Priests, Conflicts and Property Rights: The Impacts on Tenancy and Land Use in Brazil

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Abstract
Historically and today tenancy has been a mechanism for career advancement in agriculture by laborers, yet in Brazil and throughout Latin America, tenancy rates are low compared to the U.S. and the OECD countries. We test for the importance of insecure property rights in Brazil on the reluctance of landowners to rent and to invest because of a fear of expropriation arising from land reform. We instrument land conflicts with the distribution of Catholic priests from a period before the Church became directly involved in land-related issues. We find that land conflicts reduce the likelihood of tenancy and affect land use decisions with negative impacts on agricultural efficiency. The extant literature on the impact of secure property rights on investment and land use shows either greater or lesser investment, our findings are more nuanced: we find lower investment in highest and lowest productivity land uses. We also show that insecure property rights led to a net increase in farm size contributing to the already highly concentrated nature of land holding in Brazil.

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1. Introduction

Compared to the rest of the world, farmers in Brazil rely relatively little on tenant contracts.[1] In agriculture, career mobility is associated with moving up the agricultural ladder from working for wages to renting to owning [Alston and Ferrie 2005]. Alone, this fact may not present a puzzle but coupled with the large number of landless peasants and large amounts of unused land the question is: why don't landowners with unused or under-utilized land negotiate land rental contracts with the landless.[2] In Brazil this avenue for advancement has been hurt by a reluctance of owners to rent in areas experiencing land conflict. The lack of rentals is an important issue because Brazil is geographically a large country, roughly the size of the continental U.S. and has an expanding agricultural frontier, some of which is cutting into the Amazon. If the lack of land rentals is pervasive across Brazil and also signals inefficiency in production, the total magnitude is likely to be large when summed across the country. Some scholars have attributed the lack of rentals to a fear by landlords that renters will become *de facto* owners because of existing legislation making it extremely costly to evict tenants, if they are in default with their rental payments [Buanin et al. (2008); Conning and Robinson (2007) ,de Janvry, Macours and Sadoulet (2002); de Janvry and Sadoulet (1989); Deininger (2003) and Macours (2002).] A similar fear of rentals may arise from land reform projects [de Janvry, Macours and Sadoulet (2002), Rezende (2006)]. For example, in Brazil, land should be put to productive use or it may be subject to compensated expropriation [Alston, Libecap and Mueller (1999)]. Renting land could be deemed unproductive use by land reform agencies and as a result owners would be fearful of renting [Buanin et al. (2008), Brandão et al. (2001); Deininger and Chamorro (2003); Jamarillo (2001); World Bank (1994: 199-200)]. An additional explanation for the lack of rentals rests on the labor and capital intensity of different crops. Some land may not be worth the opportunity cost of capital, and the return to applying labor via a rental contract may be

[1] The use of land rentals is relatively low across all of Latin America. de Janvry, Macours and Sadoulet (2002) present tables showing the importance of land rentals across the world and for certain countries in Latin America. For the world, tenancy stood at 23% in 2000 (Federico, 2006). In Brazil, for 1996 tenancy was 2.5% (of total hectares) and 11% (of the number of farms) (IBGE, 2007).

[2] The MST (Landless Peasant Movement) estimates that there are 4 million landless peasants in Brazil. However, this estimate includes all who are 'demanding land' and is broader than those with actual aptitude for agriculture and the intention to stay on the land.

close to zero. As such landowners may opt to leave land vacant as a potential store of value or in some cases collateral for credit to be used elsewhere. Alternatively, if farmers are fearful that land may be invaded and expropriated if left idle, they might opt to rent to demonstrate use and possession, particularly if the landlord has reason to trust the renter. To the extent that land conflict and land reform policies affect land rentals and encourage expansion of the agricultural frontier into the Amazon, deforestation will result. By estimating the impact of land conflict on land rentals and land use we can better judge the deficiencies in current land reform policies and this can be a guide for better policies in the future. Better land reform policies can be trebly important: 1) Lives can be saved and poor people's lot improved if tenancy is a step on the agricultural ladder; 2) land reform policies can improve the productivity of agriculture in Brazil; and 3) land reform policies can slow the rate of deforestation in the Amazon, which holds the largest stock of tropical forests in the world.

We test for the impact of land conflict on land rentals and land use by using *municipio* (county) level data from the Brazilian censuses along with data on land conflicts from the Pastoral Land Commission (CPT). In Section 2 we give a brief overview of the theoretical literature on tenancy contracts. In Section 3 we discuss the specific hypotheses to be tested for the Brazilian case. In Section 4 we describe the data and in Section 5 we present the results and discussion. We offer concluding remarks in Section 6.

2. Theoretical Hypotheses about Tenancy

The theoretical literature on tenancy is voluminous. We assume that the standard explanations for the efficiency of sharecropping and tenancy – share and fixed-rent - are now public knowledge. By standard explanations we mean risk and transaction costs.[3] In short, depending on the endowments of landlords and workers as well as their preferences towards risk, there exist conditions such that the optimal operator status can be either, owner-operator (with only household or with hired wage workers); sharecropper; share tenant; or fixed-rent tenant.[4]

In the U.S. in the 19th and early 20th centuries there was a life-cycle to contract choice which agricultural economists referred to as the agricultural ladder. The 'ladder' referred to the

[3] By transaction costs we mean the information, monitoring and enforcement costs associated with contracting. They include issues of moral hazard and adverse selection. We stick to the Coase and Williamson pedigree in referring to the costs as transaction costs. We also follow in the footsteps of the agricultural economists analyzing tenancy in the early part of the 20th century. For a review of the some of the earlier work of agricultural economists see Alston and Higgs (1982).

[4] De Janvry, Macours and Sadoulet (2002) provide a very helpful table of the 'contextual conditions' under which each land tenure status is observed.

movement with age from the statuses of wage worker to tenant to owner [Alston and Ferrie (2005); Alston and Kauffman (1997) and (1998)]. Climbing the rungs on the ladder meant acquiring human and physical capital as well as improving socio-economic status. Most transaction cost explanations for contract choice rest on the costs of information, negotiation, supervision and enforcement. The plethora of explanations based on transaction costs (or market failures) arose because many economists initially took to heart the Marshallian inefficiency argument and then had difficulty explaining why various forms of tenancy and sharecropping have been so ubiquitous over time and space (Marshall, 1890). Now economists are turning the issue on its head: why are there some regions of the world that rely too little on tenancy and sharecropping, given the existence of transaction costs? Consistent figures are difficult to find but both North America and Europe stand out in the high percentage of land and farm establishments rented. For example, de Janvry, Macours and Sadoulet (2002; pp. 24-25) present data showing that farmers in the U.S. leased 45% of agricultural land in 1988 and in Europe the figures for 1995 range from a low of 12% for Ireland to above 60% for Belgium, France and Germany. The figure for the U.S. in 2007 was 38.5% (US Census of Agricuture 2007, Vol. 1 Table 58). Figure 1 shows the evolution of tenancy in Brazil from 1920 to 1995. The total number of farm establishments that were rented fell by nearly half from 1970 (20%) to 1995 (11%), while the corresponding area fell from a high of 10% in 1940 to a low of 2.5% in 1995.

[Figure 1 here]

Recent explanations for the lack of rentals in developing countries rest on the insecurity of property rights. Insecure property rights may reduce the prevalence of rentals because of difficulties in conflict resolution. If it is difficult to evict tenants who do not meet the rental terms, landlords may respond by using wage labor or by only renting to those they trust such as relatives and friends.[5] In some countries tenants receive the right to purchase the land that they rent and not surprisingly landlords may be reluctant to rent.[6] Some governments prohibit land rentals on land redistributed through land reform projects, either *de facto* (because there are frequently delays in assigning formal titles) or *de jure* because of a fear of absentee beneficiaries.[7]

[5] Macours (2002) found that in the Dominican Republic landlords were more likely to rent to those in their same social network.

[6] This was the case in the Pampas in Argentina under Peron (Gallo, 2003); and in the Dominican Republic following legislation passed in 1972 (de Janvrey, Macours and Sadoulet, 2002).

[7] Brazil is probably not atypical in the long delays associated with assigning formal titles. In Mexico, until recently, the government forbade the renting of *ejidos.*

Conning and Robinson (2007) analyze the effect of property rights insecurity on agricultural organization by linking a model of contract choice to a political economy model of potential property rights reform. In the contract choice model the key feature is the existence of an essential non-traded factor (skill) that is required for production in addition to land and labor. Because this factor cannot be traded, the efficient organization of agriculture requires farm sizes that are proportional to the distribution of this factor, with land being leased from those who do not have enough of the essential factor to those with an excess relative to their own holding of land. This first-best situation will hold if property rights are secure. But if landowners have reasons to fear that future events might bring a change in the security of property rights, such as a land-to-the-tiller reform, then the agents might optimally chose to forgo the potential gains of entering into tenancy contracts so as to avoid the losses that will be borne if the threat does materialize. The approach includes two factors increasing the transaction costs of renting land: a non-traded factor and insecure property rights; with both reform and the extent of tenancy being endogenously determined. The most important testable hypothesis that emerges from the model is that anything that increases the threat to property rights will lower the incidence of land rentals. We will test this hypothesis with county level data for Brazil in Section 4.

De Janvry and Sadoulet (1989) present a similar approach that integrates the choice of agricultural organization with the political economy of reform to analyze what they call 'the lost game of Latin American land reform.' The equilibrium they see prevailing in most of Latin America is one where the threat of reform in the 1960s induced large and medium sized farms to modernize and increase their productivity so as to preempt any form of expropriation, which in turn increased their economic and political power thus hindering any future attempts at reform even though these could potentially lead to large net social gains. Although the authors refer to distributive land reform, the argument fits perfectly the history of tenancy in Brazil where legislation put into place in the early 1960s was explicitly hostile to tenancy and sharecropping, inducing landowners to expel masses of tenants from their lands in the following decades (further details in section 3).

In addition to the fear by landlords of expropriation (de facto or de jure) there may be factors on the demand side limiting rentals. It may be that many 'would be' renters lack either the physical capital or human capital necessary to profitably rent land. We are less persuaded by the physical capital constraints because presumably rental markets for physical capital should arise, though we recognize that there are transaction costs associated with abuse in renting capital that

may preclude the emergence of active rental markets. On the human capital side many potential renters may lack the skills necessary to successfully rent. This may be particularly important where the region is shifting to new crops, e.g. niche crops like flowers or even a switch from tree crops like coffee to annual crops like soybeans.

3. Tenancy in Brazil: Hypotheses

3.1 – Introduction

We utilize data that includes all counties in Brazil and contains variables that measure both the agro-climatic/geographic determinants of contract choice, as well as the political economy determinants. We estimate a system where the dependent variable of each equation is the percent of total farm area that is held under each of the four categories included in the Brazilian Agricultural Census: fixed rent, sharecropper, owner and occupant (no formal title).[8] In order to measure the extent to which contract choice is determined by the natural and physical endowment of each county, we use as independent variables the percent of total farm land that is placed under cotton, rice, coffee, cane, beans, manioc, corn and soybeans. Each crop has its own physical attributes and agro-climatic requirements which determine where they can be grown and the best farm size, given relative prices. At the same time each crop's attributes along with attributes of the landowner imply that a given type of contract would be best for dealing with the problems inherent in its production. Coffee, for example, is a perennial crop, by nature labor intensive, has few economies of scale and consequently tends to be produced more productively by smaller owner-run farms than by fixed rent contracts.[9] Other variables that control for the impact of endowments, capturing elements of geography, transport costs and climate, are the distance to state capital, transport costs to São Paulo, existence of train stations, latitude and longitude.[10]

The major objective of the empirical test is to ascertain whether the choice of agricultural organization in terms of contract choice is essentially determined by endowments, that is agro-climatic and geographic factors, or whether political economy factors also have an effect,

[8] In the Brazilian Agricultural Census fixed rent are those properties that belong to a third party but are worked by a producer who pays a previously set fixed quantity in cash or its equivalent in products. Sharecroppers work properties that belong to a third party in exchange of a previously set proportion of the production. Occupants are those on land that belongs to some third party (may be public land) with no payment in exchange, which might be the case of squatting or of consensual cession of the use of the land. Owned land belongs to the producer on the land.

[9] Potentially long term leases could deal with the perennial nature of coffee but perennial leases may be more problematic with respect to the legislation's emphasis on beneficial use, issues that we discuss shortly.

[10] Other factors such as soil type, temperatures, rain, and sunshine are partially captured by state dummies.

distorting the choice of contract by limiting the extent of tenancy despite its superiority in terms of efficiency, given the crop mix in the county. To this end we use data collected by the Pastoral Land Commission of the Catholic Church (CPT) to measure the extent of land-related violence in each county from 1985 to 1995. In those places that experienced violence and conflict, land owners and claimants expect a greater probability of intervention from the government, generally in the form of expropriation and redistribution of land to landless peasants through the creation of settlement projects (Alston, Libecap and Mueller, 1999a, 1999b, 2000, 2008). The struggle for land in Brazil since the mid 1980s has essentially revolved around the strategy by organized groups of landless peasants, such as the MST, of selectively invading properties that are legally vulnerable to expropriation (regions with high tenancy, low productivity, weak title and/or large holdings) so as to attract the government and force it to expropriate in their favor. The impact of conflicts affects not only the decision of whether to plant or not, but also whether to engage in tenancy contracts. One of the main reasons for this is that the Land Statute of 1964, which still underpins all of the land related legislation, imposes very rigid limits for tenancy contracts and explicitly states that farms in rental arrangements may be preferable candidates for redistribution.[11] The origins of this bias in the legislation may be a reaction to the historically very unequal distribution of wealth and power in the Brazilian countryside. Nevertheless, as noted in World Bank (1994: 199):

> … the perverse effect is to reduce access to exactly those people the regulations were designed to protect. In addition, the Land Statute contains other provisions that relate the incidence of renting and sharecropping to the possibility of expropriation of farms, that is, the law provides that "expropriation... will be applied to: ... areas with high incidence of renters, sharecroppers and squatters." The threat of expropriation may have been much more effective in constraining the rental market and sharecropping arrangements than the provisions that regulate such arrangements. This seemed to be particularly true when claims for land reform were increasing.

