

“ A Model of Rural Conflict: Violence and Land Reform Policy in Brazil.”

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LOCAL

Fundação Getúlio Vargas
Praia de Botafogo, 190 - 10º andar - Auditório

DATA

26/03/98 (5ª feira)

HORÁRIO

16:00h

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A Model of Rural Conflict: Violence and Land Reform Policy in Brazil

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August 1, 1997

Abstract

In the past ten years the struggle for land in Brazil has taken the shape of invasions of private land by well organized groups of land less squatters. It is argued in this paper that these invasions and the resulting conflicts are a direct response to the land reform program which has been adopted by the government since 1985, which is based on the expropriation of farms and the creation of settlement projects. The set of formal and informal institutions which compromise the land reform program are used as the background for a game-theory model of rural conflicts. Testable implications are derived from this model with particular emphasis on the effect of policy variables on violence. These are then tested with panel data at state level from 1988 to 1995. It is shown that government policy which has the intent of reducing the amount of violence has the opposite effect of leading to more incentives for conflicts.

We acknowledge gratefully the financial assistance provided by the National Science Foundation grant SBR 9512107.

Section 1 - Introduction

In 1985 the Brazilian government implemented the PNRA (National Plan for Land Reform) in an attempt to attack the extremely high levels of land ownership concentration. The main difference between this plan and the many previous failed attempts was that for the first time expropriation of private land was to be the main instrument through which land for landless settlers was to be obtained. Although the Land Statute of 1964 did include expropriations as a major part of the land reform it proposed, until 1985 the basic instrument of land reform policy had been the creation of colonization projects on government land, especially in the Amazon. The PNRA encountered strong political opposition and was quickly decelerated by the government, with only a small fraction of the target expropriations and settlement projects having been implemented.¹ Nevertheless, the expropriations and settlement projects which did go through indicated the new model of land reform policy which the government would follow up to the present. The economic agents quickly recognized the pattern behind this new policy and reacted to it.

In theory the new model foresaw INCRA, the government's land reform agency, expropriating private land that was not being put to beneficial use, creating a settlement project and then calling families of landless peasants it had registered in a cadaster to occupy the plots. The families were expected to wait until their time came to be contemplated. In practice, however, the landless peasants realized that the pace at which the government was implementing the reform was extremely slow and that individual groups of peasants could expedite the process in their favor by invading land which fitted INCRA's criteria as expropriable. These invasions often escalated into a conflict with the owner of the land, leading INCRA to expropriate the farm and settle the squatters on it as a means to solve the problem.

During the late eighties this process evolved slowly and unsystematically with separate groups invading farms throughout the country, sometimes being successful and sometimes not. During the nineties, however, the invasions that did work provided a strong demonstration effect and the landless peasants started becoming increasingly organized. The largest and best organized group was the MST (Landless Peasants Movement) which was born in Rio Grande do Sul and soon spread throughout the country. The success of this group lay in their understanding of the formal as well as the implicit rules of the game which involved settlers, farmers, INCRA, the government, the courts and public opinion. This understanding led them to develop a well thought out strategy for choosing a farm, invading it and, more importantly, transforming the invasion into an expropriation by INCRA. It is precisely this notion that there is a clear implicit set of rules which govern the occurrence of rural conflicts that will be used in this paper to model them.

In order to understand the functioning of rural conflicts in Brazil it is necessary to comprehend the property right institutions that determine land tenure.² The Constitution of 1988, following the example of all previous Constitutions since 1946, states that land

¹ See Mueller, B. 1994. *The Economic History, Political Economy and Frontier Settlement of Land in Brazil*. Ph.D. thesis. University of Illinois at Champaign-Urbana.

² For a more detailed account of the property right institutions for land in Brazil and their effect on rural violence, see: Alston, L. et. al., 1997. *Competing Claims to Land: The Sources of Violent Conflict in the Brazilian Amazon*. working paper.

must fulfill its "social function", one condition of which being that it must be made productive according to some clearly specified criteria. If a farm does not fulfill its social function it may be expropriated by INCRA and given to families of landless squatters in the form of a settlement project. The purpose of these constitutional rules is to allow the severe problem of land ownership concentration to be addressed spontaneously. Formally these rules do not permit the invasion of private property by squatters since the expropriation is to be done only by INCRA, however, in practice the invasion have become institutionalized as a valid part of land reform. Although the government complains about the invasions and threatens not to give in to them, every time it does expropriate an invaded farm it implicitly acknowledges that invasions are an avenue for peasants to obtain land.

In themselves, the Constitutional rules are not necessarily the cause of rural conflicts, since they simply give incentives for squatters to invade private farms. If the farmers believed that once they have been invaded they had lost their claim to the land, then there would be no point in trying to evict the squatters. It is during evictions that most cases of violence occur. However, in practice farmers are able to go to the courts after being invaded and request a warrant for the police to evict the squatters. If the farmer is truly the owner of the land he/she will almost always be granted such a warrant, even if their farm is completely idle. The courts are aware of the Constitutional requirement that land be used productively, however, they do not treat an invasion as bringing up the question of land reform. Rather the courts deal with an invasion in the same way they deal with the taking of any other property from one individual by another; by following the Civil Code and treating property right as an absolute concept. If the invasion brings up questions of land reform, reason the courts, this is another problem which should be dealt with in a separate instance.

The competing claims for land from the landless peasants and the farmer are such that both can find legal justification for their actions. The Constitution informally legitimized the invasions by the squatters and the Civil Code justifies the resistance of the farmers to having their land invaded. INCRA acts as advocate of the squatters and the courts enforce the laws that allow the farmers to evict the squatters. Since there is no institution which determines which of the competing claims should prevail when they clash, the result are rural conflicts.

The purpose of this paper is to use a model of rural conflict to analyze the role and effect of the government's land reform policy on rural violence. This model was developed in Alston, Fuller, Libacap and Mueller (1997) where it was used to analyze the determinants of violence in the Amazon. In this paper the same model will be presented in section 2, however it will be further complemented with an examination of the reaction functions for squatters and farmers which arise from the equilibrium conditions. In section 3 the effect of changes in the governments policy variables will be analyzed using comparative statics and the reaction functions. Section 4 presents an empirical test of the model using panel data at state level from 1988 to 1995. The use of data over time allows to test the effect of changes in the government's commitment towards land reform on the level of violence. In the concluding section the results are used to assess the government's land reform policy and to suggest the links between this policy and several unintended consequences it generates.

