

AN ANALYSIS OF PROPERTY RIGHTS, LAND VALUE, AND  
AGRICULTURAL INVESTMENT ON TWO FRONTIERS IN BRAZIL

by

Lee J. Alston  
University of Illinois

Gary D. Libecap  
University of Arizona and NEBR

Robert Schneider  
World Bank

October 13, 1993

A draft prepared for presentation at Indiana University, October 18, 1993.

Acknowledgements: We wish to thank Ricardo Tarifa, Bernardo Mueller, and James Dalen Jr. for their research support and the World Bank and NSF grant SES 92113603 for financial support of this project. The authors also benefitted from comments by Ann Carlos, Gershon Feder, Doc Ghose, Shawn Kantor, Barbara Sands, and participants at workshops at the University of Colorado and the Economic History Association Meetings.

## I. Introduction.

It is generally believed that the security of property rights institutions increases with the inherent value of the land.<sup>1</sup> Moreover, research indicates that tenure conditions affect investment and the extent and pace of development of agricultural societies.<sup>2</sup> There appears to be a simultaneous relationship among these variables. That is, as land values rise due to exogenous factors, there is demand for the more precise definition of property rights, and with more secure rights, land values increase further. Additionally, secure tenure facilitates investment in the land, which in turn, raises land values. Despite interest in these relationships, there has been surprisingly little empirical analysis of the determinants of property rights and the interaction among tenure conditions, land values, and investment. The issues are important ones because land use in developing areas has attracted critical attention. There are concerns about the sustainability of development and the agricultural practices associated with it.<sup>3</sup> Clearly, land tenure will play a critical role.

In this paper, we examine the determinants of property rights and their interplay with agricultural investment and land value in two Brazilian states, Parana and Para. Parana, in the south, was a frontier state beginning in the 1930s, and settlement there was completed by 1970. Para, in the Amazon, currently is a frontier state. Indeed, only about 8 percent of the Amazon has been deforested, which is a precondition for agricultural settlement.<sup>4</sup> Comparison of property rights, investment, and land values in these two states allows for an assessment of whether settlement and tenure policies have changed over time in Brazil in ways that promote investment. The empirical analysis uses Brazilian agricultural census data from 1940 through 1985 with observations at the county or municipio level.

We find that the development of property rights and agricultural investment followed predicted patterns in Parana, but that the relationship is much weaker in Para. Moreover, titling was more rapid in Parana than it has been in Para, where squatting (the use of land without formal title) is much more prevalent. Low land values, conflicting government jurisdictions, and changing government policies regarding settlement and tenure in the Amazon have hindered the assignment of property rights to land in Para. Since most of the Amazon remains to be settled, how the tenuring process proceeds seems likely to have a critical impact on land use in the region. We examine sources of the difference in tenure conditions between Parana and Para and draw implications from the nineteenth century U.S. frontier experience, where property rights were routinely assigned and squatting appears to have been rare.<sup>5</sup>

## II. A Summary of Property Rights and Land Use on Agricultural Frontiers.

### A. General Relationships.

The importance of secure property rights as an institutional basis for economic growth has been stressed by Libecap (1986, 1989a) and North (1990).<sup>6</sup> More specific issues regarding the links among tenure conditions, agriculture, and economic development are raised by Feder and Feeny (1991).<sup>7</sup> Tenure affects agriculture and land use in a number of ways. First, clear, exclusive title to land provides the collateral necessary for farmers to access capital markets. Lending is inherently risky, and lenders require compensation not only for delaying consumption, but to compensate for inflation and the risks of default. With title, farmers can obtain capital at lower cost to finance investment in seeds, fertilizers and other crop inputs as well as longer-term land improvements. Title not only provides security

to lenders in the case of default, but it lowers uncertainty by signalling to lenders that relatively long-term, stable ownership and land use conditions prevail. Definitive title insures that lenders will have the same ability as borrowers to dispose of the land by sale to recoup their funds. Hence, secure tenure conditions promote the development of credit markets for agriculture.<sup>8</sup>

Second, guaranteed tenure encourages farmers to invest in the land through construction of irrigation networks, control of erosion, use of fertilizers, planting of permanent crops, construction of fences and farm buildings, improvement of pastures, removal of rocks and other debris, and adoption of new hybrid seeds. With exclusive property rights to their land, farmers can make investments to improve long-term productivity with reasonable assurance that they will collect the net returns. Third, with secure tenure, farmers can devote productive resources to agriculture, rather than to the defense of their holdings against encroachment or invasion by others. Fourth, well-defined and enforced property rights to land increase the exchange value of land. With formal property rights, the market of potential purchasers is widened because title provides information to those beyond the immediate locality that the land claim is safe and that the exchange transaction will be recognized and enforced. Thus, sure land tenure conditions promote gains from trade.

We have emphasized the gains from formal property rights to land, but do not mean to suggest that informal tenure arrangements cannot provide at least some of these benefits. Indeed, when inherent land values are relatively low on the frontier, informal arrangements are appropriate. They are low cost and serve to demarcate individual claims and to arbitrate

local disputes. While sufficient for those conditions, informal, local arrangements become increasingly ineffective as population densities and land values rise. They generally are not recognized away from the local community, and hence, do not provide collateral for accessing credit, nor do they allow for broad gains from trade. Local tenure practices will not supply distant, potential buyers with the ownership guarantees that they require, nor are they likely to be recognized in the courts during ownership disputes. Finally, the long-term guarantees provided by definitive title for investment are absent from informal arrangements, and hence, investment in permanent crops and improvements may not occur.<sup>9</sup> By definition, informal land access, use privileges, and property boundaries often are not recorded and depend upon community cohesion. Should this break down through immigration, as is typical of frontier societies, past, informal practices may not be remembered or recognized. Hence, they may not be durable enough to provide the security needed for longer-term land use practices that increase land values.<sup>10</sup>

Property rights to agricultural land vary not only in terms of their definition and enforcement, but also as to whether they are held by the state, groups (communal rights), and individuals. In the case of frontier settlement in the United States and Brazil, individualistic, private property rights were by far the dominant form of tenure institution. In both countries, the government used land sales and settlement as instruments of public policy—to advance agricultural occupation and production, to finance schools and colleges (U.S.), to achieve land distribution goals, and in some cases, to reward the politically influential. The overriding aim in Brazil and the United States was to establish private ownership, rather than communal, on government lands.

## B. The Establishment of Property Rights on Agricultural Frontiers.

Analysis of the assignment of property rights to land during frontier settlement provides an unusual laboratory for the study of institutional development and the role of government policy. Frontiers are transitional phenomena, characterized by sequential movements of population to new, unoccupied lands, where private ownership claims are made and agricultural production is begun. Our definition of the frontier is a region where land rents, net of transportation costs and the costs of defining simple property claims, first become positive, attracting claimants. In remote regions beyond the settlement frontier, transportation costs will be so high with respect to the value of agricultural production that individual settlers are unlikely to cover their opportunity costs, and settlement will not occur. Hence, the individuals who first arrive on the frontier are those with low opportunity costs and limited or no access to capital." If it is costly to obtain formal property rights to their land, the initial claimants will forego such arrangements and occupy their claims as squatters

Other things equal, property rights to land tend to be made more precise as land values grow. Accordingly, as population densities increase, the demand for land increases and squatters will seek to replace their claims with more formal property rights recognition, such as definitive title. If these institutions are not available, then squatting will continue. Increasingly, however, squatting claims will fail to provide the advantages offered by more secure property rights to land.

Because property institutions, agricultural investment, and land values appear to rise more or less concurrently, analysis of the frontier provides insight into how this interactive process occurs. A variety of questions can be addressed, such as: Who arrives first on the

frontier, and what kind of land rights do they secure? How do changes in the composition of settlers and increases in population density affect property rights to land? What are the roles of private arrangements and government policies in the assignment of property rights? How does the value of land affect tenure, and correspondingly, how are land values and agricultural investment influenced by tenure conditions? What markets develop for the exchange of land rights?

These are fundamental issues for the study of institutional change and economic development in rural societies. Hence, many studies of property rights formation have involved the examination historical data from frontier settlement in the nineteenth century United States.<sup>12</sup> Examination of twentieth century Brazil offers similar conditions, since large amounts of land owned by the state and federal governments also have been made available to private claimants.<sup>13</sup> As in the U.S., rural migration in Brazil has moved from densely-populated seacoast states to interior regions, with early frontiers moving through southern states, such as Parana and more recent frontiers in Amazon states, such as Para.<sup>14</sup> A comparison of the assignment of property rights on the frontier in these two states allows us to determine whether the process has been similar in both areas and whether land allocation in Brazil has been like that practiced in the nineteenth century U.S., which promoted agricultural investment by quickly providing secure tenure.

Government policy will play an important role in determining whether property rights emerge in a timely fashion and at low cost on the frontier. In relatively static conditions where asset values are low, private arrangements or informal, local institutions are likely to provide satisfactory constraints on individual resource assignment and use. Low values limit

competition and provide for relatively homogeneous claimants, who can reach agreement on property rights.<sup>15</sup> By definition, these conditions, however, do not describe frontier settlement. As land values rise due to exogenous conditions, such as the introduction of new transportation networks, a rise in population density in older settled areas, and/or an increase in commodity prices, the frontier will move to new unoccupied lands, since individuals now anticipate that the net present value of their claims to these lands will meet or exceed their opportunity costs. If land values are rising rapidly, the frontier will move quickly as large numbers of claimants are attracted to the region. These claimants are likely to be a heterogeneous group, with different originations, backgrounds, and expectations. Local private agreements regarding property rights will be difficult to reach and enforce within such a group, especially if land values are increasing rapidly. Accordingly, government policy can be critical in determining whether property rights will appear smoothly and effectively on the frontier to promote investment and the further increase in land values.

