

BRAZILIAN LAND TENURE AND CONFLICTS: THE LANDLESS PEASANTS MOVEMENT

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This article analyzes conflicts in Brazil involving landless peasants and the violence that frequently results from their invasion and occupation of privately owned rural land for the period 2000–08. Land ownership in Brazil is overwhelmingly and historically characterized by large, family-owned estates (Pichon 1997). The unequal and inequitable allocation of land together with weak institutions, weak markets, and low asset endowment may make land reform a low priority (Binswanger and McIntire 1987, Sjaastad and Bromley 1997). In the absence of effective land reforms, these factors may lead to the occupation of land by the landless poor peasants by violent means (Assunção 2008). In such an environment, land-related conflicts are common and have been previously analyzed in several studies, with a particular focus on Africa (Andre and Platteau 1998, Deininger and Castagnini 2004) and Latin America (Alston, Libecap, and Mueller 2005).

Credit rationing is part of the problem, since without credit individuals may not be able to undertake indivisible investments, such as purchasing land, which have a long period of maturation. As a result, due to the lack of access to credit markets, the poor peasant may fail to escape from poverty by not being able to own land (Fenske 2011).

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The landowners have responded to the threat of land invasion and occupation with large-scale evictions, adopting extensive livestock production and highly mechanized cultivation methods, which reduce the need for peasant labor on the farms, thereby creating obstacles to land reform (Binswanger, Deininger, and Feder 1995). In the light of these events, Latin American land reform has been described as a lost cause (De Janvry and Sadoulet 1989).

The political orientation of the leadership of organized peasants is an important determinant of land related violence. The political leadership of the main group of landless peasants in Brazil, known as Movimento dos Trabalhadores Sem Terra (MST) or the Landless Peasants Movement, is a Marxist organization with ties to the Partido dos Trabalhadores (PT) or Workers Party—the political party that has been in power since 2003, first under President Luis Ignacio Lula da Silva (2003–10) and now under President Dilma Rousseff. The MST homepage (www.mst.org.br) makes it clear that among its political objectives is the destruction of commercial agriculture in Brazil, one of the engines of Brazilian growth. Land reform through violence is an essential part of MST strategy to gain power, and is based on the Chinese and Cuban ideology and revolutionary experiences.

In this article, we extend the research on land conflict in Brazil by focusing on land occupation by farmers without land endowments. We analyze poverty, political effects, population density (Andre and Platteau 1998), and land endowment (Binswanger and McIntire 1987, Sjaastad and Bromley 1997) to explain these land occupations.

Earlier studies have examined violence and land reform in Brazil (Alston, Libecap, and Schneider 1995; Alston, Libecap, and Mueller 1997, 1999, 2005). However, our study is the first to be undertaken at a national level using a contemporary data span. An additional innovation is the use of a count data model that allows for heterogeneity, endogeneity, and dynamics. Unobserved heterogeneity has been the subject of concern and analysis in many previous studies (e.g., Chesher 1984, Chesher and Santos-Silva 2002, McFadden and Train 2000). This type of model is used frequently for data concerning events, and its omission is likely to lead to inconsistent parameter estimates or, more importantly, inconsistent fitted parameters. Endogeneity also yields estimation problems causing biased results and may arise when a covariate is simultaneously determined with the endogenous variable or when a covariate is not inserted in the regression (Greene 2007). A dynamic Poisson

model is also presented with lags of endogenous variables and leads of exogenous variables, enabling a more accurate analysis of the problem (Cameron and Trivedi 1998).

We begin with a brief review of the literature on land conflicts. We then describe the contextual background of land conflicts in Brazil and present a stylized model that predicts how political, institutional, and socioeconomic variables affect violent land occupation. Next, we present our data, discuss methodological issues, and provide our empirical findings. The policy prescriptions follow along with our conclusions.

Literature Review

A major study on the violent invasion and occupation of land by landless peasants in Brazil was conducted by Alston, Libecap, and Mueller (2005). They describe how land invasions led by the Landless Peasants Movement generated negative publicity for politicians, stimulated broad sympathy of urban voters toward the landless peasants, and led to further invasions. In another important study, Alston, Libecap, and Mueller (2010) develop a multi-principal, multitask model of interest group behavior to examine how groups with limited resources, such as the Landless Peasants Movement, influence government by manipulating media information to voters. They examine how the Landless Peasants Movement in Brazil molds information, and study the reaction of politicians in changing the timing and nature of policy. Meanwhile, Alston and Mueller (2010) find that land conflicts reduce the likelihood of tenancy, which results in a reduction in agricultural efficiency, a welfare loss to potential renters, and an expansion of the agricultural frontier through deforestation. Finally, a recent study by Oliveira (2008) examines land conflicts and deforestation in the Amazon region due to distorted agrarian, forest, and environmental policies, laws, and regulations (see also Pacheco (2009), Ludewigs et al. (2009), and Simmons et al. 2010).