Section 2 - A Model of Rural Conflict

The description of rural conflicts in Brazil in the previous section showed that there is a clear set of rules within which these conflicts occur. These rules involve both formal laws and informal institutions which determine the payoffs to squatters and farmers for each possible outcome. The participation of INCRA, the courts and the federal and local governments is an integral part of the conflicts. It is clear that squatters and farmers choose their actions in a strategic manner so as to maximize the net expected value they receive as a payoff from the conflict. In this section a game theoretic model is presented based on the incentives provided by the institutional setting for squatters and farmers to provide violence in a rural conflict.³ The squatters choose to invade a farm, resist eviction and lobby for INCRA to expropriate the land in their favor. The farmer chooses whether and how to evict the squatters. These level of these actions by the squatters and farmer are broadly defined as violence and are denoted by s and v respectively.

The probability that INCRA will expropriate a farm is given by:

$$\theta(s, P, G) \quad \text{with } \theta_s \geq 0, \theta_{ss} < 0 \quad (1)$$

where P is the level of tenure security of the farmer's claim and G is the political will of the government towards land reform. INCRA responds to violence from the squatter, s . The weaker the farmer's claim and the higher the government's commitment towards solving the problem the higher will be the probability that INCRA will expropriate the farm.

Note that the model is at the level of an individual conflict since P refers to the tenure situation of a specific farm. The variable G , on the other hand, is a nationwide variable since it reflects the level of importance given by the government to the issue of land reform and rural conflicts. As with any other issue the government only dedicates attention and resources to land reform when its political calculus deems this to be worthwhile. The level of G in Brazil has varied greatly during the past decades.⁴ During the 1990's the issue of land reform has acquired renewed political importance and G has risen accordingly. It is clear that G is affected by each conflict that occurs in the country since the government is held responsible by public opinion for not bring peace to the countryside. However, we assume that the squatters and the farmer in an individual conflict do not view G as being affected by the amount of violence they provide. That is, although G may in fact be affected by s and v , we treat it as being exogenous.⁵

After a farm has been invaded the farmer, as we are calling the person who claims to own the land, typically tries to evict the squatters. Many times the farmer will try to negotiate with the squatters for them to leave the farm by showing the title to land and offering to pay for the improvements they may have added to the land. More often, however the farmer will try to evict the squatters. This can be done through threats and physical action by the farmer himself/herself, by hiring gunmen, by obtaining a court order to engage the police, or more probably by simultaneous use of all three methods. The

³ This model was developed Alston, Fuller, Libecap and Mueller (1997). In that paper the objective was to analyze the determinants of violence, whereas in this paper the objective is to analyze government policy and deforestation.

⁴ See Alston, Libecap and Mueller (1997, chapter 2).

⁵ This is similar to assuming that in a model of perfect competition a firm takes prices as given.

court order, known as a "reintegration of possession", is requested by the farmer and issued by a local judge, and it orders the police to remove the invaders. In general judges view a "reintegration of possession" concerning invaded land as they would the taking of any other private property of one individual by another. However, given the high probability of a conflict and the social and political nature of the issue, judges may be reluctant to concede the orders in some circumstances. Accordingly, we make the probability of that a farmer's eviction will be successful a function not only of the level of violence offered by the farmer, but also of the position of the local courts towards land reform:

$$\beta(v, K) \quad \text{with } \beta_v \geq 0, \beta_K < 0, \quad (2)$$

where a higher K indicates that the local courts are more favorable to the squatters and thus has a lower propensity to order an eviction by the police.

The objective of both the farmer and the squatters in a conflict is to end up with the ownership of the land. Each side will supply violence so as to maximize the expected value of the land that they will receive. Table 1 presents the value of the land to each party under each possible outcome of the conflict. In order to simplify it is assumed that both the squatters and the farmer value owning the land at L .

Table 1 - Farmer's and Squatters' valuation of the land.

Outcome	Squatters' valuation of Land	Farmer's Valuation of Land
I - Squatters Evicted	0	L
II - No Eviction - No Expropriation	πL	δL
III - Land Expropriated	L	γL

If the squatters are evicted the farmer keeps the land and they get nothing. Another possible outcome is for the farmer to be unable to evict the squatters but there not being an expropriation. In this case the squatters remain on the land but the farmer continues having a claim to it. Eventually this situation will have to be resolved, but it may remain in this state for a long time. The value of the land to the squatters in this case is πL and to the farmer it is δL , where $0 < \pi < 1$ and $0 < \delta < 1$. If INCRA does expropriate the farm from the farmer it is given to the squatters and the farmer is compensated. Although the farmer is compensated at a "fair" price according to the Constitution, the payment is done with Titles of the Agrarian Debt redeemable in 5 to 20 years depending on the size of the farm, therefore being expropriated is generally valued by the farmer as being worse than keeping the land.⁶ Therefore, it is assumed that $\gamma < \delta < 1$.

The squatters' problem is to choose the amount of violence s to supply so as to maximize their expected payoff minus the cost of doing so. Likewise the farmer's

⁶ Some times landowners are able to secure a compensation above the market price of the land, either through corruption involving INCRA officials or through the court. Such cases are, however, exceptions.

problem is to choose v in order to maximize his/her expected payoff minus cost of supplying violence. It is assumed that all players know the probability functions and the other party's valuation of the land. Additionally it is assumed that the objective functions are twice continuously differentiable in s and v , and strictly concave in their own violence. Given these assumptions the second order conditions for maximization are satisfied and the first order conditions are sufficient for a Nash Equilibrium

Squatters' Problem

$$\text{Max } (1 - \beta(v, K)) / (1 - \theta(s, P, G)) \pi L - \theta(s, P, G) L / - C^S(s) \quad (3)$$

Farmer's Problem

$$\text{Max } \beta(v, K) L + (1 - \beta(v, K)) / (1 - \theta(s, P, G)) \delta L - \theta(s, P, G) \gamma L / - C^F(v) \quad (4)$$

Functions (3) and (4) are simply a linear combination of the payoffs to each type for each possible outcome, weighted by the probability of that outcome, minus the cost of supplying violence, where $C^S(s)$ and $C^F(v)$ are the cost of supplying s and v units of violence respectively.