Government policy will affect who receives title (through the allocation formula) when it is assigned (through marking and survey policies, pricing, and other settlement requirements), whether it is secure (through enforcement practices), and whether conflicts are adjudicated (through the police and courts). Each of these will be determined through the political process. Putting politics aside, governments will instantaneously respond to the demands for titles to frontier land by selling them to claimants as soon as the title value exceeds assignment costs—survey, demarcation, adjudication, and enforcement costs. Under these conditions, secure tenure will be provided as soon as it is justified by rising land

values. Secure tenure, in turn, will stimulate investment and increase land prices by encouraging the development of land markets.

But political factors will affect this process. For example, the demand to subsidize favored claimants may lead governments to intervene too soon to provide title before title values are equal to the costs involved. These subsidies may be controversial and lead to subsequent conflict over land, raising enforcement costs. Further, political coalitions of claimants with differing wealth and background will lead to demands for different criteria for the assignment of property rights. Resolving these disputes will delay the titling process. Or if jurisdictions to land are confused, competing governments with different constituents may grant overlapping titles, a practice that also will raise enforcement costs. Or changing macro-economic conditions or new demands on government budgets may divert resources from the assignment and enforcement of land titles on the frontier, leaving claimants without secure tenure as land values rise. Governments can transfer some of the costs of titling by selling land in large blocks to private companies that in turn will subdivide and title the land for agricultural development. Since private companies are residual claimants, they are likely to have more incentive than government officials to assign titles quickly and at low cost to settlers.

Government policy may also affect frontier settlement, tenure security, and land use in other ways beyond titling policy. In response to demands from constituents, governments may subsidize infrastructure to induce settlement of the frontier. Improvements in transportation raise the expected returns from frontier lands, changing the time path of settlement. Alternatively, the promise of government infrastructure investment will attract

speculative settlement of lands that otherwise would not justify occupation. If these promises are not forthcoming and it is costly for migrants to return to their previous locations, then claimants will be stranded, and low land values will encourage resource mining.

Additionally, governments may subsidize settlement directly by bringing claimants to the frontier. The political rationale may range from efforts of the government to capture rents from the sale of frontier lands, to implement land reform, or to obtain military security. Direct settlement, however, will induce more migration to the frontier as others seek to benefit from the expected rise in land rents. These induced migratory flows may greatly exceed the capacity of titling agencies to process claims and lead to uncertainty over property rights.<sup>16</sup>

These political factors suggest that governments are unlikely to intervene in an optimal manner to provide property institutions on the frontier. Of interest to us is whether political conditions have brought changes in land policies and tenure security as frontiers have moved across Brazil in the twentieth century.

### III. Empirical Analysis of Tenure, Settlement, and Agricultural Investment in Two Brazilian States: Parana and Para.

#### A. Property Rights and Settlement of the Frontier in Parana and Para.

We focus our empirical analysis of the determinants of tenure and its link with agricultural investment using data from two frontiers in Brazil: Parana in the south between 1940 and 1970 and Para in the Amazon between 1970 to 1985. We are interested in the factors that affect the assignment of title to land, whether the tenuring process has differed over time in Brazil, and how varying private and government jurisdictions have affected the

assignment of property rights within each of the states. Both Parana and Para experienced frontier expansion as a result of agricultural settlement, and differing land policies have applied within and across the two states. Within Parana, the state government allocated land and assigned titles in western regions, but in the north, much of the land was sold to a private land development company that recruited settlers and granted titles.<sup>17</sup> In Para, both the federal government and the state have had jurisdiction over the land. We examine whether these different jurisdictions resulted in differences in tenure. In both states, we expect that secure tenure will lead to higher land values and higher levels of agricultural investment. We now turn to these issues.

#### FIGURES 1-5 HERE

Figures 2 and 3 illustrate the amount of land in agriculture and the number of farms in Parana and Parana. There was rapid settlement of Parana after 1940 due to high coffee prices and declining yields in the neighboring state of Sao Paulo. Between 1940 and 1960, the amount of agricultural land almost doubled and the number of farms increased four-fold. On the western and northern frontiers, cropland increased by more than seven times.<sup>18</sup> The population also increased dramatically, growing from 1.2 million to 5.8 million between 1940 to 1965.<sup>19</sup> In Para, frontier expansion began in the mid 1960s at the time when settlement of Parana was nearly complete. Before the 1960s, the economy evolved around the extraction of natural resources, such as rubber and Brazil nuts. These activities did not result in much population growth, and most of the population resided along the river networks, in the "zona Bragantina" northeast of Belem, the state capital, or in Belem. After construction of the Belem-Brasilia Highway in 1959, migration increased, and directed

colonization by the federal government occurred. The land in farms doubled in the 1960s and again in the 1970s, and the number of farms rose sharply (Figures 2 and 3). The population grew from 1.5 million in 1960 to 4.3 million in 1985.

Despite this growth, Para has remained sparsely settled. In 1985, agriculture involved only 5 percent of the land in the state. In part because of large amounts of uncleared land in Para and its remote location from major markets, land values have been much lower there than in Parana. For example, census data reveal that the value of land per hectare in Para in 1970 was only 8 percent of the value of land per hectare in Parana. Even by 1980, per hectare land values in Para were only 21 percent of the 1970 value of land in Parana and only 35 percent of the value of land in Parana in 1950 (all comparisons are in 1970 cruzeiros).

As indicated in Figures 4 and 5, squatting has been more prevalent and has lasted longer in Para than in Parana. In 1970, 19 percent of agricultural land in Para was held by squatters, compared to 5 percent in Parana, and 47 percent of all farms were occupied by squatters, while in Parana 9 percent of the farms were operated by squatters. Even during the frontier period in Parana, squatting never was as pervasive as in Para. Further, the state-wide data mask even more squatting on the frontier, where in Para, 50 percent of the land often was held by squatters.

#### A. A Framework for Analyzing Property Rights, Land Values, and Investment.

The frontier settlement process described above suggests that the value of land, property rights to land, and investment in land are at least partially simultaneously

determined. The determination of property rights involves both demand and supply (government) factors. On the demand side, higher land values will prompt a greater demand for secure property rights. The value of land is the capitalized value of the potential rental stream, and the greater the potential rent, the greater the rent dissipation if property rights are insecure. We expect that the greater the population density in a region, the larger the number of claimants and hence, the greater the potential contestability for the land.<sup>20</sup> As the number of contestants rises, individual land claimants will seek government support for their holdings. On the supply side, there are several factors that influence the government's ability to provide secure tenure. Population density may influence the response of government. Competing heterogeneous claimants may affect government's ability to assign property rights. In Parana the frontier was settled mostly by migrants from within Parana and adjoining states whereas in Para, the origin of the migrants to the frontier was more heterogeneous with many coming from the south with directed colonization and others arriving independently from northeastern Brazil. Greater diversity in the claimants will bring different political interest groups with corresponding competing criteria for the assignment of property rights, delaying tenure.

Another supply factor is jurisdiction to land-private land companies, state land agencies or federal land agencies. Private land companies have an incentive to assign property rights quickly in order to increase the price that people are willing to pay for land. Historically private land companies played a greater role in Parana than Para. Accordingly, we expect that in those counties (municipios) in Parana where private land companies

operated, titles would be assigned more quickly than in other regions and compared with Para.

A related jurisdictional issue is whether the state or federal government have clear authority. In Parana, the state government had sole jurisdiction over the disposition of the public domain, and accordingly its land agencies could respond to political pressure for the assignment of title. In Para since 1971, both the state and federal governments have had conflicting claims to much of the state's land. The federal agency, INCRA, and the state land agency, ITERPA, had different constituents, with INCRA established to promote directed colonization by the federal government with colonists largely from southern Brazil. ITERPA was more responsive to local demands for tenure and associated pressures from the state government. INCRA's policies were influenced by national constituencies and distant budget priorities. Accordingly in Para, we expect that those counties where ITERPA was dominant that titling would proceed more rapidly than in INCRA areas. We expect also that the overlapping jurisdictions and contestation between state and federal agencies would lead to the slower provision of secure tenure in Para compared to Parana. In both states, the greater the budgets of land agencies, the more rapid the assignment of title, since the agencies can proceed to survey, mark, and process individual land claims.

The supply of tenure services will be affected by the size of the region involved. We anticipate that in large municipios (counties) land agency budgets will be spread more thinly and hence, that tenure will be provided more slowly.

Agricultural investment also will be affected by supply and demand factors. For our purposes we focus on site-specific variables that will influence the decision to invest in a

particular land area. All things equal, individuals are more likely to invest if property rights to the land are secure. Property rights affect investment through two mechanisms. One is to guarantee receipt of any positive rental stream from the investment, and the second is to provide collateral for access to credit. In this study, the former appears to have the major impact, since few farms receive credit. In Para especially, credit generally has not been available regardless of tenure. Based on census data, 2 percent of farms received credit in 1970, and 1 percent in 1975 and 1980. What credit has been forthcoming has been through government programs rather than through private financial institutions. Investment also will be encouraged if soil conditions are better and distances to market are shorter.

Finally, land values are influenced by supply and demand factors. Land values will be driven up if tenure is secure and investments have been made to improve land quality. Secure tenure not only allows for longer-term, rent-enhancing land use practices (as reflected in investment), but it raises the exchange value of the land by broadening the market of potential purchasers. Local, informal tenure arrangements may provide security, but these will not be understood or trusted by those who are remote to the region and not part of the local arrangement. Hence, they will discount the value of the land. Formal tenure guaranteed by the government is recognized and enforceable through the use of established courts and police forces. Innate soil qualities also will raise land values by increasing the expected income stream from land use. Additionally, land values will be increased if the government provides subsidies for particular land uses. In Para, a variety of subsidies have been provided by the federal government, and we expect these to raise the income from the land. Finally, where land is abundant relative to the number of claimants, land values will

be lower. In the absence of municipio level land prices, we use a proxy for land values, the ratio of total land in the municipio to population.

