the risk of bias due to

¹² <http://www.inec.gob.ni/>.

regional variations. Lastly and as mentioned above, the quality of the data is relatively trustworthy, as it has been collected by organizations which are known for applying statistically secure methods.

3. Background and Institutional Context

The stability and credibility of the property rights system in Nicaragua has suffered greatly due to the historical circumstances in which it has developed. The purpose of this section is to give an overview of the political and historical context in which the present Nicaraguan property rights system has evolved.

3.1 *The Somoza Period*

Like many other Latin American countries, Nicaragua is plagued by pervasive social and economic inequalities in land ownership that have led to social unrest and even civil war¹³. From the late 19th century a systematic process of land concentration started due to a series of commodity booms in coffee, cotton and meat and due to a set of policy distortions that encouraged the accumulation of land. The period of massive agro-export booms was characterized by numerous land transfers from indigenous groups and small holders to large landowners. President Somoza, who assumed presidency in 1936, accentuated the ongoing process by his and his family's land acquisitions. Somoza also undertook a land reform which mostly consisted of distributing land to agricultural labourers at the agricultural frontier.¹⁴ This redistribution of land was the first out of three waves of land reforms in Nicaragua that took place since the early 1970s.

3.2 *The Sandinista Period*

During the Sandinista revolution in 1979, the *Frente Sandinista de Liberación Nacional* unseated Somoza and distributed large tracts of lands to former workers¹⁵. When the Sandinista government came into power they initiated various agrarian reforms (SAR) that lead to a more egalitarian distribution of land to landless people.¹⁶ In 1981 a law was enacted that gave the state the right to confiscate every piece of land that was “abandoned, leased, not cultivated or badly cultivated”. With this vague law almost any land could be confiscated with complete discretion. In total, more than 40 % of all agricultural land was redistributed under the Sandinista regime¹⁷ and most of the confiscated land was given to cooperatives or single farmers.

The large amounts of land that were distributed through the SAR program were either legally not owned by the state or owned by the state but distributed to ineligible beneficiaries¹⁸. In many cases the government never properly registered or measured the

¹³ Broegaard 2002, Heltberg and Møller, p. 8.

¹⁴ IRAM 2000, p. 32.

¹⁵ Deininger & Chamorro 2002, p. 4.

¹⁶ Jonakin 1996, p. 1179.

¹⁷ Broegaard, Heltberg and Møller 2002, p. 9.

¹⁸ Nicaragua Land Policy and Administration 2003, p. 3.

distributed properties, which have led to numerous claims by former land owners whose land were expropriated¹⁹. When the Sandinista party lost the elections of 1990, the SAR therefore faced legal and judicial challenges that created insecurity regarding property rights²⁰. The Sandinistas tried to legalize a large number of the expropriated properties in between their defeat and the handing-over of power but these decrees were so vaguely written and open to interpretation that only more confusion was caused. In addition to this, a large number of Sandinista officials appropriated precious real estate during the same time, a process more widely known as the “piñata”.²¹

3.3 The Third Land Reform

When the Chamorro government took office after defeating the Sandinistas in 1990 they not only inherited an extremely complicated and confused property rights regime, but also continued with the third wave of agrarian reform programs during the 1990s. This time the beneficiaries were landless peasants or ex-combatants from both the contra and the army.²² As opposed to the SAR, the reform process initiated by Chamorro was more concentrated on guaranteeing the security of property rights and establishing a basis for functioning markets and marked a move away from redistribution. However, the process was complicated by the fact that it was often unclear whether previous titles to the land had existed or not, and many of the beneficiaries of this land reform were located on land that was already inherited. On top of this, numerous land invasions by ex-contras as a means of access to land took place and further complicated the land tenure situation²³.

The third land reform also implied strong claims from previous owners that had lost their property during the Sandinista rule and whose interests the new government actively sought to safeguard. As a result, a large volume of litigation ensued and tenure security was undermined both for those directly affected by land redistribution and for the remainder of land owners who had to live in constant fear of being subject to claims to their land²⁴. This resulted in courts overwhelmed with claims, violent conflicts in several regions of Nicaragua, and a police and military that was reluctant to get involved in the enforcement of court decisions.²⁵ Corruption and power-abuse were widespread and the over-burdened court system made very slow progress in resolving land claims²⁶.

3.4 The Current Situation

Today, tenure insecurity in Nicaragua remains pervasive. The lack of proper legal documentation of land transfers and the existence of plot allocations that the state never had legal rights to expropriate have undermined the credibility and integrity of the

¹⁹ Foltz, Larson and Lopez 2000, pp. 4-5.

²⁰ Deininger & Chamorro 2002, p. 4.

²¹ Borner, Brunetti and Weder 1995, p. 51.

²² Cervantes & Rodriguez 2004, p. 4.

²³ Deininger & Chamorro 2002, p. 4.

²⁴ Ibid.

²⁵ Broegaard, Heltberg and Møller 2002, p. 9.

²⁶ Broegaard, Heltberg and Møller 2002, p. 10.

property rights regime. These difficulties are worsened by the numerous land invasions carried out by ex-combatant bands, affecting both reform and privately held land in the country.²⁷ Households have regularly been threatened to leave their land due to conflicts coupled with physical violence and the lack of formal land-tenure documents.²⁸

Conflicts regarding communal property are another source of land tenure insecurity in Nicaragua today. Even though the Nicaraguan Constitution recognizes communal land rights for indigenous people and ethnic minorities it does not cover all issues regarding communal property conflicts. The present situation includes conflicts regarding overlapping land claims between indigenous and non-indigenous people, boundary conflicts that stem from improper delimitation of indigenous lands, as well as conflicts between economic interests and interests that seek to preserve natural resources and cultural values²⁹.

In summary, conflicts regarding property rights in Nicaragua can arise for several reasons. These mainly include the existence of weak institutional capacity and a complex political history with policy reversals and unlawful procedures. With respect to this background it does not seem far reached to conclude that increased tenure security could have a major impact in Nicaragua.

4. Theoretical Framework

This chapter presents the theoretical arguments regarding the link between property rights and rural investments. The theoretical considerations will be used as an analytical framework when analyzing the data set in chapter 6.

4.1 The Development of Property Rights

The importance of secure property rights for economic decisions has been established for centuries. It should therefore not come as a surprise that economists within this area traditionally believe that economies in which property is secure should prosper and grow, and that economies in which security of property is lacking should see stagnation. One of the first economists who developed a theory for the development of property rights is Demsetz (1967). According to him property rights evolve as they internalize externalities, which may seem rather ambiguous, but the basic line is that all external costs and benefits become internal. Changes in these externalities through the emergence of new beneficial or harmful effects can explain how development may lead to the justification and need for property rights. When the gains from internalization are higher than the transaction cost of providing for property rights, they should be introduced. New knowledge, techniques or an increase of the population density may invoke changes that create an environment in need of legal property rights. In the context of land rights this implies that land titling should be

²⁷ Laiglesia 2003, p. 3.

²⁸ Broegaard, Heltberg and Møller 2002, pp. 10-11.

²⁹ Nicaragua Land Policy and Administration 2003, p. 32.

initiated and enforced if the benefits over existing arrangements exceed the cost of establishment.³⁰

4.2 *Land Rights and Incentives*

The traditional and perhaps most well known argument for establishing property rights is that they provide agents with incentives to invest in land and use land more efficiently. The argument is easy to understand; once a landowner knows that the land he cultivates is secure, he and nobody else will be around to reap the returns from investments. Risks involved in land security are commonly associated with the risk of expropriation by the state or the lack of enforcement of land rights.³¹ As these risks reduce incentives for production and investment they are formally equivalent to a random tax on investment returns that increases with the probability of expropriation. The random tax can be expected to have two effects on investment. There is a *level* effect that predicts less investment since the overall return to investment has fallen. From the *composition* effect it follows that the incentives to undertake land-attached investments decrease as the relative prices of different investments have changed. Investments are diverted towards assets with lower risks of expropriation and land tenants then prefer to invest in mobile assets such as cattle, rather than in immobile investments such as buildings and trees.³²

4.3 *Land Rights and Access to Credit*

The traditional view of the effect of property rights on incentives and investment is nowadays accompanied by two other views as well. According to Feder (1987) secure ownership is expected to facilitate producers' access to cheaper and more extensive credit, referred to as the credit supply effect. If it can be supposed that lenders who invest in land are dependent on access to credit there exists ways in which land rights are linked to investments through credit markets. Land has traditionally been an ideal collateral asset, especially in areas where land is scarce and of high value³³. The collateral value of land depends on the ownership security of the plot and on its immunity to damage. This is because banks and lending facilities need some kind of guarantee that secures their right to dispose of the land or its use rights in order to accept land as useful collateral.³⁴ In countries where land is used as collateral it is therefore common that possession of a land title is a mandatory precondition for commercial or governmental loans. In the informal credit markets collateral play a less significant role since grants of credit rather are based on personal familiarity than on formal titles. However, informal credits are also characterized by higher interest rates and short-term loans of small amounts due to higher risks involved in the outstanding loans. In a competitive credit market without major asymmetric information problems, better forms of collateral will reduce interest rates faced by borrowers since risk premiums are reduced. In this way formal credit institutions

³⁰ Handbook of Development Economics 1995, p. 2719.

³¹ Feder & Feeny 1996, p. 244.

³² Besley 1998, *The New Palgrave Dictionary of Economics and The Law*, p. 360.

³³ Binswanger & Rosenzweig 1986, pp. 510-512.

³⁴ Feder & Feeny 1996, p. 245.

can encourage borrowers to carry out investments.³⁵ Moreover, if the banking sector is unwilling to use untitled land as collateral for credit the issuance of titles could perhaps contribute to increase their presence in areas that are dependent on informal credit. It should be mentioned though, that if the constraints to obtain credit are caused by other factors, such as small farm sizes or low profitability, land titles may fail to be useful as collateral until other measures are taken.³⁶

Below some facts about access to capital in the Nicaraguan land markets illustrate the arguments touched upon in this section.

4.3.1 The Nicaraguan Credit Market

In Nicaragua it is particularly difficult for producers in rural areas to obtain credit from the private banking sector, which controls a major share of all types of credit in the country. With respect to the economic importance of the agricultural sector in the country it is noteworthy that only 15% of the total private-bank portfolio is concentrated in the agricultural and livestock sector. This low level of private bank participation in non-urban areas reflects the problem of land ownership, the lack of security in the countryside, and the high levels of arrears in the state-banking system.³⁷ Furthermore, the private banks generally consider that loans to rural producers are both costly and risky. The high costs are associated with difficulties in administering the loans and limitations in the use of land as collateral as producers often lack legal property documents. Other problems that are linked to rural credits are asymmetric information and moral hazard. Asymmetric information involves difficulties to estimate the credit worthiness of prospective lenders. The risk of moral hazard comes from the complicated task to monitor that loans to borrowers in remote and hard to reach regions are used in a productive and intended way.

About one fifth of the rural households obtained credit from any source in 1998. Since credits from private banks are restricted rural credit mainly comes from NGOs, *caja rurales*, rural/municipal banks, government programs, credit cooperatives and from commercial credit. NGOs and government programs are similar in the sense that credit from these sources is subsidized and intended for smaller scale loans. *Caja rurales*³⁸ are microfinance institutions that are financed by either NGOs or government programs. Rural/Municipal banks are specially designed to distribute credit to large scale farms and are not intended for smaller farms or producers. Credit cooperatives are used by smaller producers in order to access credit. By applying for credit together, which is commonly used for grain purchases, credit cooperatives facilitate access to credit and provide better terms of credit than if the producers apply for credit on their own. Lastly, commercial credit is distributed by traders of agricultural input that extend credit to farmers. These credit sources are all present in the data set and the access to credit for producers with and without secure titles will be analysed in chapter 8.