The first order conditions for maximization are:

$$(1 - \beta) \theta_s (1 - \pi) L = C^S_s \quad (5)$$

$$\beta_v [\theta L (\delta - \gamma) - L (1 - \delta)] = C^F_v \quad (6)$$

The left-hand side in (5) is the expected marginal benefit for the squatter's of supplying an additional unit of violence. Doing so increases the probability that INCRA will expropriate the farm in their favor, which moves the squatters from outcome II to outcome III in table 1, weighted by $(1 - \beta)$ the probability that the squatters are not evicted. At the optimum this marginal benefit must equal the cost of the marginal unit of s .

Analogously the left hand side in (6) is the expected marginal benefit to the farmer of an additional unit of violence. By adding an additional unit of v the farmer increases the probability of eviction by β . This moves the farmer from outcome II to outcome I, thus avoiding a loss of $(1 - \delta)L$, and, were it the case that an expropriation would occur if the eviction were not successful, moves the farmer from outcome III to outcome II, thus avoiding a further loss of $(\delta - \gamma)L$. The right hand side in (6) is the marginal cost of the farmer's violence.

Given that each side is acting strategically, understands the rules of the game and possesses all the information regarding the probability functions and valuations, it is reasonable to expect that they will end up in a Nash Equilibrium which is the joint solution to the optimization problem. In such an equilibrium the farmers choose v^* and the squatters choose s^* such that equations (5) and (6) hold simultaneously. For any given level of P , G and K the probability of expropriation is $\theta(s^*, P, G)$ and the probability of an eviction is $\beta(v^*, K)$.

The arguments of the probability functions will be omitted in the first order conditions. Derivatives are denoted by a subscript, e.g., $\frac{\partial \beta(v, K)}{\partial v} \equiv \beta_v$.

In order to visualize the interaction between the farmer and the squatters it is useful to derive the reaction curves for each party. Let λ^S be the objective function of the squatter's and λ^F that of the farmers. That is⁸:

$$\lambda^S(s, v) = (1 - \beta(v))[(1 - \theta(s))\pi L + \theta L] - C^S(s) \quad (7)$$

and

$$\lambda^F(s, v) = \beta(v)L + (1 - \beta(v))[(1 - \theta(s))\delta L + \theta(s)\gamma L] - C^F(v) \quad (8)$$

$$\text{Let } \lambda_s^S(s, v) = \frac{\partial \lambda^S(s, v)}{\partial s} \quad (9) \text{ and } \lambda_v^F(s, v) = \frac{\partial \lambda^F(s, v)}{\partial v} \quad (10)$$

To find the slopes of the reaction curves define $R^S(v)$ to be the best action that the squatters can take given that the farmer chooses v , and $R^F(s)$ to be the best action that the farmer can take given that the squatters choose s . The first order condition for the squatter is therefore $\lambda_s^S = (R^S(v), v) = 0$ and for the farmer $\lambda_v^F = (s, R^F(s)) = 0$. In a Nash Equilibrium the squatters will be playing $s^* = R^S(v^*)$ and the farmer will be playing $v^* = R^F(s^*)$.

The slope of each reaction curve can be obtained by differentiating $\lambda_s^S = 0$ with respect to v and $\lambda_v^F = 0$ with respect to s . For λ_s^S , this yields $\lambda_{sv}^S + \lambda_{ss}^S \frac{\partial R^S}{\partial v} = 0$ and for λ_v^F it yields $\lambda_{sv}^F + \lambda_{vv}^F \frac{\partial R^F}{\partial s} = 0$. Rearranging, expressions for the slopes of the reaction curves are obtained:

$$\frac{\partial R^S}{\partial v} = -\frac{\lambda_{sv}^S}{\lambda_{ss}^S} \quad (11) \text{ and } \frac{\partial R^F}{\partial s} = -\frac{\lambda_{sv}^F}{\lambda_{vv}^F} \quad (12)$$

Because the denominator of these expressions is negative, from the second order condition for maximization, the sign of the reaction curves depends on the signs of λ_{sv}^S and λ_{sv}^F , which are:

$$\lambda_{sv}^S = -\beta_v \theta_s (1 - \pi) L \leq 0 \quad (13) \text{ and}$$

$$\lambda_{sv}^F = \beta_v \theta_s (\delta - \gamma) L \geq 0 \quad (14)$$

Therefore the squatters' reaction curve is negatively inclined and that of the farmer is positively inclined. This means that violence is strategic substitute for the squatters but a strategic complement for the farmer.⁹ That is, the squatters react to more violence from

⁸ To simplify notation only s and v are included as arguments.

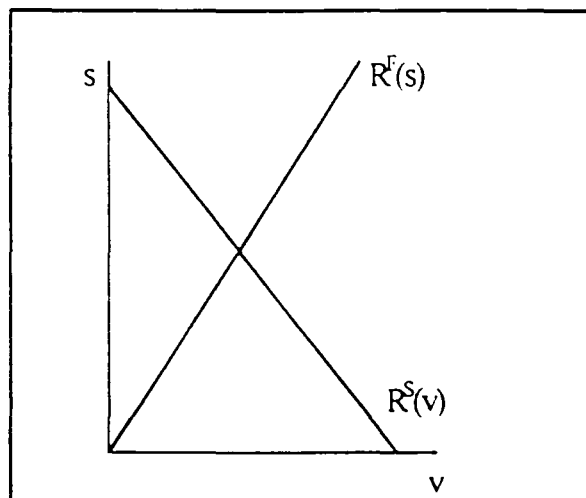
⁹ This classification comes originally from Bulow, J., J. Geanakoplos and P. Klemperer, 1985.