Other factors such as population growth combined with limited economic opportunities may lead to an increase in land invasion and occupation, since they increase nonagricultural demand for land and intensify competition for a limited or decreasing amount of land available. This could also result in conflicts between groups, particularly in environments where risk is high and land is a key asset and

source of livelihood (Andre and Platteau 1998). In contrast, property rights and institutional frameworks that safeguard these rights decrease land occupation (see, e.g., Alston, Libecap, and Schneider 1995, and Mueller 1997).

Land occupation has sometimes been considered a strategic policy in less-developed countries to thwart far left-wing insurgency. In Brazil, there is involvement of the current governing party, the Workers Party or PT, and elements of the Catholic Church in land occupation (Simmons et al. 2010). According to Ludewigs et al. (2009), land reform in Brazil is a powerful tool in the struggle to reduce rural poverty and may attenuate environmental destruction, chiefly in the state of Amazonas (Simmons et al. 2010, Pacheco 2009).

Aspects that characterize the violence related to land reform in general and land occupation in particular are contextual variables such as poverty (Waeterloos and Rutherford 2004, Rigg 2006), population density (Simmons et al. 2010), and land productivity (Minten and Barrett 2008, Place 2009). Moreover, political forces, like the Brazilian left-wing Workers Party, also shape the land reform process (Alston, Libecap, and Mueller 1997, 1999, 2005). Institutional support for land occupations is manifested in measures such as the expropriation of land from the landowners by decree (Binswanger and Deininger 1993, Pacheco 2009). Other events, such as conflicts over water (Bakker et al. 2008), actions of resistance to land occupation, demonstrations supporting land occupation, generic conflicts related to land occupation, attempted murders, and death threats are all part of the backdrop to land reform and clearly may affect it.

Brazilian Land Reform and Violent Land Occupations

Brazil land tenure is characterized by large, family-owned properties. A federal land reform agency, INCRA (Instituto Nacional de Colonização e Reforma Agrária/the National Agency for Land Reform and Settlement) was established in 1969. The government allocated funds to buy land and to redistribute it among poor families. Since its inception, INCRA engaged in lengthy, bureaucratic processes of land expropriation, with an average cost per beneficiary of \$58,000. A Federal Ministry of Agrarian Reform was created in 1996. Land expropriation was expedited through the a priori selection of the land by community groups, establishing an agreement on a willing-seller/willing-buyer basis, paying the landowners in cash and funding the endeavors of the new peasant-landholders. The

expropriation price per beneficiary decreased to \$19,600. Grant financing is provided for complementary and community infrastructures. The Central Institute for Agrarian Studies was established to encourage discussions and research on rural reforms. A recent survey of Brazilian land reform can be seen in Simmons et al. (2010).

Land reform and rural conflict scenarios in Brazil have changed significantly since the creation and growth of landless peasants and rural workers interest groups, most notably the Landless Peasants Movement (MST), which was officially founded in 1984, on the departure from power of the Brazilian military dictatorship. Alston, Libecap, and Mueller (2005), using a principal-agent model, describe this transition scenario.

Prior to the creation of the MST, organizations formed to promote and defend the interests of landless peasants and rural workers were too weak to be able to influence governmental land reform policies. At the same time, the powerful landowners, in contrast, could afford to spend both time and money on efforts to avoid expropriation, or to pursue claims for generous compensation from the government in the event of land reforms actually being enacted.

Since the emergence of the MST, combined with the spread of urban voters sympathy for the case of the landless rural workers, political pressure for land reform has increased. Consequently, so have land-related conflicts. In practice, this pressure is applied through social insurgency (e.g., farm occupations,¹ marches, invasions of government offices including INCRA, and roadblocks), combined with accusations that the government is failing pledges or is dragging its feet with regard to land reform implementation, always with the objective of influencing public opinion by way of media coverage. The MST's political influence through the media channels, as described by Alston, Libecap, and Mueller (2005), is highlighted in Table 1.

Today a myriad of social movements of the landless peasants exists in Brazil besides the MST, which is the largest and most important. There are various splinter movements, such as the CPT (Pastoral Land Commission), the MLT (the Struggle for Land Movement), the MLTS (Syndicate of Small Rural Producers), the OTC (the Rural Workers Organization), and the STR (Local Rural Workers Unions), all adhering to left-wing revolutionary ideology and coupled with

¹See, for example, Estado de São Paulo (2009). Members of the MST destroyed 7,000 orange trees on a private estate.