To test for these relationships, we use agricultural census data from Brazil for Parana from 1940 to 1970 and Para from 1970 to 1985 with municipio level observations, as noted earlier. Our measure of tenure insecurity is the proportion of farmers in the municipio who were squatters. Accordingly, one minus the squatter share provides an indication of the proportion of farmers who held land with reasonably secure tenure for each of the census periods. Population divided by the amount of agricultural land in each municipio provides a measure of population density and potential competition for land. The land value variable is the total value of agricultural land in the municipio in constant cruzeiros, divided by the amount of farm land in the municipio.<sup>21</sup> For Parana, we introduce a dummy variable for those municipios administered by the private land settlement agency. For Para, municipios are separated as to whether land was primarily administered by INCRA, the federal land agency, or by ITERPA, the state land agency. We introduce a dummy variable for those, municipios where INCRA was the dominant land agency. Unfortunately, there is considerable overlap within municipios. Average soil quality in the municipio is reflected by a scale of 1 to 5, with highest quality at 5. For agricultural investment in both states, we have a consistent measure across the census periods, which includes investment in buildings, fences, corrals, livestock, and equipment.<sup>22</sup> In both states, we include variables for municipio size to capture the pressure on land agency budgets, and the ratios of agricultural area to total municipio area to proxy for land availability. For Para, we add a variable to capture subsidies made available for ranching. We introduce distance to markets by

including the distance from the municipio capital to Belem (Para) or to Curitiba (Parana).<sup>23</sup>

The equations that we estimate in the statistical tests are as follows:

a). PROPERTY RIGHTS EQUATION:  $R = a_1 + a_2V + a_3D + a_4J + a_5A + e$ ;

where R is 1-the squatter share of total municipio farmers; V is land value per hectare; D is municipio population divided by agricultural land in the municipio; J is a dummy variable for the jurisdictional unit that supplies property rights (in Parana, 1 if a private company; in Para, 1 if INCRA); and A is the amount of agricultural land in the municipio.

b). INVESTMENT EQUATION:  $I = b_1 + b_2K + b_3R + b_4S + e$ ; where I is investment in improvements divided by total farm hectares in the municipio; K is distance; R is tenure; S is soil quality.

c). VALUE OF LAND EQUATION:  $V = c_1 + c_2Q + c_3I + c_4R + c_5P + e$ ;  
where V is land value per hectare; Q represents soil quality; I is investment in improvements; R is tenure; and P reflects land scarcity (municipio hectares per capita). For Para, we add another variable G for government subsidies for cattle ranching.

### C. Econometric Results.

Tables 1 through 3 present the estimation results for Parana and Para. Two-stage least squares were used to estimate the simultaneous system of property rights, investment, and land value. Box-Cox tests indicated that a log linear specification was appropriate.<sup>24</sup> Overall, the simultaneous model offers somewhat greater explanatory power for Parana than Para. In part, this is due to ongoing settlement conditions in Para and to government policies that we discuss below.

## Table 1 here

Turning to Table 1 and the determination of property rights on the frontier in the two states, land value has the predicted positive effect in the seven of the eight cases and the four cases where the variable is significant at the 5 percent level.<sup>25</sup> Though the coefficients are generally small for Parana, this is most likely the result of relatively high levels of property rights with little variation in our sample of municipios. For example, as early as 1950 in Parana the mean percent of farmers with tenure across municipios was 92 percent and the mean of non-squatted land was 96 per cent. In sum, the data support the notion that individuals sought more secure tenure on the most valuable land in both states.

Population density generally has a positive effect on tenure security, indicating that as the number of claimants grew, demands for more secure property rights increased, and the government responded. The jurisdiction variable is never significant at the 5 percent level in Parana, suggesting that the private land companies did not provide tenure services more rapidly than the state agency. In Para, the variable suggests that INCRA was slower in providing tenure than was the state agency, ITERPA. These results, however, must be interpreted with caution since our variable is crude and because INCRA municipios may have been more remote than other municipios. We explore federal land tenuring policies through INCRA below. Finally, with regard to the amount of agricultural land in a municipio, where the variable is significant, it is positive, indicating that in larger municipios land agencies provided tenure more completely than elsewhere. This was not anticipated. We had hypothesized that in large municipios that land agency budgets would be spread more thinly.

Table 2 here

Table 2 provides the estimation results for investment in agricultural land on the frontier. Property rights have a positive effect on investment, as predicted to provide incentives for long-term production and possibly, collateral for credit, in all eight cases. In Parana, the rights variable is always significant at the 5 percent level, but never in Para. We explore why the link between tenure security and investment may be weaker in Para than on earlier frontiers below. In Parana, there was more investment in more remote municipios and where soil quality was highest. We had anticipated the opposite effect for distance, however, distance and soil quality may be related. In Para, where transportation costs are a much more severe problem, distance has the anticipated negative effect. Investment, however, tends not to be related to soil quality, or when it is, the relationship is negative. Absent credit, frontier farmers may forego investment in richer soils.

Table 3 here

Table 3 provides the final estimation results for land value on the frontier.<sup>26</sup> The coefficients on property rights presented here represent only the independent effect of rights not already captured in investment, such as increasing the exchange value of land. The effect of tenure on land value is mixed in Parana, and is generally positive in Para, although the variable is never significant by the usual standards. One reason for this result is that there has been an active local land market for squatter claims. Investment always has a positive impact on land value. Soil quality has no clear impact on value, possibly because the census variable is very crude. Subsidies for cattle raising do not have a significant effect

on values in Para, nor does the variable introduced to capture land availability (município hectares per capita).

IV. An Explanation for Differences in Property Rights in Parana and Para and Implications from the U.S. Frontier Experience.

A. Explaining Differences in Tenuring Policies in Brazil.

Figures 4 and 5 and the results presented in Tables 1 through 3 indicate that tenuring conditions may have changed over time in Brazil, at least as represented by data from an earlier frontier in Parana and a current frontier in Para. The model of the relationship among property rights, land value, and investment performs somewhat less well for Para than for Parana. This is most evident in the examination of agricultural investment, where tenure is important in Parana, but less so in Para. These results suggest that a more in depth examination of land allocation practices in the two states is warranted to understand why the results vary.

Brazilian land policies have been developed by a mix of federal and state agencies, as well as by private companies that have purchased or received land grants to colonize the frontier. The Brazilian Constitution of 1891 gave the states legal ownership and political control of unclaimed government lands (*terras devolutas*), but it left open the question of authority over land bordering other countries. The Constitution of 1937 delegated control to the federal government of 150 kilometers along the borders. The states could give land to private claimants within those regions, provided the grants did not exceed 2,000 hectares and were subject to the review and ratification of the federal government.<sup>27</sup> Some states, such as Parana, however, did not recognize the authority of the federal government over border

lands and continued to grant title to land in this area to private claimants without federal review. Prior to 1970, the federal government did not contest such practices; hence when land was distributed in Parana, the state government had jurisdiction. Migration to Parana came largely from neighboring states, such as Sao Paulo, through individual decisions to take advantage of rising coffee and land prices.<sup>28</sup>

By contrast, much of the settlement in Para has been initiated by directed colonization policies of the federal government, which may have led to premature migration to the region, where relative land values remain very low. Subsidized colonization not only brought settlers directly to the region, but brought many more indirectly by sending signals that claimants could expect government investment in infrastructure. Without government intervention, migrants would have moved to the Amazon when the present value of their future net income stream from the land at least equalled their opportunity costs. But government subsidies that either lowered expected costs or increased expected revenues would have encouraged earlier migration. The promised subsidies included road construction, schools, medical facilities, credit, and permanent and annual plants. These subsidies would weaken the usual relationships between tenure and investment.

Moreover in Para, the federal and state governments have competed intensely for jurisdiction over government land, and this has confused the assignment of clear title. The military revolution of 1964 brought with it a series of moves by the federal government to increase its authority over land. Additionally, the new government sought to respond to pressures for land reform by directing land claimants to government lands in the west and north of Brazil. The moving of the capital from Rio de Janeiro to the newly-constructed city

of Brasilia in Goias in the late 1950s, and the construction of major highway arteries, such as the Belem-Brasilia highway in the 1960s and the TransAmazon highway in the 1970s, are examples of conscious efforts to direct population to a new frontier.<sup>29</sup> In the drive to settle the Amazon in the 1960s, the motto of the Brazilian government was "Terras sem homens para homens sem terra" (land without people for people without land). In 1966 the federal government created Legal Amazonia in the north, and following this, in the Constitution of 1969, claimed all public lands essential to national security. In 1971, under Decree-Law 1164 the federal government claimed 100 kilometers on either side of all federal roads constructed, under construction, or projected in Legal Amazonia.<sup>30</sup>

As we noted earlier, INCRA was put in charge of the lands claimed by the federal government to implement colonization schemes. At the same time, state agencies were established to grant property rights to state land. ITERPA, the Para land agency, sold lands and issued titles in an attempt to preempt future land claims by INCRA. Both agencies constructed roads for their colonies, and these roads attracted "spontaneous" settlement by squatters who were not part of the formal colony. Since 1970, however, funding and staffing for both INCRA and ITERPA have fluctuated with macro-economic and political conditions, so that even within lands where jurisdiction is undisputed, the processing of claims can take two to three years or more, apparently longer than earlier in Parana.

During the settlement of frontier lands in southern Brazil prior to 1960, state agencies and private land companies played the dominant role. Jurisdictional disputes seem to have been avoided, titles were granted more routinely and timely, and long-term squatting was less pronounced than later in the Amazon, as indicated in Figures 4 and 5. In the Amazon,

INCRA has organized colonization projects, especially along the Transamazon highway, bringing colonists from southern Brazil with promises of infrastructure and credit. Beginning in 1971, the Program for National Integration was launched to bring colonists to the Amazon. Of the goal of placing 100,000 families in these organized colonies, however, only 7,800 families were actually settled along the Transamazon highway.<sup>31</sup> Nevertheless, a larger number of settlers arrived outside of the formal colonies, generally from all over Brazil.<sup>32</sup> Other formal projects for colonization along the Transamazon and Belem-Brasilia highways in Para included PIC Altamira, PIC Maraba, and the 1971 Program for Redistribution of Land and Stimulus to Agroindustry in the North and Northeast (PROTERRA).