"Multimarket Oligopoly: Strategic Substitutes and Complements." *Journal of Political Economy* 93 (1985): 488-511. See also Tirole J., 1992. "The Theory of Industrial Organization". Cambridge, MIT Press, Part II.

the farmer by offering less violence, and the farmer reacts to more violence from the squatters by offering more.¹⁰

Graph 1 shows the reaction curves for the squatters and the farmer. At the intersection of both curves each side is taking the best response to what the other side is doing, so neither wants to change their action and that point is a Nash-Equilibrium.¹¹

Graph 1 - Farmer's and Squatters' Reaction Curves



Section 3 - The Effect of Policy Variables on Rural Conflicts

The model presented in the previous section can be used to examine the effect of government policy on rural violence. Government policy can affect several of the variables in the model; changes in the budget for land reform and changes in personal commitment by the President affect G ; changes in agricultural policy and availability of credit affect L , the price of the land; changes in the rules for land reform and enforcement of property rights can affect P ; and changes in the courts' attitude towards land reform and conflicts can affect K . In this section comparative statics are used to analyze the effects of such changes on rural violence and show that theoretically many of the policies adopted by the government may lead to more rural violence. Some of these policies are not directly related to land reform and incentive they give for more violence is simply an unforeseen side effect. Other policies, however, are directly aimed at reducing violence and promoting land reform and are having an effect opposite to that which is intended. In the next section we test these predictions empirically.

To simplify the derivation of testable hypotheses, a few assumptions are made.¹²

¹⁰ Note that the reaction curves are only an expositional device since in fact it is a one-shot game and both parties move simultaneously.

¹¹ The curves have been drawn with slopes that guarantee that the process converges to the equilibrium allocation from the initial position. The condition for this is $\lambda_{ss}^S \lambda_{vv}^F > \lambda_{sv}^S \lambda_{vs}^F$.

¹² None of these simplification alters the basic results obtained below.

We assume that $\pi=0$, $\delta=1$, and $\gamma=0$; that is, the squatters' valuation of the land, if there is neither eviction nor expropriation, is zero and the farmer values the land at its full value, L ; additionally, there is no compensation to the farmer if the land is expropriated. These simplifications allow us to focus on the effects of changes in squatter and farmer violence, s and v , on the probabilities of expropriation and eviction. With these simplifications equations (5) and (6), the squatter's and farmer's first order conditions, respectively become:

$$(1-\beta(v,K)\theta_s(s,P,G))L - C_s^s(s) = 0 \quad (15)$$

$$\beta_s(v,K)\theta_s(s,P,G)L - C_v^f(v) = 0 \quad (16)$$

In a Nash Equilibrium equations (15) and (16) hold simultaneously, allowing us to differentiate both equations with respect to an exogenous variable or a parameter and to solve the resulting system to determine the impact on squatter and farmer violence. Accordingly, we analyze the impact of a) changes in the level of property rights security, P ; b) changes in land value, L ; c) changes in the government's stand on land reform G ; and d) changes in the position of the courts, K .

Differentiating equations (15) and (16) with respect to P and rearranging, yields a set of simultaneous equations which we solve to obtain the following expressions for the effect of a change in the level of property rights security on the amount of violence offered by the squatters and by the farmer:¹³

$$\begin{bmatrix} (1-\beta)\theta_s L - C_s^s & -\beta_v \theta_s L \\ \beta_v \theta_s L & \beta_{vv} \theta_s L - C_v^f \end{bmatrix} \begin{bmatrix} \frac{\partial s}{\partial P} \\ \frac{\partial v}{\partial P} \end{bmatrix} = \begin{bmatrix} -(1-\beta)\theta_{sP} L \\ -\beta_{vP} \theta_s L \end{bmatrix} \quad (17) \text{ and } (18)$$

In order to interpret the comparative statics results it is necessary to determine the signs of each term in the above equations. It will be assumed that β_{vv} and θ_{ss} , the second derivatives of the probability functions, are all negative. This assumption seems reasonable since probabilities are bounded between zero and one, so that it should be expected that as violence increases the functions would tend asymptotically to one. Additionally the second derivatives of the cost functions, C_s^s and C_v^f , are reasonably assumed to be positive. The term $|\det|$ is the determinant of the first matrix above. Given that β_{vv} and θ_{ss} are assumed negative, and that the terms on the main diagonal are negative due to the second order condition to maximization, $|\det|$ is seen to be positive.

Solving (17) and (18) the following expressions are obtained:

$$\frac{\partial s}{\partial P} = \frac{[(1-\beta)\theta_{sP} L - C_s^s][-\beta_{vP} \theta_s L] - [\beta_{vP} \theta_s L][-(1-\beta)\theta_{sP} L]}{|\det|} \quad (19)$$

$$\frac{\partial v}{\partial P} = \frac{[-(1-\beta)\theta_{sP} L][\beta_{vv} \theta_s L - C_v^f] - [-\beta_{vP} \theta_s L][-\beta_v \theta_s L]}{|\det|} \quad (20)$$

¹³ From here on we drop the arguments of β and θ to simplify the presentation.

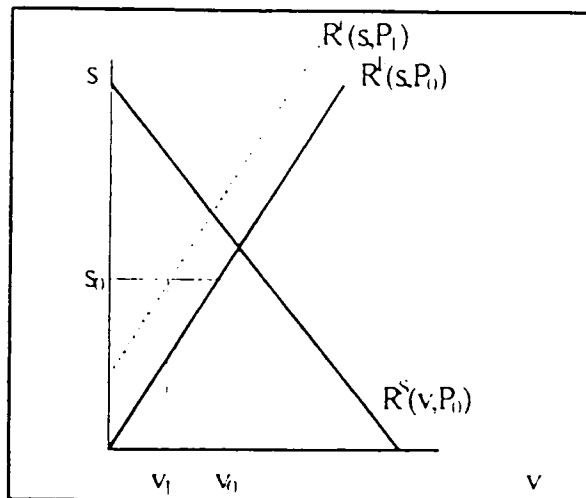
By definition $\theta_P \leq 0$ and $\theta_{vP} \leq 0$; an increase in the level of the farmer's property rights security decreases the probability of INCRA intervening in the conflict. The term θ_P is the direct effect of the more secure tenure on INCRA's probability of expropriating and the term θ_{vP} is the indirect effect of INCRA becoming less sensitive to squatter violence when tenure is more secure. Given these considerations $\frac{\partial v}{\partial P}$ can be shown to be unambiguously non-increasing. To understand the logic behind this result it is necessary to look at the farmer's first order condition (16). The term $\beta_v \theta L$ is the marginal benefit to the farmer from an additional unit of v . That is, by increasing v the probability of an eviction is increased by β_v and thus the potential loss θL , which would result from an expropriation, will occur with a smaller probability. If the farmer's tenure security is increased then θ will be smaller and the potential loss will be reduced. This means that an eviction by the farmer would be avoiding a smaller loss and the marginal benefit from a higher v is reduced. The farmer will thus supply less violence.