TABLE 1
THE LANDLESS PEASANTS MOVEMENT (MST)
AND THE MEDIA

Characteristics	Summary
Low marginal cost to influence the news	Regardless of voters sympathy, the MST has the “technological” means to obtain extensive media coverage for its activities. One of the factors that favorably affect this is that the invasions and occupations are very labor-intensive, which increases their visibility. Another factor is the low opportunity cost of landless peasants (“peasant army reserve”), compared with the opportunity cost of farmers.
Productive efforts to influence the news on land reform issues	In practice, the MST receives more benign visibility than farmers. Farmers have not achieved the same influence in the political arena.
Extreme configuration of voters preferences	Voters are favorable to land reform, and this is, empirically speaking, a variable that increases the popularity of the president.

SOURCE: Adapted from Araujo Jr., Shikida, and Alvarenga (2008).

regional organizations, such as the Movement of Corumbiara Peasants (Simmons et al. 2010).

The aggressive occupation of private and public lands is justified on the basis of the moral authority and constitutional right of the landless peasants (Stedile 1997, Wolford 2004). There is evidence that while some original settlers remain on the acquired land and develop villages (Ludewigs et al. 2009), others, after fragmenting and selling off their plots initially received from INCRA, migrate to new agricultural frontiers in order to start the process once again (Alston, Libecap, and Muller 1999), or to urban centers (Bowder and Godfrey 1997).

A distinctive aspect of the Brazilian land occupation political movement is the role played by the Workers Party, as well as by the left wing of the Catholic Church.

Table 2 presents the characteristics of the Brazilian states in relation to the problem of land occupation. It shows that land

TABLE 2
CHARACTERIZATION OF BRAZILIAN LANDLESS
MOVEMENT IN 2008

State	Number of lands occupied	% population below poverty line	Number of lands taken from landlords by decree	Population
Acre	0	0.224	6	680,073
Alagoas	20	0.212	5	3,127,557
Amapá	0	0.109	0	613,164
Amazonas	1	0.165	0	3,341,096
Bahia	28	0.151	22	14,502,575
Ceará	4	0.186	12	8,450,527
Distrito Federal	0	0.000	16	2,557,158
Espírito Santo	2	0.034	2	3,453,648
Goiás	10	0.034	21	5,844,996
Maranhão	1	0.228	11	6,305,539
Mato Grosso	1	0.042	6	2,957,732
Mato Grosso do Sul	6	0.028	2	2,336,058
Minas Gerais	10	0.032	15	19,850,072
Pará	17	0.104	12	7,321,493
Paraíba	10	0.165	25	3,742,606
Paraná	14	0.036	1	10,590,169
Pernambuco	52	0.172	15	8,734,194
Piauí	0	0.204	27	3,119,697
Rio de Janeiro	2	0.040	2	15,872,362
Rio Grande do Norte	1	0.142	5	3,106,430
Rio Grande do Sul	11	0.042	13	10,855,214
Rondônia	3	0.096	0	1,493,566
Roraima	1	0.117	0	412,783
Santa Catarina	5	0.013	4	6,052,587
São Paulo	49	0.029	4	41,011,635
Sergipe	3	0.142	10	1,999,374
Tocantins	1	0.120	8	1,280,509
Mean	9	0.106	9	7,022,696.82
Std. deviation	13	0.073	8	8,422,434.61

occupation varies throughout the country, with northern rural states more prone to land occupation and related activities than southern states.

A Model of Land Invasion and Occupation

In this section, we present a highly stylized model. The objective is to determine the role, if any, of the factors identified by the empirical literature on land conflicts in increasing or reducing land invasion. Our model provides a platform to hypothesis testing; it is not an end in itself. There are useful models available in the literature one could build on to model the same issue, such as the conflict models of Grossman (1991) and Blomberg et al. (2004) in which peace is disturbed by disgruntled groups seeking to increase their voice, power, and control, or the game-theoretic models developed by Addison, Le Billon, and Mushed (2002) in which collective action is highlighted.

Our intertemporal dynamic model with a landless peasant as a representative agent allows one to study the dynamic path of land invasion and landless peasant consumption. We assume the peasant seeks to maximize his welfare over time subject to the dynamics of land invasion and occupation, which are related to the collective action of the Landless Peasants Movement. This is why the MST is exogenous from the viewpoint of an individual peasant who may or may not choose to join the movement. The framework of the model is in line with Levy and Faria's (2007) conflict model.

The solution of the model clearly shows a rationale for the peasant to join the group that organizes land invasion and occupation, since in the optimal path, given the initial conditions, the peasant may have an extraordinary increase in welfare by joining the group.

The dynamics of land invasion and occupation depend on the differences between forces favorable to invasion (given by function F) and against invasion (given by function G). As arguments of function F we have: (1) the expected return of occupied land, (2) political support for land occupation, (3) conflicts over common resources, (4) agricultural credit funded by a public agency, and (5) peasant poverty (m).