Table 4 here

By the late 1970s, however, as federal budgets changed and land polices shifted, the promised infrastructure and credit support were not forthcoming. Further, limited staffing of INCRA land offices, slowed land surveys and the processing of titles.<sup>33</sup> Table 4 describes real INCRA budgets for all of Brazil and for Para. INCRA Para budgets peak in 1976 and then fall rapidly through 1979. They rise again in 1980 through 1982, but remain well below those of 1976. After 1982, budgets again fall until 1986. In 1989 the agency was dissolved and its functions transferred to the Ministry of Agriculture. In 1989, it was reinstated. Given these fluctuating budgets and uncertain conditions, field offices in Para have dramatically slowed their processing of titles. In some cases, INCRA offices have been swamped by claims from settlers outside of the organized colonies, and disputes have risen with invasions by migrants on lands claimed by others—usually larger farmers and ranchers.

Ranchers had been attracted to the Amazon in the 1970s by federal subsidies for cattle raising from the Superintendency for the Development of Amazonia (SUDAM), a federal agency that administered a series of credit benefits and fiscal incentives.<sup>34</sup> Recently, the flow of migration to the Amazon has slowed as federal subsidies and colonization projects have been halted.

As Table 5 shows land values have remained low, compared to those in the south.<sup>35</sup> Table 5 provides indexes of real land prices between 1970 and 1987 for the south and the north (states of Rondonia, Acre, Amazonas, Roraima, Para, and Amapa) with land prices in the north in 1970 equal to 100. The data are clear that real land prices in the Amazon did not reach their 1970 levels on a sustained basis until 1985. Indeed, real land prices are relatively flat with negative annual rates of change for nine of the 18 years. In the south, real land prices are not only much higher than in the north, but generally rise rapidly in real terms. The absence of significant expected land rents explains the small role played by private land companies in settling the region, compared to that observed in Parana.<sup>36</sup>

Table 5 here

This summary of settlement and land allocation policies in the Amazon suggests that the more gradual and perhaps, more natural settlement that occurred in Parana has not characterized Para. It appears that much of the frontier settlement in Para has been premature—encouraged by federal government subsidies and directed colonization schemes. These programs would weaken the relationship between investment and land tenure in Para as observed in Table 2. Moreover, since support by the federal government has not been sustained and INCRA budgets and jurisdictions have been reduced, claimants have remained

as squatters for longer periods than in Parana. Under INCRA rules, each individual could clear 50 percent of a land claim and receive title to up to three times the area that was cleared of forest. INCRA then granted each claimant an authorization to occupy. These normally would be processed into titles, but many small holders remain on the land with no formal documentation or only with these authorizations. The authorization to occupy technically cannot be used for collateral, nor are they to be transferred. In practice, these authorizations are transferred routinely, at least locally, so that the absence of title has not prevented the development of local land markets, but credit generally has not been available in the Amazon for small holders, regardless of title.<sup>37</sup> Though credit schemes occasionally have been announced by the government, they have not materialized significantly, and private credit institutions have not found it profitable to move into the region, supporting the notion that the area has been prematurely settled. In commenting on settlement projects in Para, Donald Sawyer noted that: "Rather than a result of state action, it would be more accurate to consider such occupation [squatter claims] as being due to official inaction."<sup>38</sup>

#### B. Implications from U.S. Land Policies.

The frontier settlement and land tenuring process in Parana seems to have been more similar to that in the nineteenth century United States than in Para. In the United States as in Parana, government lands were placed open for individual claimants. Migration proceeded from densely-populated eastern seacoasts to the interior with a progressive movement of the frontier.<sup>39</sup> In general, U.S. frontier land policies granted property rights quickly and smoothly to claimants. Squatting does not appear to have been widespread or long lasting as

the frontier moved from the Atlantic seaboard through the Midwest. The General Land Office processed claims, and there were no other important land agencies, state or federal, with conflicting jurisdiction over frontier lands to confuse the titling process.

General Land Office officials surveyed and opened lands for private claiming at the local land office as transportation networks were completed.<sup>40</sup> In some cases, claimants moved ahead of the surveys, staking squatter, or pre-emption claims.<sup>41</sup> Pre-emption laws enacted between 1830 and 1841 gave squatters preference in receiving title from the government after payment of \$1.25 per acre for the land they occupied up to the acreage limits specified in the law.<sup>42</sup> Nevertheless, the overall number of squatters and amount of land held by them for short periods appears to have been very small.<sup>43</sup> Moreover, unlike in Para, there was little squatting on land already titled. There was sufficient land for claiming and the titling process was smooth enough that most settlers on the frontier appear to have been able to obtain property rights to their holdings quickly. For instance, between 1830 and 1838, 60,329,740 acres of federal lands were sold, and of those, only 3.7 percent were sales under the Pre-emption laws that applied to squatters.<sup>44</sup> The institutional structure reduced uncertainty and conflict over control, and hence, contributed to the increase in agricultural output and productivity observed in the United States in the nineteenth century.<sup>45</sup> For example, during the period 1869-1878, agriculture contributed 35 percent of gross domestic product in the United States. By 1880, agricultural exports accounted for 56 percent of all U.S. exports, with the most important being cotton and wheat.<sup>46</sup> Similarly, southern Brazilian frontier regions have been the source of expansion of coffee and soy bean production for export. In 1973, for example, agriculture accounted for 23.4 percent of

GDP.<sup>47</sup> In contrast, by the late 1980s the agricultural output of the Amazon accounted for under .5 percent of Brazilian GDP.<sup>48</sup>

## V. Concluding Remarks.

In this paper, we have examined the interaction among property rights, agricultural investment, and land values in two Brazilian states that represent different frontier periods. The results indicate settlement and land tenuring processes were reasonably smooth in Parana between 1940 and 1970. The situation in southern Brazil appears to have been similar to the frontier settlement process in the U.S. in the nineteenth century, where squatters played a comparatively minor role. This is an under-appreciated characteristic of U.S. land policy that encouraged investment and the development of land and capital markets.<sup>49</sup> In the more recent Amazon frontier of Para, the relationships are much weaker. Indeed, active intervention by the federal government to colonize the region in the 1960s-1980s seems to have brought settlers to the Amazon prematurely. Without government subsidies and colonization projects, migration to the Amazon would have been much slower.

Now that direct colonization is no longer a policy objective and the subsidies have been withdrawn, migration has declined. Land values in the Amazon remain low, and much of the land is used for long periods by squatters. Although tenure conditions are not as well defined in Para as they were in Parana, low land values and population densities have meant limited conflict over land among small holders. The exception has been in disputes between ranchers with large claims, and settlers who have invaded the ranches in southeast Para. The absence of credit availability in the Amazon to all small holders (with or without title) also

has mitigated the effects of a lack of title. As land values and population densities rise over time, however, the potential for tenure uncertainty will increase for those with squatter holdings. At that point, long-term investment will suffer and wasteful land practices will be encouraged unless new tenuring policies are adopted to ensure the rapid and smooth assignment of property rights. This looms as a major policy issue for those concerned about resource use in the Amazon.

## ENDNOTES

1. For an analysis of the relationship between land value and property rights institutions, see Libecap (1978).
2. See Besley (1993), Place and Hazel (1992), Ostrom (1990), and Alston and Higgs (1982).
3. For a summary of the concerns with respect to deforestation, see Schneider (1990).
4. Schneider (1990, pp. ii, iv). The frontier nature of the Amazon is discussed by Schrink and Wood (1984, 1992). The Amazon frontier also is examined by Almeida (1990).
5. Although the literature on the U.S. frontier is immense, it generally has not emphasized the role secure tenure played in promoting investment and production.
6. Classic articles on property rights are by Gordon (1954), Hardin (1968), and Cheung (1970).
7. See also Besley (1993), Place and Hazel (1992), Ostrom (1990), Ostrom, Feeny and Picht (1988), Eggertsson (1990), Alston (1981, 1990), Alston and Higgs (1982), Alston and Ferrie (1989, 1993).
8. The links between tenure and credit are made by Feder, Onchan, and Chalamwong (1988), Feder and Feeny (1991), and Besley (1993).
9. Local custom and enforcement by the courts may be sufficient to induce investment by squatters if they are compensated for improvements. For example, see the discussion for Peru by Barrantes (1992).
10. Frontier settlement also is characterized by fluid conditions and new migrants with different backgrounds, objectives, and norms. Under these circumstances, there may be little social cohesion to act as an effective constraint on behavior regarding land use. These are the constraints usually relied upon in communal systems. For discussion of successful community-based arrangements, see Ostrom (1990).
11. Our surveys of settlers in the state of Para in 1992 and 1993 indicate that during settlement, those with the lowest opportunity costs arrive first, with many subsequently selling to later settlers who have greater wealth and education. There is a common practice of exchanges, of informal squatter claims. The later migrants tend to receive secure property rights faster than the initial settlers, as both wealth and education appear to lower the costs of obtaining title.
12. See Libecap (1989) for a summary of some of these studies.
13. Brazil is approximately 9 percent larger than the continental U.S. and its population density remains among the lowest in Latin America (Wildie and Contreros, 1992, p. xvi).
14. For discussion of the moving frontier in Brazil, see Sawyer (1984), Santos (1984), and Moran (1986).
15. For an analysis of the impact of low resource values and homogeneity on property rights institutions, see Libecap (1978) and Libecap and Wiggins (1985).