The sign of $\frac{\partial s}{\partial P}$ does not have an unambiguous sign. It depends on two effects which can be seen in the squatter's first order condition (15). The term $(1-\beta) \theta_v L$ is the marginal benefit to the squatter of offering an additional unit of violence. Because the farmer will offer less violence given an increase in P , the term $(1-\beta)$ will be larger, implying a larger marginal benefit, which leads the squatters to choose a higher level of s . On the other hand, the term θ_v will be smaller due to the increase in P , since θ_{vP} is negative. This reduces the marginal benefit and the squatters will prefer to offer less violence. The first of these effects is the softening of the farmer due to improved tenure security and the second is the desensitizing of INCRA to squatter's violence. The sign of $\frac{\partial s}{\partial P}$ will therefore depend on which of these effects predominates.

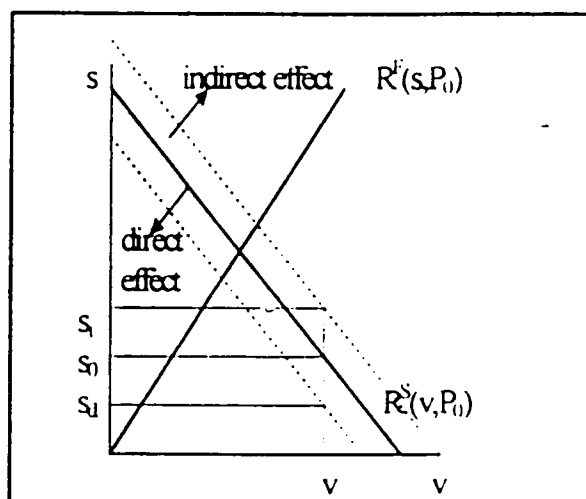
Graph 2 shows the effect on the farmer's reaction curve of an increase in P , that is, in a strengthening of the farmer's property rights to land. The comparative statics have shown that this change should lead to a decrease of the amount of v . In the graph this is represented by an upward shift in the farmer's reaction curve as P goes from P_0 to P_1 . For a given value of s the farmer now prefers to offer less violence $v_1 < v_0$.

The change in P also affects the squatter's reaction curve. According to the comparative static results the change in P has two effects on the amount of violence offered by the squatter. The first effect is the direct effect of making an expropriation less probable, which makes the squatters offer less violence. In Graph 3 this is depicted as a downward shift of the squatters' reaction curve, so that for any given value of v , the squatters will offer a smaller amount of violence, $s_d < s_0$ (where the subscript "d" refers to the direct effect). The second effect comes from the reduced amount of v which occurs due to the increase in P . In the graph this indirect effect is represented by an upward shift of the squatters' reaction curve, so that for any given v the squatters will offer a higher s , $s_i > s_0$. Depending on which effect is stronger the final result of the increase in P will be a lower or a higher s , or no change if both effects cancel out.

Graph 2 - Effect of a Change in P on the Farmer's Reaction Curve



Graph 3 - Effect of a Change in P on the Squatters' Reaction Curve



The effect of a change of G , the government's position on land reform, is analogous to that of a change in P , since P and G enter the farmer's and squatters objective functions in the same way; as an exogenous variable affecting the probability of expropriation.¹⁴ The only difference is that while an increase in P reduces the probability of expropriation, an increase in G has the opposite effect. Therefore, the effect of a change in G on the amount of violence supplied by the farmer is unambiguously positive. The effect on the squatters is to increase s through the direct effect of making Incra more

¹⁴ To save space the comparative statics for a change in G will be discussed and not shown explicitly.

sensitive to their cause, but to decrease s through the indirect effect which comes from the increased violence from the farmer.

In order to determine the effect of an increase in the price of land on the amount of violence, equations (15) and (16) are differentiated with respect to L and the following expressions are obtained:

$$\frac{\partial v}{\partial L} = \frac{[(1-\beta)\theta_v L - C_v^s][-\beta_v \theta] - [\beta_v \theta, L][-(1-\beta)\theta_v]}{|\det|} \quad (21)$$

$$\frac{\partial s}{\partial L} = \frac{[-(1-\beta)\theta_v][\beta_v \theta L - C_v^s] - [-\beta_v \theta][-\beta_v \theta, L]}{|\det|} \quad (22)$$

In equation (21) the first term in brackets is negative, from the second order condition to maximization, the second term in brackets is also negative, the third term is positive and the fourth term is negative. Thus an increase in the value of land unambiguously leads to an increase in the amount of violence offered by the farmer. This is easily seen in the farmer's first order condition (16), since an increase in L increases the benefit of offering an additional unit of v .