Regarding the expected return of occupied land, if the peasant thinks that occupied land (L) yields an output $f(L)$ that is enough for

his current welfare, as captured by a desired consumption level (c)—that is, if $f(L) - c > 0$ —then this can lead him to join the movement and invade and occupy privately owned lands. If $f(L) = c$, then the argument vanishes from function F and the expected return of occupied land has no role on the forces for land invasion and occupation.

In the same vein, every type of political support for land reform, represented by p , such as governments ruled by left-wing political parties, active land reform carried out by the government, organized political movements, and organized political violence for land reform, increase function F , since the peasant feels more confident in invading because the risk of punishment is smaller.

Conflicts over the management of common resources, represented by a , such as water allocation, can spill over and become a political issue, increasing calls for land reform and making the peasant more likely to invade.

Agricultural credit funded by a public agency, A , stimulates land invasion because the provision of credit is attached to the land obtained either by legal land distribution or by land obtained through organized and politically motivated land invasion. Peasant poverty, m , is usually associated with more land invasions because it lowers the opportunity cost of joining a rebellion.

Given the above discussion, function F has the following characteristics:

$$F(f(L) - c, p, a, A, m), F_1 > 0, F_2 > 0, F_3 > 0, F_4 > 0, F_5 > 0,$$

and $F_{11} = 0, F_{12} > 0, F_{13} > 0, F_{14} > 0, F_{15} > 0$; that is, political participation, conflicts over common resources, agricultural credit funded by a public agency, and peasant poverty increase the marginal impact of the expected return of occupied land on F .

The forces against land invasion and occupation are captured by function G . The arguments of function G are: (1) agricultural production, wL , where w is the unit value of production per unit of land, L ; (2) peasant poverty, m ; (3) probability of successful land occupation, v ; and (4) rural population density, n .

Agricultural production reduces land invasion and occupation since it uses land and employs labor, hence increasing the opportunity cost of land invasion for a landless peasant. Related to agricultural production is the issue of land eviction of peasants by landowners. In order to decrease the risk of land conflicts landowners can

reduce the demand for labor by mechanizing agriculture and/or adopting extensive large-scale livestock production. Of course, this is a burdensome growth process for the peasant population in which more evictions lead to more poverty. According to this line of reasoning, productive privately owned land is more difficult to be invaded and occupied, so at least locally, poverty of the peasant population may be associated with less land invasion and occupation. An additional explanation is to assume that poor peasants may prefer to look for federal assistance programs, including food assistance, rather than engage in conflicts in order to occupy privately owned land.

Uncertainty of land occupation is an important factor influencing the decision to invade land. If the probability of successful land invasion and occupation, v , is high, the peasant decides to join a peasants movement and invade land; otherwise he will not join and invade land. For instance, if the government reacts to land invasion enforcing the rule of law and preserving the landowners property rights, then the landless peasant has less incentive to invade. In the same vein, if rural landowners fight invasions back, by reinforcing the protection of their properties, this may increase the uncertainty and reduce land invasions.

Given the above discussion, the function G has the following characteristics:

$$G(wL, m, v, n), G_1 > 0, G_2 > 0, G_3 > 0, G_4 < 0,$$

and $G_{11} > 0, G_{12} > 0, G_{13} > 0, G_{14} < 0$; that is, function G is convex in agricultural production, rural population density reduce the marginal impact of the agricultural production on G , and poverty and probability of land occupation increase it.

It is important to stress that poverty (m) is an argument in both functions F and G . Its role is highly complex because there are reasons to think that it has a positive impact on land invasion and occupation and, at the same time, a negative impact. Although its final impact cannot be a priori theoretically determined, being clearly an empirical issue, we hypothesize that the negative impact prevails.

The landless peasant problem is:

$$\begin{aligned} & \text{Max}_c \int_0^{\infty} U(c) \exp(-\theta t) dt \\ (1) \quad \text{s.t.} \quad \dot{L} &= F(f(L) - c, p, a, A, m) - G(wL, m, v, n), \end{aligned}$$

where the landless peasant preferences for consumption over time are represented by the utility integral, the instantaneous utility

function $U(c)$ is nonnegative and a concave increasing function of the consumption, c , θ is the landless peasant rate of time preference, and $f(L)$ is a production function, where labor is supplied inelastically. The current value Hamiltonian associated with the problem is:

$$H = U(c) + \lambda\{F(f(L) - c, p, a, A) - G(wL, m, n, v)\},$$

where λ is the costate variable, the shadow price of land invasion and occupation, L , for the landless peasant. The first order conditions are:

$$(2) \quad U_c(c) - \lambda F_1(f(L) - c, p, a, A) = 0$$

$$(3) \quad \dot{\lambda} - \theta\lambda = -\lambda[F_1(f(L) - c, p, a, A)f_L(L) - wG_1(wL, m, v, n)]$$