16. For a description of governmentally induced migration in the Brazilian state of Rondonia, see Mueller (1980).
17. The state of Parana sold 12,463 sq. km of land in the north to a private land development company, the Companhia de Terras do Norte do Parana, which sold urban and rural lots to the settlers it recruited, granted them clear titles, and extended railways and roads.
18. Nicholls and Paiva (1969, p. 8).
19. Nicholls and Paiva (1969 p. 41).
20. In part, population density is endogeneous, rising with land values. However, at any point in time, the greater the population density, holding land values constant, the greater the potential contestability over land.
21. These values are deflated for Parana and Para. For the pooled runs, the Parana data are in 1970 cruzeiros and the Para data are in 1985 cruzeiros.
22. The agricultural census provides a combined variable that includes the value of land and investment in buildings, fences, corrals, equipment, and animals. Since the census separately provides land value data, we can remove land value to get an overall investment variable. Unfortunately, we cannot remove investment in livestock to obtain a measure of land-only investment.
23. These distance measures are quite arbitrary in that Belem may not be the major market for all Para municipios or Curitiba for all municipios in Parana. We also estimated these distances using maps. In the case of Para, because of the importance of river transport, we used water transport if the distance was less than by road.
24. The Box-Cox test is a likelihood ratio test for linearity vs log linearity of the model. The test is based on the Box-Cox transformation. See A. Harvey (1991).
25. Municipios were dropped in each of the census years because of missing observations. Two Parana municipios were dropped in 1960 and three in 1970 due to missing observations regarding population density or crops. In Para, the municipios of Belem, Ananindeua, and Benevides were not used because they are primarily urban areas.
26. The land value variable for 1985 in Para was not provided by the Census. We constructed it by taking the ratio of land value to the value of agricultural farms (which included land) for 1970, 1975, and 1980. The growth rates of this ratio were obtained and an average growth rate calculated. The 1980 ratio was then multiplied by this growth rate to give the 1985 ratio which, in turn, was multiplied times the 1985 agricultural farms variable.
27. Foweraker (1981, pp. 87-88).
28. As with the U.S., early rural migration in Brazil moved sequentially from the densely-populated Atlantic seacoast states of Rio de Janeiro, Sao Paulo, and Espirito Santo to neighboring states, such as Parana, Goias, and Moto Grosso do Sul.

29. These policies would avoid the politically-disruptive forced reallocation of land in settled regions of the south. For discussion of highway construction, see Sawyer (1984, pp. 188-189).
30. Foweraker (1981, p. 100) reports that during the early 1970s, the state of Para lost control of 80 percent of its public lands to the Federal Government.
31. Wood and Wilson (1984, p. 142); Sawyer (1984, p. 189). For an assessment of government settlement projects, see Moran (1986b)
32. The leading states in order of number of mi grams for the period 1970 to 1980 were Maranhao, Goias, Ceara, and Minas Gerais (IBGE, 1991, p. 190). For discussion, see Mueller (1980), Sawyer (1984, p. 189), Santos (1984), and Moran (1986a).
33. Moran (1984, pp. 290-291).
34. Schneider (1990, pp. 290).
35. Schneider (1990, p. 8).
36. The most significant private venture in Para was by Colonizadora Andrade Gutierrez (CAG). In 1979, the company purchased 400,000 hectares of land in southern Para and established a colony called Tucuma. During its colonization efforts, however, gold was discovered nearby and the company was unable to defend its land claims. The company abandoned the exercise. See, Foweraker (1981), Butler (1985), Nascimento (1985), and Schneider (1990, Annex III, p. 43), and Schmink and Wood (1992).
37. Our surveys of small holders in Para indicate that with title land values would rise because a larger group of potential buyers would be attracted. Further, settlers claim that with title, they would be able to use the land as collateral, once credit becomes available.
38. Sawyer (1984, p. 189).
39. For discussion of the Brazilian frontier experience, see Sawyer (1984, p. 182). For the U.S., the literature is large. One excellent discussion of public land policies is by Gates (1968).
40. State and federal governments were actively involved in the construction of canals and railroads. See Fogel (1964), Ransom (1964), and Fishlow (1965).
41. For discussion of pre-emption claims and squatting on the U.S. frontier, see Gates (1968, pp. 219-247).
42. This usually was 160 acres, although smaller amounts were sometimes authorized. See Gates (1968, pp. 222-229).
43. Bogue (1963).
44. Data compiled from General Land Office Annual Reports, as reported by Gates (1968, p. 230). Total pre-emption acres was reported as 2,207,921. Gates describes considerable confusion in documenting and administering squatter claims, but placed in the overall settlement process, these conditions seem to be quite limited.

45. Hurst (1964), Scheiber (1969), Libecap (1978), and Friedman (1985). Although U.S. land policy generally supported the rapid transfer of property rights to land and thereby provided an institutional structure that reduced uncertainty and conflict over control, the arrangements did not rule out rapid harvest or nutrient mining of the land that also depended upon expected relative prices, as well as knowledge. In the U.S. South, for example, there may have been soil mining because land was relatively cheap, compared to the costs of labor and capital. See Wright (1986), Trimble (1985), and Margolis (1977). For another view on the issue, see Earle (1992a, 1992b). Johnson and Libecap (1979) examine a related example concerning the rapid harvest of the Great Lakes forest.
46. U.S. Department of Commerce (1975, pp. 232, 890, 899).
47. Ruddle and Barrows (1974).
48. Schneider (1990, pp. ii, iv).
49. Davis (1965).

## BIBLIOGRAPHY

- Almeida, Anna Luiza Ozorio de, 1990, The Colonization of the Amazon. Rio de Janeiro: IPEA.
- Alston, Lee J., 1981, "Tenure Choice in Southern Agriculture, 1930-1960," Explorations in Economic History. 18: 211-232.
- \_\_\_\_\_, 1990, "Issues in Postbellum Southern Agriculture," in Agriculture and National Development: Views on the Nineteenth Century. Lou Ferleger, ed., Ames: Iowa State University Press, 207-228.
- Alston, Lee J. and Joseph P. Ferrie, 1989, "Social Control and Labor Relations in the American South Before the Mechanization of the Cotton Harvest in the 1950s," Journal of Institutional and Theoretical Economics. 145: 133-157.
- \_\_\_\_\_, 1993, "Paternalism in Agricultural Labor Contracts in the U.S. South: Implications for the Growth of the Welfare State," American Economic Review. September.
- Alston, Lee J. and Robert Higgs, 1982, "Contractual Mix in Southern Agriculture Since the Civil War: Facts, Hypotheses and Tests," Journal of Economic History. 42: 327-353.
- Barrantes, Roxana Maria Irma Caceres, 1992, Land Tenure Security and Resource Use in Peruvian Amazonia: A Case Study of the Ucayali Region. PhD Dissertation, University of Illinois at Urbana/Champaign.
- Besley, Timothy, 1993, "Property Rights and Investment Incentives: Theory and Microevidence from Ghana," working paper, Research Program in Development Studies, Princeton University.
- Binswanger, Hans P., 1989, "Brazilian Policies that Encourage Deforestation in the Amazon," Environment Department working paper, no. 16, World Bank.
- Bogue, Allan G., 1963, From Prairie to Corn Belt: Farming on the Illinois and Iowa Prairies in the Nineteenth Century. Chicago: University of Chicago Press.
- Browder, John O., 1986, "Logging the Rainforest: A Political Economy of Timber Extraction and Unequal Exchange in the Brazilian Amazon," Phd dissertation, University of Pennsylvania.
- Bunker, Steven G., 1985, Underdeveloping the Amazon: Extraction, Unequal Exchange, and the Failure of the Modern State. Chicago: University of Chicago Press.

- Butler, John R., 1985, "Land, Gold, and Farmers: Agricultural Colonization and Frontier Expansion in the Brazilian Amazon," Phd dissertation, University of Florida.
- Cheung, Steven N.S., 1970, "The Structure of a Contract and the Theory of a Non-Exclusive Resource," Journal of Law and Economics. 13: 47-90.
- Cohen, R., 1986, "Comment on Smallholder Settlement of Tropical South America: The Social Causes of Ecological Disaster," Human Organization. 45: 359-360.
- Collins, J., 1986, "Smallholder Settlement of Tropical South America: The Social Causes of Ecological Disaster," Human Organization. 45:1-10.
- Copp, Henry N., 1875, Public Land Laws with the Important Decisions of the Secretary of the Interior, and Commissioner of the General Land Office, the Opinions of the Assistant Attorney General, and the Instructions Issued from the General Land Office. Washington D.C.: Government Printing Office.
- Danhof, Clarence H., 1941, "Farm Making Cost and the 'Safety Valve,'" Journal of Political Economy. 49: 317-359.
- Davis, Lance E., 1965, "The Investment Market, 1870-1914: The Evolution of a National Market," Journal of Economic History. 25:- 355-393.
- Demsetz, Harold, 1967, "Toward a Theory of Property Rights," American Economic Review. 57: 347-377.
- Easterlin, Richard A., George Alter, and Gretchen A. Condran, 1978, "Farms and Farm Families in Old and New Areas: The Northern States in 1860," in Tamara K. Hareven and Maris A. Vinovskis, eds., Family and Population in Nineteenth Century America. Princeton: Princeton University Press, pp. 22-84.
- Earle, Carville, 1992a, "The Price of Precocity: Technical Choice and the Ecological Constraint in the Cotton South, 1840-1890," Agricultural History. 66:25-60.
- \_\_\_\_\_, 1992b, "Into the Abyss...Again: Technical Change and Destructive Occupance in the American Cotton Belt, 1870-1930," in The American Environment: Interpretations of Past Geographies. Larry M. D. Saver and Craig E. Colton, eds., Lanham, Md: Rowman and Littlefield, pp. 53-88.
- Eggertsson, Thrainn, 1990, Economic Behavior and Institutions. New York: Cambridge University Press.
- Fearnside, P. M., 1986, Human Carrying Capacity of the Brazilian Rainforest. New York: Columbia University Press.