The sign of (22), as in the previous case, depends on two different effects. The increase in L increases the marginal benefit in the squatter's first order condition, $(1-\beta)\theta_v L$, leading the squatters to offer more violence. However, the increase in land value also led to a higher value of v and thus a lower value for $(1-\beta)$, which decreases the marginal benefit and prompts a lower value of s . If the positive direct effect of the increase in land value is stronger than the negative effect of a more aggressive farmer, then the increase in land value will lead to a higher supply of violence by the squatters.¹⁵

The final comparative static result examined is the effect of a change of the position of the courts K on the levels of s and v . These effects can be obtained following the same procedure as above:

$$\frac{\partial s}{\partial K} = \frac{[\beta_K \theta_v L][\beta_v \theta L - C_v^s] - [-\beta_v \theta L][-\beta_v \theta, L]}{|\det|} \quad (27)$$

$$\frac{\partial v}{\partial K} = \frac{[(1-\beta)\theta_v L - C_v^s][-\beta_v \theta L] - [\beta_v \theta, L][\beta_K \theta, L]}{|\det|} \quad (28)$$

The expression in equation (27) is non-decreasing, which shows that as the courts become more favorable to the squatters they will offer more violence. This happens because $\beta_K \leq 0$, so the increase in K increases the squatters marginal benefit in their first order condition (15), by making it less likely that they will get evicted by the farmer. The effect of the change by the courts on the farmer's supply of violence is not unambiguous. The sign of expression (28) is affected in different directions by the change in K and the

¹⁵ The effects the change in L and other variables examined below have an analogous effect on the reaction curves to that caused by a change in P . These effects will not be shown graphically here.

change in s . As can be seen in the farmer's first order condition (16), an increase in K decreases the farmer's marginal benefit, since $\beta_{K,K} \leq 0$, but the accompanying decrease in s increases the marginal benefit through θ . The final sign of $\frac{\partial V}{\partial K}$ will depend on which effect predominates. It is interesting, therefore, that, according to the model a change that makes the courts more responsive to land reform and squatter's rights, will not only increase the amount of violence from the squatters, but may also lead to more violence from the farmers, leading to an overall increase in violence, a result opposite to that which was intended by the policy change. Table 2 summarizes the results of the comparative static results.

Table 2- Determinants of violence

Parameter	Effect on violence by the farmer	Effect on violence by the squatter
Property Rights; P	-	+ or -
Gov.'s Position; G	+	+ or -
Land Value; L	+	+ or -
Court's Position; K	+ or -	+

Section 4 - Empirical Tests of the Effect of Policy on Rural Conflicts

The model of rural conflicts presented in the Section 2 and the analysis of the effects of changes in the policy variables in Section 3 provide some implications that can be tested in order to determine if the model is a reasonable representation of rural conflicts in Brazil. Alston et. al. (1997) used data at the municipio level for the state of Pará for 1985 and found strong evidence in favor of the model.¹⁶ In particular it was found that there was a positive relation between changes in land values and conflicts, and a negative relation between both the level of property rights security and the cost of violence and conflicts. Given the cross-sectional nature of the data used in that study and also the fact that the data involved only one state, there was no way to test the effect of the government's will towards land reform, variable G , which is a key variable in the model. In this paper we will use data at state level for all Brazil for eight years (1988 to 1995) in order to test the model's prediction, with special emphasis on the effect of government policy on conflicts. This data is particularly well suited to test the model because it involves the late eighties and the nineties, the period when the strategic use of violence by squatters became established. The data will be used in two ways; firstly a causality test between rural violence and G will be performed and then a panel data regression will be run explaining conflicts as a function of G , P and L .

¹⁶ Whereas that paper was more interested in the property rights and conflicts in the Amazon, this one uses data for the entire country.

Recall that in section 2 we modeled violence as increasing the probability that INCRA would expropriate an invaded farm, $\theta_i > 0$. Because expropriations are usually the first step towards a settlement project, this implies a causality from conflicts to settlements. On the other hand, Section 3 showed that an increased level of governmental effort towards land reform, which can be proxied by the number of settlements being implemented, may increase the probability of expropriation. The positive correlation coefficient between conflicts and settlement projects is 0.31 and provides some empirical support for the view that the net effect of the government's land reform project is to increase violence.¹⁷ The first direction of causality comes from INCRA responding to conflicts by initiating more expropriations and subsequently creating settlement projects. The second direction comes from the reaction of squatters to the increase in the number of settlements. Settlements that result from violence signal to potential squatters that they can increase the probability of an invasion successfully turning into a settlement project by engaging in more violence.

In order to investigate more formally the two way causality between conflicts and settlement projects, we performed a Granger causality test. The definition of causality used in this test is that variable x causes variable y if taking account of past values of x improves the predictions for y .¹⁸ Table 3 shows the results. In the first column conflicts are regressed against lagged conflicts and lagged settlement projects. The test rests on the statistical significance of the lagged settlement project variable. If it is statistically different from zero, then we can infer that settlements "Granger-cause" conflicts. Likewise in the second column settlement projects are regressed against lagged projects and lagged conflicts, with the significance of the lagged conflicts variable determining whether conflicts "Granger-cause" settlement projects.¹⁹ The results of the test using both one and two lags indicate that we cannot reject the existence of Granger causality in both directions between conflicts and settlement projects.²⁰ This result is consistent with the

¹⁷ The correlation is statistically different from zero at a 1% level of confidence.

¹⁸ Harvey (1990, p.303-305). More precisely, causality from x to y is inferred to exist when lagged values of x , have explanatory power in a regression of y , on lagged values of y , and x .

¹⁹ Because the data consists of a panel of 27 states for nine years, we estimated the coefficients using a pooling technique that takes into consideration the possibly cross-sectionally heteroskedastic and timewise autoregressive nature of the data. The estimation method used was the Pool command of SHAZAM version 7.0 econometric software, which uses the pooling technique described in Kmenta (1986, Section 12.2, pp.616-625). In essence the method performs a double transformation of the variables in order to correct first for autoregression, and then for heteroskedasticity.