Another strong legal impediment to tenancy in Brazil is the 1963 Rural Worker Statute that extended the set of legal labor benefits already held by urban workers to those in agriculture (Rezende and Kreter, 2007; The Economist, 2011: 43).[12] The Statute set regional minimum wages, established the 13th salary, holidays, payment for overtime, 48-hour workweek and

[11] For a very good discussion of the hostility towards tenancy arrangements in Brazilian legislation see Rezende (2006, section 8). See also Romeiro and Reydon (1994).

[12] To the present day Brazil possesses very progressive labor laws conceding a wide set of benefits and privileges to rural and urban workers. Labor justice in Brazil almost always decides in favor of the employee, which at least reduces uncertainty. However these benefits make for more rigid labor markets and may increase unemployment.

limited the employers' acceptable justifications for firing. It is argued by several authors that even though this regulation was not well enforced, it was far from innocuous and the imposition of these encumbrances led landowners to dispense hordes of rural workers, both tenants and wage workers and to switch towards using temporary workers [Saint, 1980; Ribeiro and Stolf, 1975; Nichols, 1971, IPARDES 1978; Carvalho, 1991].

Given this nature of land and labor policy in Brazil, our expectation is that the variable that measures conflict will be negatively related to both the percentage of area in fixed rent and sharecropping and positively related to the area in owner-farmed properties, even after controlling for endowments. Although labor legislation and those parts of the land legislation that directly refer to tenancy impose impediments to this type of contracting, land reform legislation may provide incentives in the other direction. As noted above, land reform today in Brazil starts with invasion of unproductive properties by organized landless peasant groups with the government providing land reactively. In this scenario it may make sense for a landowner who wants to hold land but not yet put it to use, to lease the land as a means to make it productive and thus immune to expropriation.[13] Our results will allow us to test which effect of conflicts dominates in Brazil, or if they cancel each other out. If we find a positive and statistically significant impact of land conflict on fixed rent and sharecropping, then we can conclude that land reform provides incentives for landowners to enter into more rental arrangements than they would in the absence of conflicts, and the low levels of tenancy in Brazil would be even lower without conflicts. This result would be in line with that found in Ghana by Besley (1995), in Uganda by Place and Otsuka (2002), in Paraguay by Carter and Olinto (2003), in Africa by Pinckney and Kimuyu (1994) and for Brazil by Vertova (2006). If, however, we find the coefficient of conflicts in the fixed rent and sharecropping equations to be negative, this will be strong evidence of a perverse effect of land legislation on the choice of agricultural contract leading to inefficiencies of the type predicted in the models by Conning and Robinson (2007) and de Janvry and Sadoulet (1989).[14] It

[13] During much of the 1970s and 1980s the lack of a more highly developed financial system meant that land ownership was a widely used instrument to hedge against inflation. This resulted in large areas of unproductive latifunidia despite the possibility for the owners to gain twice by renting the land out to productive use while still fulfilling its financial objective. Rezende (2006) argues that the lack of rentals results from the hostility of the agrarian legislation towards tenancy arrangements.

[14] Pande and Udry (2006) provide a very detailed review of the literature on the effect of property rights on economic outcomes in agriculture in developing countries. In Table 5 they summarize numerous studies for many different countries. The results in the literature vary considerably leading the authors to conclude that "… land titling and registration typically increase agricultural productivity and farm investment. However, the extent of increase depends upon the details of the titling program and the pre-existing land tenure system."

is also possible that different impacts prevail in different regions, for different types of producers and in different periods of time. We test for these possible variations where the data allow.

In addition to testing the effect of property rights on tenancy, we also estimate its impact on land use, that is, the decision whether and what to plant. We use the same independent variables from the tenancy equations (endowments plus conflicts) in a system of eight land use equations where the dependent variables are the percent of land in the *municipio* in: natural forest, planted forest, permanent crops, temporary crops, natural pasture, planted pasture, fallow, and usable but unused land.[15] The impact of conflict in each of these equations will provide additional evidence of whether insecure property rights increase or decrease productive activity. Before turning to the results, it is necessary to address the problem of endogeneity of conflicts.

3.2 – Instruments for the First-stage Estimation of Conflict

Our major objective is to determine the relative impacts of conflicts and endowments on contract choice and land use. However, there is a potential endogeniety of conflicts that would render OLS estimates inconsistent, given that land invasions and other forms of violence may be more probable in areas where there is a greater incidence of tenancy arrangements and farms without formal title. Similarly, certain types of land uses, such as forests or unused land, are characterized as unproductive and may attract invasion and expropriation. We confirm this endogeneity by a Hausman-Wu test which we present in the results section (Tables 4 and 5). Therefore we need to find appropriate instruments for conflict in order to estimate a first-stage equation that will allow us to control for the potential simultaneity. These instruments must be correlated with conflicts but should have no direct link to contract choice or land use. The dependent variable of the second-stage regressions is contract choice and land use in 1996 (the last agricultural census available with reliable county level data). Because we want to determine the impact of conflict on contract choice and land use, the conflict data aggregates all land-related conflicts in each county from 1985 to 1995.[16]

An appropriate instrument should be a variable that has a strong relationship with rural conflicts. A natural place to look is at groups and organizations that helped landless peasants to

[15] The census ascribes all the land in a *municipio* to a mix of these eight land uses plus another category 'useless land'. The sum of the area in these nine categories adds up to 100% of the farm land in that *municipio*. We suspect that the 'useless land' category is calculated by residual because when all nine variables are used in the system it results in covariance matrix of errors that is singular. We take the amount of 'useless' land as given and not a choice, and thus leave this variable out of the system. The average value of this variable is 4.7% of total area.

[16] Note that this gives some element of dynamics to our estimation despite it being a cross-section. Conflict data is only available for years since 1985.

organize and fight for their rights. There has long been a struggle for land in Brazil leading to violence and conflicts. But, with the exception of a few isolated historical cases, it was only in the early 1980s that there came about a systematic increase in the number of organized groups of landless peasants throughout the entire country. As is often the case with grassroots movements, the widespread emergence of organized landless peasants groups in the 1980s in Brazil was not a spontaneous phenomenon, but rather the result of social groups that sought to catalyze social change by organizing and prompting peasants into action. The main motivation for these groups was the extremely poor living conditions and high levels of exploitation of the rural poor in Brazil, which are essential features of the country's historical legacy. A measure of the presence of such groups across *municipios* would thus be a strong candidate for an instrumental variable for conflicts, though we would still have to certify that the presence of these groups was in no way affected by the existence of tenancy arrangements or specific types of land use.

A historical analysis of this period in Brazilian history suggests three groups that played important roles in organizing landless peasant groups in the late 1970s and early 1980s; rural unions, the Catholic Church and local politicians. Counterintuitively, rural unions were supported by the military-technocratic elite that saw them as a means to weaken the hold that regional oligarchies and local elites had over much of the country's interior areas. The government sought to empower the rural communities by encouraging unions that would, under its tutelage, organize the poor and give the state a stronger presence. Unfortunately there is no systematic data at the *muncipio* level of the strength or presence of rural unions for this period, so we cannot pursue this variable as an instrument for conflict.

The second candidate instrument is the presence of the Catholic Church. During the 1970s the Catholic Church in Brazil was undergoing a process of change in its political stance and its relation to the military regime and ruling elites. In this period it became the "most progressive Church in Latin America" (Bruneau, 1985: 271) and explicitly announced a 'preferential option for the poor'. By the early 1980s the Church was explicitly engaged in organizing groups of landless peasants throughout the country to demand their rights (Mainwaring and Wilde, 1989). As noted by Houtzager (2001):

> The church was an ideal institutional host. It is a transnational institution with firm roots in rural communities. It is able, on the one hand, to garner critical resources, information, and political support from national and international sources and, on the other, it is a local actor represented by the Bishop, the parish priest and local pastoral agents. Progressive clergy and lay activists in Brazil were able to mobilize

> rural social groups (primarily small farmer and peasant groups) and local resources through the church's impressive associational web, its own elaborate organizational structure, and a popular religious identity. The church's myriad pastoral programs, the CPT and other church entities, linked community leaders and activists to each other and to the national movements of the left emerging in the transition. …The religious content of its organizing initiatives resonated with the prevailing belief system in rural communities and allayed the fears of community members of being labeled communists and agitators by local authorities and the military. Religion conferred a degree of legitimacy and provided protection from repression by local elite groups and the national state. This depth of the church's involvement in organizing rural social groups and its direct, self-conscious, sponsorship of these groups' involvement in a national movement, distinguishes the church as institutional host from the church as a simple ally. Houtzager (2001: 23-24)

This key role of the Church in organizing rural communities is highlighted by one of the founders and still currently the main leader of the Landless Peasant Movement (MST) João Pedro Stédile in Menezes Neto (2007):

> The CPT (Pastoral Land Commission) was the practical application of the Theology of Liberation, which was an important contribution to the landless peasants' struggle from the ideological point of view. The priests, pastoral agents and pastors discussed with the peasants the need for them to organize themselves. The Church stopped doing messianic work and saying to the peasant: 'Wait and you will go to heaven.' Now they started saying 'You have to get organized and fight to solve your problems here on earth'.

Adriance (1991, 1994, 1995), Hewitt (1990) and Krischke (1991), Mainwaring (1986), Maybury-Lewis,(1994) recognize the critical role of the Catholic Church in enabling the rural organizations that changed the nature of the struggle for land in the 1980s. Therefore a variable that measures the strength of the church's presence in a given *municipio* during this period should correlate with the existence of conflicts over land. We do have data on the number of priests per *municipio* for several years starting in 1966, so this variable may be used as an instrument for conflict if it also passes the exclusion restriction (investigated below).

A third group, opposition political parties, may also have facilitated the organization of landless peasant groups. In *municipios* where the opposition had a greater influence there would be greater ease for progressive ideas and organization to thrive, leading to higher chances of invasions and land-related conflicts (Houtzager 2001, 25-26; Ondetti, 2008: 52-53). By the end of the 1970s the Brazilian military rulers had already initiated a 'slow and gradual' process of political opening and in 1982 held the first

elections for governors since 1965. Although there had been elections for municipal assemblies throughout the period, the election held in 1982 saw a greater extent of real opposition given the slow decline of the military government's power. Thus a variable that measures the percentage of the seats in the local assembly that were won by the MDB (Brazilian Democratic Movement) in the 1982 election and by the PT (Worker's Party) in 1996, may correlated with the existence of conflicts. Each of these parties was the main (only) opposition party in each of those periods.

In order for priests or politicians to be appropriate instruments for conflict in our contract choice and land use regressions it is necessary that there be no direct relation between these variables. In other words it must be that priests and politicians are distributed across *municipios* in a manner unrelated to land contracts and land use. This is a tough condition to satisfy for it seems natural that if these catalyzing groups cared about landlessness, they would tend to focus their presence in those areas where there was a greater incidence of landownership concentration, sharecropping, inequality and other potentially explosive agrarian issues. In order to avoid this problem for the priest variable we analyzed the historical timing of the Catholic Church's involvement in agrarian issues to pick a period before it had expressed concerns or taken actions to systematically assist the landless and rural poor. Fortunately, there is a distinctly recognizable and well documented trajectory of the Church's ideological and practical shifts over the past decades which we can explore to assure that our measure of priest allocation is not linked to the way land was being used. During the 1970s in most of Latin America, and most prominently in Brazil, the Catholic Church gradually abandoned its traditional position as an ally of the prevailing regimes and ruling elites to take an explicit stand in favor of the poor and dispossessed. The first manifestation of this change was the meeting of the Latin American episcopate in Medellin, Columbia, in 1968. The meeting produced a document, which instead of being based on religious dogma and doctrine was inspired by Dependency Theory and Liberation Theology, with clear anti-capitalist rhetoric professing the need for the Church to play a central role in combating poverty and inequality (Brito, 2010). During the 1970s this point of view sparked much controversy and disagreement within the Church as conservative forces resisted these new ideas. The culminating point of this power struggle was in a subsequent meeting of the Latin American episcopate in Puebla, Mexico, in 1979 after which the episcopate issued a new

document. Even though the conservative forces counted with the presence of the newly elected Pope John Paul II, who attended the meeting, the outcome was a clearly progressive document in which the Church officially established the famous 'preferential option for the poor.'

In Brazil the Church had supported the military coup of 1964 but as the regime became increasingly repressive it shifted to a clearly opposing position by the mid-1970s (Skidmore, 2003: 247). In 1975, the Brazilian Catholic Church created the Pastoral Land Commission (CPT), demonstrating a growing concern for agrarian issues, though at that point it focused only on Amazonian states. But most importantly, in 1980 a General Assembly of the Brazilian Bishops released an official document called "The Church and Problems of the Land" in which it emphatically affirmed its intention to play a direct role in improving the lot of the rural population. After a long diagnosis directly blaming the capitalist system for the exploitation of rural workers and landless peasants, the document proposes to take the following (among other) lines of action as guiding principles of its pastoral commitments:

> 2nd – We commit to denounce openly inequitable and violent situations that are committed in our dioceses and parishes and **to combat** the causes of those injustices and violence …
>
> 3rd – We reaffirm our support for the initiative of workers' organizations **placing our power and means at the disposal of their cause** … Our pastoral action, careful not to substitute the initiatives of the people, will **stimulate the conscious and critical participation of workers in unions, associations, commissions and other forms of cooperation, so that they can be truly autonomous and free, defending their interests and coordinating the demands of their members and of their entire class**. (CNBB, 1980: paragraphs 97 and 98. Our emphasis in bold.)

This document can be interpreted as marking the point in which the Church in Brazil started to actively and directly engage with agrarian issues. There may have been individual and isolated instances in the 1960s and increasingly in the 1970s where priests and other lay church members got involved in such issues. But this document marks the turning point where this involvement became an explicit policy of the Church as whole. It is noteworthy that the bishops' document was approved by an overwhelming majority of 174 votes against 4 (Martins, 1980: 39). The following years from 1980 to 1985 would be the heyday of the Church's involvement in land-related issues. It is during this period that the Landless Peasants Movement (MST) was incubated, having been officially founded in 1984. Our conflict data begins in 1985 partly because it was at this point that land

invasions started to become a sufficiently widespread and systematic phenomenon to merit record keeping.