- Feder, Gershon, Tongroj Onchan, Yongyuth Chalamwong, and Chira Hongladrarom, 1988, Land Policies and Farm Productivity in Thailand. Baltimore: Johns Hopkins University Press.
- \_\_\_\_\_ and David Feeny, 1991, "Land Tenure and Property Rights: Theory and Implications for Development Policy," World Bank Economic Review. 5 (1): 135-153.
- Fishlow, Albert, 1965, American Railroads and the Transformation of the Antebellum Economy. Cambridge: Harvard University Press.
- Fogel, Robert, 1964, Railroads and American Economic Growth: Essays in Econometric History. Baltimore: Johns Hopkins University Press.
- Foweraker, Joseph, 1981, The Struggle for Land: A Political Economy of the Pioneer Frontier in Brazil. 1930 to Present. New York: Cambridge University Press.
- Friedman, Lawrence M. , 1985, A History of American Law. 2nd edition, New York: Simon and Schuster.
- Gates, Paul W. , 1968, History of Public Land Law Development. Washington D.C.: Public Land Law Review Commission.
- Gillis, Malcolm and Robert Repetto, 1988, Deforestation and Government Policy. San Francisco: ICS Press.
- \_\_\_\_\_, 1989, Public Policy and the Misuse of Forest Resources. New York: Cambridge University Press.
- Gordon, H. Scott, 1954, "The Economic Theory of a Common-Property Resource: The Fishery," Journal of Political Economy. 62: 124-142.
- Hardin, Garrett, 1968, "The Tragedy of the Commons," Science. 162: 1243-1248.
- Hareven, Tamara and Maris A. Vinovskis, eds., 1978, Family and Population in Nineteenth Century America. Princeton: Princeton University Press.
- Hartshorn, Gary S., 1988, "Natural Regeneration of Trees on the Palcazu Demonstration Strips," Washington D.C.: U.S. Department of Agriculture, Tropical Science Center.
- Harvey, A. , 1991, The Econometric Analysis of Time Series. 2nd edition, Cambridge: MIT Press.

Hecht, Susan, Richard Norgaard, and G. Possio, 1988, "The Economics of Cattle Ranching in Eastern Amazonia," Interciencia. 13: 233-240.

Human Rights Watch, 1991, Rural Violence in Brazil. New York.

Hurst, J. Willard, 1964, Law and Economic Growth: The Legal History of the Lumber Industry in Wisconsin, 1836-1915. Cambridge: Harvard University Press.

IBGE, 1991, Geografia do Brasil-Regiao Norte. Vol. HI, Rio de Janeiro.

IDESP Para Agrario. No. 1,2,3,4,5,6, and 7.

Johnson, Ronald and Gary D. Libecap, 1979, "Efficient Markets and Great Lakes Timber: A Conservation Issue Reexamined," Explorations in Economic History. 17: 372-385.

Kluck, P., 1979, "Small Farmers and Agricultural Development Policy: A Look at Brazil's Land Reform Statute," Human Organization. 88: 44-51.

Lamarao, 1980, Para Desenvolvimento No. 2.

Libecap, Gary D., 1978, "Economic Variables and the Development of the Law: The Case of Western Mineral Rights," Journal of Economic History. 38: 338-362.

\_\_\_\_\_, 1981, Locking Up the Range: Federal Land Use Controls and Grazing. Cambridge: Ballinger.

\_\_\_\_\_, 1986, "Property Rights in Economic History: Implications for Research," Explorations in Economic History. 23: 227-252.

\_\_\_\_\_, 1989a, Contracting For Property Rights. New York: Cambridge University Press.

\_\_\_\_\_, 1989b, "Distributional Issues in Contracting for Property Rights," Journal of Institutional and Theoretical Economics. 145: 6-24.

\_\_\_\_\_ and Ronald Johnson, 1979, "Property Rights, Nineteenth Century Federal Timber Policy and the Conservation Movement," Journal of Economic History. 39: 129-142.

Mahar, Dennis J., 1989, Government Policies and Deforestation in Brazil's Amazon Region. Washington D.C.: the World Bank.

Margolis, Maxine, 1977, "Historical Perspectives on Frontier Agriculture as an Adaptive Strategy," American Ethnologist. 4(1), February, 42-64.

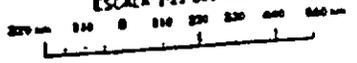
- Moran, Emilio F., 1975, "Pioneer Farmers of the Transamazon Highway: Adaptation and Agricultural Production in the Lowland Tropics," Phd dissertation, University of Florida.
- \_\_\_\_\_, 1984, "Colonization in the Transamazon and Rondonia," in Marianne Schmink and Charles H. Wood, eds., Frontier Expansion in Amazonia. Gainesville: University of Florida Press, pp. 285-303.
- \_\_\_\_\_, 1986a, "Adaptation and Maladaptation in Newly Settled Areas," in Debra A. Schumann and William L. Partridge, eds., The Human Ecology of Tropical Land Settlement in Latin America. Boulder: Westview Press, pp. 20-39.
- \_\_\_\_\_, 1986b, "Government-Directed Settlement in the 1970s: An Assessment of Transamazon Highway Colonization," in Debra A. Schumann and William L. Partridge, eds., The Human Ecology of Tropical Land Settlement in Latin America. Boulder: Westview Press, pp. 172-197.
- Mueller, Charles, 1980, "Frontier Based Agricultural Expansion: The Case of Rondonia," in Land, People, and Planning in contemporary Amazonia. Françoise Barbira-Scazzocchio, ed., Cambridge, England: Cambridge University, Center of Latin American Studies, Occasional Publication No. 3.
- Nascimento, Jose R. 1985, "Brazilian Amazon Development and the Forest-Based Sector," Phd dissertation, University of Minnesota.
- Nicholls, William N. and Ruy Miller Paiva, 1969, Ninety-Nine Fazendas: The Structure and Productivity of Brazilian Agriculture. 1963. Nashville: Vanderbilt University, Graduate Center for Latin American Studies.
- North, Douglass C, 1990, Institutions. Institutional Change, and Economic Performance. New York: Cambridge University Press.
- Ostrom, Elinor, 1990, Governing the Commons: The Evolution of Institutions for Collective Action. New York: Cambridge University Press.
- Ostrom, Vincent, David Feeny, and Hartmut Picht, 1988, Rethinking Institutional Analysis and Development: Issues, Alternatives, and Choices. San Francisco: Institute for Contemporary Studies.
- Peffer, E. Louise, 1951, The Closing of the Public Domain: Disposal and Reservation Policies. 1900-1950. Palo Alto: Stanford University Press.
- Peters, Charles, Alwyn Gentry, and Robert Mendelson, 1989, "Valuation of an Amazonian Rainforest," Nature 339: 655-656.

- Place, Frank and Peter Hazell, 1992, "The Efficacy of the Indigenous Land Tenure Systems in Sub-Saharan Africa," working paper, the World Bank.
- Ransom, Roger, 1964, "Canals and Development, A Discussion of the Issues," American Economic Review. 54: 365-376.
- Ruddle, Kenneth and Donald Oderman, 1972, Statistical Abstract of Latin America. 1971. Los Angeles: UCLA Latin America Center, Vol. 15.
- \_\_\_\_\_ and Kathleen Barrows, 1974, Statistical Abstract of Latin America. 1972. Los Angeles: UCLA Latin America Center, Vol. 16.
- Santos, Roberto, 1984, "Law and Social Change: The Problem of land in the Brazilian Amazon," in Marianne Schmink and Charles H. Wood, eds., Frontier Expansion in Amazonia. Gainesville: University of Florida Press, pp. 180-284.
- Sawyer, Donald R., 1984, "Frontier Expansion and Retraction in Brazil," in Marianne Schmink and Charles H. Wood, eds., Frontier Expansion in Amazonia. Gainesville: University of Florida Press, pp. 180-284.
- Sedjo, Roger A., 1989, "Can Tropical Forest Management Systems Be Economic?" working paper, Resources for the Future.
- Scheiber, Henry N., 1969, Ohio Canal Era: A Case Study of Government and the Economy. 1820-1861. Athens: Ohio University Press.
- Schmink, Marianne, 1982, "Land Conflicts in Amazonia," American Ethnologist, pp. 341-357.
- \_\_\_\_\_ and Charles H. Wood, eds., 1984, Frontier Expansion in Amazonia. Gainesville: University of Florida Press.
- \_\_\_\_\_, 1992, Contested Frontiers in Amazonia. New York: Columbia University Press.
- Schneider, Robert, 1990, "Brazil: An Economic Analysis of Environmental Problems in the Amazon," Washington D.C.: The World Bank.
- Scully, Gerald W., 1988, "The Institutional Framework and Economic Development," Journal of Political Economy. 96 (3): 652-662.
- Spears, John, 1988, "Containing Tropical Deforestation: A Review of Priority Areas for Technological and Policy Research," Environment Department working paper, no. 10, World Bank.

- Trimble, Stanley, W., 1985, "Perspectives on the History of Soil Erosion in the Eastern United States," Agricultural History. 59(2), April, 162-180.
- Uhl, Christopher and Ima Celia Guimaraes Vieira, 1989, "Ecological Impacts of Selective Logging in the Brazilian Amazon: A Case Study from the Paragominas Region of the State of Para," Biotropica 21: 98-106.
- \_\_\_\_\_, 1991a, "Aging of the Amazon Frontier: Opportunities for Genuine Development," working paper, Pennsylvania State University.
- \_\_\_\_\_, 1991b, "Wood as an Economic Catalyst to Ecological Change in Amazonia," working paper, Pennsylvania State University.
- U.S. Department of Commerce, 1975, Historical Statistics of the United States. Washington D.C.: Government Printing Office.
- Wilkie, James W. and Carlos Alberto Contreras, 1992, Statistical Abstract of Latin America. 1991. Los Angeles: UCLA Latin America Center, Vol. 29.
- Wilson, John F., 1985, "Ariquemes: Settlement and Class in a Brazilian Frontier Town," Phd dissertation, University of Florida.
- Wood, Charles and Marianne Schmink, 1978, "Blaming the Victim: Small Farmer Production in an Amazon Colonization Project," Studies in Third World Societies. Vol 7.
- \_\_\_\_\_ and John Wilson, 1984, "The Magnitude of Migration to the Brazilian Frontier," in Marianne Schmink and Charles H. Wood, eds., Frontier Expansion in Amazonia. Gainesville: University of Florida Press, pp. 142-152.
- Wozniak, Gregory D., 1987, "Human Capital, Information, and the Early Adoption of New Technology," Journal of Human Resources. 22 (1): 101-112.
- Wright, Gavin, 1985, Old South. New South: Revolutions in the Southern Economy Since the Civil War. New York: Basic Books.