²⁰ One important issue in a causality test is how to decide the number of lags to use. We performed the tests with 1 lag (columns I and II) and with two lags (columns III and IV). Because with every additional lag we lose an observation, and because we only have 9 time-series observations for each state, adding more lags would reduce the power of the test significantly. The value of the Schwartz criterion, frequently used to select the number of lags, is presented in Table 3. The specification that minimized the Schwartz criterion in both cases was the use of two lags. The results were robust to the use of one or two lags. Given the small length of the time-series, we could not use unit-root tests to determine if the series are stationary, however, performing the test on first-differenced data did not alter the results of the hypothesis test.

predictions of our model: conflicts increase settlements via expropriations and settlements increase conflicts.²¹

Table 3 - Granger Causality Test

Granger Causality Test between Settlement Projects and Conflicts				
Dep. Variable	I Conflict	II Projects	III Conflict	IV Projects
Conflict _{t-1}	0.671 (16.19)	0.080 (4.85)	0.606 (9.11)	-0.134 (1.64)
Conflict _{t-2}			0.132 (2.26)	-0.049 (0.725)
Projects _{t-1}	0.546 (5.25)	-0.060 (0.98)	0.261 (2.05)	0.120 (5.31)
Projects _{t-2}			-0.187 (1.86)	-0.023 (1.12)
Constant	2.889 (4.38)	2.745 (6.76)	3.364 (5.16)	2.984 (6.29)
N	216	216	189	189
Schwartz Crit.	0.6525	0.6071	0.3133	0.2771
F-stat. for H ₁	5.25	4.85	3.03	14.11
H ₀	Proj. = Conf.	Conf. = Proj.	Proj. = Conf.	Conf. = Proj.
Decision	Accept**	Accept**	Accept*	Accept**

Estimated as a pooled cross-section time-series of 27 states from 1987 to 1995 (see SHAZAM User's Reference Manual Version 7.0, 1993, pp.241-250). Levels of significance: 1% **, 5% *, t-ratios in parenthesis.

The fact that there seems to be a causal link from conflicts to settlement projects is straightforward and is generally recognized by all parties involved. However, the existence of a causal link from settlement projects to conflicts is not that obvious. It indicates that an increase in the effort by the government towards land reform, within the current land policy parameters of expropriation and settlement, contributes toward an increase in the number of conflicts. This is clearly not the effect intended by the government, who is presumably responding to conflicts in order to reduce the amount of violence. The problem is that for every conflict extinguished by an expropriation and settlement project, several other conflicts may arise spurred by the demonstration effect of the success of the earlier invasions. Although the government now seems to be aware of this unintended consequence of its land reform policy, it has been politically constrained to continue in this same track. Halting the current land reform program or substituting it for

²¹ The model predicts an ambiguous effect of G on squatter violence and a positive effect on farmer violence. The final effect could therefore go both ways and is an empirical issue. Note however that the direct effect of G on the squatters is positive and the indirect effect negative. It seems reasonable to expect the direct effect to outweigh the indirect effect so we expect the overall effect of G to be positive. Unfortunately our data do not allow us to separate s from v .

another program without expropriations could lead to claims that the government was faltering in its resolve to go through with a land reform.²²

In order to further test the model of rural conflicts the state level data was used to run the following regression:

$$Conflict_{it} = \beta_0 + \beta_1 Settlements_{it} + \beta_2 Price_{it} + \beta_3 Latifundia_{it} + \varepsilon_{it} \quad (29)$$

The panel data includes 22 states and the years from 1989 to 1995.^{23 24} The variable *Conflicts* is the number of conflicts per hectare of agricultural land in state *i* at year *t*, and it represents the combined effect of *s* and *v*. The *Settlement* variable is the number of settlement projects per hectare in state *i* at year *t-1*. This variable was lagged one year to avoid problems of simultaneity which was shown to exist above. Because a settlement project signals to other groups of squatters that INCRA may respond to their demands if they are able to pressure it sufficiently, it is reasonable to assume that the effect of settlements in one year may carry over to next year. The number of settlements acts as a proxy for the government's effort towards land reform, variable (*G*), and, as mentioned above it is expected that this variable will have a positive effect on conflicts as long as the direct effect on squatters is larger than the indirect effect.

The effect of land prices on conflicts should also be positive if the direct effect on squatter's outweighs the indirect effect. There are a couple of problems, however, in estimating the effect of land price on conflicts. In cross-sectional data the estimated coefficient may be capturing the fact that the more frontier and less developed states tend to have more violence than the older and more central states. In time-series data for a same state this would not happen and the coefficient would capture the dynamic relationship between these variables, which we expect to be positive. Given that we are using panel data both forces are at work. In the results presented below we show the estimation of equation (29) first using only *Settlements* and *Prices* as regressors. Then we add the variable *Latifundia* which is the percent of the agricultural land in state *i* that is classified as a latifundia by INCRA and thus subject to expropriation. This variable captures the level of property right insecurity in a state and represents variable *P*. The inclusion of this variables controls for the stage of development of the land in a state and should therefore remove that influence from the effect of price on conflict.

A second problem with the land price variable is that it is potentially endogenous since a high incidence of violence in a state may decrease the value of the land. In order to

²² In May of 1997 the government put together a committee of land policy specialists from various sectors of society to elaborate new guidelines for its land reform and supposedly correct some of the problems the current program is facing.

²³ These were the years and states for which all variables were available.

²⁴ The area of agricultural land is taken from the 1985 agricultural census by IBGE and is used to transform *Conflict*, *Settlements* and *Credit* (to be discussed below) into per hectare values, since there is not yearly area data available. In order to make the units of the *Conflict*, *Settlement* and *Price* data more manageable they were, respectively, multiplied by 10,000, multiplied by 10,000 and divided by 100,000. The *Price* data is from Fundação Getúlio Vargas - Centro de Estudos Agrários. The land prices and credit data are values per hectare and have been set at December 1993 Cr\$ using the IGP index of FGV. The conflict data is from the CPT - Pastoral Land Commission - Goiânia, yearly reports. The settlement data was obtained through personal correspondence with INCRA in Brasília. The *Latifundia* variable is from INCRA, 1992, *Indicadores Básicos*, Brasília.

find consistent estimators if *Price* is in fact endogenous, we estimated *Price* as a function of the amount of rural credit granted to each state in each per hectare of agricultural land and included state dummies to capture the fixed effects of each state.²⁵ ²⁶ The estimated *Price* is then used in the place of the original land price data.