³⁵ Besley 1998, *The New Palgrave Dictionary of Economics and The Law*, p. 360.

³⁶ Handbook of Development Economics 1995, p. 2720-2721.

³⁷ <http://www.developmentgap.org/imfnicaragua.html>.

³⁸ The Spanish term translates to “rural funds”.

Out of the credit sources included in the analysis, private banks are the most formal as they have the strictest requirements for credit distribution. It is reasonable to assume that a secure land title is especially important for this type of credit. Less formal credit sources such as NGOs and government programs can be expected to have more lax credit requirements. However, they also contribute to the presence of costly and scarce credit in rural areas since they tend to distort credit markets and create disincentives for commercial banks to enter these markets. Although these organizations do provide a temporary relief for many potential borrowers by offering more lax collateral requirements necessary development may thereby actually be delayed.³⁹

The shortage of available financial services and disproportional credit costs in rural areas clearly affect the agricultural sector and the entire growth of the country in a negative way. Agriculture has shown to be more capital intensive than non-agriculture in a large sample of developing countries and the presence of expensive loans may therefore severely hamper investments.⁴⁰ This suggests that land titling in Nicaragua could increase the possibilities for private banks to expand their credit operations to rural areas. With land being used as collateral, the costs of monitoring should decrease and lower the costs of granting loans. In line with the theory presented greater access to credit and less costly loans should in turn lead to increased productivity and investment in the country. Despite that this line of reasoning has led to a widespread belief that land titles will help promote rural credit in practice it is important to keep in mind that credit institutions may find rural lending undesirable on other grounds. As mentioned earlier, many potential borrowers live in hard to reach areas, which increase the cost of monitoring and transaction costs for the banks. It could also be that rural loans are unprofitable due to small lending volumes and farm sizes involved. The impact of land titling on credit supply in rural Nicaragua is therefore likely to depend on the existence of supportive institutions and on measures to overcome constraints for rural lending.

4.4 Land Rights and Efficient Allocation of Land

According to Feder (1987) a third prediction of secure property documents is that they are believed to create expanded trading opportunities by reducing the cost of transacting land in the market. The argument behind this reasoning is that the formalization of land rights reduces the problem of informational asymmetries on the ownership status of land and increases the allocative efficiency in the economy. A problem with information asymmetries involved in land sales is that they generate inefficiencies in the land market since the price of land may not reflect its real value. The number of transactions becomes less than optimal and the remedy is to create institutional arrangements such as land rights and public registers.⁴¹

With the increased possibility of land transfers investments are believed to increase, because less money is required to be spent on reducing uncertainty when formal rights

³⁹ Nicaragua Promoting Competitiveness and Stimulating Broad-based Growth in Agriculture 2003, pp. 33-36.

⁴⁰ Ibid.

⁴¹ Handbook of Development Economics 1995, p. 2719.

exist. With the path of development the incentives for farmers to trade their lands increase since they may need to adjust the land input to the level of education, experience and ability. In the early stages of agricultural development most transactions take place among members of the same community and these members often have a wide knowledge of the seller and his land rights. But as the agriculture gets more advanced the need for transactions with outsiders increases and so does the need for formal land rights.⁴²

4.5 Concretization of Theory

In line with the reasoning above one can conclude that property rights and the need for them appear as societies emerge and develop. They are generally considered as a precondition for economic growth and development and at the conceptual level property rights are thought to lead to increased economic activity for three reasons⁴³:

1. They provide incentives for owners to undertake land intensive investments because the risk of expropriation diminishes
2. They increase access to formal credit from institutional lenders, which enables more investments to take place.
3. They decrease the cost of trading with land in society, meaning that land is allocated in a more efficient way in the economy.

Even though most scholars acknowledge these channels there exist different opinions regarding their relative importance, as well as the magnitude and the distribution of potential benefits from exogenous interventions to increase tenure security⁴⁴. An important reason why the opinions differ regarding the potential impact of these channels has to do with problems involved in land titling in practice. According to the theory presented a solution to the problem of tenure insecurity could be to title land as secure land titles lead to increased investments. In practice however, land titling will not automatically lead to secure land rights because their conceptual significance is so much more than just a piece of paper. Whether land titling enhance investment incentives, land markets, and credit supply via increased tenure security rests on the assumption that land titles are supported by a system that is capable of enforcing land rights. If this system involves corrupt, partial, and improper procedures land titling could actually increase rather than reduce tenure security. Moreover, general lack of trust in institutions caused by high levels of corruption can lead to tenure insecurity, irrespective of titling.⁴⁵ This perspective on the existence of a one-to-one relationship between investment and land titles is especially important to have in mind with respect to Nicaragua, as its turbulent history of policy reversals and land reforms has undermined the credibility of the entire property rights system. Therefore, the benefit of any titling program depends on how well land rights are implemented and enforced as well as the perception of tenure security associated with the possession these rights.

⁴² Ibid.

⁴³ Deininger & Chamorro 2002, p. 1.

⁴⁴ Ibid.

⁴⁵ Broegaard et al. 2002, pp. 2-8.

In line with the reasoning above the perception of the security of the land title that represents secure ownership in the regression analysis is of decisive importance of the legitimacy of the measure. Instead of choosing formal titles that are secure according to Nicaraguan law only, the variable that represents secure ownership in the econometric study has been carefully selected with respect to the opinions of the people interviewed in order to capture the complexity of the security aspect involved in land rights. Having said that, the hypotheses tested have been formulated to find out if land rights do enhance investments in land and additionally, the existence of a credit supply effect according to the second channel will be discussed. It would also have been interesting to study the specific impact of channel 1 and 3 on investment, but unfortunately the data set does not provide sufficient information for such analysis.

The effect of land titles on rural investments is tested by the two following hypotheses stated as follows;

Hypothesis 1: *Possession of secure land titles increases the value of land-attached investments carried out by producers*

Hypothesis 2: *The probability of carrying out land-attached investments increases for producers in possession of secure land titles*

The credit supply effect is tested by the third hypothesis;

Hypothesis 3: *Producers in possession of secure land titles have better access to credit*

Hypothesis 1 is tested by an OLS regression model. If the value of land-attached investments significantly increases for producers in possession of secure land titles the hypothesis is accepted. Hypothesis 2 is different from Hypothesis 1 in the sense that it is tested by a logistic model that measures the probability of making land-attached investments. Both models involve the same controlling variables and should be regarded as complements that provide two different ways of investigating the same issue, i.e. the impact of secure land rights on rural investments. The potential of these models to prove a causal relationship between secure land rights and investment depends on the variables included in the model as well as on the ability to control for the eventual presence of endogenous relationships. Econometric concerns of this kind affect the validity of the models and will be further discussed in chapter 7. Bearing the econometric limitations of omitted variables and endogeneity in mind, the selection of the variables in the regression models has been made with regards to relevant theory, observations from the field and previous research.

Hypothesis 3 tests if producers with secure titles have better access to credit. It is based on the credit supply effect argument, which states that credit from institutional lenders increases with the value of collateral. Producers with secure titles in turn, are assumed to have a higher collateral value of their land compared to other producers. Once producers

have access to credit they are also expected to invest more in land, as they are less credit constrained.

4.6 Empirical Evidence

Until today, several studies have looked into the links between land rights and economic activity in developing countries. Despite the fact that secure land rights in theory are mentioned as a prerequisite for investment and growth, empirical evidence for their importance to increase investments is hard to find. In Africa, where most of the studies have been performed, there is very mixed evidence on the effects of land rights. The reason for this can be measurement or specification problems but it is in any case striking that the evidence does not strongly confirm what the theory suggest. In Asia Lin (Lin 1988, 1992) finds in a study conducted in China that a shift to more household responsibility from a commune based land system seems to have enhanced investment incentives. On the issue of tenure security another study in China by Feder (Feder et al 1992) finds no evidence of reduced investments due to insecurity. Feder et al (1987, 1988) also argue for a credit-based link between investments and land rights in Thailand. As in the case of Africa, previous research found little systematic evidence of a positive link between investments and land rights in the papers from Latin America. A possible explanation for why it is relatively hard to find empirical evidence that support theory is that the possession of formal titles is not sufficient to create actual feelings of security⁴⁶. In contrast to this however, Alston et al (1996) find that land titling has a positive impact on both land values and investments in Brazil.

4.6.1 Empirical Evidence from Nicaragua

Few studies have rigorously studied the effects of land titling on rural investments and access to credit in Central America. There are some studies though, which touch upon the subject of property rights and their influence on economic activity in Nicaragua. Deininger & Chamorro (2002) have written a paper which examines the impact of award of registered and non-registered title on land values and changes in land-attached investments. The main finding is that registered titles greatly increase the propensity to invest and that titling can have a positive distributional effect. De Laiglesia (2003) makes use of the same data set as Deininger & Chamorro in his study concerning the effect of registered titles on tenure security, agricultural investment incentives and credit access. His main finding is that registration is found to increase the probability of carrying out land attached investments by 35 %.

It is important to underline the differences between this study and the one performed by De Laiglesia in order to show our contribution to previous research. Firstly, De Laiglesia analyzes the credit supply effect by a regression model, while the authors have chosen to study the same channel by descriptive statistics from the census. Secondly, De Laiglesia makes use of a probability model while this study includes a log-linear model and a probability model to strengthen the robustness of the results. Thirdly, another difference

⁴⁶ Besley 1998, *The New Palgrave Dictionary of Economics and The Law*, pp. 360-361.

between the two studies that is worth mentioning is the use of interviews as a means to interpret the results and to find controlling variables that are country specific.

Lastly, De Laiglesia makes use of a different data set which contains fewer respondents and less geographical coverage compared to the Agricultural census. The Agricultural census is also more recently conducted.

5. Descriptive Statistics

With as many as 206 631 observations in the data, where each observation is equal to one producer, the Censo Agropecuario 2001 is an exceptionally large database. It covers information regarding all types of farmers; from small-scale squatters to large-scale producers. Even though the data set covers a large variety of respondents they will for simplicity be called producers when referred to as one group. This chapter presents some descriptive statistics regarding the land ownership and household characteristics of these producers.

The census divides land ownership into six categories; *escritura pública* (*escritura*), *título reforma agraria* (*agrarian reform title*), *título reforma agraria mancomunada*, producers in a legalization process, producers renting land, and other type of land tenure.

The *escritura* will be referred to as the most secure title present in Nicaragua today⁴⁷. This type of title is used as a variable representing a secure land right in the regression models testing hypotheses 1 and 2. Like the name suggests, agrarian reform titles were distributed through agrarian reforms, in many cases with unlawful manners during the Sandinista revolution⁴⁸. The *título de reforma agraria mancomunada* is an agrarian reform title which is owned by several producers, a title that has caused many problems for the security of land ownership⁴⁹. Producers that are in a legalization process are expecting to have a properly registered land title in the future. This process can be long, costly and cumbersome and it is not for sure that the producers will end up with a secure title in the end. Other type of land tenure is all kinds of informal documents and in some cases the only proof of land ownership is a word of mouth.

The size of operated area varies greatly between the producers. Land in Nicaragua is unequally distributed, where a few rich families own a large part of the fertile land and the majority of the population owns a small share of the total land area. The data set tells us something about a bias in favor of the richer producers regarding *escritura* holders. As a matter of fact, 78.5%⁵⁰ of the rich producers, where rich is being defined as producers owning more than 500mzs, have an *escritura* protecting their land while the same figure for the total sample is 51,6%. Statistics also show that that only 36.8% of the rural poor and 50% of the non-rural poor possessed an *escritura* in 2001⁵¹.

⁴⁷ See p. 21.