Yet, after the first half of the 1980s, the Church's direct association with land-related issues started to wane. In part this happened as a result of their own success in jump starting grassroots organizations such as the MST, unions and cooperatives that eventually became autonomous and self-organized. Also, with redemocratization in 1985 several other mediating groups that had been suppressed during military period (re)emerged and actively competed with the Church for the role as the main institutional link for the new peasant groups, foremost among these political parties, NGOs and unions. Other determinants of the decline of the Church's direct involvement in agrarian issues include the direct pressure from the Vatican under Pope John Paul II (who was strongly anti-Marxist) and staunch competition from evangelical movements (Adriance, 1992; Serbin, 2000). Hewitt (1990) noted that:

> In more recent years the Church has become increasingly confused with respect to support for societal transformation. Not only has the upper hierarchy become more fractious, a tendency toward conservatism has also become apparent. The Church as an institution has returned to previous modes of political influence and appears to be **abandoning its support for grassroots movements in favor of direct pressure on political policy makers**. (pg. 148)

From the description above one can visualize a graph of the evolution of the Church's **direct** involvement in agrarian issues over time that starts at low levels in the early 1960s, gradually increases until the mid-1970s when it bends upward, spiking in the early 1980s only to drift back down systematically to moderately low levels by the 1990s. This timing is central for our identification strategy. The dependent variables in our analysis (land contracts and land use) are from 1996. The key explanatory variable (conflicts as a proxy for property rights) is from the period of 1985-1996. By using priest data from 1966 as an instrument for conflicts, that is, before the Church demonstrated the inclination and propensity to get directly involved in land-related issues, we can be confident that this variable can be viewed as randomized for the purpose of estimating conflicts. The allocation of priests in the early 1980s may have been affected by the Church's decision to directly interfere with rural issues at that time. But the allocation of priests in 1966 was not contaminated by this change that would only take place some 15 years later. Menezes (2009: 1) notes that those isolated cases prior to the early 1960s

where religion took part in the struggle against rural strife "… took place out of institutionalized churches, especially the Catholic Church." For our purposes the allocation of priests by 1966 can thus be assumed to have been determined by a series of historical and tradition-related factors with roots prior to that time, with agrarian issues not featured prominently among them. This 'randomized' allocation persisted until the early 1980s due to institutional inertia, that is, the Church simply did not change its distribution of priests significantly over time.[17] The correlation of the number priests per 1000 rural population in 1966 and 1985 is a high 0.81. This suggests that even when the Church did make the decision to get directly involved in land-related issues it probably did so not so much by changing the number of priests in different locations as by encouraging those priests that were already there to be more proactive on agrarian issues.

The withdrawal of the Church from direct hands-on support for peasant movements by the mid-1990s is also important for our identification strategy. If landholders in 1996 had their decision to enter into tenancy arrangements affected by the greater or lesser presence of priests in the region, our identification strategy could be compromised. However, as we have argued, by that time the Church no longer played a direct part in the struggle for land, having been substituted in that role by the now highly successful groups representing landless peasants, especially the MST. Thus the marker that landowners would use to gauge the risk involved in entering into tenancy contracts or in planting different crops, would not be how many priests there are in the region but rather the presence of mobilized groups of landless peasants with their red flags patiently waiting for the right moment to launch another invasion.

A final concern regarding priests as an instrument is that the data on rural conflict is collected by the Pastoral Land Commission (PLC), which is part of the Church, so that the correlation we find between priests and conflicts could potentially be due to a bias in the way the PLC collects data on conflicts. The concern is that the data may under-represent conflicts in areas where there are fewer priests because the PLC has a weaker presence in such places. In this case any impact of priests on conflict in our estimation

[17] During this period there was actually a drop in the number of priests as fewer candidates were willing to undertake this career and lifestyle. This trend only changed in the late 1970s as a rising supply of candidates from lower classes and rural backgrounds appeared to substitute for the dwindling number of middle class candidates that had traditionally filled the ranks of the priesthood (Antoniazzi, 2003: 6). This fact may also be a cause and consequence of the Church's involvement in agrarian issues at that point in time.

would not be solely through the channel of priests organizing grassroots movements, but also partly due to the data-collection process. Note, however, that even if the data is skewed in this way it does not violate the exclusion restriction for priests to be a suitable instrument. It would mean that our estimate of the impact of priests on violence would be overstated, and that in the second stage our measure of property right insecurity would not be as encompassing, but nevertheless the estimation would be consistent. We note that the Pastoral Land Commission conflict data seems to be complete and is used not only by the Church as the definitive measure of rural unrest, but also by the government, the landless movements, the press and academics.[18] Whereas there is great controversy regarding the numbers of families that the government has settled in its land reform program, we have found no critiques of the CPT data of land conflicts.

In order to better capture the catalyzing effect of priests over rural organization we will interact our priest variable with another variable that measures the 'frontierness' of the *municipio*. The idea is that frontier areas are more contentious, with less well-defined property rights than areas that are already well established (Garcia-Jimeno and Robinson, 2009). Similarly, in these areas the priests suffer less monitoring from hierarchical superiors that tend to be less progressive and thus have greater liberty to pursue more radical interventions. This strategy allows us to identify how the effect of priests on conflicts varies with the socio-political nature of the county in question. Robustness of the results with and without the interaction will be analyzed in Section 6.4.

In order to measure the 'frontierness' of a given county we take advantage of the fact that over time the number of *municipios* in Brazil has greatly increased through the subdivision of counties into two or more autonomous entities. This movement has lead to an increase from 643 *municipios* in 1872 to 5,507 in 2000. The evolution of the number of *municipios* suggests that the creation of new *municipios* accompanies the expansion of the economic, demographic and agricultural frontiers (Reis, Pimentel and Alvarenga, 2009). As the frontier expands there is a natural tendency for political-administrative decentralization by creating new counties out of localities within the original *municipio*. Our index of 'frontierness' explores this correlation to create a measure of which *municipios* have undergone a greater process of frontier expansion. The subdivisions that take place over time have made comparisons of county-level data over time

[18] Hidalgo et al. (2010) use Pastoral Land Commission data from 1988 to 2004 and claim that their results are robust to different samples and measures that are used to assess if there is any coverage or reporting bias in the data.

very difficult. Fortunately, the Census has recently created minimum comparable areas (MCA) that aggregate the data in such a way that makes comparison possible (IBGE, 1984; Reis, Pimentel and Alvarenga, 2009). In our empirical tests we use the MCAs for 1970-2000 which aggregate the 5,507 counties of 2000 into 3659 comparable areas. We create our index of 'frontierness' by counting the number of *municipios* of 2000 that are in each of these MCAs. The great majority of MCAs (2894 out of 3659) did not undergo any modification from 1970 to 2000, indicating a consolidated frontier process. The remaining 765 MACs underwent varying number of subdivisions, with the distribution varying from 482 MCAs that subdivided twice to one that subdivided 52 times. We use our 'frontier' variable in the conflict equation both to access its own impact on conflict as well as interact it with our data on priests. An alternative to try to capture the same effect is the distance from the state capital, which will also be used, however the frontier index is superior as the furthest places are not always where the frontier has expanded the most.

For the variable that measures the strength of opposition parties the argument that it passes the exclusion restriction is not as tight as the case for priests. If in 1982 the opposition party (MDB) was able to systematically win seats in areas that had greater incidence of tenancy arrangements or of certain types of land uses, then this variable will not be a suitable instrument. Although this may have happened it is probably the case that the electoral results were determined by a host of different effects, many of them linked to the specific nature of the historical moment the country was going through with the transition from dictatorship to a democracy. Similarly in 1996 the success of the Workers Party in local elections was probably not importantly influenced by agrarian issues. Although we recognize that the arguments in favor of opposition parties as instruments for conflicts are not as strong as those for priests, we will maintain it under consideration for now. In Section 5, after presenting the data, we will make a data-based analysis of whether priests and opposition parties are likely to pass the exclusion restriction. We discuss and present post-estimation tests of the appropriateness of the instruments in Section 6.4, after we present our main results.

4. Data

Our estimation procedure, presented in the next section, involves a first-stage regression to obtain predicted level of conflicts per hectare in each county, and then a second stage where contract choice or land use is the dependent variable. This involves four general groups of variables which we describe briefly here leaving the details to Appendix 1. As noted above the observations are at the level of minimum comparable areas for the period 1970-2000, which

comprises a total of 3,659 observations. Some of the variables were available for downloading from IPEADATA (www.ipeadata.gov.br) in the MCA format, but other variables, such as the conflict and priest data, and even some of the agricultural census variables had to be aggregated to fit the MCA format.[19]

The first group of variables is from the Agricultural Census (IBGE). This includes the contract choice variables (% of total farm land), crop mix (% of total farm land), land use variables (for example, natural forest, planted forest, permanent crops, temporary crops, and pasture, all in % of total farm land), average size of farms (hectares), and tractors per hectare. We use agricultural data for both 1995 and 1985, sometimes to calculate growth rates.

We use conflict data from the Pastoral Land Commission (CPT) of the Catholic Church. The CPT released data on conflicts in yearly reports since 1985. The data cover threats, murders, murder attempts and occupation, by *municipio*. We used this data to create a simple additive index. In this index we gave a weight of ten to occupations because these are central to land conflicts and involve large numbers of people. A non-weighted index yielded essentially the same results.[20] In creating the index the total number of violence-related incidents is divided by the number of farms in the *muncipio*.

Our third set of variables measures the presence of the Catholic Church in each county. We use data from Catholic Hierarchy (http://www.catholic-hierarchy.org/) which provides not only the number of Catholics and of priests per diocese but even the names of all the bishops. In order to make the diocese level data compatible with the county and MCA data we used the Catholic Census of Brazil compiled by CERIS (1997). The data on priests is available for several different years starting in the early 20th century. We choose to use data for 1966 as this is the earliest year for which the data cover all *municipios* given our use of minimum comparison areas. We divide the number of priests by rural population to account for the different diocese sizes.

Our final group of variables captures assorted effects. There are variables that control for geographic and climatic variations such as distance of the county to the state capital, transportation cost to São Paulo, number of train stations and latitude and longitude coordinates. Other variables control for economic and political effects such as county GDP and the number of assemblymen in the opposition party in 1982. We present descriptive statistics in Table 1.

[Table 1 here]

[19] We thank Mario Miranda and Adam Canton for research assistance preparing the data.
[20] The index is merely additive instead of being created by principal components because most observations had no conflicts, and these methods do not work well when the series have many zeros.

5. A Preliminary Test of the Instruments

In order determine if our candidate instruments pass the exclusion restriction we use the data to investigate whether the past incidence of tenancy affected (i) the way priests were subsequently allocated and (ii) the percentage of seats won by opposition parties. In Table 2 we investigate the determinants of priest allocation and political party strength by regressing them against five sets variables: (i) their own lagged values; (ii) the incidence of tenancy (sharecropping and fixed rent) in the past; (iii) economic and social variables (population growth, GDP growth, schooling and income); (iv) geographic variables (distance to state capital, frontier index, latitude and longitude); and (v) state dummies. The purpose is to see if the allocation of priests in 1985 (the height of the Church`s involvement in agrarian issues) was affected by the existence of tenancy in the previous decade. Similarly we want to investigate if opposition parties tended to win a greater share of the seats in those *municipios* where tenancy was more prevalent. If we do find this link for either case, then that instrument would not satisfy the exclusion restriction.

[Table 2 here]

In Table 2, we present the results from a variety of specifications with the number of priests (per 1000 rural population) in 1985 as the dependent variable. In Column I, we regressed this variable against the number of priests in 1966. The estimated coefficient is close to 1 and statistically significant at 1%, which indicates a strong inertia in the distribution of priests. The value for the R-squared (0.64) shows that the past allocation in 1966 explains most of the variation of the distribution of priests in 1985, suggesting little change over time. In Column 2 the reported coefficients are for the percentage of land in each *municipio* under each type of land contract in 1970 (owner-run farms is the left out category), as regressors. The results show that where there higher levels of fixed rent and sharecropping in the past did play a role in determining the allocation of priests by 1985. This seems to suggest that priests do not pass the exclusion restriction. However, the extremely low R-squared (0.005) indicates that, although statistically significant, these variables explain very little of the distribution of priests in 1985. Also, the coefficients for sharecropping and squatters are negative, the opposite of what an interest of the Church for the landless would suggest. Furthermore, as can be seen in Column V, when other controls are added, the statistical significance disappears. In Column III the results are for population growth and GDP growth from 1970 to 1980 as regressors, together with income

and schooling in 1970. The results show that the Church allocated priests by 1985 to *muncipios* that were poorer yet more educated in 1970, *ceteris paribus*. In Column IV we used geographic variables as regressors, with the result that all of variables, except longitude, are statistically significant. In Column V, we ran all four sets of variables, plus state dummies, simultaneously. The past value of the distribution of priests dominates all other variables with the same near-unitary coefficient of Column I, confirming the highly inertial character of the allocation of priests. Distance to the state capital is the only other variable that is significant, reflecting that there are fewer priests further from the central regions. Given that the adjusted R-squared is the same in Columns I and V indicates that for this period, looking solely at past allocations is sufficient to understand current allocations with very little information being gained from other variables. The fact that the distribution of priests in 1985 was not affected by the existence of tenancy in the previous fifteen years suggests that the Church did not use a strategy of placing more priests where there were more tenants and squatters. The finding that the allocation of priests does not vary much over time suggests that the strategy in the late 1970s and early 1980s was to increase the level of effort of all priests towards agrarian issues, given their current allocation, i.e., working through the intensive rather than the extensive margin. Furthermore, because we use priests in 1966 as an instrument, which is 30 years earlier than the contract choice and land use dependent variables in our main regressions, we have a strong case to claim that the allocation of priests was randomized for the purpose of our main regressions determining contract choices.