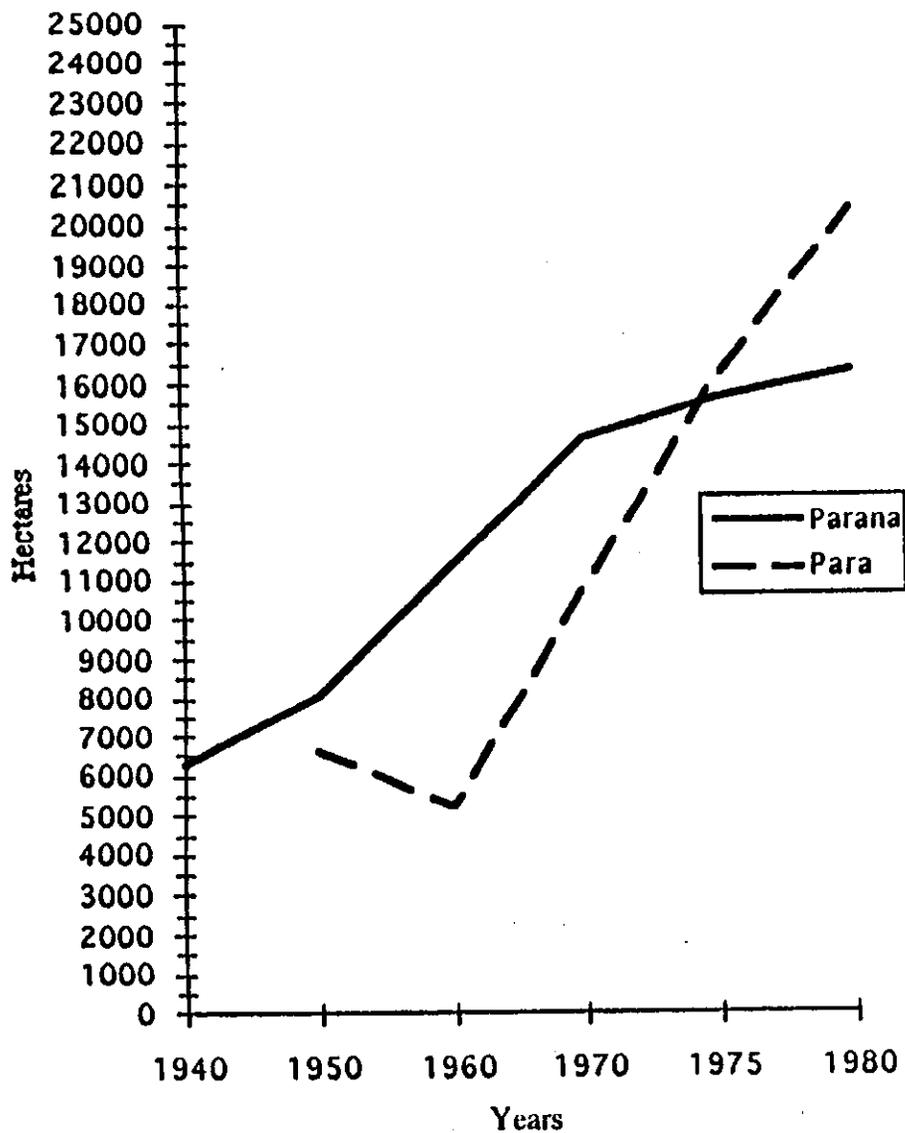
ESCALA 1:27 000 000



PARA

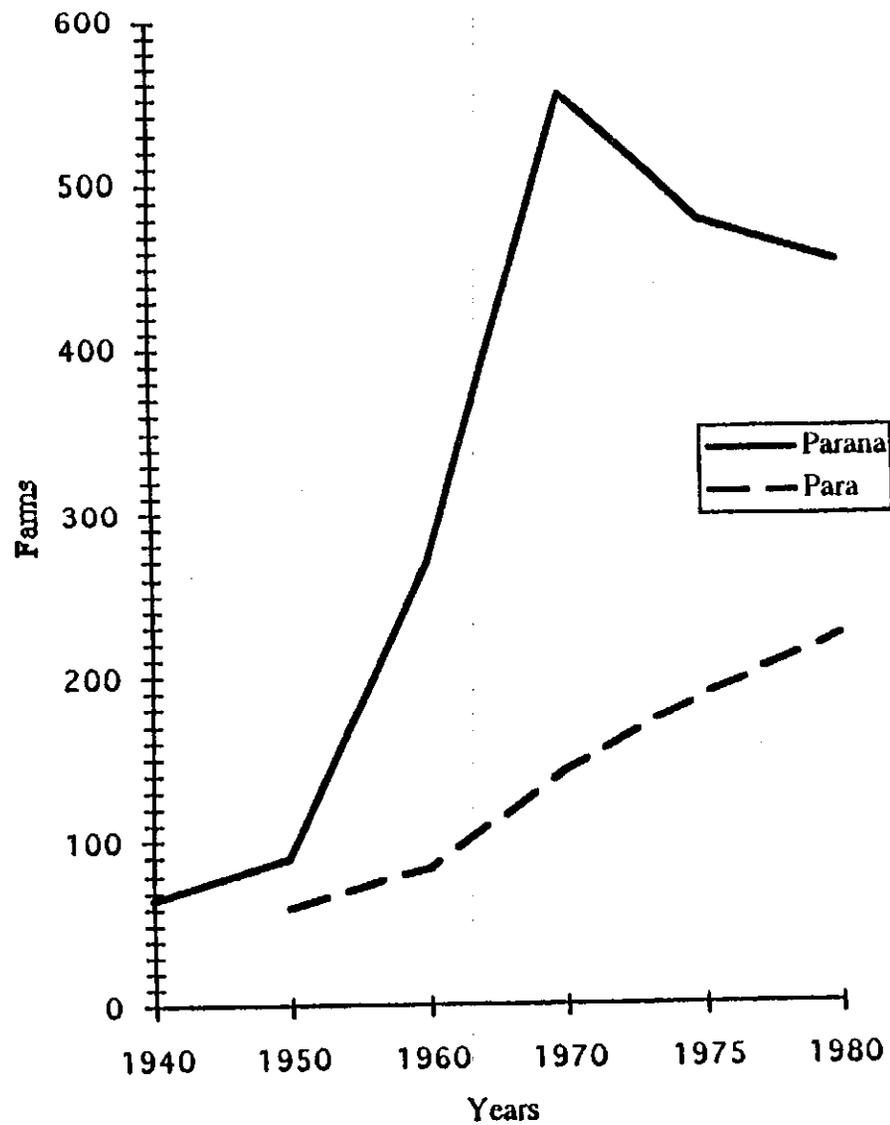
PARANA

**Figure 2**  
**Total Hectares in Farms**



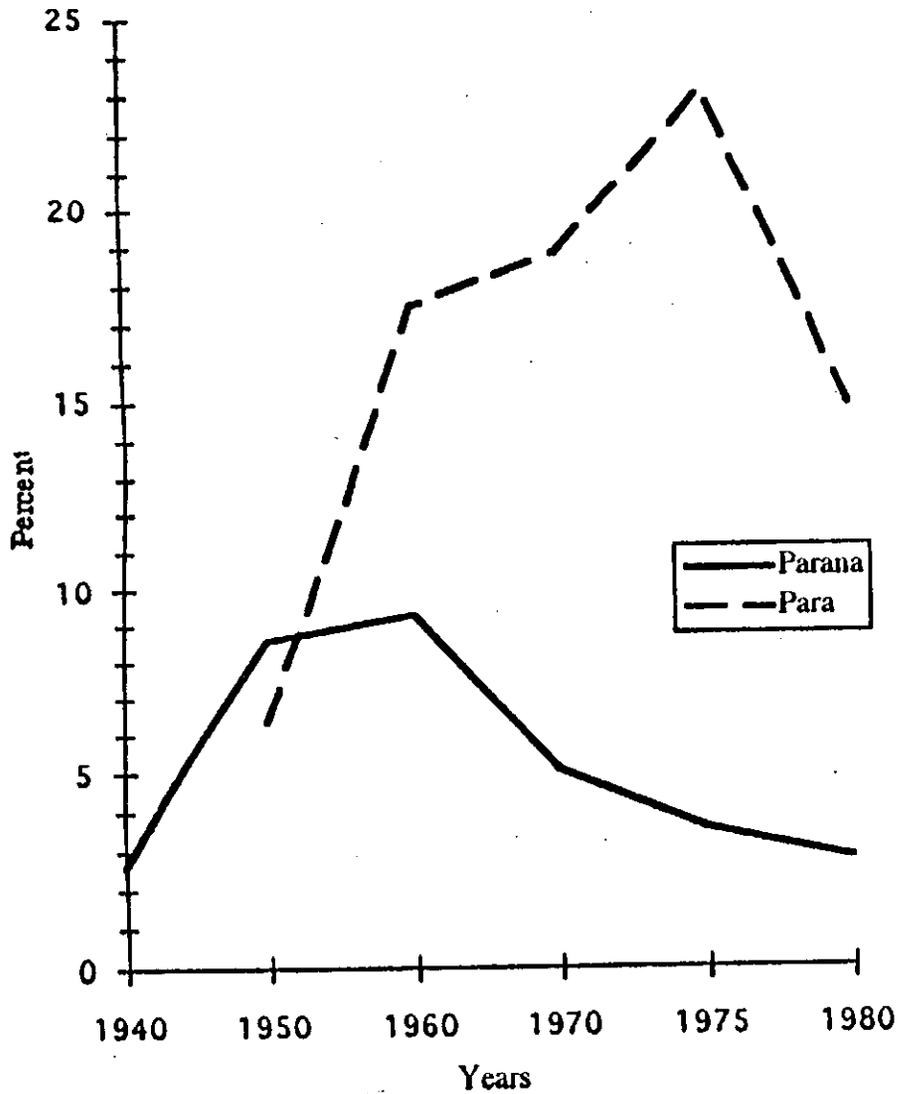
Source: IBGE- Censo Agropo: 1940-1980, Brasilia.