⁴⁸ See p. 10.

⁴⁹ Análisis de Encuesta Rural 1995, p. 27.

⁵⁰ Censo Agropecuario 2001.

⁵¹ Perfil Comparativo de la Pobreza en Nicaragua 2003, p. 23.

Table 1 presents some descriptive statistics regarding the percentages of producers holding different land rights and household characteristics that will be controlled for in the regression models⁵². It is obvious that escritura holders make more investments than all other tenants. However, these producers are also older, more educated and own more land, machinery and cattle than other producers. As the descriptive statistics indicate that there is a presence of a positive bias toward rich producers in possession of escrituras, it is particularly important that wealth status is controlled for in the regression models.

Table 1. Sample characteristics

Land title	Distribution of land titles ⁵³	Investments in land ⁵⁴	Age	Level of Education ⁵⁵	Land area in mzs ⁵⁶	Number of machines ⁵⁷	Total cattle ⁵⁸
<i>Escritura</i>	51.6	1938.88	50.8	1.62	53.89	9.47	97.38
<i>Agrarian R.</i>	8.2	957.42	47.64	1.04	50.31	8.6	35.37
<i>Agrarian R. M</i>	2.0	844.12	46.08	1.21	40.88	8.53	29.08
<i>Legalization</i>	14.4	871.06	45.18	1.26	34.43	7.97	29.52
<i>Rented land</i>	4.3	805.18	44.63	1.31	10.71	8.32	90.12
<i>Other</i>	22.5	564.53	44.63	1.04	33.38	6.88	28.09

Source: Censo agropecuario 2001

6. Econometric Analysis

In this chapter two regression models will be specified to test hypotheses 1 and 2. These models include key variables that are expected to affect the impact of secure land rights on investments⁵⁹. Both models test the impact and significance of secure land ownership⁶⁰ on two different measurements of investments in land. The specifications of the models are explained in two separate sections. All computations and testing of hypotheses are made on the data set of Censo Agropecuario 2001.

⁵² Descriptive statistics for all variables is included in *Table 7* in Appendix 1.

⁵³ Distribution in percent. A few respondents have more than one title so the sum exceeds 100.

⁵⁴ See *Table 8* in Appendix 2 for a full account of the investments included. Values in US dollar.

⁵⁵ The level of education is based on 7 different educational levels, where 0 is the lowest and 7 is the highest.

⁵⁶ 1 mzs is equal to 0.7 ha.

⁵⁷ This value includes the average number of machines owned by the producers in the data set.

⁵⁸ This value includes the average number of cattle owned by the producers in the data set.

⁵⁹ Controlling variables that generally are used in this field of research have been included, such as variables controlling for household characteristics (for example education, age and gender), land characteristics and welfare status. In addition, variables that can be expected to have an impact on investments in Nicaragua according to field experience have been added.

⁶⁰ The explanatory variable that defines secure land ownership is motivated in section 6.1.3.

6.1 Construction of an Econometric Model to Test hypothesis 1

This section builds a regression model to test hypothesis 1 stated as follows;

Hypothesis 1: *Possession of secure land titles increases the value of land-attached investments carried out by producers*

The regression model used to test the first regression is a log-linear regression model (OLS). Below the different variables included in the model will be explained.

6.1.1 Dependent Variable

Value of Land-attached Investments (INV)

The dependent variable in the regression model is equal to the total value of the number of land-attached investments carried out by the producers in the data set⁶¹. The investments considered are long-term and immobile agricultural investments such as silos, sheds and stables. A complete list of the different investments is presented in Appendix 2. Immobile land investments are chosen because they are likely to be more relevant for the impact of land rights as they are not, unlike mobile investments, possible to remove in case of property loss. The dependent variable is logged in order to receive a percentage value of the land right effect on investments.

6.1.2 Explanatory Variable

Secure Land Title (ESCRITURA)

According to Nicaraguan law properly registered formal titles, no matter if the titles originate from the reform or the non-reform sector, are fully secure titles in terms of ownership right⁶². This means that only registered titles offer complete legal protection against a claim over land ownership⁶³. Registered titles can both be in the form of agrarian reform titles and escrituras. Even though all registered titles are supposed to guarantee equal ownership rights, inappropriate procedures that have contributed to overlapping claims and demands for compensation are strongly associated with the agrarian reform titles. As opposed to agrarian reform titles escrituras are almost always registered in the public register. Since it is not unusual that several owners of an agrarian

⁶¹ The values for used investments are based on calculations conducted by Walter Lopez, agrarian economist at Fondeagro in Matagalpa. In addition, a small value of 1\$ has been added to each observation in order to include producers that have not made any investments in the model. If this is not corrected for the results from the analysis could be biased as it is possible that producers that do not make any investments in many respects differ from producers that make investments.

⁶² Análisis de Encuesta Rural 1995, p. 30.

⁶³ Laiglesia (2003), p. 8.

reform title claim the same land plot there exist legal obstacles to have it registered. An escritura on the other hand, faces no such legal obstacles and the only procedure that the owner has to go through to get the title registered is to pay a small fee (of symbolic value that even the poor can afford). In line with this reasoning the authors have chosen to equal escrituras with registered titles⁶⁴.

From the field experience it was clear that the perception of the security of land titles is of major importance for investments to take place. Even if a person has a perfectly legal title he or she may still feel insecure if there is a risk that someone else will make claims to the land. What matters for rural investments to take place is how people feel about the security of their land and not necessarily what kind of title they have.⁶⁵ In order to find out how the security of land titles is perceived the producers were asked, during the complementary interviews, which type of land title they viewed as most secure. Almost all of the interviewees said that they perceived an escritura as a fully secure land right as opposed to how they perceived other types of titles. In addition, the possession of an escritura was considered the most important factor for improved security regarding land ownership. Two farmers however, answered that even though an escritura is the most secure land title offered they would still not feel completely secure with the title with regards to the turbulent history and the several policy reversals in the country. The aid agencies and the Nicaraguan property right department (OTR) were also asked the question which type of land title according to their opinion granted the most secure ownership right.⁶⁶ They all agreed that with respect to the Nicaraguan institutional context, an escritura is a fully secure land title.

From the reasoning above the authors have decided to use an escritura as a measure for a secure land right. In line with theory secure land ownership should lead to increased investments and conclusively, a positive relationship between the value of investments and the dummy for the possession of an escritura is expected.

6.1.3 Controlling Variables

The controlling variables are included in the regression model to control for other effects than ownership that are expected to affect investments. These variables are mainly chosen on the basis of variables included in previous research and information gathered from the field.

Credit (CREDIT)

From the interviews it was obvious that the producers are under severe credit constraints and that they need better access to credit in order to invest in their land. It is all linked together however, since formal land rights in many cases are required as collateral in order to achieve credit. A registered escritura would not only increase the security of their land, but also increase their access to credit, and thereby realize plans to invest in

⁶⁴ As opposed to the agrarian reform there cannot be any formal obstacle to register an escritura.

⁶⁵ Interview with Norman Piccioni (2004- 08-03).

⁶⁶ Interviews with people at OTR, The World Bank, Fondeagro, and IDB.

agriculture. With the measurement of land-attached investments as the dependent variable, the impact of credit on investments should depend on the credit source and on the size of the investment. Based on field experience the authors expect loans from private banks to have a larger and more positive effect on the investments included in comparison to other subsidized and less formal credit. The reason for this is that the latter is generally composed of relatively small amounts that mainly are used to undertake minor investments.

Technical Assistance (TA)

Technical assistance in agriculture is provided by various agricultural programs in Nicaragua. It includes knowledge sharing as how to plant crops more efficiently or how to use the available equipment in a more productive way⁶⁷. Provided that technical assistance is effective and that it leads to better knowledge in making productive use of the land, it should have a positive effect on land-attached investments.

Gender (MALE)

Nicaragua is a country where gender inequality is widespread in society, something that should be reflected in the will to invest in land as well. Experience from the field also revealed that it is usually the man that takes decisions regarding the household. A positive relationship between the MALE variable and the number of investments is therefore anticipated.

Age (AGE)

It is reasonable that the age of the producers has an effect on the dependent variable and the variable is always included in these types of regressions in order to control for household characteristics.⁶⁸ The AGE variable representing the number of years of the producers has therefore been included in the model.

Education (EDUCATION)

According to human capital theory individuals mainly spend money on education to raise their income and productivity⁶⁹, and investments are an important link to increase the growth in these. Higher education in Nicaragua is reserved for a very small minority, especially outside urban areas. The national percentage of analphabetism in rural areas is as high as 79.8 compared to 37.3 percent in urban areas.⁷⁰ In this context it is reasonable that education has a positive effect on the propensity to make rural investments.

Welfare Variables (WELFARE)

By using different measurements for welfare it is possible to control for the fact that some producers are better off than others. Land titling can be both a lengthy and costly

⁶⁷ Fondeagro Phase II 2004, pp. 7-8.

⁶⁸ See for instance Laiglesia.

⁶⁹ Perkins 2001, p. 335.

⁷⁰ Encuesta Nacional de Hogares sobre Medición de nivel de vida EMNV 1998, p. 45.

process in Nicaragua, and as was seen in the descriptive statistics part, possession of secure land rights tends to be biased in favour of the rich. The data set does not provide any information regarding the incomes of the producers. It therefore makes sense to use indirect factors that represent the welfare status of the producers in the sample. Deininger and Chamorro find that total farm area is strongly correlated with levels of household welfare⁷¹. In this thesis land area in combination with total cattle per producer⁷², total number of machines per producer, and the existence of a water source on the operated land are used as approximations for welfare.

Because a superior level of wealth is expected to enable desired investments to a higher degree compared to an inferior level of wealth, we can expect to find a positive relationship between the welfare variables and the value of land-attached investments⁷³.

Land Characteristics (VEGETATION)

The quality of land may be decisive for land cultivation and investment. Previous research studies have therefore included variables controlling for different plot characteristics. Land use and plot characteristics included in this model involve crop cultivation, different vegetation and land used for other purposes than cultivation.

Socio-economic Sectors (SOCIAL)

Nicaragua is a country with wide regional variation and the countryside is divided into different socio-economic and agricultural sectors depending on where you go. These sectors are characterized by an interaction of agro climatic factors and the economic development in different parts of the country. The nature of the land, financial resources, infrastructure and other physical factors influence the way the producers manage agriculture⁷⁴ and have a major impact on productivity levels within the country⁷⁵. Hence, it is likely that the socio-economic and agricultural sectors affect the value of rural investments as well as the probability for carrying those out. In line with this reasoning variables controlling for regional variation in productivity and climate are included in the regression model.

Table 2 below provides an overview of the variables listed above and used in the log-linear model. All variables in the table except the dependent variable will also be used in the model described in section 6.4. Descriptive statistics showing min-, max-, mean values and standard deviations for all the variables used in both regression models can be studied in *Table 7* in Appendix 1.

⁷¹ Deininger and Chamorro 2002, p. 6.

⁷² The value of cattle is used by Laiglesia as a welfare variable.

⁷³ The water source variable is technically used in the regressions as the non-existence of a water source and therefore the effect is expected to be negative.

⁷⁴ Marin & Pauwels 2001, p. 30.

⁷⁵ Deininger & Chamorro 2002, p. 6.