In Column VI we present regression results where the dependant variable is the share of seats in the municipal assembly won by the opposition party in 1982. Because of the prior military regime, this is the first election in decades and there is no lagged value of the dependent variable. Our results show a positive and statistically significant effect of past tenancy, which is evidence that elections may have been affected by the presence of greater numbers of tenants and sharecroppers in some *municipios*. When the dependent variable was the share won by the opposition in 1996, the results in Column VII show that the coefficients for sharecropping and occupied land are statistically significant at slightly above 10%. Although it is not clear whether this is a direct effect of tenancy on politics or due to a correlation with other omitted variables, we choose not to include opposition parties as instruments and retain only priests.

6. Estimation and Results

6.1 – First-stage: Determinants of Rural Conflict

In Table 3 we present the results of the first-stage regression where we estimate the determinants of rural conflict per 1000 farms using priests as an instrument. In Column I we present the first-stage results using data on priests for 1966 and in the Column 2 we present results for adding opposition parties as an additional regressor for comparison. We used a Tobit procedure because there are 2,974 observations censored at zero, that is, without any conflicts from 1985 to 1995. We interact priests with the frontier index, so the estimated impact of priests on rural conflict has to be interpreted taking into account the coefficients of all three variables, priests, frontier and the interaction term. This impact is more easily perceived in Figure 2 that plots the estimated coefficient of priests for every value of the frontier index in our sample (1 to 52).[21] The interpretation is that for *municipios* where the frontier index equals 1, that is, those that have been consolidated since 1970, the estimated coefficient for priests is negative but not significant. For *municipios* with a frontier index greater than or equal to 2 the impact of priests on conflict is positive, significant and growing as the index increases. An additional priest per 1000 rural population in a county with a frontier index of 10 leads to 0.31 additional conflicts per 1000 farms. At a frontier index of 20 this value jumps to 0.71 conflicts. Our results indicate that priests serve as catalysts for land related conflict by organizing social movements, as recognized in the literature cited in a previous section. Our result qualifies this perception by showing that it is stronger in areas that are currently undergoing a more intense frontier process. Besides these impacts through priests, the frontier index also has a positive and significant direct effect on conflicts, with a unit increase in the index leading to an additional 0.03 conflicts per 1000 farms. A McDonald and Moffit (1980) decomposition of the marginal effects of the independent variables on the number of conflicts shows that 19% of these effects work through *muncipios* that already have conflicts (above the limit) and 81% through those that do not. This implies that policies that seek to reduce the determinants of rural conflicts should not focus exclusively in areas that have already experienced violence, as the potential for conflict is often latent even in areas that have been apparently peaceful in the past.

[Table 2 here]

[21] The coefficient of the interaction term in Table 3 is the value that holds when the frontier index is zero, a value which makes no sense as the index starts at 1. Similarly the reported standard deviation for the estimate of this coefficient ignores some covariance terms which should be taken into account. The correct interpretation of the interaction term taking these issues into account is given in the graph of Figure 3.

[Figure 2 here]

Apart from the frontier variable none of the other geographic variables are statistically significant, though the effect of temperature and other climatic factors are also partially captured by the state dummies. We found some variables that control for the level of agricultural activity in the county to be negative and statistically significant. These variables are the number of tractors per hectare and the proportion of rural to urban population. These results indicate that conflicts are less likely, *ceteris paribus*, where there is more rural economic activity. On the other hand greater population growth from 1985 to 1995 – which includes migration – has a positive and significant effect on conflicts as does population density. Similarly those *municipios* that experienced greater rates of GDP growth from 1985 to 1995 registered more violence.[22] The data are very clear in showing that conflicts are more likely in regions where there are rents to be captured, a notion which is in line with several models of the evolution of property rights, such as Demsetz (1967) and Alston, Harris and Mueller (2009).[23]

Finally there are the crop mix variables, all in % of total area for 1995. The results show that coffee and beans are less likely, *ceteris paribus*, to lead to conflict. Soybeans and sugarcane on the other hand are found to be positively associated with conflict. In addition state dummies are statistically significant for several states, indicating that there are many idiosyncratic factors not captured in our other variables.

6.2 – Second Stage: Determinants of Contract Choice

The objective of this second-stage regression is to test for the determinants of contract choice. The dependent variables are the percent of total farm land that is cultivated under fixed rent, sharecropping, by the owner, or cultivated without formal title. We estimate a system of four equations through seemingly unrelated regression. The advantage of this method is that we can restrict the coefficients of every variable in the four equations to add up to zero. This is desirable because the dependent variables are measured in percent of total farm land so that if a change in an independent variable causes one of the dependent variables to rise, this must be compensated

[22] We used GDP growth rather than levels to reduce the possibility of endogeneity of GDP. Removing GDP from the equation has practically no effect on the other results.

[23] Hidalgo et al. (2010) reach the opposite conclusion when estimating the impact of negative shocks to income on the number of land invasions, instrumented by the amount of rainfall, especially in *municipios* with higher income concentration. They find that agricultural income and land invasions are negatively correlated. The two studies are different in that their central interest is the impact of income on conflict and we are estimating conflict in a first-stage regression where income is used merely as a control. We used agricultural GDP growth (1985-1996) rather than levels so as to attenuate the possibility of endogeneity of income. When income is excluded all other results are practically unchanged.

with a decline in one or more of the other three dependent variables. Furthermore, because the conflict variable that enters each equation is endogenously estimated in the first stage, the method will actually be three-stage least squares, which besides applying instrumental variable estimation to each equation also controls for 'contemporaneous' correlation in the errors. A Hausman-Wu test in each of the four equations (see last line in table 3) shows that instrumental variables are necessary. The exogeneity of conflicts is strongly rejected (1%) for the sharecropping, fixed rent and owner cultivated equations, and at 5% for occupied land. We present the non-instrumented and thus not consistent results in Table A1 in Appendix 2.

The purpose of the estimation is to ascertain the relative impacts of endowments and political/institutional factors on the form of agrarian organization. The endowments of a given county are captured by the crop mix that is found to prevail in 1995, the idea being that given relative prices, the choice of crops is overwhelmingly determined by agro-climatic and geographic factors, i.e. you can't grow coffee too far south because of frost. We also use latitude and longitude coordinates as well as variables that measure distance to the state capital, transportation costs, the growth from 1985 to 1995 of the *municipio's* GDP, tractors, cattle, population growth, urbanization and population density as additional endowment controls to the crop mix variables.

We capture the political/institutional determinants of contract choice by the conflict variable that we estimated in the previous section. The conflict variable includes any incidence of land related violence that was registered from 1985 to 1995 by the Pastoral Land Commission. The assumption is that the existence of such events in a *municipio* reflects a perception by economic agents of property rights insecurity that, given the biases in Brazilian land legislation and enforcement discussed in section 3, may affect their choice of contract. Our interest is not only to determine whether these issues actually affect contract choice, but also the direction of the impact. In Section 3 we showed that there are theoretical models and empirical evidence in the literature going both ways, that is, more insecure property rights leading to either more or fewer tenancy arrangements. We present our results in Table 4.[24]

[Table 4 here]

Our results show that the crop mix in a given county affects the form of agrarian organization. Most of the estimated coefficients for the eight crops are statistically significant in

[24] Table 4 shows the results using data on priests for 1966. Using data on priests from 1970, 1980, 1985 or 1995 gives the same basic results, which once again shows that the distribution of priests has not changed dramatically across *municipios* over time.

each of the four equations. Both fixed rent and sharecropping contracts are more probable where operators plant cotton, soybeans, rice and sugar cane and fixed rent is less probable where operators plant coffee and corn, the planting of beans and manioc having no statistically significant effect. These results are compatible with generally held perceptions of the nature of these crops, for example Almeida and Buainain (2001: 4-5) state that in Brazil fixed rent contracts are particularly intense in rice growing areas. The magnitudes of the impacts of the crop variable will be discussed below in comparison to the impact of conflicts. First we will interpret the impact of the other variables. Latitude and/or longitude are statistically significant in all of the four equations except sharecropping, thereby increasing the confidence that we are controlling for geographic and climatic factors so that any effect captured by the conflict variable will be *ceteris paribus*. Similarly we found that counties that are more distant from the state capital used more sharecropping and less occupied. Transport costs to São Paulo increased the area in occupations and reduced the owned area. The availability of train stations increased the area in fixed rent contracts and reduced owned area.

The positive effect of GDP growth from 1985 to 1995 on occupied areas and the negative effect on owner-run areas is an indication that less-developed areas tended to grow more during this period. An increase in the number of tractors per hectare had the effect of causing landowners to be more sharecropper and occupant intensive to the detriment of owner-operated area. Increases in cattle reduced occupied and increased owned area, while population density increased fixed rent and reduced owned areas. The greater the proportion of rural to urban population increased the land operated by occupants and reduced fixed rent.

Conflicts per farm is our main variable of interest. Our results show that increases in conflicts lead to lower use of fixed rent and sharecropping, with a corresponding increase in owner run and occupied farms. All coefficients are statistically significant. This result provides strong evidence that property rights insecurity is detrimental to the adoption of tenancy arrangements and may have important efficiency effects as recognized by the large literature on the economics of agricultural organization. The evidence in our test corroborates for Brazil the hypotheses in Conning and Robinson (2007) and de Janvry and Sadoulet (1989) concerning the perverse effects of politics and conflict.

Not only are the impacts of conflicts and of the endowment variables significant, but they are also quite large. If all variables are set to their mean values and conflicts at zero, the predicted proportion of agricultural land in fixed rent and in sharecropping would be 7.3% and 3.2%. If the

number of conflicts is increased to 4.4, which is the average number of conflicts per 1000 farms in those *municipios* that had any conflicts, then those proportions drop to 3.8% and 0.4%. That may not look like much of a drop, but if applied to total area in farms in the country, the reduction in area in fixed rent would be greater than the area of North Korea (117,000 sq. km.) and the reduction in sharecropping area would be greater than Portugal (93,000 sq. km).

Of the crop variables the ones that had the greatest impact were cane, soya and rice. A one-standard deviation increase in the area dedicated to cane would increase, *ceteris paribus*, the proportion of area in fixed rent from 6.9% to 9.9% and in sharecropping from 3.2% to 4.2%. This is equivalent to the area of South Korea (99,000 sq. km) and Azerbaijan (32,000 sq. km), respectively. The impact of soya on fixed rent area would be an increase of 2.2%, which also implies an increase the size of a small country if extended to the entire agricultural area of Brazil. Although the estimated coefficients in Table 4 are small, the impacts when extended to the entire country are very consequential.

Ideally we would like to take into account in the estimation procedure the fact that spatial autocorrelation may be present, as several of the variables in a given *municipio* may be affected by the levels of the same variable in neighboring *municipios*. In the absence of an econometric procedure that allows us to control for spatial autocorrelation in the context of Three Stage Least Square estimation with a first stage Tobit, in Appendix 3 we provide a sensitivity analysis using alternative estimating procedures and show that spatial autocorrelation though present does not affect the results significantly.

6.3 – Second Stage: Determinants of Land Use

In Table 5 we present the results from the eight equation system of land use determinants. Similarly to the contract choice system the purpose here is to estimate the impact of property rights insecurity on the choice of what to plant, controlling for natural endowments and other factors. Different types of land uses have different implications for how vulnerable a farm is to invasion and expropriation for land reform purposes. Land that is not being used productively is by constitutional mandate liable to be expropriated by the government. Each of the eight land uses in our data is associated with a different level of perceived productivity. Unused (but usable) land is clearly the least productive activity. Fallow land, though not used at that moment in time, may be considered an investment, though it might nevertheless be targeted by landless peasants. Though pasture may be highly productive it is often a default option for leaving the land unused in Brazil. Our data distinguishes between natural and planted pasture, where the latter can be

assumed to carry a greater level of security of property rights. Forest is also disaggregated into natural and planted, though planted forests are only 2.2% of total farm area. Forest is typically considered an unproductive use of the land and may be vulnerable to expropriation, though there is environmental legislation that requires farmers to hold parts of their properties in its original vegetation. Finally permanent and temporary crops involve higher levels of investments which imply that the land is fulfilling its social function and can therefore not be expropriated. The average coverage of each land use are (though there may be significant local variation): natural forest 15%, planted forest 2%, permanent crops 5%, temporary crops 16%, natural pasture 25%, planted pasture 23%, fallow 3%, unused 5% and useless land 5%.

The purpose of this test is to determine whether insecure property rights in a region induce farmers to adopt more productive activities as predicted by Besley (1995), Place and Otsuka (2002), Olinto (2003), Pinckney and Kimuyu (1994) Vertova (2006) and others, or whether the reaction is to withhold investment as predicted by Alston, Libecap and Mueller (199a, 1999b, 2000), Conning and Robinson (2007) and others. The advantage of using a system of eight land use equations with interlinked coefficients through zero-sum constraints is that we can get a more detailed picture of the response to insecure property rights. Rather than examining a land use activity individually, we can get a picture of how the decisions of all the farmers in a given *municipio* calibrate among different land uses that have different vulnerabilities when faced with tenure insecurity.

[Table 5 here]

The results in Table 5 show a pattern of land use that supports some elements of both of the hypotheses above. Even after controlling for the impact of crop type and geographic endowments, conflict has a statistically significant impact on all types of land use except fallow. The impact of conflict is to reduce the area of both the more productive land use (temporary crops) and of the least productive land uses (unused land and natural pasture), with a corresponding increase in the intermediate types of land use (permanent crops, forests and planted pasture). Table 6 shows the magnitudes of the impact of conflicts on land use. The first line shows the predicted percent of each land use category when conflicts are set to zero and all other variables are set at their means using the estimated coefficients from Table 5. The second line shows how these proportions change when conflicts is increased to 4.4, which is the average number of conflicts per 1000 farms in those *municipios* that had a positive number of conflicts. The third line shows the percentage change due to conflicts and the fourth line calculates what

would be corresponding change in area under each land use category if we treated the whole country's agricultural area as a single *municipio*. For the sake of comparison the final line lists countries whose areas are approximately equal to the changes that would take place if conflicts go from 0 to 4.4. This shows that although the percentages affected are small, the total impact in terms of land area and people involved is not inconsequential.