plus the transversality condition:

$$\lim_{t \rightarrow \infty} (\lambda L e^{-\theta t}) = 0.$$

Differentiating equation (2) with respect to time and using equations (2) and (3) yields a differential equation describing the evolution over time of consumption:

$$(4) \quad \dot{c} = \frac{U_c}{U_{cc}} (\theta + wG_1 - F_1 f_L).$$

Equation (4) presents the Keynes-Ramsey rule for the landless peasant model. In a typical Ramsey model without population growth the marginal rate of transformation from production corresponds to the difference between the rate of time preference and the marginal product of capital (Blanchard and Fischer 1989). In this model there is no capital, and the marginal rate of transformation from production is given by the difference between the rate of time preference θ , and the marginal expected return of invaded land (the term $F_1 f_L$) plus the forgone income if land is invaded (the term wG_1). Given that $U_c > 0$, $U_{cc} < 0$, it follows from equation (4) that consumption grows with the marginal expected return of invaded land, and decreases with the rate of time preference and the forgone income if land is invaded.

The determinant of the Jacobian ($\det J$) of the dynamic system formed by the differential equations (1) and (4) is equal to:

$$\det J = \frac{U_c}{U_{cc}} F_1(w^2 G_{11} - F_1 f_{LL}).$$

And the model displays saddle point stability if $\det J < 0$, which holds if $F_1 f_{LL} < w^2 G_{11}$.

In the steady state: $\dot{c} = 0 = \dot{L}$ in equations (1) and (4), we have:

$$(5) \quad F(f(L) - c, p, a, A, m) = G(wL, m, v, n)$$

$$(6) \quad F_1(f(L) - c, p, a, A, m) f_L(L) = \theta + wG_1(wL, m, v, n).$$

Equations (5) and (6) determine simultaneously the steady state equilibrium values of consumption, c^* , and land invasion and occupation, L^* . With c^* and L^* , then equation (3) determines λ , the shadow price of land invasion and occupation. By using explicit functions for F , G and U , we can obtain explicit expressions for c^* and L^* .

The dynamic system formed by equations (1) and (4) yields the optimal path of landless peasant consumption and land invasion converging towards c^* and L^* . If the initial level of land invaded, L_0 is below L^* , land invasion grows towards L^* , and for a given level of initial consumption c_0 associated with L_0 we have an increase in the landless peasant consumption. So this optimal path shows that the landless peasant has a lot to gain by joining the movement of land invasion and occupation, since his welfare increases.

Our focus, however, is to investigate the impact of poverty (m), agricultural productivity (w), population density (n), political support for land occupation (p), probability of successful land invasion and occupation (v), water conflict (a), and agricultural credit (A) on equilibrium land invasion and occupation (L^*). The comparative statics analysis of the system (5) and (6) yields the following multipliers:

$$(7) \quad \frac{dL^*}{dm} = \frac{(wG_{12} - F_{15}f_L)}{F_1 f_{LL} - w^2 G_{11}} > 0 \Leftrightarrow wG_{12} \begin{matrix} < \\ > \end{matrix} F_{15}f_L$$

$$(8) \quad \frac{dL^*}{dw} = \frac{(wLG_{11} + G_1)}{F_1 f_{LL} - w^2 G_{11}} < 0$$

$$(9) \quad \frac{dL^*}{dn} = \frac{wG_{14}}{F_1 f_{LL} - w^2 G_{11}} > 0$$

$$(10) \quad \frac{dL^*}{dp} = \frac{-F_{12}f_L}{F_1 f_{LL} - w^2 G_{11}} > 0$$

$$(11) \frac{dL^*}{da} = \frac{-F_{13}f_L}{F_1f_{LL} - w^2G_{11}} > 0$$

$$(12) \frac{dL^*}{dv} = \frac{wG_{13}}{F_1f_{LL} - w^2G_{11}} < 0$$

$$(13) \frac{dL^*}{dA} = \frac{-F_{14}f_L}{F_1f_{LL} - w^2G_{11}} > 0$$

According to the comparative statics analysis [(7)–(13)], equilibrium land invasion and occupation (L^*) increases with population density (n), political support for land occupation (p), water conflict (a), and agricultural credit funded by a public agency (A). Land invasion and occupations decreases with agricultural productivity (w) and uncertainty (v). The impact of poverty (m) on land invasion and occupation is, a priori, ambiguous: it may increase or decrease it. In the following empirical part of this article, we test these predictions of the model.

Methodological Framework and Hypotheses

The following variables are considered in the empirical estimations of our model: percentage of poverty in the state, agricultural productivity, population density, state governed by the Workers Party, lands allocated by decree, agricultural credit, water conflicts, resistance events, demonstrations, murder attempts, number of land conflicts, number of murders related to land reform, and the number of death threats related to land reform. The panel data by Brazilian state is for the period 2000–08. Table 3 presents the characteristics of the data used.