Table 2. Variables in the log-linear model

Variable	Description
<i>Dependent variable:</i>	
INV	Total value of land-attached investments
<i>Explanatory variable:</i>	
ESCRITURA	Dummy variable for a secure land right
<i>Credit source:</i>	
PRIVATE BANK	Dummy variable for credit from private bank
CAJA RURAL	Dummy variable for credit from a rural cashier's office
NGO	Dummy variable for credit from NGO
RURAL BANK	Dummy variable for credit from rural bank
GOVERNMENT PROGRAM	Dummy variable for credit from government program
CREDIT COOPERATIVE	Dummy variable for credit from credit cooperative
COMMERCIAL CREDIT	Dummy variable for commercial credit
OTHER CREDIT	Dummy variable for credit from other sources than above
<i>Household characteristics:</i>	
TA	Dummy variable for technical assistance
MALE	Dummy variable for the sex of the producer
AGE	Age of producer in number of years
EDU	Level of education
<i>Welfare:</i>	
NO WATER SOURCE	Dummy variable for no water source on the plot
LAND	Size of total land owned measured in manzanas
MACHINERY	Numeric value of total machinery
CATTLE	Numeric value of total cattle
<i>Vegetation:</i>	
TEMPORARY	Size of land in manzanas that is cultivated with temporary crops
PERMANENT	Size of land in manzanas that is cultivated with permanent crops
FALLOW	Size of fallow land in manzanas
PASTURE	Size of land in manzanas used for pastures
CULTIVATED PASTURE	Size of land in manzanas used for cultivated pasture
FORREST	Size of land in manzanas covered by forrest
INFRASTRUCTURE	Size of land in manzanas used for buildings and roads
SWAMP	Size of swamp land in manzanas
NATURAL CALAMITY	Size of land in manzanas that has been hit by some kind of natural calamity
<i>Socio-economic sectors⁷⁶:</i>	
LATIFUNDIO COFFEE ZONE	Dummy for latifundios in the coffee growing zone
MILK SECTOR	Dummy for milk sector
COASTAL ZONE	Dummy for coastal zone
CATTLE ZONE (SOUTH)	Dummy for cattle zone in the South of the country
NEW AGR. FRONTIER	Dummy for land at the new agricultural frontier
OLD CATTLE FRONTIER	Dummy for land at the old cattle agricultural frontier
OLD COFFEE FRONTIER	Dummy for land at the old coffee growing frontier
NATIVE COMMUNITIES	Dummy for land in native communities
PACIFIC COFFEE ZONE	Dummy for land at the Pacific coffee growing zone
LATIFUNDIO (DRY AREA)	Dummy for latifundios in dry areas
SMALL FARMER ZONE (NORTH)	Dummy for land used by small farmers in the North
PACIFIC PLAIN	Dummy for plain land at the Pacific

Source: Censo agropecuario 2001

⁷⁶ The omitted category is a variable for conifer area.

Based on the variables listed and explained above the following model is estimated:

$$\ln(INV) = \beta_1 + \beta_2 ESCRITURA + \sum_{i=1}^8 \beta_{i+2} CREDIT_i + \beta_{11} TA + \beta_{12} MALE + \beta_{13} AGE + \beta_{14} EDUCATION + \sum_{i=1}^4 \beta_{i+14} WELFARE + \sum_{i=1}^9 \beta_{i+18} VEGETATION_i + \sum_{i=1}^{12} \beta_{i+27} SOCIAL_i + \varepsilon_i$$

In the next section the results of the estimated log-linear model will be presented.

6.2 Results and Evaluation of the Log-linear Model

The values of the coefficients used in the log-linear model, the number of observations, the F-statistics and the R-square values are shown in *Table 3*. As can be seen from the table only 29730 observations of the originally 206631 observations remain when the final regression is run. This has to do with the presence of missing values increasing with the number of variables included in the model. In order to detect possible bias of the remaining observations the mean values of the variables used in the final model have been compared with the mean values when all observations are included. The means of the observations in the model did not significantly diverge from the values of the original sample size regarding any variable⁷⁷. Observations lost due to missing values do thus not significantly affect the results differently than if all observations in the database had been included

The variables in *Table 3* have been entered stepwise by group in order to see if the ESCRITURA variable changes in an unexpected way. Column 1 includes the credit variables, column 2 adds household characteristics, column 3 adds welfare variables, column 4 adds vegetation variables and lastly column 5 includes all variables. With a coefficient of 0.861 the ESCRITURA variable points towards the existence of a strong positive relationship with the dependent variable. According to the model a producer in possession of a secure land title invests 86.1% more in land compared to a producer without such land right.

Despite the fact that the ESCRITURA variable is of primary interest some words regarding the signs of the other variables are of interest as well. With a sign of 33.6% the MALE variable is positive according to expectations. This result indicates that investment in Nicaragua depends on gender, which is in line with observations from the field. The TA variable can be assumed to have a strong positive impact on investments as it increases investments by as much as 77.4%. Moreover, education also seems to be of importance for investment since the variable is significantly positive and according to theory. The welfare variables are significant and they all have expected signs, except for the CATTLE variable, which surprisingly is insignificant and has a coefficient value of 0%. Finally, it is of interest to note that all credit variables are significant and have a positive impact on investment. Among these variables, the private banks have the most

⁷⁷ This result only applies when the cases are listed as pair-wise instead of list-wise in SPSS.

positive effect on the dependent variable followed by commercial credit and credit cooperatives.

Table 3. Estimated coefficients in the log-linear model

Dependent variable: ln(INV)	Credit source	Household	Welfare	Vegetation	All
	(1)	(2)	3)	(4)	(5)
ESCRITURA	1.367*** (33.4)	1.207*** (28.8)	1.169*** (29.1)	1.051*** (26.4)	0.861*** (21.5)
<i>Credit source:</i>					
PRIVATE BANK	1.831*** (18.2)	1.413*** (14.0)	0.856*** (8.78)	0.873*** (8.87)	1.085*** (11.2)
NGO	0.443*** (4.77)	0.254*** (2.74)	0.266*** (3.00)	0.312*** (3.57)	0.284*** (3.31)
CAJA RURAL	0.717*** (5.47)	0.648*** (4.99)	0.395*** (3.17)	0.448*** (3.65)	0.401*** (3.32)
RURAL BANK	0.329*** (2.97)	0.216*** (1.97)	0.254*** (2.42)	0.288*** (2.78)	0.332*** (3.26)
GOVERNMENT P.	0.649*** (6.72)	0.454*** (4.72)	0.418*** (4.54)	0.453*** (4.99)	0.373*** (4.18)
CREDIT COOP.	0.888*** (9.11)	0.713*** (7.37)	0.528*** (5.69)	0.575*** (6.31)	0.669*** (7.45)
COMMERCIAL CRE.	0.782*** (7.08)	0.571*** (5.21)	0.198* (1.88)	0.297*** (2.86)	0.718*** (6.92)
OTHER CREDIT	0.451*** (3.20)	0.314*** (2.25)	0.171 (1.28)	0.284*** (2.16)	0.354*** (2.75)
<i>Household:</i>					
TA		0.949*** (15.2)	0.810*** (13.4)	0.790*** (13.3)	0.774*** (13.2)
MALE		0.617*** (11.9)	0.400*** (8.01)	0.345*** (7.02)	0.336*** (6.97)
AGE		0.012*** (8.68)	0.014*** (10.4)	0.012*** (9.63)	0.009*** (7.26)
EDU		0.221*** (16.3)	0.235*** (17.9)	0.202*** (15.6)	0.188*** (14.2)
<i>Welfare:</i>					
NO WATER SOURCE			-1.676*** (-40.5)	-1.538*** (-37.5)	-1.44*** (-32.3)
LAND			0.002*** (14.5)	0.006*** (4.69)	0.009*** (6.80)
MACHINERY			0.022*** (16.3)	0.034*** (21.9)	0.034*** (22.1)
CATTLE			0.000* (1.73)	0.000 (1.37)	0.000 (1.42)
<i>Vegetation:</i>					
TEMPORARY				-0.005*** (-2.72)	-0.007*** (-4.50)
PERMANENT				-0.008*** (-6.41)	-0.010*** (-8.15)
FALLOW				-0.007*** (-4.86)	-0.010*** (-6.90)
PASTURE				0.002 (1.47)	-0.002 (-1.24)

CULTIVATED PASTURE	0.000	-0.003**
	(0.26)	(-2.08)
FORREST	-0.007***	-0.010***
	(-5.17)	-7.02
INFRASTRUCTURE	-0.012***	-0.016***
	(-3.98)	(-5.33)
SWAMP	-0.010***	-0.012***
	(-5.27)	(-6.94)
NATURAL CALAMITY	-0.003	-0.005*
	(-0.87)	(-1.66)
<i>Socio-economic sectors:</i>		
LATIFUNDIO COFFEE ZONE		0.281***
		(3.02)
MILK SECTOR		1.672***
		(18.6)
CATTLE ZONE		1.025***
		(9.08)
COASTAL ZONE		1.164***
		(4.56)
NEW AGR. FRONTIER		-0.825***
		(-8.00)
OLD CATTLE FRONTIER		0.344***
		(4.61)
OLD COFFEE FRONTIER		-0.897***
		(-9.38)
NATIVE COMMUNITIES		-1.212***
		(-7.54)
PACIFIC COFFEE ZONE		-0.108
		(-0.68)
LATIFUNDIO		0.904***
		(11.5)
SMALL FARMER ZONE		0.253***
		(2.81)
PACIFIC PLAIN		0.092
		(1.08)
Observations	29841	29730
F-statistic	228.8	218.4
R-squared	0.065	0.087

t-statistics in the parentheses

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

Source: Censo agropecuario 2001

6.2.1 Multicollinearity and Heteroscedasticity

Multicollinearity means that two or several explanatory variables are correlated. If the correlation is strong it becomes difficult to separate the effects from the different explanatory variables on the dependent variable.⁷⁸ Several pair-wise correlations above 0.5 are a possible but not a necessary condition of multicollinearity. As can be seen in Appendix 3 the ESCRITURA variable has no pair-wise correlation above 0.5. It can thus be concluded that the ESCRITURA variable is free from multicollinearity concerns.

⁷⁸ Edlund 1997, pp. 84-91.

The log-linear regression model assumes that the variance of the residual is constant and independent of the explanatory variables. If that is not the case the residual is heteroscedastic. Whether heteroscedasticity is present in the log-linear model is tested by the Breusch-Pagan-Godfreys test of heteroscedasticity and the calculations are included in Appendix 3. According to the test the hypothesis that the residual is homoscedastic can be rejected. Since heteroscedasticity seems to be present in the model the results should be interpreted with some care.

6.3 Construction of an Econometric Model to Test Hypothesis 2

This section builds a regression model to test hypothesis 2 stated as follows;

Hypothesis 2: *The probability of carrying out land-attached investments increases for producers in possession of secure land titles*

In order to test hypothesis 2 it is necessary to explain a dummy variable and a different test procedure than the former regression model has to be applied. A binary logistic model which takes the natural log of the odds of the dependent variable occurring or not, land-attached investments in this case, has been used to test hypothesis 2. The outcome of logistic regression models is interpreted differently compared to OLS regressions. Logistic models estimate the probability of a certain event occurring and the coefficients measure the change in probability for a unit change in the explanatory variables that the event represented by the dependent variable occurs. The logistic regression model used to test hypothesis 2 therefore measures how the probability of carrying out land-attached investments changes as the explanatory variables change by one unit.⁷⁹

6.3.1 The Dependent Variable

Presence of Land-attached Investments (INVESTMENTS)

The dependent variable of the logistic model is a dummy variable for the presence of investments in land, where the 0 equals no investment and 1 equals investments carried out. Land-attached investments with values above 500US\$ have been selected to be included in the model. Investments with lower values are excluded in order to have a comparable value range and the measure of the dependent variable as accurate as possible.⁸⁰ The list of included investments is in Appendix 2.

6.3.2 Explanatory Variable and Controlling Variables

The explanatory variable and the controlling variables used in the logistic model are the same variables that were used in the linear regression. This means that all variables listed in *Table 2* except the dependent variable in the log-linear model are included in the estimated logistic model as well.