**Figure 3**  
**Total Number of Farms**



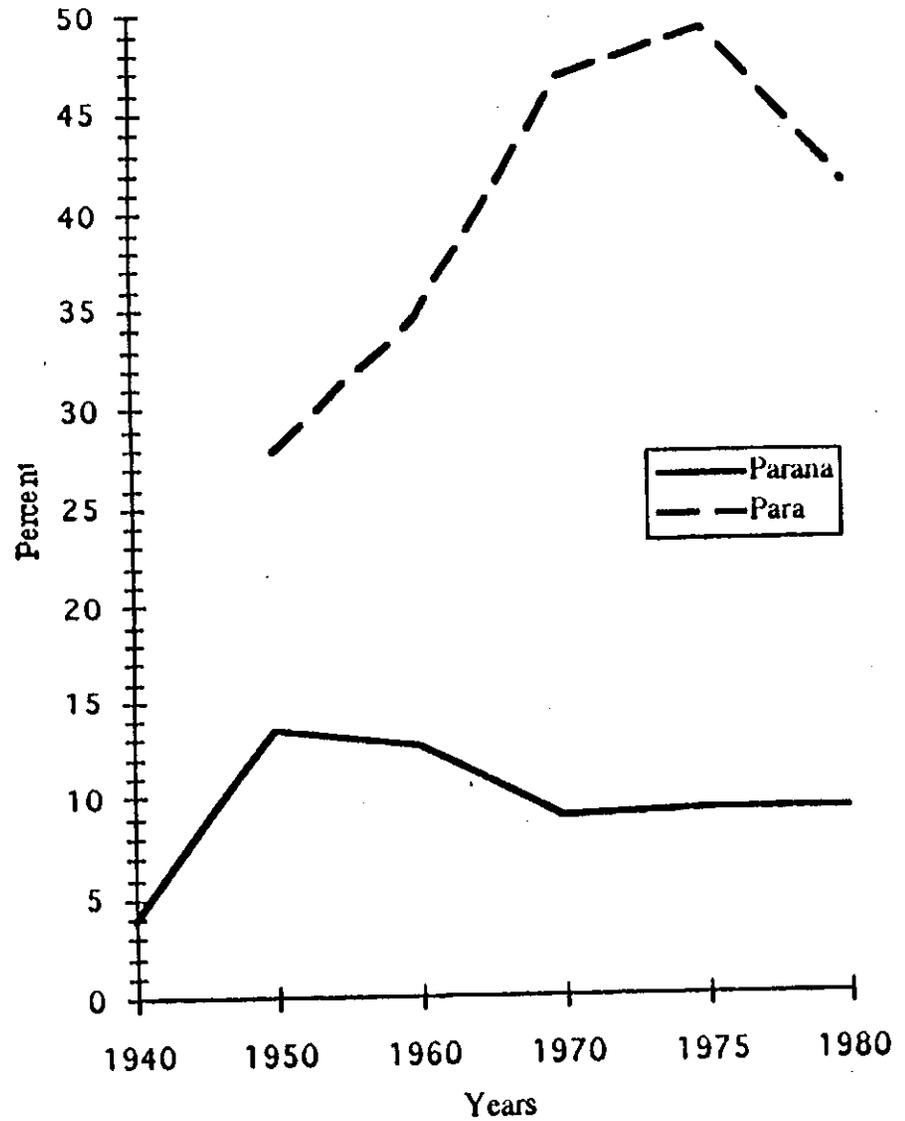
Source: IBGE- Censo Agropo: 1940-1980, Brasilia.

**Figure 4**  
Percent of Total Farm  
Land Held By Squatters



Source: IBGE- Censo Agropo: 1940-1980, Brasilia.

**Figure 5**  
Percent of all Farms  
Operated by Squatters



Source: IBGE- Censo Agropo: 1940-1980, Brasilia.

Table 1

The Determinants of Property Rights in Two Frontier Brazilian States

Dependent Variable: Percent of Farmers with Tenure.

Parana

	Constant	Land Value	Population Density	Jurisdiction	Area	R <sup>2</sup>	N
1940	- 1.14 -(1.71)	0.06 (0.56)	0.24 (1.60)	-0.26 -(1.32)	0.14 (2.20)	.02	49
1950	-0.47 -(0.39)	-0.25 -(0.70)	0.16 (0.57)	-0.14 -(0.83)	-0.13 -(0.36)	.002	80
1960	0.18 (0.14)	0.07 (0.77)	0.15 (0.56)	-0.18 -(0.91)	-0.01 -(0.06)	.06	162
1970	-0.09 -(1.01)	0.05 (2.76)	0.03 (2.17)	0.03 (1.33)	0.004 (0.45)	.13	288

Para

	Constant	Land Value	Population Density	Jurisdiction	Area	R <sup>2</sup>	N
1970	-4.35 -(1.60)	2.60 (2.00)	-0.18 -(0.35)	-1.03 -(1.87)	0.75 (2.14)	.13	79
1975	-5.08 -(1.70)	1.77 (1.60)	0.18 (1.07)	-0.29 -(0.97)	0.54 (1.59)	.001	79
1980	-1.66 -(1.86)	0.74 (2.58)	0.18 (1.78)	-0.34 -(1.34)	0.18 (1.68)	.09	79
1985	-0.63 -(1.14)	0.30 (1.47)	0.02 (0.25)	-0.03 -(0.20)	0.04 (0.60)	.08	79

Table 2

The Determinants of Agricultural Investment on the Frontier

Dependent Variable: Agricultural Investment Per Hectare

Parana

	Constant	Rights	Distance	Soil	R <sup>2</sup>	N
1940	-2.76 -(10.01)	3.47 (4.14)	-0.10 -(1.08)	0.36 (2.01)	.25	49
1950	-2.77 -(3.56)	7.29 (4.30)	0.71 (2.78)	0.69 (1.43)	.18	80
1960	-2.30 -(5.33)	2.58 (3.64)	0.33 (2.43)	0.21 (0.74)	.04	162
1970	0.30 (0.68)	11.71 (7.74)	0.04 (0.41)	0.11 (0.65)	.21	288

Para

	Constant	Rights	Distance	Soil	R <sup>2</sup>	N
1970	0.62 (0.31)	0.43 (1.04)	-0.14 -(0.41)	-0.76 -(1.41)	.14	79
1975	0.66 (0.53)	0.004 (0.005)	-0.32 -(1.03)	0.39 (0.99)	.17	79
1980	2.07 (1.40)	0.40 (0.27)	-0.33 -(0.98)	-0.53 -(0.94)	.16	79
1985	2.61 (1.63)	1.16 (0.40)	-0.31 -(0.99)	-0.94 -(1.63)	.14	79

Table 3

The Determinants of Land Value on the Frontier

Dependent Variable: Land Value Per Hectare

Parana

	Constant	Rights	Investment	Land Area/ Population	Soil	R <sup>2</sup>	N
1940	0.62 (0.45)	0.94 (0.60)	1.20 (1.73)	0.14 (0.36)	0.13 (0.55)	.57	49
1950	-8.92 (-7.40)	7.50 (1.62)	0.51 (1.08)	1.33 (1.58)	-0.12 (-0.19)	.05	80
1960	2.45 (3.89)	-1.66 (-1.83)	2.13 (6.39)	0.14 (0.64)	-0.23 (-0.80)	.44	162
1970	-0.59 (-0.37)	-24.87 (-0.49)	2.22 (0.78)	-0.14 (-0.52)	-0.04 (-0.28)	.08	288

Para

	Constant	Rights	Invest	Land Area/ Population	Soil	Subsidy	R <sup>2</sup>	N
1970	-1.23 (-0.39)	-0.50 (-0.53)	1.69 (1.60)	0.01 (0.03)	1.13 (0.90)	-0.72 (-0.83)	.06	79
1975	-0.53 (-0.79)	0.36 (0.78)	0.77 (3.61)	0.07 (0.88)	-0.02 (-0.07)	0.02 (0.48)	.22	79
1980	-0.58 (-0.53)	1.64 (1.14)	0.43 (1.28)	0.13 (0.83)	0.17 (0.32)	0.003 (0.03)	.10	79
1985	-0.01 (-0.005)	1.67 (0.64)	0.53 (1.05)	0.01 (0.05)	0.31 (0.48)	-0.02 (-0.32)	.05	79

Table 4

INCRA Budgets  
(Deflated to December 1971 Cr\$ 1000)

Year	Total INCRA	INCRA Para
1971	234,291	15,727
1972	243,487	5,299
1973	227,953	10,284
1974	257,043	13,373
1975	331,229	11,936
1976	515,341	53,764
1977	437,998	26,827
1978	473,618	19,740
1979	398,116	16,667
1980	336,447	29,156
1981	307,933	28,361
1982	389,777	42,161
1983	284,620	28,139
1984	295,211	14,754
1985	255,029	14,664
1986	650,391	45,375

Source: INCRA Annual Reports

Table 5

Relative Land Values in the Southern and Northern Regions of Brazil

Year	North	South
1970	100	165
1971	96	183
1972	72	222
1973	55	401
1974	64	633
1975	78	679
1976	71	735
1977	107	796
1978	96	692
1979	84	679
1980	55	586
1981	86	833
1982	56	837
1983	84	766
1984	94	859
1985	126	1,021
1986	201	1,409
1987	135	941

Source: Schneider (1990, p. 12).