The number of land occupation actions is of paramount importance for its strategic management. Our analysis includes a count data model to identify statistical significant covariates in the sample (Greene 2005). The research utilizes data from the Comissão Pastoral da Terra, a Catholic organization that supports poor peasants and landless farmers (www.cptnac.com.br/?system=news&eid=6), supplemented with additional variables from other sources (www.ipeadata.gov.br).

TABLE 3
DATA DESCRIPTIVE ANALYSIS

Variables	Description	Mean	Std. Dev.	Min.	Max.
Invasion and Occupation	Number of Occupations	12.736	19.885	0	165
Political and Institutional Context					
PT	Dummy equal to one if PT governs the state	0.127	0.334	0	1
INCRA	Number of lands taken from landowners by decree	10.13	12.16	0	78
PRONAF	Agricultural credit real value, 2008	320,939,801	1,284,035,714	4,576	19,427,486,432
Economic and Social Context					
Poverty Agricultural Productivity	% of population below poverty line	0.147	0.005	0	0.409
	Agricultural production by hectare	1.093	0.526	0.175	3.534
Population Density	Population density by state	63.166	94.914	0.038	440.744
Conflicts					
Water Conflicts	Number of conflicts	1.456	2.478	0	20

Group Fights					
Resistance Actions	Number of resistance actions per state related to land reforms	0.378	1.050	0	7
Demonstrations	Number of demonstrations per state related to land reforms	25	20	0	118
Individual Land Conflict					
Murder Attempt	Number of murder attempts per state related to land reforms	2.617	5.422	0	32
Death Threats	Number of menaces per state related to land reform	8.530	18.725	0	118

According to the theoretical model, land occupation depends on the following factors:

H1 (PT): States governed by the left-wing Partido dos Trabalhadores (PT), the Workers Party, increase land occupation. This effect is based on ideological preferences by left-wing parties for equity over efficiency, inducing the occupation of the lands owned by absentee landlords (Alston, Libecap, and Mueller 1997, 1999, 2005; Araujo Jr, Shikida, and Alvarenga 2008).

H2 (INCRA): Lands allocated for reform by decree by INCRA, tend to validate a posteriori land invasion and occupation, fueling further land occupations. This problem has been analyzed by Binswanger and Deininger (1993) and Pacheco (2009).

H3 (PRONAF): Agricultural credit funded by Programa Nacional de Fortalecimento da Agricultura Familiar/National Program to Strengthen Family Agriculture (PRONAF), a program of the Ministry of Agricultural Development that finances individual projects or groups of farmers and agrarian reform settlers, tends to support land occupation, being with hypothesis 4 and 5 part of the political process that the left-wing government has established to promote land occupation.

H4 (Poverty): Poverty may increase or decrease land occupation, this variable is often used to study land conflicts (Waeterloos and Rutherford 2004, Finan et al. 2005, Rigg 2006).

H5 (Agricultural Productivity): Agricultural productivity generates more wealth and food supply in the state and therefore it decreases land invasion and occupation. It is often used in land reform models (Caviglia-Harris 2003, Minten and Barrett 2008, Place 2009).

H6 (Population Density): Rural population density increases land occupation. It is frequently use in land reform models (Simmons et al. 2010).

H7 (Water Conflicts): Conflicts over water management, such as those arising from severe shortages in semi-arid states in north-eastern Brazil, increase land occupation (Bakker et al. 2008).

H8 (Resistance Actions and Demonstrations): Resistance actions and demonstrations are indicators of political determination to invade and occupy land, which help reduce uncertainty over the success of land invasion. Although these variables have not been used in previous research of land reform, they are intrinsically part of the process of land occupation.

H9 (Murder Attempt and Death Threats): The number of individual land conflicts, such as murder attempts and death threats, are generic aspects of individual aspects of land occupation, usually occurring prior to the land occupation and derived from land evaluation by the occupiers (Peters 2009), and serve to decrease land occupations since they increase the uncertainty of successful land invasion.

In order to test the foregoing hypotheses, we first estimate an OLS model that serves as a reference for the Poisson model. The motivation to use the Poisson model is derived from the fact that the dependent variable is the number of times the Landless Peasants Movement invades privately owned land (Cameron and Trivedi 1998). This variable is a counting variable that is characterized as being nonnegative, which should be modeled as a Poisson or a negative binomial model (Greene 2005).

The Poisson model is based on the hypothesis that the endogenous variable y_i (counts of the number of land invasions), given the covariates x , is independent with the Poisson distribution and probability density function.