⁷⁹ <http://www2.chass.ncsu.edu/garson/pa765/logistic.htm> .

⁸⁰ See the list of the investments that is included in Appendix 3.

Based on the reasoning of included variables in section 6.3.1 and 6.3.2 the estimated logistic model is stated as follows:

$$INVESTMENTS = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_1 + \beta_2 ESCRITURA + \sum_{i=1}^8 \beta_{i+2} CREDIT_i + \beta_{11} TA + \beta_{12} MALE + \beta_{13} AGE + \beta_{14} EDUCATION + \sum_{i=1}^4 \beta_{i+14} WELFARE_i + \sum_{i=1}^9 \beta_{i+18} VEGETATION_i + \sum_{i=1}^{12} \beta_{i+27} SOCIAL_i + \varepsilon_i$$

Where the odds ratio in favour of making land-attached investments is represented by:

$$\frac{P_i}{1-P_i} \text{ and } P_i \text{ represents the probability of these investments occurring.}^{81}$$

6.4 Results and Evaluation of the Logistic Model

The predictions produced by the model to the observed outcomes are measured in the classification table below. The figures in *Table 4* show that 15266 of the producers with no-investments undertakings were correctly predicted by the model and 6810 of the producers that had carried out investments were correctly predicted. The off-diagonal entries show that 5672 of the producers that did not invest were incorrectly classified as investors and 1952 investors were misclassified as non-investors. As many as 73% of the non-investors were correctly specified, while the equivalent number for investors was 77.7%. The overall correct prediction of the model is 74.3%.

Table 4. Classification table for the logistic model

		Predicted		Percentage correct
		No	Yes	
Observed	No	15266	5672	73 %
	Yes	1952	6810	77.7%
Overall percentage				74.3%

*Cut off point: 0.25. **Source:** Censo agropecuario 2001

Table 5 shows the estimated coefficients, total number of observations, chi-square values and two different pseudo R-square measures⁸² for the logistic model. The table reveals that the probability to undertake investments in land increases by 64.7% if the producer possesses an escritura. The coefficient of the ESCRITURA variable is thus in line with

⁸¹ For readers interested in the details regarding logistic regression models see the link below <http://www2.chass.ncsu.edu/garson/pa765/logistic.htm>.

⁸² In a logistic model there is no real R square that measures the explanatory power of the regression model. However, there exist several pseudo R squares that seek to quantify the explanatory power in the regression. The Cox & Snell and Nagelkerke R squares are two such measures. The former is rather difficult to interpret as its maximum can be below 1, and the Nagelkerke R square is a modification to assure that the R square value can vary from 0 to 1.

both theory and expectations stated earlier. Other variables showing expected signs are the TA and the EDUCATION variables. As was the case in the log-linear model, the AGE variable has a positive effect on the propensity to invest in the logistic regression. This is also true for the welfare variables. The MALE variable however, affects the probability to invest negatively and is thus not in line with theory or the results in the log-linear model. Regarding the credit variables the same credit sources that had the most positive effect on the value of investments in the previous regression, i.e. credits from private banks, commercial credit, and credit cooperatives also are the ones that have the largest positive effect on the probability of carrying out land-attached investments.

Table 5. Estimated coefficients in the logistic model

Dependent variable:	Credit source	Household	Welfare	Vegetation	All
INV	(1)	(2)	(3)	(4)	(5)
ESCRITURA	2.495*** (1014)	2.240*** (747.8)	1.757*** (308.6)	1.691*** (256.9)	1.647*** (221.4)
<i>Credit source</i>					
PRIVATE BANK	2.892*** (288.2)	2.189*** (147.8)	1.304*** (13.45)	1.332*** (15.29)	1.394*** (19.93)
N.G.O.	0.982 (0.098)	0.918 (2.032)	0.924 (1.429)	0.938 (0.936)	0.916 (1.673)
CAJA RURAL	1.447*** (19.34)	1.423*** (17.20)	0.970 (0.105)	0.970 (0.103)	0.996 (0.002)
RURAL BANK	1.270*** (11.52)	1.191** (5.984)	1.224*** (6.616)	1.248*** (7.858)	1.142* (2.726)
GOVERNMENT P.	1.161** (5.792)	1.085 (1.650)	1.071 (0.990)	1.069 (0.913)	1.036 (0.254)
CREDIT COOP.	1.390*** (28.34)	1.287*** (16.17)	1.101 (1.940)	1.098 (1.812)	1.207*** (7.034)
COMMERCIAL CRE.	1.652*** (53.16)	1.474*** (30.33)	1.150* (3.133)	1.269*** (9.064)	1.634*** (36.18)
OTHER CREDIT	1.211** (4.261)	1.135 (1.793)	1.008 (0.007)	1.016 (0.024)	1.070 (0.401)
<i>Household:</i>					
TA		1.235*** (55.86)	1.185*** (29.93)	1.208*** (35.62)	1.204*** (33.32)
MALE		1.145*** (11.55)	0.938 (2.170)	0.922* (3.348)	0.935 (2.279)
AGE		1.017*** (251.4)	1.012*** (110.6)	1.012*** (103.7)	1.009*** (57.43)
EDU		1.250*** (571.1)	1.156*** (181.0)	1.167*** (194.5)	1.145 *** (140.4)
<i>Welfare:</i>					
NO WATER SOURCE			0.447*** (522.6)	0.485*** (412.4)	0.433*** (493.5)
LAND			1.011*** (542.6)	1.002 (1.517)	1.002 (2.308)
MACHINERY			1.041*** (409.1)	1.047*** (506.2)	1.049*** (526.6)
CATTLE			1.006*** (165.4)	1.002*** (34.59)	1.002*** (27.87)
<i>Vegetation:</i>					

TEMPORARY				1.001 (0.907)	0.999 (0.233)
PERMANENT				0.996** (5.120)	0.997 (2.585)
FALLOW				1.000 (0.026)	1.001 (0.136)
PASTURE				1.026*** (197.8)	1.026*** (190.3)
CULTIVATED PASTURE				1.017*** (71.65)	1.017*** (72.74)
FORREST				0.997* (2.978)	0.998 (0.818)
INFRASTRUCTURE				1.491*** (206.8)	1.446*** (176.2)
SWAMP				1.001 (0.060)	0.999 (0.089)
NATURAL CALAMITY				1.010 (1.981)	1.010 (1.932)
<i>Socio Economic sectors:</i>					
LATIFUNDIO COFFEE ZONE					0.651*** (45.97)
MILK SECTOR					1.344*** (19.12)
COASTAL ZONE					0.849 (0.608)
CATTLE ZONE					2.269*** (17.84)
NEW AGR. FRONTIER					0.134*** (53.21)
OLD CATTLE FRONTIER					0.598*** (75.39)
OLD COFFEE FRONTIER					0.440*** (140.51)
NATIVE COMMUNITIES					0.446 (2.282)
PACIFIC COFFEE ZONE					0.675*** (6.576)
LATIFUNDIO					1.259*** (15.75)
SMALL FARMER ZONE					0.618*** (56.37)
PACIFIC PLAIN					1.049 (0.492)
Observations	29842	29729	29700	29700	29700
Chi-squared	2303,183	3101.621	7727.081	8544.594	9141,465
Cox & Snell	0.074	0.099	0.229	0.250	0.265
Nagelkerke	0.106	0.141	0.326	0.356	0.377

Wald statistics in the parentheses

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

Source: Censo agropecuario 2001

7. Econometric Concerns

This chapter deals with econometric concerns that may affect the validity of the results presented in section 6.2 and 6.4. As already mentioned, the degree of causality found depends on issues regarding endogeneity and unobserved characteristics from omitted variables.

7.1 Omitted Variables and Endogeneity

The first concern that could cause some doubt about the validity of the results is the issue of omitted variables. This is the case since the models do not control for all variables that affect investments in land. It is for example not possible to control for the fact that some producers are more entrepreneurial and likely to invest than others with the data set at hand. Omitted variables of this kind are always a potential problem in regressions since the variables included in the models depend on the information available in the data set. However, even though the inclusion of omitted variables could alter the results of the models the robustness of the explanatory variable seems to be strong. In both models, the ESCRITURA variable remained highly significant and positive despite the fact that new variables were included. This indicates that the effect of secure ownership on investments is likely to be significant and positive even though variables not included in the models would be added.

Another problem involved in these types of regression models is endogeneity issues. Part of the literature on property rights has ignored that certain aspects of land rights are endogenous and need to be treated as such in order to prove a purely causal relationship between land rights and investments. If endogeneity is present in the model there is a spurious positive association between land rights and investments. There exist two possibilities that could lead to biased studies of how land rights affect investments. The first one implies that there is a reverse relationship in the regression analysis, i.e. that investments increase the probability of achieving or possessing land rights. This would tend to bias the analysis in favour of finding an effect of land rights on rural investments. According to Laiglesia, the presence of such endogeneity in Nicaragua is of rather small significance⁸³ since investments can only help to enhance claims if the landowner is in possession of a certain land title. This title, a supplementary title, is not widespread in the country or in the data set and the regression results are therefore relatively safe from such reverse causation. However, the presence of the second endogenous relationship can still be imparted into the study. It involves a possible bias regarding the decision to title land. The observed positive effect of land rights on investment could in other words have picked up characteristics from omitted variables that may be correlated with the decision to seek title. Regarding econometric studies of titles and investment in Nicaragua

⁸³ Laiglesia 2003, p. 12.

political connections could for instance be an omitted variable of this kind that causes endogeneity.

Endogeneity issues can in theory be solved through instrumental variable analysis. To identify such variables is very difficult though and few studies have succeeded or even tried to do so⁸⁴. In order to control for an endogenous relationship it is necessary to find an instrumental variable that is highly correlated with the measure of land right and at the same time exogenous in its relation to investment. No such variable was found in the data set, why it is unfortunately not possible to exclude the presence of endogeneity in the two models. At this point it is important to stress that the results from the regression models show the correlation between land rights and investments and not necessarily the causation. As the data set in the agricultural census does not provide enough information that would permit an instrumental variable analysis the presence endogeneity will not be further investigated.

8. The Credit Supply Effect

In this chapter the presence of a credit supply effect for producers with secure land rights will be discussed and analyzed with the help of descriptive statistics. The credit supply effect assumes that individual, transferable and secure land titles increase access to formal credit. This is based on the argument that land has excellent properties as collateral if it can be foreclosed and sold by the credit institution in case of default. In line with this reasoning we expect that producers with secure land titles have better access to credit compared to farmers without such titles. Provided that producers with secure land have better access to credit they are also expected to make more investments compared to other producers since they are less credit constrained.

8.1 Indications from the Regressions

The results from the log-linear regression model reveal that once credit has been granted, the value of land-attached investments increases by 108.5% if credit is granted from a private bank, by 71.8% if the producer has received a commercial credit and by 66.9% for producers with credit from credit cooperatives. The other types of credits have remarkably less positive effects on the value of these investments. This is not to say that they are not useful, but they are generally used for other purposes than the relatively large land-attached investments that are measured. Credit from NGOs and government programs is typically used by self-sufficient farmers for investments on a smaller scale.

The results from the logistic model show that once credit has been given, the probability that land-attached investments are carried out increases by 39.5% for producers with loans from private banks and by 63.4% for producers that have received commercial credit. The regression results also show a positive effect from credit cooperatives on the probability that investments occur but with a coefficient of 20.7% this effect is less

⁸⁴ Besley 1998, *The New Palgrave Dictionary of Economics and the Law*, p. 361 and p. 364.

strong. The other credit sources have much smaller positive effects, or even negative effects, on the probability that investments occur.