Table 4 - Descriptive Statistics for Conflict Regression

Variable	Observs.	Mean	Std.Dev.	Minimum	Maximum
Conflict	154	0.181	0.252	0	2.231
Settlement	154	0.031	0.043	0	0.313
Price	154	2.57	2.065	0.113	9.949
Price (Estimated)	154	2.57	1.857	0.239	6.075
Latifundia	154	0.605	0.147	0.300	0.840

Table 5- Regression Results for Estimation of Conflicts per Hectare

Estimation of Number of Conflicts per hectare Panel Data - 22 states - 7 Time Periods			
Variable	I	II	III
Settlements	0.71 (4.89)	0.94 (5.89)	0.94 (5.39)
Price	0.008 (1.51)	0.03 (4.58)	0.03 (4.40)
Latifundia		0.32 (5.36)	0.30 (4.43)
Constant	0.13 (8.65)	-0.13 (-2.73)	-0.12 (-2.24)
Busc R ²	0.04	0.20	0.17

Descriptive statistics for the variables used in the estimation are presented in Table 4 and the regression results are shown in Table 5. Column I in table show the results without *Latifundia*. The number of settlements per hectare in the previous year has a positive and statistically significant (at 1%) on conflicts. The value of the land has a

²⁵ Several studies on land prices in Brazil have found that the amount of credit is the variable which best explain price. Other variables which theoretically could explain land prices, such as the returns to agriculture and GNP growth, have only weak explanatory power. The main reason for the strong relationship between credit and land price is the fact that rural credit has long been subsidized in Brazil, so the subsidy naturally gets capitalized into the value of the land. See Rezende, G.C., 1982, "Crédito Rural Subsidiado e Preço da Terra no Brasil", *Estudos Econômicos*, São Paulo, 12(2): pp. 117-138; and Brandão, A.S., 1992, "Mercado de Terra e Estrutura Fundiária", in Brandão, A.S. ed. *Os Principais Problemas da Agricultura Brasileira: Análise e Sugestões*, Serie PNPE, Rio de Janeiro, pp. 139-180.

²⁶ The adjusted R² in the OLS estimation of *Price* is 0.78.

positive effect of conflicts, however it is not significant at a 10% level of confidence. However, as shown in column II, once we control for the level of property rights security in the state, by adding *Latifundia*, the value of the land becomes significant at 1%. Moreover, the *Latifundia* variable is also positive and statistically significant at a 1% level of confidence, indicating that *P* does in fact have a positive effect on violence. The R^2 in the regression are relatively low, indicating, as one would expect, that there are several other variable not included in the specifications which affect the level of violence. In Column III the estimated *Price* is used in place of the actual price and it is found that the results are essentially the same.

Section 5 - Concluding Remarks

These results in the previous section provide strong support in favor of the model of rural conflict presented in this paper as a good representation of determinants and the workings of rural conflicts in Brazil. The variables *Settlements*, *Price* and *Latifundia* are reasonable proxies for the variable *G*, *I*, and *P*, for data at state level. These are key variables in the model and the results not only show that they do affect rural violence, as predicted by the model, but that also that the direction of their influence is such that the direct effect of a change in each of these variable outweighs the indirect effect. In the case of *G*, for example, this implies that for our sample, an increase of the government's effort towards land reform led; (1) to more violence from the farmers, and (2) either to more violence from the squatters or to less violence but not enough to counter the increase in farmer violence. Therefore, as far as its goals of reducing the amount of rural violence, the government's land reform policy is having the opposite effect to that which is intended. Although the more central goal of land reform is to reduce the extremely high levels of land ownership concentration, this may not be achieved if the efforts in that direction have the unintended consequence of inducing more violence. The government may therefore need to find a new model of land reform which is able to pursue this latter goal without providing incentives for more violence.

The results also suggests another way in which the government's agricultural policy inadvertently leads to rural violence. Since subsidized rural credit leads to an increase in land prices (see footnote 23) and an increase in land prices lead to more violence, this policy may be having an unwanted effect on rural violence. It is intuitively clear that the potential for rural conflict is higher when the possession and ownership of the land is a necessary condition for access to subsidized rural credit. Note that the fact that the credit is subsidized may make it attractive even for those who do not intend to use the land and will chose to leave the property idle and thus subject to invasion. This is not to say that rural credit may not be a useful instrument for agricultural policy, an issue which we do not address here, but it does imply that when considering the use of subsidized credit the effect on rural violence should be explicitly considered and if possible mechanisms should be introduced to break that link.

Another unintended consequence of government land reform policy which is suggested by the results in this paper is to lead to more deforestation, particularly in the Amazon region where one of the main ways to avoid being invaded is to clear parts of your farm. When the threat of invasion increases a landowner may opt to clear more than

he/she would if property rights were secure. Therefore, any action by the government which increases the amount of violence, though increases in either G or L or decreases in P , will also potentially have the effect of giving incentives for clearing of forests.

Although we do not have systematic data in order to measure the extent of this effect we do have evidence that the link does exist. When we surveyed farmers in Parauapebas in November 1996, INCRA staff were present in the region to "regularize" several farms, that is, straightened out their tenure situation. Most of the farmers in this region did not have title but had been on the land for over 10 years. Typically only a small fraction of the land had been cleared. INCRA regularized all the farms that had been invaded. Each farmer was allowed to purchase the cleared area plus 1.5 times that amount. Squatters were settled in the remaining land or moved to other land if not enough remained. The farmers affected viewed this process favorably, as long as the price of the land was reasonable, because it not only allowed them to finally get title but it solved their problems with the squatters. One consequence of this policy, as we discovered upon surveying both some of the regularized farmers and others which had not been invaded, was to give a strong incentive for clearing. Those which had been regularized admitted to clearing prior to INCRA's visit in order to increase the area they would have titled in their favor, and many who had not been affect stated that they would clear for the same purpose since they also expected to be regularized in the future.

The general insecurity of property rights to land in the Amazon in itself is a cause of deforestation, since landowners often clear parts of their property to preempt an invasion by squatters. Since clearing is seen as beneficial use by INCRA it reduces the probability of an expropriation and deters squatters. The rules of the game, as described in the introduction and formalized in the model, therefore provide incentives for deforestation. Furthermore, this paper has shown that several other policy actions by the government may be adding to those incentive. By creating more violence they increase the threat of invasion and give the landowners further motive to clear.

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N.Cham. P/EPGE SPE M946m

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Título: A model of rural conflict : violence and land



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