It is currently assumed that the basic Poisson model is too restrictive with regard to the features of the observed data (Cameron and Trivedi 1998). Common deviations from the basic Poisson model are endogeneity, dynamic nature of data, and overdispersion. Endogeneity occurs when there is a correlation between the exogenous variable and the error term. It can also arise as a result of measurement error, simultaneity, omitted variables, and sample selection errors. Another cause of endogeneity lies on the dynamic nature of the data and with autocorrelated errors, justifying the dynamic analysis of the data (Greene 2005).

Overdispersion is the failure to satisfy the conditional mean and conditional variance restriction. If the conditional variance of the data exceeds the conditional mean, overdispersion is present. The most commonly given explanation for overdispersion is the unobserved heterogeneity in the data—that is, there are omitted variables in the mean function. Other explanations are measurement errors in explanatory variables and the stochastic character of the structural parameters. A common approach to overcoming this problem is to estimate Poisson models allowing for heterogeneity in the mean (Greene 2005), or to estimate a random Poisson model.

Our empirical strategy follows these procedures. We first estimate the OLS model, followed by estimates of a standard and fixed effects

Poisson model (Hilbe 2008). Next, we estimate a Poisson model with heterogeneity and a Poisson model with endogeneity (Mullahy 1997). Finally, we estimate a dynamic Poisson model to investigate lags of endogenous variables and leads of exogenous variables.

Results and Discussion

Table 4 presents the results. Stata software was used to estimate the model. The first model is the OLS presented as a reference. The second column presents a standard Poisson model. The third model is the fixed effects Poisson model. The fourth model is the random Poisson model allowing for heterogeneity. The fifth model is the endogenous Poisson model allowing for endogeneity in the political variables, namely PT, INCRA, PRONAF, poverty, and productivity. The Generalized Method of Moments (GMM) estimator of Poisson regression is adopted allowing for endogenous variables to be instrumented by excluded instruments. Standard errors are estimated by bootstrapping. Prior to estimating the endogenous mode, we performed a Hausman test that reached the value of 28.16 with a small p-value, signifying that there was endogeneity in the variables. We then ran the model without each possible endogenous variable such as possible political induced land invasion (PT, INCRA, PRONAF) and contextual induced land invasion (poverty, agricultural productivity, and population density) and concluded that the endogenous variables are PT, INCRA, and PRONAF. The instrumental variables were adopted using the percentage of state PT municipal heads in the state total, total agricultural bank credit in the state, and each variable lag.

The immediate thing we observe in the results is that almost all signs of variables are maintained throughout the various models. Based on the loglikelihood, the dynamic Poisson is chosen. In the dynamic Poisson model, it is verified that lags in the endogenous variable are statistically significant, meaning that this is a process with persistence. The dummy variable PT, which indicates the left-wing party controls the state, is positive and significant, which means that it contributes to land occupation.² INCRA is also positive, which

²In contrast with President Rousseff's policies, the agrarian policy committee of PT demands increasing expenditures with land reform. PT internal politics demands the strengthening of social movements like MST, which tends to promote more land conflicts (Agencia Estado 2011). However, it is important to note that our research covers the period 2000–08.

TABLE 4
EMPIRICAL RESULTS
DEPENDENT VARIABLE: NUMBER OF LAND INVASIONS AND OCCUPATIONS

Variable	OLS	Standard Poisson Model	Poisson with Fixed Effects	Poisson with Heterogeneity	Poisson with Endogeneity	Dynamic Poisson
Constant	-38.661 (-2.59)	-2.221 (13.82)	—	-19.598 (-35.39)	-2.334 (21.32)	-8.624 (-3.91)
Occupation $t-1$	—	—	—	—	—	0.009 (3.15)
Occupation $t-2$	—	—	—	—	—	-0.005 (-1.32)
Occupation $t-3$	—	—	—	—	—	0.013 (3.02)
PT	4.654 (2.16)	0.230 (3.63)	0.418 (2.03)	0.145 (2.16)	0.833 (3.82)	0.293 (3.23)
INCRA	0.388 (2.69)	0.016 (13.80)	0.0046 (2.02)	-0.001 (-1.46)	0.068 (3.07)	0.011 (2.47)
INCRA $t-1$	—	—	—	—	—	-0.017 (-2.67)
LogPRONAF	1.416 (2.54)	0.731 (10.25)	0.523 (3.218)	0.536 (12.77)	0.134 (0.88)	0.127 (3.218)