Both regressions show that these three types of credit are particularly important for investments. In the next section we will look at how the possession of a secure land right affect the access to these credits. If access to these credits is facilitated it will also have a positive effect on investments.

8.2 Evidence of Better Access to Credit with Secure Land Titles

Table 6 illustrates how credits from different credit sources are divided between producers with and without escrituras and for all producers. Figures for how many producers that applied for credit and the proportion of these that received credit applied for are also presented.

Table 6. The credit supply effect

	Producers without escritura%	Producers with escritura%	All producers%
Applied for credit	23.0	24.2	23.7
Received credit ⁸⁵	58.6	67.1	63.2
<i>Received Credit</i> ⁸⁶ :			
Private bank	7	18	14
NGO	39	32	34
Caja rural	5	3	4
Rural/Municipal bank	7	9	8
Government program	18	14	16
Credit cooperative	15	15	15
Commercial credit	5	7	6
Other	4	2	3

Source: Censo agropecuario 2001

Of all producers, 23.7% have applied for credit and the proportion of applying producers that received credit is 63.2%. Interestingly, this proportion was somewhat higher for producers that possess an escritura; 67.1%. Producers with an escritura also applied for

⁸⁵ This is the percentage of the applicants that received credit.

⁸⁶ This is the distribution of credits by credit source shown for producers with and without escritura as well as for all producers.

credit to a slightly larger extent if compared to all producers; 24.2%. When compared to producers without an *escritura* the differences are even greater. Out of this group only 23.0% applied for credit and from those only 58.6% received credit. In conclusion, these figures indicate that secure land rights facilitate access to credit.

Whether land rights have an effect on the source of credit can also be studied from *Table 6*. The table reveals that the proportion of credit distributed from private banks, rural/municipal banks and commercial credit increases with the ownership of an *escritura*. Credits from private banks increases with the holding of *escrituras* from 7% to 18%. The proportion of commercial credit increases from 5% to 7%. Also credits from municipal/rural banks increase from 7% to 9% but all other credit either decreases or remains unchanged. It is interesting to see that less formal credit from NGOs and government programs decreases for producers with an *escritura*. This indicates that with more secure land titles comes a shift from less formal subsidized credit to more formal commercial credit from private banks in particular. It is likely that borrowers in possession of *escrituras* have better access to formal credit and do not need to apply for credit from less formal credit sources.

9. Discussion and General Conclusions

Evidence presented from the agricultural census suggests that the possession of a secure land title significantly increase land-attached investments. The possession of an *escritura* was found to increase the value of land-attached investments carried out by 86.1%. This result is underpinned by the significant findings from the logistic regression model where the probability to make a land-attached investment increased by 64.7% for producers that own secure land rights. We can therefore conclude that both hypothesis 1 and 2 are accepted. With these hypotheses accepted formal land documents clearly seem to matter for economic outcomes.

As was discussed in chapter 7 the fact that the decision to invest could be driven by factors that are not included in the models and the possibility of endogeneity in these models should be considered a caveat in the interpretation of the results above. Even though the results from both models support the theoretical arguments that secure land rights are essential for economic growth it is also legitimate to question how far the findings from the regressions can be drawn with respect to advice on future economic policy. It is beyond the scope of this thesis to engage in a detailed discussion regarding proper policies to tackle the problem of property rights in Nicaragua. Even so, a few words should be added to emphasize some of the observations from the field work to complement the findings above. In order for legally secure land rights to actually have an effect on investments their validity must be trusted by the owners. Land titling could indeed lead to more economic activity and growth, but by no means for sure. Whether land titling renders the desired effect on investments or not highly depends on the institutional capacity of the country and the political will to enforce legal ownership rights. The perception of the security of land ownership rights in other words depends on the enforcement of property rights, and with that, the investment decisions carried out by land owners. This is something that is changeable with time depending on the events

taking place in the political and economical sphere. Despite the fact that the legal property rights system over land is very complex and often involve contradictory propositions, formal and registered land titles are generally perceived as secure in Nicaragua today. With respect to the results from the regression models it does not seem far reached to assume that land titling has the potential of making important contributions to economic development and growth. Having said that though, does not imply that secure land rights should be interpreted as the only viable solution to enhancement of investments in Nicaragua. In order for land rights to actually achieve an optimal effect on investments other measures need to be taken into consideration as well. Viewing land rights as the single causal factor to economic development is to neglect the complexity of the network of factors that affect investments. The regressions showed that other variables were also important for the propensity to invest and for the value of investments to increase. Education, the quality of land and welfare are all important factors for investments taking place. Land titling is also not likely to lead to more investment undertakings if the producers lack capital. This suggests that the access to credit is important when making investments.

There is support for hypothesis 3 as descriptive statistics indicate that secure land titles do facilitate access to credit in Nicaragua. This is especially true for credit from private banks but also for commercial credit and credit from municipal/rural banks. At the same time the proportion of credit from less formal credit sources is smaller for producers in possession of escrituras, which is an indication of a shift towards more formal credit from less formal credit as the producers receive secure land titles. Further, credit from private banks, commercial credit, and credit from cooperatives significantly increase the value of investments made. Credits from these sources are also the ones that increase the probability that investments are carried out for the most part.

When studying the effect from land rights it is difficult to see to what extent it attributes to security, credit or land allocations and to quantify feelings of security is always difficult when working with data material. The interviews showed that security is an issue, but also that credit constraints are an obstacle to investments. By this logic it is likely that land titles enhance investments through both increased security and a credit supply effect. Investments are directly affected through the better ability to receive credit and more indirectly through perceived better security. Indirectly since security is needed for credit and an investment friendly environment and directly through credit since credit is needed for investments.

Much can be said about property rights. Their importance for economic prosperity was realized centuries ago, and today there is still a world-wide ongoing debate about their effects for society and economic development. By digging into the vast jungle of the Nicaraguan property rights system the authors' intention was to make a contribution to this debate from an economic growth perspective.

10. Suggestions for Future Research

The findings in this thesis suggest that land titling can have a major impact on rural investments. According to theory the reason why property rights enhance investments is explained by three channels; they increase incentives to invest, they improve access to credit and lastly, they decrease transactions costs in land markets. The credit channel has to some extent been explored by descriptive analysis from the data set used. As concluded above the statistics indicate that credit access to loans from the formal sector is better for land owners in possession of a secure land title. An interesting scope for future research is to investigate the prospect and incentives for extended lending activities in rural markets in Nicaragua. In order to fully exploit the positive economic effects from the enforcement of an efficient property rights system, a greater presence of private lending institutions in rural areas should benefit the country. Attempts to study the credit effect have been made in previous research but too little research has been directed towards how land titling can contribute to a better business climate in practice. This involves investigating how foreign aid eventually should be phased out in a reasonable speed in order to create sound incentives for commercial alternatives.

Another scope for future research is to explore the effect of land titling on transactions in land markets as very little research has been made on the effects of this specific channel. Even though it is generally difficult to find data that provides information over land transactions, it is worth a try to investigate their impact on investments as there is a general consensus that they are of importance, not least according to theory on property rights on land.

Lastly, the issue of endogeneity deserves special attention from future researchers. The presence of endogeneity can represent serious difficulties in identifying the impact of land rights on rural investments. Studies that succeed to find instrumental variables for land rights could therefore make important contributions in order to prove the existence of a causal relation between land rights and investments.

References

- Alston, L. J., Libecap, G.D. and Schneider, R. (1996), "The Determinants and Impact of Property Rights: Land Titles on the Brazilian Frontier", *Journal of Law, Economics and Organization*, 12: 25-61.
- Besley, T. (1995), "Property Rights and Investment Incentives: Theory and Evidence from Ghana", *Journal of Political Economy*, 103: 903-937.
- Besley, T. (1998), "Investment Incentives and Property Rights" entry in Newman, P., *The New Palgrave Dictionary of Economics and the Law*, London: Macmillan.
- Binswanger, H. and Rosenzweig, M. (1986), "Behavioral and Material Determinants of Production Relations in Agriculture", *Journal of Development Studies*, 22: 523-39.
- Biswanger, H., Deininger K., Feder, G. (1995), "Distortions, Revolt and Reforms in Agricultural Land Relations" entry in J. Behrman and T.N. Srinivasan (eds.), *Handbook of Development Economics*, Vol. III, 2659-2772.
- Blomqvist, H. and Lundahl, M. (1992), *Ekonomisk utveckling*, Stockholm: SNS Förlag, Stockholm.
- Borner, S., Brunetti, A., Weder, B. (1995), "Policy Reform and Institutional Uncertainty: The Case of Nicaragua." *KYKLOS*, 48: 46-64.
- Broegaard R. J., Heltberg R., Malchow-Moller N. (2002), "Property Rights and Land Tenure Security in Nicaragua", CEBR, Copenhagen.
- Cervantes, M. and Rodriguez L., (2004), "Actividades fuera de la finca que generan ingresos - Estudios sobre campesinado y organizacion campesina en Nicaragua", Universidad Nacional autonoma de Nicaragua.
- Demsetz, H. (1967), "Toward a Theory of Property Rights", *The American Economic Review*, 57: 253-257.
- Deininger, K. and Chamorro, J. S. (2002), "Investment and income effects of land regularization: The case of Nicaragua" World Bank Policy Research Working Paper 2752, University of Wisconsin
- De Laiglesia J. R., (2003), "Investment effects of land titling and registration: evidence from Nicaragua." London School of Economics.
- De Soto, H. (2000), *The Mystery of Capital – Why Capital Triumphs in the West and Fails Everywhere Else*, Great Britain: Bantam Press.

Edlund, P-O (1997), *SPSS för Windows 95*, Lund: Studentlitteratur.

Embassy of Sweden in Managua (2004), *Fondeagro Phase 2 (2004-08) - Assessment Memo*.

Feder, G. and Feeny, D. (1996), "The Theory of Land Tenure and Property Rights" entry in Braverman, A., Hoff, K., Stiglitz, J. (1996), *The Economics of Rural Organization – Theory, Practice, and Policy*, Oxford: Oxford University Press, 240-250.

Feder, G., Lau, L. J., Lin, J.Y and Luo, X (1992). "The Determinants of Farm Investment and Residential Construction in Post-Reform China", *Economic Development and Cultural Change*, 41: 1-26.

Feder, G., Onchan, T., Chalamwong, Y. and Hongladrom, C. (1988), *Land Policies and Farm Productivity in Thailand*, Baltimore: Johns Hopkins University Press for the World Bank.

Feder, G. and Onchan, T. (1987), "Land Ownership Security and Farm Investment in Thailand", *American Journal of Agricultural Economics*, 71: 215-16.

Foltz J., Larson B. A., Lopez R. (2000), "Land Tenure, Investment, and Agricultural Production in Nicaragua." Development Discussion Paper No. 738, Harvard Institute for International Development, Harvard University.

FondeAgro (2002), *Caracterización de la Economía Agrícola de los Municipios de El Cuá y Wiwili*. Fondo de Desarrollo Agropecuario.

Gujarati, D. (2003), *Basic Econometrics*, Fourth Edition, Singapore: McGraw-Hill.

INEC (2000), *Encuesta nacional de hogares sobre medición de nivel de vida EMNV '98*, Proyecto Mecovi.

INEC (2003), *Perfil Comparativo de la Pobreza en Nicaragua*, Proyecto Mecovi.

IRAM (2000), *Estudios sobre la Tenencia de la Tierra*, parte 1.

Jonakin, J. (1996), "The Impact of Structural Adjustment and Property Rights Conflicts on Nicaraguan Agrarian Reform Beneficiaries", *World Development*, 24: 1179-1191.

Lin, J. Y. (1988), "The Household Responsibility System in China's Agricultural Reform: a Theoretical and Empirical Study", *Economic Development and Cultural Change*, 36: 199-224.