The biggest impact would be a drop in the percentage of natural pasture from 19.7% of the total farm area in the *municipio* to only 2.8%. For the country as a whole this is equivalent to an area the size of Greece. In Brazil natural pasture is often an unproductive use of the land, often not stocked with cattle or already in a degraded state. As such it would not be fulfilling its social function and could be invaded by landless peasant for expropriation through land reform. The same is true of unused but usable land, which would drop from 4.6% to 0.9% of the total farm area due to the presence of conflicts. The results for both of these types of land use support the hypothesis that insecure property rights raise the level of investments as unproductive land would be put to a higher valued use. However, the area in temporary crop would also drop due to conflicts in the *municipio*, from 18.4% to 15.3% of total farm area. In this case weaker property rights lead to a reduction in investment. Even though the decrease in the area of the unproductive uses is larger than that of the highly productive use, the monetary impact is probably higher for the decrease in temporary crops. Because we are dealing with percentages the decrease in temporary crops, natural pasture and unused land have to be compensated by increases in other uses. The main compensating change happens with planted pasture which increases from 25.6% of total farm area to 36.9%, an area equivalent to Honduras if one considers the impact for the entire country. This suggests that one of the main impacts of conflict might be to lead natural pasture to be transformed into planted pasture, which is less immune to invasion and land reform. Additionally, our results indicate more conflict leads to higher levels of natural and planted forest, and also permanent crops. The impact for the country as a whole is equivalent to the area of a small country for each of these land uses (see Table 6). For the case of planted forest and permanent crops, our result suggests that planting trees is considered a productive use of the land for the purposes of land reform, making this land less prone to expropriation. For the case of natural forest the most probable interpretation is that land holders refrain from clearing the land in the presence of insecure property rights, as removing the forest cover is a highly costly investment that makes the land more susceptible to invasion.

The upshot from the system of equations in Table 5 is that property rights are highly consequential for land use choices. However, the impact is not unidirectional as is often supposed in the debate in the property rights literature. Instead there is a readjustment in the face of property rights insecurity that discourages both the more highly productive land uses, where the land holder has more to lose, and the unproductive land uses, which are subject to invasion and expropriation, with a corresponding increase in land uses that do not require high levels of investment but enough to be deemed productive for the purposes of land reform.

[Table 6 here]

6.4 – Testing the appropriateness of the instruments

In Section 3.2 we provided the historical and political rationale for why priests can be considered randomized for the purposed of estimating land use and contracts. In this section we provide a statistical analysis of the instrument's appropriateness. For the results in Table 4 and 5 to be valid the priest variable must have certain properties. The first is that it should have a clear effect on conflict. The second is that there must be no direct link between contract choice/land use and priests except through the channel of conflicts. One way to test for the first property, that is, whether the instruments are weak, is through an F-statistic on the joint significance of the instruments in the first-stage regression (Stock, Wright and Yogo, 2002). If the F-statistic is greater than a given threshold value then the instruments can be considered as not being weak. The threshold value at 5% for the case of 5 instruments is 9.20 (Stock, Wright and Yogo, 2002: Table 1 pg. 522). Table 7 Panel A shows the results for the contract choice equations and Panel B the results for the land use system. In each panel we compare the results shown above in Tables 4 and 5 with an alternative specification where the interaction term of priests and frontier is dropped. In both specifications the null hypotheses of weak instruments is clearly rejected.

In order to test the second property of the instrument, that is, the exclusion restriction, a Sargan–Hansen statistic to test for over identifying restrictions would be recommended. However this is not possible in our case because although we do have more than one instrument in the first stage, the second stage is estimated using the fitted value from the first stage as a single instrument rather than plugging in the separate fitted values. This procedure is necessary because the first stage is nonlinear (Wooldridge, 2002: 542; Angrist and Pischke, 2009: 191). Applying 2SLS reasoning directly with a non-linear first-stage is not guaranteed to produce first-stage residuals that are uncorrelated with fitted values and covariates. In any case we show in Table 7 that our main result is robust to different specifications of the instruments. In both panels our

main results concerning the impact of property rights on contract choice and on land use still hold if priests are used as an instrument without the frontier interaction and even if political parties are used as additional instruments. There is some slight non-systematic variation in the magnitude of the coefficients but the signs and statistical significance remains unchanged.[25]

[Table 7 here]

7 – Which Tenancy Contracts are Forgone Due to Property Rights Insecurity?

With census data aggregated at the *municipio* level we cannot directly examine which types of contracts are most affected by the property rights insecurity in the form of land conflicts. Figure 3, constructed using that data, shows the distribution of fixed rent and sharecropped farms both in terms of area and number of properties. These distributions show that sharecropping tends to take place on smaller farms, but this does not provide any information on the channels through which conflicts affect contract choice. We can, however, get at this issue indirectly by using our data to test the determinants of average farm size. This can be done by using the results from our contract choice regression (Table 4) to calculate how a change in violence affects average farm size through its effect on contract choice. In order to do this we assume that all the variables in the contract choice regression, as well as the instruments in the conflict regression, affect average farm size indirectly through the choice of contract type. In Table 8 we regress average farm size on the contract variables and add state dummies to capture other fixed local effects. Because the four contract type variables add up to zero we cannot have them all simultaneously in the regression and must leave one out. The excluded variable is the one against which the estimated coefficients for the other three variables will be interpreted. Each estimated coefficient measures the amount by which average farm size changes given a change in that coefficient keeping the other two fixed. If we exclude the variable '% owned', for example, the estimated coefficient for '% fixed rent' gives us a measure of how an increase in the % area under fixed rent and the corresponding decrease in % area of owned properties, keeping 'sharecrop' and 'occupied' fixed affects average farm size. In Table 8 we show four estimations each excluding one of the four contract variables. We will focus only on the first Column that excludes owned properties because our main interest is to understand how violence affects the choice between renting and owner-operated.

[25] The results are also robust to using data on priests from other years after 1966.

[Figure 3 here]

[Table 8 here]

The results show that a decrease in the area under fixed rent leads to a decrease in average area, and that a decrease in sharecropped area leads to an increase in average area, both statistically significant at 1%. This implies that when conflicts reduce both types of contracts, as we showed above, the impact on average farm size is different through fixed rent and sharecropping. Because a drop in fixed rent reduces average farm size, it must be that the fixed rent contracts that are being forgone on the margin involve farms larger than the average size. Thus an increase in violence that reduces fixed rent contracts is on average impeding farm owners with larger properties (compared to the average in the *municipio*) from contracting for a fixed rent. With sharecropping the effect is the opposite. When violence decreases sharecropping, the average farm size increases, which implies that the sharecropping must occur predominantly on properties below the *municipio* average. The coefficient for occupied is not statistically different from zero so no changes to average farm size take place when occupied area changes. These results show that the losses in efficiency due to insecure property rights that we identified involve mostly the forgoing of fixed-rent contracts on larger size farms and the forgoing of sharecropping contracts on smaller size farms.

In order to measure the magnitude of these effects we use the contract choice equations in Table 4 to estimate how much a change in violence from zero to the average level of violence in those *muncipios* that had any violence (that is, 4.4 conflicts/1000 farms) affect the average farm size through its impact on fixed rent and sharecropped farms. The effect of this change in violence on average farm size through its impact on fixed rent is a decrease from 169 to 148 hectares, that is, a drop of 12%. The effect through sharecropping is an increase in average farm size from 169 to 213 hectares, a 26% increase. These are not trivial changes. They imply that when property rights are insecure due to conflicts in the *municipio* the pattern of land holding is greatly affected. Both the increase in average size that results from the decrease of sharecropping as well as the decrease that results from lower fixed rent are inefficient as they preclude gains to trade that would be realized were it not for the insecurity of property rights caused by conflict. Furthermore, the 46 hectare increase due to less sharecropping is greater than the 21 hectare fall due to less fixed rent, so that in net average farm size increases, which in a country with such high land ownership concentration as Brazil, is considered in itself an undesirable outcome.

6 – Concluding Remarks

In Brazil, land reform, by affecting the security of property rights via increasing land conflicts, has a perverse impact on land rentals resulting in an inefficiency or inability to realize the gains from agricultural contracting. In a large commodity based country like Brazil the losses are undoubtedly high. Even if there are other reasons not related to land conflict for why some farmers may want to hold large and unproductive properties, such as to hedge against inflation (very relevant for the time period of our data) or for political power, it would still be advantageous to the prospective tenant and sharecroppers, as well as to society, for the landowner to rent the land and profit twice (Rezende, 2006; Sayad, 1982). Similarly we show that conflicts reduce both the investment in productive temporary crops and the incidence of idle land, skewing land use towards low level productivity uses, mainly pasture. The very low levels of tenancy and productive land use in Brazil and much of Latin America are thus a puzzle. The difficulty of solving this paradox lays not so much in being able to point to causes of this behavior. In this paper we have provided very robust evidence that insecure property rights are an important deterrent to tenancy arrangements and more productive land use. The greater puzzle, as noted by Conning and Robinson (2007: 421) is why economic agents are not able to contract around these inefficiencies.

The extent of the losses from forgoing rental contracts in Brazil has in the recent past led to several attempts at getting around the impediments of tenancy by creating special regional programs where all the necessary conditions would be provided by policymakers and other organizations for rental transactions to take place. Buainain et al. (2008) survey some of these attempts and conclude that "however well considered the initiatives are, they have not achieved their goals … county administrations do not manage to use either the incentives or the coercive instruments required to induce landowners and landless farmers to negotiate under equal conditions leading to mutually profitable contracts." It is the understanding of this greater inability to credibly commit to not expropriating rented farms and thereby the inability to realize the gains from contracting that is the real puzzle to be explained. Put another way: given that both landowners and tenants would benefit from more secure property rights, what are the impediments to a more sensible land reform policy? We conjecture that the answer rests on the politics of land reform, a debate that entails the entire electorate and not simply the parties to the contract. Given Brazil has the highest land inequality in Latin America, with a highly urbanized and enfranchised citizenry, voters favor a land reform policy based on redistribution which has

the unintended consequence of increasing land conflicts and reducing the career mobility prospects of many landless rural peasants.

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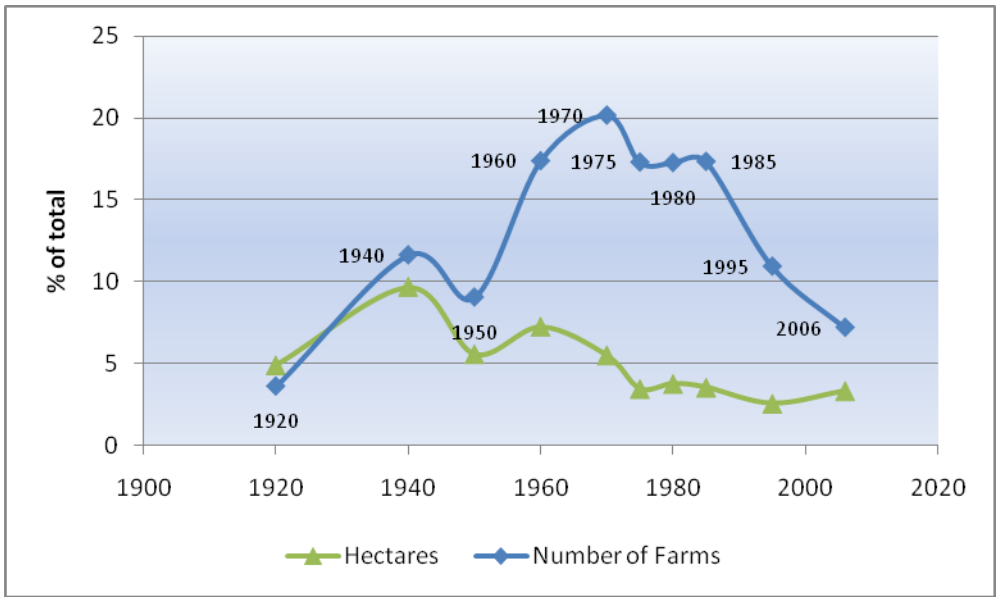
Figure 1 – Evolution of Tenancy over time in Brazil



Source: IBGE (2007). Data for 2006 from the 2006 Agricultural Census and may not be perfectly comparable.

Figure 2 – Interaction of Priests and Frontier: Effect of Priests on Conflicts.