Lin, J. Y. (1992), "Rural Reforms and Agricultural Growth in China", *American Economic Review*, 82: 34-51.

Lundahl, U. and Skärvad, P. H. (1982), *Utredningsmetodik för samhällsvetare och ekonomer*, Lund: Studentlitteratur.

Marin, Y. and Pauwels, (2001), *El Campesino-Finquero – Hacia una modernización incluyente de la Región Central*, UCA Publicaciones and Nitlapán.

NC State University (2005), “Logistic Regression”. Available online: www.2.chass.ncsu.edu/garson/pa765/logistic.htm [2005-02-11].

Neira, O. (2005), “The IMF and Financial-Sector Reform in Nicaragua”. Available online: <http://www.developmentgap.org/imfnicaragua.html> [2005-01-29].

Nitlapán – U.C.A (1995), *Diagnostico de la Produccion Agropecuaria en el Interior del Pais*, Análisis de Encuesta Rural 1995.

Perkins, D. H. (2001), *Economics of Development*, New York and London: W.W. Norton & Company.

World Bank (2003), *Nicaragua Land Policy and Administration: Toward a More Secure Property Rights Regime*. Rural Development Unit, Latin America Region.

World Bank (2003), *Nicaragua Promoting Competitiveness and Stimulating Broad-based Growth in Agriculture*. Rural Development Unit, Latin America Region.

Web sites

INEC www.inec.gob.ni/ [2004-09-10]
Utrikespolitiska Institutet www.ui.se [2004-09-21]

List of interviewed producers (Jinotega region, Nicaragua, July 2004)

Respondents from el Cuá	Respondents from Wiwili
Catalina Gutierrez	Gladis Salgado
Aquilino Valdivia	José Lopez
Gavino Perez	Hernan Araof
Fransisco Acuña	Pedro Hoyes
Juana Maria	Israel Acevedo
Enrique Rado	Estefan Espinoza
Santomino Cruz	Maria Chavaria
José Thelaia	Marcio Raillo
Fransisco Salgado	José Valdivia
Maria Olivas	David Flores
Paula Castillo	Aristides Cruz
Mercedez Gaveaz	Alfonzo Peralta
Fransisca Hernandez	Pablo Carasco
	Vidal Benavidez
	Augustina paguada
	Saul Beravidez
	Sebastian Perez
	Fransisco Martinez
	Maria Rodrigues
	Maria Hernandez
	José Velasquez
	José Lopez

List of other interviews

Alfredo Ruiz Garcia	Investigator, Nitlapan, FDL – UCA, 2004-07-02, Managua
Arturo Grigsby	Executive Director, Nitlapan – UCA, 2004-08-09, Managua
Christine Goffin	Manager of the Mecovi program, INEC, 2004-06-29, Managua
Eduardo Baumeister	Researcher, Fondeagro, 2004-07-15, Matagalpa
Guillermo Aléman Gómez	Lawyer, INVUR, 2004-06-29, Managua
Jaime Cofre	Agricultural Specialist, IDB, 2004-08-02, Managua
Mario Brockman	Programme Officer, Swedish Embassy, 2004- 06- 28, Managua
Norman Piccioni	Agricultural Specialist, World Bank, 2004- 08-03, Managua
Patricia Hernandes	Lawyer, OTR, 2004-07-01, Managua
Patricia Salazar de Lanzas	Administrative Assistant, Fondeagro, 2004-07-15, Matagalpa
Sonia Lopez Zalenó	Specialist, MAGFOR, 2004-07-07, Managua

Appendix 1.

Table 7. Descriptive statistics table

Variables	Min. ⁸⁷	Max.	Mean	Std. Deviation
ESCRITURA			0.517	0.500
PRIVATE BANK			0.145	0.352
CAJA RURAL			0.040	0.195
NGO			0.364	0.481
RURAL BANK			0.081	0.273
GOVERNMENT P.			0.164	0.370
CREDIT COOP.			0.157	0.364
COMMERCAL CREDIT			0.064	0.245
OTHER CREDIT			0.032	0.175
TA			0.119	0.323
MALE			0.820	0.384
AGE	15	98	48.00	15.30
EDU	0	7	1.380	1.567
NO WATER SOURCE			0.335	0.472
LAND	0	35000	43.91	177.0
MACHINERY	1	2478	8.371	15.27
CATTLE	0	1000005	66.30	3949
TEMPORARY	0	4509	4.799	19.76
PERMANENT	0	15608	2.119	51.91
FALLOW	0	9619	8.504	47.45
PASTURE	0	7495	14.69	64.51
CULTIVATED PASTURE	0	4422	6.672	41.78
FORREST	0	25000	6.367	87.42
INFRASTRUCTURE	0	4000	0.506	9.242
SWAMP	0	3740	0.805	17.65
NATURAL CALAMITY	0	1500	0.311	6.413
LATIFUNDIO COFFEE ZONE			0.066	0.248
MILK SECTOR			0.077	0.267
COASTAL ZONE			0.043	0.203
CATTLE ZONE			0.005	0.074
NEW AGR. FRONTIER			0.057	0.232
OLD CATTLE FRONTIER			0.258	0.437
OLD COFFEE FRONTIER			0.072	0.259
NATIVE COMMUNITIES			0.015	0.123
PACIFIC COFFEE ZONE			0.015	0.123
LATIFUNDIO			0.125	0.331
SMALL FARMER ZONE			0.074	0.262
PACIFIC PLAIN			0.081	0.273

N= 206631

Source: Censo agropecuario 2001

⁸⁷ All variables except the ones presented in *Table 8* in columns Min. and Max. are dummy variables with a minimum value of 0 and a maximum value of 1.

Appendix 2.

Table 8. List of investments in the log-linear model

Investment	Value in US\$
Collective house building	5000
Farm office building of wood and cement (4*4 meters)	2300
Wine cellar made of wood (5*5 meters)	700
Grain silo (capacity of 18QQ)	60
Shed	1400
Fodder silo made of iron spits (capacity of 4QQ)	150
Farmyard (6*6 meters)	1400
Stable for 4 animals	100
Warehouse (3m x 3m)	100
Bathtub for cattle	900
Enclosed yard (10*10 meters)	3100
Scales for cattle attached to a platform	1748
Poultry	80
Pigsty	150
Basin for cattle made of stone (10*1 meters)	300
Water tank mad of 200 gls plastic material	150
Landing net	20

Source: Censo agropecuario 2001. The value of the investments is estimated by Walter Lopez, agricultural economist at Fondeagro, in 2005.

Table 9. List of investments in the logistic model

Investment
Collective house building
Farm office building of wood and cement (4*4 meters)
Wine cellar made of wood (5*5 meters)
Shed
Farmyard (6*6 meters)
Bathtub for cattle
Enclosed yard (10*10 meters)
Scales for cattle attached to a platform

Source: Censo agropecuario 2001

Appendix 3.

Table 10. Correlation matrix

	Esc.	Priv. B.	NGO	Caja R.	Rur. B.	Gov. P.	Cred. C.	Com. C.	Oth. C.	T.A.	Male	Age	Edu	No W.S.	Land
ESCRITURA	1	.162	-.084	-.036	.040	-.059	-.008	.054	-.039	.040	-.044	.196	.165	.006	.060
PRIVATE BANK	.162	1	-.293	-.076	-.114	-.170	-.162	-.047	-.070	.020	.013	.040	.247	-.106	.137
N.G.O.	-.084	-.293	1	-.140	-.210	-.279	-.288	-.180	-.124	.075	-.010	-.016	-.103	.090	-.058
CAJA RURAL	-.036	-.076	-.140	1	-.054	-.081	-.076	-.042	-.033	-.050	-.010	-.015	-.023	-.033	.004
RURAL BANK	.040	-.114	-.210	-.054	1	-.119	-.114	-.066	-.049	-.067	-.006	.025	-.015	.055	-.015
GOVERNMENT P.	-.059	-.170	-.279	-.081	-.119	1	-.162	-.105	-.071	.053	-.001	-.018	-.052	.023	-.029
CREDIT COOP.	-.008	-.162	-.288	-.076	-.114	-.162	1	-.087	-.070	-.017	.011	-.006	-.016	-.040	-.015
COMMERCAL CREDIT	.054	-.047	-.180	-.042	-.066	-.105	-.087	1	-.041	-.012	.018	-.009	.049	-.069	.007
OTHER CREDIT	-.039	-.070	-.124	-.033	-.049	-.071	-.070	-.041	1	-.023	-.009	-.006	-.012	.008	.016
TA	.040	.020	.075	-.050	-.067	.053	-.017	-.012	-.023	1	.041	-.013	.115	.000	.018
MALE	-.044	.013	-.010	-.010	-.006	-.001	.011	-.018	-.009	.041	1	-.078	.026	-.074	.044
AGE	.196	.040	-.016	-.015	.025	-.018	-.006	-.009	-.006	-.013	-.078	1	-.158	.050	.016
EDU	.165	.247	-.103	-.023	-.015	-.052	-.016	.049	-.012	.115	.026	-.158	1	.040	.101
NO WATER SOURCE	.006	-.106	.090	-.033	.055	.023	-.040	-.069	.008	.000	-.074	.050	.040	1	-.126
LAND	.060	.137	-.058	.004	-.015	-.029	-.015	.007	.016	.018	.044	.016	.101	-.126	1
MACHINERY	.077	.140	-.052	-.015	-.016	-.039	-.012	.052	.002	.119	.053	.035	.130	-.062	.386
CATTLE	.008	.031	-.011	-.001	-.003	-.006	-.005	-.004	-.002	.019	.003	-.001	.017	.004	.007
TEMPORARY	.002	.146	-.044	-.006	-.018	-.030	-.025	.013	-.002	.046	.037	.012	.056	-.082	.281
PERMANENT	.016	.062	-.024	-.006	-.008	-.012	-.010	.012	.020	.034	.007	.002	.050	-.012	.414
FALLOW	.017	.087	-.040	.016	-.013	-.022	-.005	.009	.001	-.007	.027	.011	.049	-.086	.632
PASTURE	.106	.130	-.064	.007	-.013	-.022	-.004	-.016	-.008	.005	.039	.023	.099	-.127	.530
CULTIVATED PASTURE	.056	.125	-.056	.016	-.004	-.029	-.015	-.005	.000	.005	.033	.012	.076	-.095	.403
FORREST	-.013	.065	-.029	.007	-.013	-.021	-.007	.015	.027	.003	.018	-.004	.021	-.039	.703
INFRASTRUCTURE	.011	.027	-.009	-.002	-.003	-.005	-.005	-.001	.005	.012	.005	.001	.021	-.020	.321
SWAMP	.014	.032	-.013	.001	-.003	-.005	-.005	-.003	.021	.011	.008	.010	.039	-.022	.426
NATURAL CALAMITY	.005	.044	-.011	-.002	-.001	-.012	-.008	.007	-.002	.005	.005	.010	.021	-.018	.147
LATIFUNDIO COFFEE ZONE	.076	.060	-.002	-.034	-.042	-.032	-.007	.066	-.028	.050	.006	.001	.014	.023	-.029
MILK SECTOR	.123	.005	-.011	.041	-.010	.038	-.017	-.047	-.010	.016	-.014	.046	.050	-.059	.029
CATTLE ZONE	-.064	.027	-.037	.038	.003	-.020	.024	-.020	.008	-.064	.022	-.071	-.078	-.131	.076
COASTAL ZONE	-.008	.021	.008	-.003	-.005	-.011	.014	.001	-.008	.008	-.009	.010	.022	-.014	.000
NEW AGR. FRONTIER	-.147	-.021	.024	.062	-.017	-.016	-.020	-.022	.021	-.073	.033	-.093	-.072	-.115	.056
OLD CATTLE FRONTIER	-.076	-.024	-.090	.070	-.055	.042	.079	.015	.022	-.058	.051	-.113	-.120	-.238	.037
OLD COFFEE FRONTIER	-.040	.056	-.127	-.018	-.041	-.073	.104	.224	.014	.018	.005	-.066	-.030	-.066	-.037
NATIVE COMMUNITIES	-.095	-.013	.016	.030	.005	-.012	-.014	-.009	.000	-.031	.009	-.034	.001	.017	.012
PACIFIC COFFEE ZONE	.042	.021	-.050	-.004	.028	.002	-.007	.025	.017	.015	-.013	.035	.102	.162	-.020
LATIFUNDIO	.024	-.047	.067	.004	.020	.012	-.028	-.073	.003	.019	.014	.079	.003	.029	.005
SMALL FARMER ZONE	-.015	-.118	.187	-.040	-.057	.019	-.025	-.084	-.017	.095	.008	.043	-.012	.081	-.036
PACIFIC PLAIN	.055	.059	-.001	-.022	.059	.022	-.046	-.038	.005	.008	-.053	.074	.126	.166	-.024

Source: Censo agropecuario 2001

Table 10. Correlation matrix, continued

	Machinery	Cattle	Temp.	Perm.	Fallow	Pasture	Cult. Pas.	Forrest	Infrastr.	Swamp	Nat. Cal.	Lat. Coff.	Milk. S.	Cattle Z.	Coast
ESCRITURA	.077	.008	.002	.016	.017	.106	.056	-.013	.011	.014	.005	.076	.123	-.064	-.008
PRIVATE BANK	.140	.031	.146	.062	.087	.130	.125	.065	.027	.032	.044	.060	.005	.027	.021
N.G.O.	-.052	-.011	-.044	-.024	-.040	-.064	-.056	-.029	-.009	-.013	-.011	-.002	-.011	-.037	.008
CAJA RURAL	-.015	-.001	-.006	-.006	.016	.007	.016	.007	-.002	.001	-.002	-.034	.041	.038	-.003
RURAL BANK	-.016	-.003	-.018	-.008	-.013	-.013	-.004	-.013	-.003	-.003	-.001	-.042	-.010	.003	-.005
GOVERNMENT P.	-.039	-.006	-.030	-.012	-.022	-.022	-.029	-.021	-.005	.005	-.012	-.032	.038	-.020	-.011
CREDIT COOP.	-.012	-.005	-.025	-.010	-.005	-.004	-.015	-.007	-.005	-.005	-.008	.007	-.017	.024	-.014
COMMERCAL CREDIT	.052	-.004	.013	.012	.009	-.016	-.005	.015	-.001	-.003	.007	.066	-.047	-.020	.001
OTHER CREDIT	-.002	-.002	-.002	.020	.001	-.008	.000	.027	.005	.021	-.002	-.028	-.010	.008	-.008
TA	.119	.019	.046	.034	-.007	.005	.005	.003	.012	.011	.005	.050	.016	-.064	.008
MALE	.053	.003	.037	.007	.027	.039	.033	.018	.005	.008	.005	.006	-.014	.022	-.009
AGE	.035	-.001	.012	.002	.011	.023	.012	-.004	.001	.010	.010	.001	.046	-.071	.010
EDU	.130	.017	.056	.050	.049	.099	.076	.021	.021	.039	.021	.014	.050	-.078	.022
NO WATER SOURCE	-.062	.004	-.082	-.012	-.086	-.127	-.095	-.039	-.020	-.022	-.018	.023	-.059	-.131	-.014
LAND	.386	.007	.281	.414	.632	.530	.403	.703	.321	.426	.147	-.029	.029	.076	.000
MACHINERY	1	.040	.217	.523	.181	.104	.084	.143	.435	.326	.036	.061	.013	-.022	.001
CATTLE	.040	1	.001	.003	.003	.006	.007	.001	.011	.004	.001	-.003	-.001	.000	.000
TEMPORARY	.217	.001	1	.033	.171	.099	.076	.110	.028	.099	.128	-.019	-.018	.031	.023
PERMANENT	.523	.003	.033	1	.051	.010	.007	.122	.653	.527	.005	.009	-.005	-.002	.002
FALLOW	.181	.003	.171	.051	1	.222	.148	.407	.046	.160	.134	-.028	-.003	.065	-.001
PASTURE	.104	.006	.099	.010	.222	1	.211	.072	.029	.122	.058	-.031	.085	.070	-.007
CULTIVATED PASTURE	.084	.007	.076	.007	.148	.211	1	.068	.023	.087	.055	-.030	.028	.090	.003
FORREST	.143	.001	.110	.122	.407	.072	.068	1	.074	.124	.048	-.008	-.012	.025	-.001
INFRASTRUCTURE	.435	.011	.026	.653	.046	.029	.023	.074	1	.383	.008	-.003	.002	.007	.002
SWAMP	.326	.004	.099	.527	.160	.122	.087	.124	.383	1	.055	-.004	.012	.001	.004
NATURAL CALAMITY	.036	.001	.128	.005	.134	.058	.055	.048	.008	.055	1	-.001	.000	-.004	-.002
LATIFUNDIO COFFEE ZONE	.061	-.003	-.019	.009	-.028	-.031	-.030	-.008	-.003	-.004	-.001	1	-.077	-.056	-.020
MILK SECTOR	.013	-.001	-.018	-.005	-.003	.085	.028	-.012	.002	.012	.000	-.077	1	-.061	-.021
CATTLE ZONE	-.022	.000	.031	-.002	.065	.070	.090	.025	.007	.001	-.004	-.056	-.061	1	-.016
COASTAL ZONE	.001	.000	.023	.002	-.001	-.007	.003	-.001	.002	.004	-.002	-.020	-.021	-.016	1
NEW AGR. FRONTIER	-.025	-.002	.036	.003	.061	-.031	.011	.086	.006	.008	.014	-.065	-.071	-.052	-.018
OLD CATTLE FRONTIER	-.027	-.003	.015	-.007	.024	.075	.038	-.011	.002	-.004	-.010	-.157	-.170	-.125	-.044
OLD COFFEE FRONTIER	-.013	-.003	-.025	.007	-.026	-.048	-.030	-.010	-.006	-.010	-.007	-.074	-.080	-.059	-.021
NATIVE COMMUNITIES	-.008	-.001	.001	.001	.016	-.021	-.012	.038	-.004	.000	-.004	-.033	-.036	-.027	-.009
PACIFIC COFFEE ZONE	.016	.023	-.022	.013	-.014	-.026	-.019	-.006	-.003	-.004	-.005	-.033	-.036	-.026	-.009
LATIFUNDIO	.011	-.002	.021	-.012	.021	.007	.005	-.012	.001	.014	.015	-.100	-.109	-.080	-.028
SMALL FARMER ZONE	-.020	-.003	-.019	-.009	-.025	-.032	-.028	-.014	-.006	-.008	.013	-.075	-.082	-.060	-.021
PACIFIC PLAIN	.012	.003	.001	.014	-.025	-.034	-.022	-.007	.007	.006	.001	-.079	-.086	-.063	-.022

Source: Censo agropecuario 2001

Table 10. Correlation matrix, continued

	New A.F.	Old Catt. F.	Old Coff. F.	Nat. Comm. Pac.	Coff. Z.Latifundio	Small F.Z.	Pac. Plain	
ESCRITURA	-.147	-.076	-.040	-.095	.042	.024	-.015	.055
PRIVATE BANK	-.021	-.024	.056	-.013	.021	-.047	-.118	.059
N.G.O.	.024	-.090	-.127	.016	-.050	.067	.187	-.001
CAJA RURAL	.062	.070	-.018	.030	-.004	.004	-.040	-.022
RURAL BANK	-.017	-.055	-.041	.005	.028	.020	-.057	.059
GOVERNMENT P.	-.016	.042	-.073	-.012	.002	.012	.019	-.022
CREDIT COOP.	-.020	.079	.104	-.014	-.007	-.028	-.025	-.046
COMMERCAL CREDIT	-.022	.015	.224	-.009	.025	-.073	-.084	-.038
OTHER CREDIT	.021	.022	.014	.000	.017	.003	-.017	.005
TA	-.073	-.058	.018	-.031	.015	.019	.095	.008
MALE	.033	.051	.005	.009	-.013	.014	.008	-.053
AGE	-.093	-.113	-.066	-.034	.035	.079	.043	.074
EDU	-.072	-.120	-.030	.001	.102	.003	-.012	.126
NO WATER SOURCE	-.115	-.238	-.066	.017	.162	.029	.081	.166
LAND	.056	.037	-.037	.012	-.020	.005	-.036	-.024
MACHINERY	-.025	-.027	.013	-.008	.016	.011	-.020	.012
CATTLE	-.002	-.003	-.003	-.001	.023	-.002	-.003	.003
TEMPORARY	.036	.015	-.025	.001	-.022	.021	-.019	.001
PERMANENT	.003	-.007	.007	.001	.013	-.012	-.009	.014
FALLOW	.061	.024	-.026	.016	-.014	.021	-.025	-.025
PASTURE	-.031	.075	-.048	-.021	-.026	.007	-.032	-.034
CULTIVATED PASTURE	.011	.038	-.030	-.012	-.019	.005	-.028	-.022
FORREST	.086	-.011	-.010	.038	-.006	-.012	-.014	-.007
INFRASTRUCTURE	.006	.002	-.006	-.004	-.003	.001	-.006	.007
SWAMP	.008	-.004	-.010	.000	-.004	.014	-.008	.006
NATURAL CALAMITY	.014	-.010	-.007	-.004	-.005	.015	.013	.001
LATIFUNDIO COFFEE ZONE	-.065	-.157	-.074	-.033	-.033	-.100	-.075	-.079
MILK SECTOR	-.071	-.170	-.080	-.036	-.036	-.109	-.082	-.086
CATTLE ZONE	-.052	-.125	-.059	-.027	-.026	-.080	-.060	-.063
COASTAL ZONE	-.018	-.044	-.021	-.009	-.009	-.028	-.021	-.022
NEW AGR. FRONTIER	1	-.145	-.068	-.031	-.031	-.093	-.069	-.073
OLD CATTLE FRONTIER	-.145	1	-.164	-.074	-.073	-.223	-.167	-.175
OLD COFFEE FRONTIER	-.068	-.164	1	-.035	-.035	-.105	-.079	-.083
NATIVE COMMUNITIES	-.031	-.074	-.035	1	-.016	-.047	-.035	-.037
PACIFIC COFFEE ZONE	-.031	-.073	-.035	-.016	1	-.047	-.035	-.037
LATIFUNDIO	-.093	-.223	-.105	-.047	-.047	1	-.107	-.112
SMALL FARMER ZONE	-.069	-.167	-.079	-.035	-.035	-.107	1	-.084
PACIFIC PLAIN	-.073	-.175	-.083	-.037	-.037	-.112	-.084	1

Source: Censo agropecuario 2001

Breusch-Pagan-Godfreys Test

$$\hat{\sigma}^2 = \frac{\sum u_i^2}{n} = \frac{296309.3}{29731} = 9.966$$

$$ESS = 37367.663$$

$$\chi_{obs}^2 = \frac{ESS}{2} = \frac{37367.663}{2} = 18683.832$$

$$df = (k - 1) = 39 - 1 = 38$$

H_0 : The residual is homoscedastic

Reject H_0 that the residual is homoscedastic if $\chi_{obs}^2 > \chi_{Critical}^2$

$$\chi_{Critical}^2(38, 0.01) = 61.162$$

$\Rightarrow$ The assumption that the disturbance term is homoscedastic is rejected