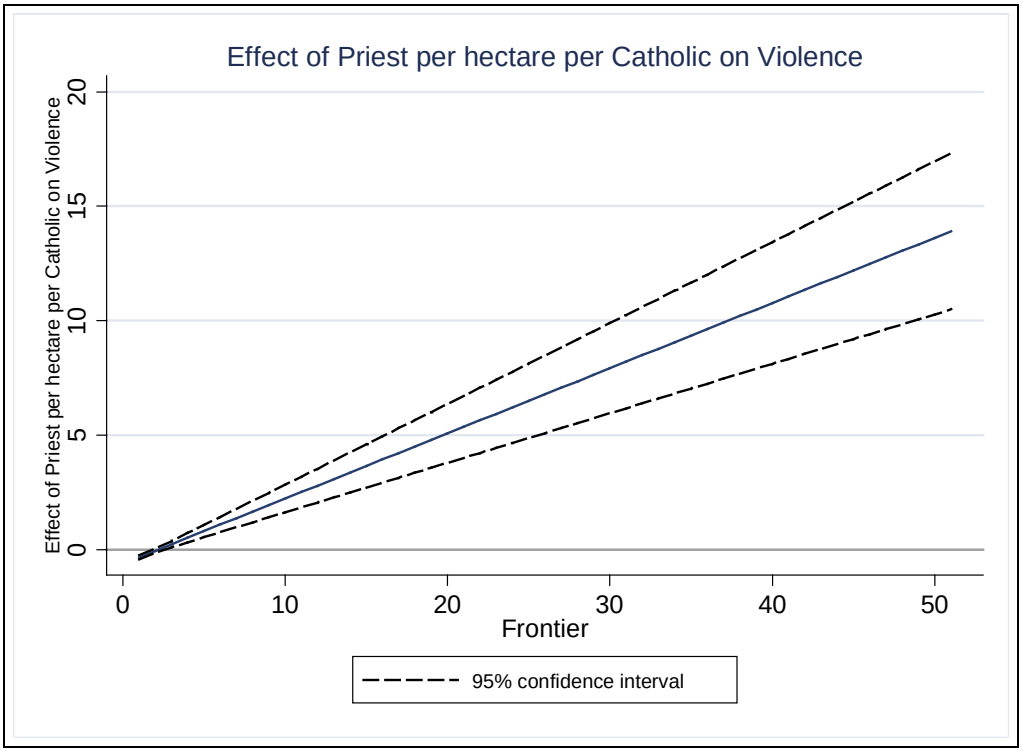


Table 1 – Descriptive Statistics

Variable	N	Mean	Stand. Dev.	Min	Max
Conflicts per 1000 farms	3659	0.7877	5.918	0	283.582
Priests per rural population 1966	3647	15.670	66.913	0.052	3562.50
Priests per rural population 1980	3631	16.56	49.925	0	1137.39
Priests per rural population 1985	3631	16.658	42.231	0.073	831.683
Frontier	3659	1.505	2.262	1	53
Political opposition 1982 (%seats – MDB)	3659	0.340	0.243	0	1
Political opposition 1996 (% seats – PT)	3659	0.025	0.057	0	0.615
Population density 1995	3640	240.62	13,572.77	0.0087	818,792.3
GDP growth 1985-1995 (log)	3643	-0.165	0.677	-4.806	4.062
Tractors per hectare1995	3640	0.004	0.007	0	0.130
Average size of farms (hec.) 1995	3640	93.720	174.619	0.104	4296.837
Cattle per hectare1995	3640	0.556	1.227	0	63.462
Latitude	3659	-16.491	7.644	-33.519	3.843
Longitude	3659	44.881	5.833	32.411	72.67
Rural/Urban Population (1995)	3621	1.071	1.631	0.0004	63.661
Population growth 1985-1995	3659	0.121	0.666	-0.960	38.349
Natural Forest (% total farm area) 1995	3640	0.154	0.136	0	0.900
Planted Forest (% total farm area) 1995	3640	0.022	0.054	0	0.799
Temporary crops (% total farm area) 1995	3640	0.163	0.174	0	0.993
Planted pasture (% total farm area) 1995	3640	0.231	0.217	0	0.901
Natural Pasture (% total farm area) 1995	3640	0.250	0.184	0	0.911
Permanent crops (% total farm area) 1995	3640	0.053	0.093	0	1
Usable but not used (% total farm area) 1995	3640	0.048	0.069	0	0.601
Fallow area (% total farm area) 1995	3640	0.031	0.039	0	0.313
% of land in Fixed Rent contracts, 1995	3640	0.049	0.073	0	0.781
% of land in Sharecropping contracts, 1995	3640	0.021	0.041	0	0.714
% of land farmed by owner, 1995	3640	0.892	0.104	0	1.00
% of land occupied, 1995	3640	0.038	0.063	0	1.00
Cotton, % 1995	3640	0.003	0.012	0	0.315
Rice, % 1995	3640	0.008	0.026	0	0.709
Coffee, % 1995	3640	0.012	0.038	0	0.429
Cane, % 1995	3640	0.039	0.142	0	1.00
Beans, % 1995	3640	0.024	0.047	0	0.715
Manioc, % 1995	3640	0.009	0.027	0	0.580
Corn, % 1995	3640	0.048	0.067	0	0.851
Soya, % 1995	3640	0.021	0.136	0	0.901
Distance to state capital (km)	3659	240.467	158.039	0	1365.742
Transport cost to São Paulo (index)	3658	1475.81	1114.83	0	10,511.92
Train stations	3659	0.485	1.696	0	63

Table 2 – Determinants of Priest Allocation and Opposition Party Strength

Dep. Variable: Priest per 1000 rural pop in 1985	**I**	**II**	**III**	**IV**	**V**	**Dep. Var: Opposition party†**	**VI Opp. 1982**	**VII Opp. 1996**
Priest / 1000 rural pop 1966	1.09***				1.09***	Oppo. Party (1982)		0.010*
	(11.96)				(11.48)			(1.92)
Fixed rent % (1970)		23.763**			3.109	Fixed rent %	0.144***	-0.012
		(2.42)			(0.40)		(2.87)	(-0.89)
Sharecrop % (1970)		-14.756*			-10.553	Sharecrop %	0.213***	0.053
		(-1.67)			(-1.15)		(3.30)	(1.63)
Occupied % (1970)		-24.222***			-2.178	Occupied %	-0.045	0.019
		(-5.14)			(-0.78)		(-1.28)	(1.62)
Population growth 1970-80			3.151		-0.012	Pop. growth	0.040***	-0.001
			(1.04)		(-0.01)		(3.51)	(-0.90)
GDP growth 1970-80			0.109		0.063	GDP growth	-0.0003	-0.001***
			(0.61)		(0.42)		(-0.31)	(-2.76)
Income (1970)			-0.0001**		-0.00001	Income	-2.2e-7***	0.0000001***
			(-2.29)		(-1.41)		(-4.06)	(3.47)
Schooling (1970)			12.017***		1.453	Schooling	0.082***	0.014***
			(9.66)		(1.53)		(12.26)	(8.46)
Distance to state capital				-0.048***	-0.008**	Dist. to state capital	-0.0002***	0.00004***
				(-7.52)	(-2.41)		(-6.15)	(3.95)
Frontier				-1.411***	0.088	Frontier	0.002*	0.0004
				(-5.72)	(0.90)		(1.72)	(1.24)
Latitude				-1.036***	0.009	Latitude	-0.003	0.002***
				(-11.41)	(0.03)		(-1.11)	(2.93)
Longitude				0.311***	0.327	Longitude	0.012***	-0.004***
				(2.92)	(1.55)		(4.52)	(-4.31)
Constant	0.805	17.234***	-0.165	-0.677	-23.517*	Constant	-0.709***	0.318***
	(0.75)	(18.74)	(-0.13)	(-0.17)	(-1.88)		(3.45)	(3.75)
Number of observations	Total: 3631	Total: 3631	Total: 3631	Total: 3631	Total: 3631	Number observations	Total: 3656	Total: 3656
State dummies (27 states)	No	No	No	No	Yes	State dummies (27 states)	Yes	Yes
R^2 adjusted	0.64	0.005	0.05	0.07	0.64	R^2 adjusted	0.35	0.10
F(k, n-k)	142.94	13.50	30.44	37.13	74.79	F(k, n-k)	84.07	9.94
Prob>F	0.0000	0.0000	0.0000	0.0000	0.0000	Prob>F	0.0000	0.0000

OLS regression. t-stats in parentheses. Robust standard errors. Statistical signif.: 1% ***. 5% **, 10% *. † For Column VI land contract variables are from 1970, growth rates are from 1970 to1980 and income & schooling are from 1970. For Column VII land contract variables are from 1980, growth rates are for 1980-1996 and income & schooling are for 1980.

Table 3 – Determinants of Rural Conflict – First Stage Equation

Dep. Var.: Violence 1985-1996	Priests 1966 No Opposition Parties	Priests 1966 Opposition Parties
Priests per rural population	-0.629***	-0.614***
	(-10.47)	(-10.26)
Frontier	0.233***	0.232***
	(5.01)	(5.00)
Interaction: Priest x Frontier	0.287***	0.285***
	(8.21)	(8.13)
Political opposition 1982 (% seats in state assembly – MDB		6.680***
		(3.52)
Political opposition 1996 (% seats in state assembly – PT		15.803**
		(2.30)
Agricultural GDP growth 1985-1995.	2.683***	2.810***
	(4.68)	(4.91)
Distance to state capital	0.004	0.006**
	(1.39)	(2.02)
Transport cost to São Paulo	0.001	0.001
	(1.26)	(1.05)
Number of train stations	0.150	0.127
	(0.80)	(0.68)
Latitude	0.195	0.250
	(0.84)	(1.08)
Longitude	-0.359	-0.423*
	(-1.35)	(-1.59)
Cattle per hectare1995	-0.656	-0.668
	(-0.67)	(-0.66)
Tractors per hectare1995	-1240.63***	-1241.46***
	(-8.57)	(-8.60)
Rural/Urban Population (1995)	-1.650***	-1.394***
	(-4.28)	(-3.59)
Population growth 1985-1995	1.236***	1.265***
	(2.65)	(2.71)
Population density 1995	0.010***	0.010***
	(4.68)	(4.53)
Cotton, % of total farm area	-25.481	-22.299
	(-0.62)	(-0.54)
Rice, % of total farm area	-19.454	-18.140
	(-0.95)	(-0.88)
Coffee, % of total farm area	-46.258***	-46.759***
	(-2.65)	(-2.70)
Cane, % of total farm area	9.899***	8.588***
	(3.71)	(3.21)
Beans, % of total farm area	-52.060***	-46.531***
	(-3.79)	(-3.37)
Manioc, % of total farm area	-24.394	-21.850
	(-1.45)	(-1.30)
Corn, % of total farm area	6.119	0.075
	(0.72)	(0.01)
Soy Beans, % total farm area	23.556***	24.585***
	(4.08)	(425)
Constant	19.994	20.930
	(1.10)	(1.15)
Number of observations	Total: 3616 Censored at 0: 2967 Uncensored: 648	Total: 3616 Censored at 0: 2967 Uncensored: 648
State Dummies (27 states)	Yes	Yes
Pseudo R^2	0.14	0.15
$\chi^2(55)$	1131.91	1150.37
Prob>χ^2	0.0000	0.0000

Tobit Estimation. t-stats in parentheses. Statistical significance: 1% ***. 5% **, 10% *. Weighted by the number of county subdivision from 1970-2000.

Table 4 – Determinants of Contract Choice

	Fixed Rent (%)	Sharecropper (%)	Owner (%)	Occupant (%)
Conflict per 1000 farms	-0.008***	-0.006***	0.010***	0.004**
	(-3.60)	(-4.21)	(3.39)	(2.50)
Cotton, % of total farm area	0.428***	0.181***	-0.689***	0.080
	(4.21)	(2.61)	(-4.99)	(1.05)
Rice, % of total farm area	0.275***	0.227***	-0.512***	0.011
	(5.97)	(7.19)	(-8.18)	(0.30)
Coffee, % of total farm area	-0.146***	0.042*	0.124***	-0.021
	(-4.14)	(1.73)	(2.60)	(-0.78)
Cane, % of total farm area	0.187***	0.068***	-0.225***	-0.030***
	(17.77)	(9.47)	(-15.73)	(-3.83)
Beans, % of total farm area	-0.050	0.089***	-0.167***	0.129***
	(-1.40)	(3.61)	(-3.42)	(4.76)
Manioc, % of total farm area	0.062	0.097***	-0.695***	0.536***
	(1.21)	(2.78)	(-9.98)	(13.94)
Corn, % of total farm area	-0.042*	0.021	0.019	0.002
	(-1.70)	(1.23)	(0.57)	(0.11)
Soy Beans, % total farm area	0.218***	0.032***	-0.219***	-0.032**
	(13.21)	(2.82)	(-9.73)	(-2.55)
Frontier	-0.0004**	0.00003	0.0009***	-0.0005***
	(-2.28)	(0.21)	(4.05)	(-4.05)
GDP growth 1985-1995	0.006**	0.004**	-0.013***	0.003**
	(2.47)	(2.40)	(-3.87)	(1.52)
Latitude	-0.004***	-0.0001	0.005***	-0.001**
	(-4.60)	(-0.15)	(4.64)	(-2.15)
Longitude	-0.001	-0.0007	-0.003**	0.005***
	(-0.93)	(-1.01)	(-2.01)	(5.79)
Distance to state capital	-0.000002	0.00002***	0.00001	-0.00003***
	(-0.19)	(2.66)	(0.58)	(3.23)
Transport cost to São Paulo	0.000003	-0.0000002	-0.00001**	0.00001***
	(0.73)	(-0.10)	(-2.52)	(3.68)
Number of train stations	0.002***	-0.0001	-0.003***	0.0003
	(3.57)	(-0.21)	(-2.85)	(0.60)
Population density 1995	0.00002**	0.000001	-0.00002**	-0.000003
	(2.06)	(1.47)	(-1.96)	(-0.52)
Rural/Urban Population 1995	-0.002**	-0.0008	-0.00005	0.003***
	(-2.32)	(-1.56)	(-0.05)	(4.59)
Population growth 1985-1996	0.003	0.002	-0.002	-0.003
	(1.12)	(1.36)	(-0.62)	(-1.61)
Tractor per hectare growth 1985-1995	-0.243	0.512***	-0.775**	0.507***
	(-1.06)	(3.26)	(-2.48)	(2.94)
Cattle per hectare1995	-0.002	0.0002	0.007**	-0.005***
	(-0.65)	(0.11)	(2.06)	(-2.96)
Constant	0.077	0.075	1.100***	-0.248***
	(1.09)	(1.54)	(11.42)	(-4.68)
Number of observations	Total: 3616	Total: 3616	Total: 3616	Total: 3616
State dummies (27 states)	Yes	Yes	Yes	Yes
Pseudo R^2	0.17	0.05	0.18	0.22
$\chi^2(44)$	1757.51	720.98	1754.12	1649.15
Prob>χ^2	0.0000	0.0000	0.0000	0.0000
Hausman-Wu Test	$X^2(1)=25.06$	$X^2(1)=30.66$	$X^2(1)=21.18$	$X^2(1)=5.39$
H_0: Conflicts are exogenous.	p-value= 0.0000	p-value=0.0000	p-value=0.0000	p-value=0.0202

Estimated by 3-Stage Least Squares using predicted conflict as the single excluded instrument (Wooldridge, 2002: 542). t-stats in parentheses. Statistical signif.: 1% ***. 5% **, 10% *. The coefficients for all four equations are constrained to add up to 0 for every variable.

Table 5 – Determinants of Land Use

	Natural Forest %	Planted Forest %	Perm. Crops %	Temp. Crops %	Nat. Pasture %	Plant. Pasture %	Fallow %	Unused %
Conflict per 1000 farms	0.006**	0.006***	0.017***	-0.007***	-0.038***	0.063***	0.00003	-0.008***
	(3.17)	(6.21)	(8.97)	(-5.00)	(-9.60)	(8.20)	(0.06)	(-7.70)
Cotton, % of total farm area	-0.731***	-0.098	-0.097	0.815***	-0.511	0.736***	-0.015	-0.099
	(-4.65)	(-1.19)	(-0.60)	(6.59)	(-1.45)	(2.67)	(-0.35)	(-1.03)
Rice, % of total farm area	-0.356***	-0.063*	-0.111	0.531***	-0.071	-0.099	0.155***	0.013
	(-4.99)	(-1.70)	(-1.51)	(9.48)	(-0.45)	(-0.79)	(7.75)	(0.31)
Coffee, % of total farm area	-0.223***	-0.116***	1.056***	-0.213***	-0.135	-0.319***	-0.018	-0.032
	(-4.10)	(-4.08)	(18.79)	(-4.97)	(-1.11)	(-3.34)	(-1.16)	(-0.96)
Cane, % of total farm area	-0.157***	-0.053***	-0.034**	0.647***	-0.162***	-0.244***	0.017***	-0.014
	(-9.95)	(-6.36)	(-2.12)	(52.18)	(-4.59)	(-8.81)	(3.81)	(-1.45)
Beans, % of total farm area	-0.097*	0.047*	-0.077	0.623***	-0.123	-0.264***	0.021	-0.129***
	(-1.83)	(1.68)	(-1.41)	(14.96)	(-1.04)	(-2.84)	(1.39)	(-4.00)
Manioc, % of total farm area	-0.862***	-0.029	0.428***	0.908***	-0.573***	0.050	0.024	0.055
	(-10.78)	(-0.70)	(5.23)	(14.47)	(-3.22)	(0.36)	(1.06)	(1.16)
Corn, % of total farm area	-0.195***	-0.052***	0.023	0.499***	-0.299***	-0.096	0.088***	0.031
	(-5.07)	(-2.61)	(0.60)	(16.53)	(-3.48)	(-1.42)	(8.19)	(1.32)
Soy Beans, % total farm area	-0.075***	-0.039***	-0.092***	0.782***	-0.081	-0.404***	-0.059***	-0.031**
	(-2.92)	(-2.89)	(-3.47)	(38.69)	(-1.41)	(-8.96)	(-8.17)	(-2.02)
Frontier	0.002***	-0.0002	-0.0001	0.0004	-0.002***	0.0005	-0.0001	-0.0001
	(5.77)	(-1.37)	(-0.32)	(1.57)	(-3.13)	(1.03)	(-0.96)	(-0.79)
GDP growth 1985-1995	0.007**	-0.0003	-0.029***	0.002	0.036***	-0.024***	0.001	0.008***
	(2.04)	(-0.18)	(-8.68)	(0.83)	(4.89)	(-4.27)	(1.44)	(4.11)
Latitude	0.004***	-0.0008	0.004**	-0.0003	-0.029***	0.018***	0.002***	0.003***
	(2.62)	(-1.05)	(2.49)	(-0.29)	(-9.40)	(7.50)	(4.34)	(4.01)
Longitude	0.003**	-0.001*	0.003	0.002*	-0.031***	0.026***	0.0006	-0.002**
	(2.12)	(-1.72)	(1.61)	(1.79)	(-9.21)	(9.85)	(1.41)	(-2.21)
Distance to state capital	0.000001	-0.00005***	-0.0001***	-0.000001	0.0001**	0.00004*	-0.000004	0.00003***
	(0.05)	(-5.72)	(-5.80)	(-0.04)	(2.33)	(1.03)	(-0.78)	(2.61)
Transport cost to São Paulo	-0.000002	0.0000002	-0.000002	0.000006	0.00007***	-0.0001***	-0.000002	0.00000006
	(-0.41)	(0.08)	(-0.37)	(1.55)	(6.75)	(-9.24)	(-1.20)	(0.11)
Number of train stations	-0.004***	0.001**	-0.002**	-0.002*	0.008***	-0.003	0.0008**	0.0007
	(-3.93)	(2.09)	(-2.07)	(-1.86)	(3.47)	(-1.53)	(2.52)	(1.08)
Population density 1995	0.00002**	-0.00002***	0.00003**	0.00002**	0.00002	-0.0001***	0.0000001	0.00001**
	(2.17)	(-2.99)	(2.34)	(2.38)	(0.66)	(-4.32)	(0.02)	(2.00)
Rural/Urban Population 1995	0.003**	0.0001	0.002	0.0006	-0.005**	-0.0008	0.0007**	0.0004
	(2.28)	(0.23)	(1.40)	(0.67)	(-2.05)	(-0.41)	(2.09)	(0.61)
Population growth 1985-1995	0.007**	-0.0004	-0.004	0.005**	0.006	-0.016***	-0.00008	0.003
	(2.10)	(-0.25)	(-1.25)	(2.11)	(0.83)	(-2.95)	(-0.09)	(1.64)
Tractor per hectare growth 1985-1995	-0.407	-0.107	2.747***	3.661***	-4.465***	-2.472*	-0.013	0.051
	(-1.14)	(-0.57)	(7.52)	(13.16)	(-5.62)	(-3.92)	(-0.13)	(0.23)
Cattle per hectare1995	-0.038***	-0.012***	-0.016***	-0.006**	0.021	0.058***	-0.004***	-0.004*
	(-10.65)	(-6.38)	(-4.31)	(-2.13)	(2.71)	(9.27)	(-3.71)	(-1.90)
Constant	0.532***	1.096*	-0.140	-0.155*	1.681***	-1.273***	0.00004	0.215***
	(5.02)	(1.74)	(-1.29)	(1.87)	(7.11)	(-6.88)	(0.00)	(3.39)
Number of observations	Total: 3616	Total: 3616	Total: 3616	Total: 3616	Total: 3616	Total: 3616	Total: 3616	Total: 3616
State dummies (27 states)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.37	0.07	0.11	0.74	0.12	0.29	0.38	0.23
$\chi^2(44)$	4904.52	829.24	993.45	14975.28	1225.01	2787.73	2421.12	2340.63
Prob>χ^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Estimated by Three Stage Least Squares. t-stats in parentheses. Statistical signif.: 1% ***. 5% **, 10% *. The coefficients for all eight equations are constrained to add up to 0 for every variable. A Hausman-Wu endogeneity test rejects exogeneity of conflicts in all of the equations at 1% (except Natural Forest at 5%) except Fallow.

Table 6 – Impact of Conflict on Land Use

% of Total Farm Area	Natural Forest (%)	Planted Forest (%)	Perm. Crops (%)	Temp. Crops (%)	Natural Pasture (%)	Planted Pasture (%)	Fallow (%)	Unused Land (%)
Conflict = 0	11.5%	4.3%	8.9%	18.4%	19.7%	25.6%	2.22%	4.6%
Conflict = 4.4	14.0%	6.8%	16.2%	15.3%	2.8%	36.9%	2.23%	0.9%
Change in land use (%)	2.5%	2.5%	7.3%	-3.1%	-16.9%	11.3%	0.01%	-3.7%
Total area in Brazil (km^2)	888,823	53,960	75,412	342,489	780,171	996,332	83,025	163,441
Change due to conflict (km^2)	22,242	1,383	5,500	-10,603	-132,038	112,945	11	-6,027
Comparison	Israel	Hong Kong	Brunei	Lebanon	Greece	Honduras	-	Palestinian Territories

Notes: Calculated using the coefficients from Table 4 setting all variables at their mean levels and the estimated state dummy for São Paulo. 1 sq. km. = 100 hectares. Change due to conflict calculated by multiplying total agricultural land area in Brazil by predicted % in each category, with conflict = 0 and conflict = 4.4, and subtracting.

Table 7 – Analysis of Instruments

Panel A	F-test first stage	Sharecrop (impact of conflict)	Fixed-Rent (impact of conflict)	Occupied (impact of conflict)	Owned (impact of conflict)
Priests 1966 w/ interaction	F(3, 3568) = 53.95	-0.006***	-0.008***	0.004**	0.010***
		(-4.21)	(-3.60)	(2.50)	(3.39)
Priests 1966, no interaction	F(1,3569) = 55.28	-0.008***	-0.004**	0.008***	0.004
		(-4.48)	(-2.15)	(3.80)	(1.56)
Priests 1966 w/ interaction and opposition parties	F(5, 3566)=36.04	-0.005***	-0.005***	0.003**	0.007***
		(-4.07)	(-2.68)	(2.09)	(2.72)

Panel B	F-test first stage	Nat. Forest	Plant. Forest	Perm. Crops	Temp. Crops	Nat. Pasture	Plant Pasture	Fallow	Unused
Priests 1966 w/ interaction	F(3, 3568) = 53.95	0.006**	0.006***	0.017***	-0.007***	-0.038***	0.063***	0.00003	-0.008***
		(3.17)	(6.21)	(8.97)	(-5.00)	(-9.60)	(8.20)	(0.06)	(-7.70)
Priests 1966 no interaction	F(1,3569) = 55.28	0.003*	0.003***	0.018***	-0.003**	-0.044***	0.032***	-0.0001	-0.009***
		(1.64)	(3.37)	(9.12)	(-2.21)	(-9.76)	(8.84)	(-0.26)	(-7.88)
Priests 1966 interct. + oppo.	F(1,3569) = 55.28	0.006**	0.005***	0.016***	-0.005***	-0.037***	0.023***	-0.0002	-0.008***
		(3.13)	(5.96)	(8.92)	(-3.46)	(-9.61)	(7.84)	(-0.40)	(-7.66)

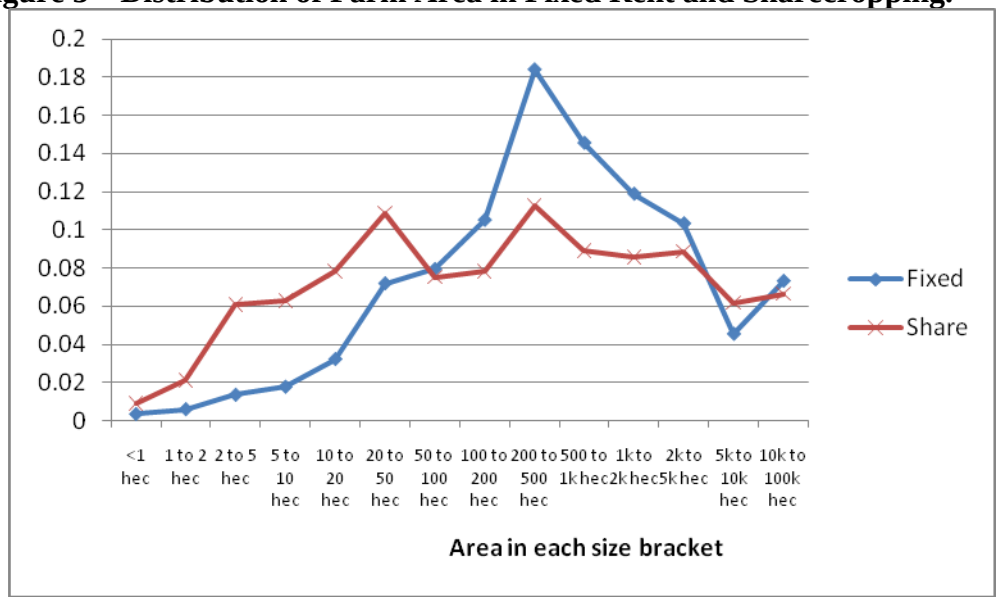
The first Column in each panel shows an F-test on the instruments in the first stage conflict estimation. The remaining Columns show the estimated coefficient and t-stat for the instrumented conflict variable on the second stage regressions. The remaining results are omitted in the interest of space. * = 10%, ** = 5% and *** = 1% statistical significance.

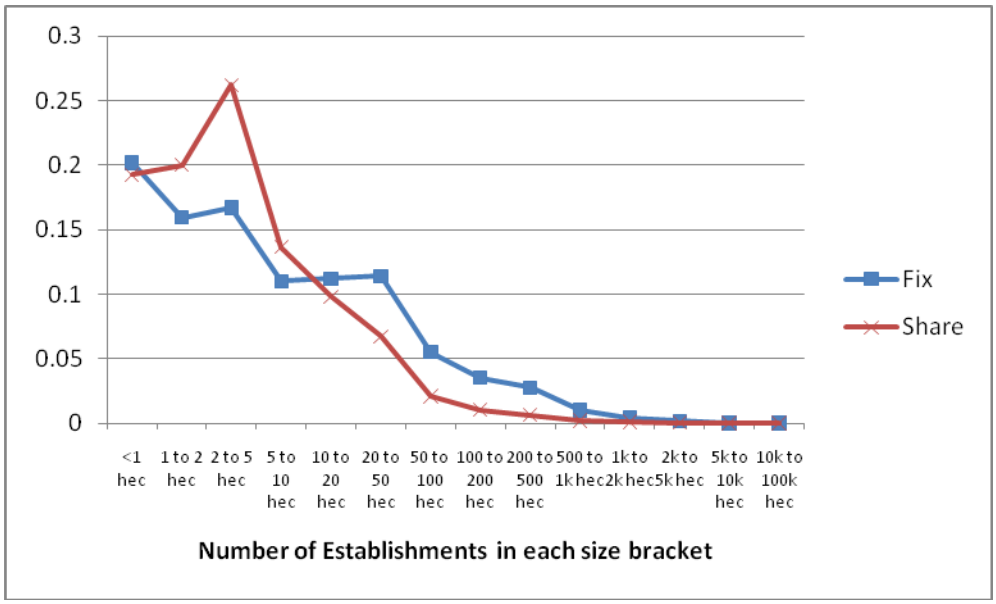
Table 8 – Impact of Contract Choice on Average Farm Size

Dep. Variable: Avg. farm size (hectares)	**Excluded category: Owner**	**Excluded category: Fixed Rent**	**Excluded category: Sharecropping**	**Excluded category: Occupant**
Sharecrop (% of total farmland)	-1604.23***	-2193.30***		-1461.7***
	(-6.34)	(-6.64)		(-4.41)
Fixed Rent (% of total farmland)	596.05***		2165.2***	765.5***
	(5.40)		(6.22)	(5.42)
Occupant (% of total farmland)	-182.0	-782.59***	1392.2***	
	(-1.30)	(-5.57)	(4.01)	
Owner (% of total farmland)		-593.5***	1564.1***	160.8
		(-5.50)	(6.01)	(1.17)
Constant	181.7***	776.61***	-1384.7***	16.6
	(3.89)	(7.20)	(-5.02)	(0.14)
Number of observations	Total: 3616	Total: 3616	Total: 3616	Total: 3616
State dummies (27 states)	Yes	Yes	Yes	Yes
R^2	0.393	0.397	0.385	0.390
R^2 - adjusted	0.388	0.392	0.380	0.385
F(29,3526)	99.42	100.09	98.04	98.84
Prob>F	0.0000	0.0000	0.0000	0.0000

Instrumental Variables Estimator. Instruments are all the right-hand side variables in Table 4. t-stats in parentheses. Statistical significance: 1% ***. 5% **, 10% *.

Figure 3 – Distribution of Farm Area in Fixed Rent and Sharecropping.





Appendix 1 – Data

Total number of observations = 3659. This the AMC7097 grouping created by IPEA/IBGE which makes data comparable from 1970 to 2000 by adding, or in some cases averaging, the data of *municipios* that sub-divided from 1970 to 1997. There are 27 states. The data for most of the variables are available for two set of years, 1985 and 1995/96. Agricultural data and Priest data can be added for 1980 and 1975, but Conflict data only goes back to 1985. Not all variables are used in the estimation but we list all variables available.

Agricultural data (source = IBGE Agricultural Census)

1) Area in farms (1985 and 1996), hectares.
2) Number of establishments (1985 and 1996).
3) Total municipio area (fixed)
4) Farm area in natural forest (1985 and 1996), hectares.
5) Farm area in planted forest (1985 and 1996), hectares.
6) Farm area in permanent crops (1985 and 1996), hectares.
7) Farm area in temporary crops (1985 and 1996), hectares.
8) Farm area in natural pasture (1985 and 1996), hectares.
9) Farm area in planted pasture (1985 and 1996), hectares.
10) Farm area left fallow (1985 and 1996), hectares.
11) Farm area productive but not used (1985 and 1996), hectares.
12) Farm area unsuitable for productive use (1985 and 1996), hectares.
13) Total area in farms run by owner (1985 and 1996), hectares.
14) Total number of owner run farms (1985 and 1996).
15) Total area in rented farms (1985 and 1996), hectares.
16) Total number of rented farms (1985 and 1996).
17) Total area in sharecropped farms (1985 and 1996), hectares.
18) Total number of sharecropped farms (1985 and 1996).
19) Total area in squatted farms (1985 and 1996), hectares.
20) Total number of squatted farms (1985 and 1996).
21) Number of heads of cattle (1985 and 1996).
22) Number of tractors (1985 and 1996).
23) Investments realized in the year R$ (thou) of 2000(mil) (Deflated) (1985 and 1996).
24) Revenues received in the year R$ (thou) of 2000(mil) (Deflated) (1985 and 1996).
25) Expenditures in the year R$ (thou) of 2000(mil) (Deflated) (1985 and 1996).
26) Area irrigated (1985 and 1996) hectares.
27) Total number of tractors in the municipio (1985 and 1996).
28) People working in farms (1985 and 1996).
29) Area in cotton (1985 and 1996) hectares.
30) Area in rice (1985 and 1996) hectares.
31) Area in coffee (1985 and 1996) hectares.
32) Area in sugar cane (1985 and 1996) hectares.
33) Area in beans (1985 and 1996) hectares.
34) Area in manioc (1985 and 1996) hectares.
35) Area in corn (1985 and 1996) hectares.
36) Area in soy beans (1985 and 1996) hectares.

Conflict data

37) Number of murders, yearly data (1985 to 1995). (Pastoral Land Commission)
38) Number of threats of murder, yearly data (1985 to 1995). (Pastoral Land Commission)
39) Number of murder attempts, yearly data (1985 to 1995). (Pastoral Land Commission)
40) Number of occupations/invasions, yearly data (1988 to 1995). (Pastoral Land Commission)
41) Area expropriated for land reform, yearly data (1979 to 1996). (INCRA/Ipeadata)
42) Capacity for settling families in settlement projects, yearly data (1979 to 1996), unit=families. (INCRA/Ipeadata)
43) Number of expropriations, yearly data (1979 to 1996). (Pastoral Land Commission) (INCRA/Ipeadata)

Priest data (source Catholic Hierarchy – The hierarchy of the Catholic Church http://www.catholic-hierarchy.org/)

44) Number of Catholics, data for 1975, 1985, 1995 (proximate years in some cases).
45) Total population (data from Catholic Hierarchy, not IBGE), for 1975, 1985, 1995 (proximate years in some cases).
46) Number of priests in Diocese, data for 1975, 1985, 1995 (proximate years in some cases).
47) Number of Catholics per preist, for 1975, 1985, 1995 (proximate years in some cases).

Other data

48) Area of entire municipio, square kilometers (oddly this varies from 1985 to 1996) (IBGE/Ipeadata).
49) Distance from the municipio head to the federal capital, kilometers, fixed for 1985 and 1996.
50) Distance to the state capital kilometers, fixed for 1985 and 1996.
51) Transport cost to São Paulo (index) – Nucleo de Estudos e Modelos Espaciais Sistêmicos, http://www.nemesis.org.br/ .
52) Number of train stations in the município - Nucleo de Estudos e Modelos Espaciais Sistêmicos, http://www.nemesis.org.br/ .
53) Latitute, degrees, fixed for 1985 and 1996.
54) Longitude, degrees, fixed for 1985 and 1996.
55) Total population, 1980 and 1996. (IBGE/Ipeadata)
56) Total rural population, 1980 and 1996. (IBGE/Ipeadata)
57) Total urban population, 1980 and 1996. (IBGE/Ipeadata)
58) Economically active population 1985 and 1996. (IBGE/Ipeadata)
59) Economically active rural population 1985 and 1996. (IBGE/Ipeadata)
60) Economically active urban population 1985 and 1996. (IBGE/Ipeadata)
61) County GDP in R$ of 2000 (thou) (deflated), 1985 and 1996. (IBGE/Ipeadata)
62) County agricultural GDP in R$ of 2000 (thou) (deflated), 1985 and 1996. (IBGE/Ipeadata)
63) Number of county assemblymen elected by the main opposition party (MDB in 1982 and PT in 1996) (TSE/Ipeadata)
64) Total number of county assembly seats, 1982 and 1996.

Appendix 2
Table A1 - Non-Instrumented Results

	Fixed Rent (%)	Sharecropper (%)	Owner (%)	Occupant (%)
Conflict per 1000 farms	0.0002	-0.00004	-0.0001	-0.0001
	(1.41)	(-0.42)	(-0.31)	(-0.81)
Cotton, % of total farm area	0.463***	0.208***	-0.734***	0.062
	(5.93)	(4.33)	(-6.59)	(0.91)
Rice, % of total farm area	0.308***	0.252***	-0.553***	-0.007
	(8.72)	(11.53)	(-10.96)	(-0.23)
Coffee, % of total farm area	-0.127***	0.056***	0.101***	-0.030
	(-4.70)	(3.35)	(2.63)	(-1.29)
Cane, % of total farm area	0.175***	0.059***	-0.210***	-0.024***
	(22.63)	(12.33)	(-19.03)	(-3.56)
Beans, % of total farm area	0.0008	0.128***	-0.231***	0.102***
	(0.03)	(8.09)	(-6.31)	(4.56)
Manioc, % of total farm area	0.047	0.086***	-0.676***	0.543***
	(1.20)	(3.52)	(-12.02)	(15.80)
Corn, % of total farm area	-0.027	0.032***	-0.001	-0.006
	(-1.45)	(2.74)	(-0.04)	(-0.34)
Soy Beans, % total farm area	0.213***	0.028***	-0.212***	-0.029**
	(16.66)	(3.53)	(-11.63)	(-2.58)
Frontier	-0.0004***	0.0001	0.0009***	-0.0006***
	(-2.67)	(0.62)	(4.78)	(-4.71)
GDP growth 1985-1995	0.0002	-0.0005	-0.006***	0.006***
	(0.15)	(-0.58)	(2.75)	(4.75)
Latitude	-0.003***	0.0009**	0.004***	-0.002***
	(-4.10)	(2.23)	(4.18)	(-3.72)
Longitude	0.001	0.0008*	-0.005***	0.004***
	(1.43)	(1.89)	(-5.57)	(6.13)
Distance to state capital	-0.00003***	0.00001	0.00004***	-0.00002***
	(-3.21)	(1.18)	(3.53)	(-2.93)
Transport cost to São Paulo	-0.000001	-0.000003**	-0.00001*	0.00001***
	(-0.54)	(-1,99)	(1.90)	(5.14)
Number of train stations	0.002***	-0.0004	-0.002***	0.0006
	(3.69)	(-1.49)	(2.72)	(1.27)
Population density 1995	0.00001	-0.0000003	-0.00001	0.000002
	(0.99)	(-0.10)	(-0.96)	(0.49)
Rural/Urban Population 1995	-0.0008	-0.0001	-0.001	0.002***
	(-1.45)	(-0.22)	(-1.57)	(4.39)
Population growth 1985-1995	-0.001	-0.0007	0.003	-0.009
	(-0.99)	(-0.69)	(1.15)	(-0.64)
Tractor per hectare growth 1985-1995	-0.081	0.636***	-0.976***	0.421***
	(-0.46)	(5.88)	(3.90)	(2.75)
Cattle per hectare1995	-0.004**	-0.002	0.009***	-0.004***
	(-2.13)	(-1.43)	(3.75)	(-2.68)
Constant	-0.054	-0.028	1.26***	-0.181***
	(-1.21)	(-1.01)	(19.86)	(-4.66)
Number of observations	Total: 3616	Total: 3616	Total: 3616	Total: 3616
State dummies (27 states)	Yes	Yes	Yes	Yes
R^2	0.44	0.28	0.42	0.42
$\chi^2(44)$	2835.14	1404.88	2033.70	2587.83
Prob>χ^2	0.0000	0.0000	0.0000	0.0000

Estimated Seemingly Unrelated Regresion. t-stats in parentheses. Statistical signif.: 1% ***. 5% **, 10% *. The coefficients for all four equations are constrained to add up to 0 for every variable.

Appendix 3 – Sensitivity Analysis for Spatial Autocorrelation

Ideally we would like to take into account the effect of spatial autocorrelation in our regressions in Table 4. Although we are able to run estimation procedures controlling for spatial autocorrelation using latitude and longitude to indicate each *municipio's* location, we have not found any program or routine that can do so in the context of three-stage least squares estimation with all coefficients of the same variable constrained to add up to zero across equations and when the first stage is a Tobit. Therefore, for the purpose of sensitivity analysis we did three separate estimation procedures which can be compared to ascertain the relative impact on results of spatial autocorrelation versus the 3SLS. The first step is to use GMM estimation with the estimated level of conflict from the first-stage Tobit directly in each separate second-stage contract-choice equation. This procedure was then repeated including an additional procedure (Conely, 1999) which takes into account also the possibility of spatial autocorrelation of errors, that is, the impact of neighboring *municipios'* variables on a given *munícipio´s* dependent variable. The estimates from the two GMM procedures can be compared to see how much spatial autocorrelation affects the results. The second step is a comparison of the 3SLS results in Table 4 and the non-spatial GMM estimation in order to ascertain how much of the former results are due to taking into account contemporaneous correlation and to constraining the coefficients to add up to zero. The relative impacts of spatial autocorrelation and of the 3SLS can then be compared. The estimated coefficient of conflict in the contract choice equations is shown in Table A2.[26]

Table A2 – Sensitivity Analysis for Estimation Procedure

	Coefficient of Estimated Conflict (from 1st stage) in Contract Equations	**Fixed Rent (%)**	**Sharecrop (%)**	**Owner (%)**	**Occupant (%)**
1	Three Stage Least Squares, Instrumental variables, no spatial correction (Table 3)	-0.008*** (-3.60)	-0.006*** (-4.21)	0.010*** (3.39)	0.004** (2.50)
2	GMM Instrumental variables, separate equations, no spatial correction	-0.020* (-1.82)	-0.010** (-2.38)	0.033*** (2.68)	-0.004* (-1.65)
3	GMM instrumental variable, spatial autocorrelation (Conley, 1999)	-0.020 (-1.63)	-0.011* (-1.92)	0.033** (2.16)	-0.004 (-1.46)
	Number of observations	3616	3616	3616	3616

Lines 2 and 3 estimated using IPEAGeo 1.0.0. t-stat in parentheses. Statistical significance: 1% ***, 5% **, 10% *. Spatial GMM based on Conley (1999) using latitude and longitude as x and y coordinates with proportional distance set at 10% of maximum distance. Same controls used as in Table 4 except state dummies.

[26] The results for the other variables are omitted in the interest of space.

Line 1 in Table A2 shows the estimated coefficient for conflict using 3SLS, replicated from Table 4. Line 2 shows the GMM estimates with no consideration of spatial autocorrelation. Finally line 3 shows the GMM estimates including the correction for autocorrelation. Comparison of lines 2 and 3 show the impact of spatial autocorrelation on the standard errors. By construction the estimated coefficients are the same. Comparison of line 1 and 2, none of which consider spatial autocorrelation, show the impact of estimating the equations in a system by 3SLS with constrained coefficients rather than estimating separate equations through GMM, though the same instruments are used in both procedures.

The comparisons show that including the impact of spatial autocorrelation has very little impact on the t-stats, which become slightly smaller but do not change the result of the tested hypotheses. In both cases conflicts are found to reduce fixed rent and sharecropping, though no effect is found on occupied. On the other hand, the impact of using 3SLS is large. The estimated coefficients vary and the t-stats become larger, adding substantial statistical significance to the result that the tenancy contracts are inhibited by conflict. The 3SLS results are preferable to the GMM results because they are more efficient econometrically. This is so for two reasons. The first is that the simultaneous estimation of the equations including the 'contemporaneous' correlation of errors makes the estimates more efficient. The second is due to the additional information that is added by the constraints that force all coefficients of each variable to add up to zero across equations. The upshot is that we can have confidence in the results presented in Table 4, with perhaps a small but inconsequent underestimation of the standard errors. The same conclusion extends to the estimates of the land use variables in Table 5.