continued

TABLE 4 (cont.)
 EMPIRICAL RESULTS
 DEPENDENT VARIABLE: NUMBER OF LAND INVASIONS AND OCCUPATIONS

Variable	OLS	Standard Poisson Model	Poisson with Fixed Effects	Poisson with Heterogeneity	Poisson with Endogeneity	Dynamic Poisson
LogPRONAF _{t-1}	—	—	—	—	—	0.032 (3.127)
Poverty	1.510 (0.88)	-1.505 (-3.81)	0.193 (0.10)	-2.448 (-8.70)	-2.702 (-2.53)	-1.539 (-1.04)
Agricultural Productivity	6.515 (3.43)	-0.110 (-6.71)	-0.126 (-0.29)	-0.461 (-5.84)	-0.539 (-0.91)	-0.113 (-0.49)
LogPopulation Density	1.470 (1.43)	0.318 (4.16)	0.017 (0.94)	0.219 (5.95)	0.126 (1.44)	0.472 (3.25)
LogPopulation Density _{t-1}	—	—	—	—	—	-0.002 (-2.47)
Water Conflicts	0.395 (1.38)	-0.010 (-1.49)	-0.032 (-1.99)	-0.024 (-2.95)	-0.071 (-1.82)	-0.006 (-0.36)
Resistance Action	3.915 (3.03)	0.023 (3.21)	0.057 (1.56)	0.080 (4.60)	0.207 (2.34)	0.121 (2.81)
Demonstrations	0.453 (5.58)	0.021 (23.39)	0.003 (4.31)	0.046 (39.08)	0.037 (5.23)	0.015 (3.89)

Murder Attempts	0.144 (0.78)	-0.003 (-0.89)	0.0084 (2.16)	-0.023 (-6.22)	0.024 (1.21)	0.009 (0.85)
Death Threats	0.040 (0.75)	0.006 (2.86)	0.015 (1.57)	-0.007 (-3.44)	-0.021 (-2.14)	0.004 (0.69)
Alpha	—	—	—	0.163	—	—
Nobs	234	234	234	234	234	234
Loglikelihood	-1,221.16	-1,431.45	-879.990	-2,065.49	-1,932.45	-2,172.35
Chi-Squared			100.66	392.56		
Prob [chi sqd > value]			(0.000)	(0.000)		

NOTE : The parameters in bold are statistically significant at 1 percent or 5 percent.

signifies that number of lands taken from landowners by decree induce land occupation. Agricultural credit also increases land occupation, but this variable is not endogenous. The fact that agricultural credit is not endogenous means that it contributes to the process through market dynamics, after the property rights are allocated to the occupant.

The first conclusion is that land occupation in Brazil is explained by political variables such as political support by the party in power, institutional support by public entities through INCRA that expropriate the occupied land from the landowners by decree, and agricultural credit by a public agency. Note that INCRA and PRONAF have statistically significant leads, which add to the statistically significant lag of the endogenous variable—meaning this is an ongoing process with persistence. These results validate Hypotheses 1, 2, and 3.

The second result is that poverty is negative and statistically significant in several models. However, there are two models in which poverty is positive but statistically insignificant. Poverty is positive but statistically insignificant in the fixed effects model. The fixed effects model displays a weak fit, meaning there are no fixed effects in the data. A possible explanation for this is that invasions are concentrated in a small number of Brazilian states. Poverty is also positive and statistically insignificant in the OLS model. In all other models, poverty is negative and statistically significant with the exception of the dynamic Poisson model. Although the literature considers poverty an important covariate of land invasion, the results of all our models convinced us that poverty is not an important covariate, and based on the chosen model it is not statistically significant. Thus, it is not addressed in our policy prescriptions.

The third result is that productivity in agriculture decreases land occupation, validating Hypothesis 5, that is, high agricultural productivity increases peasants income and therefore decreases the need for land ownership through land occupation. Population density increases land occupation, validating Hypothesis 6 and suggesting that it is among the main causes of land reforms in developing countries (Hidalgo et al. 2010).

Conflicts over water management are not statistically significant and decrease land occupation, which does not confirm Hypothesis 7. Resistance and demonstrations increase land occupation, validating Hypothesis 8. Finally, murder attempts and death threats have a mixed effect on land occupation, not validating Hypothesis 9, and

implying that fear and uncertainty about the success of land invasion has a mixed effect on land conflicts.

Policy Prescription

The policy implication of this research is that the government should use its institutional framework to minimize conflicts and conduct land reform where it is necessary under the strict rule of the law. The government has to reduce the power of peasants political movements that feed on violence by not granting property rights to invaders of privately owned land. The land reform has to reinforce property rights rather than oppose them. For example, Brazil's Land Statute (Federal Law, Nr. 4.504, November 1964) prevents the expropriation by the government of lands that have suffered invasion. The rule of law is of paramount importance. If the government, for political reasons, aims at maintaining political support from these peasants movements with a clear revolutionary agenda, like the MST, and, at the same time, does not reinforce property rights and the rule of law, it sends a mixed message that fuels violence.³

According to our results, the Landless Peasants Movement focuses on regions with less poverty and greater population density to invade and occupy land. This of course may disrupt production in the main agricultural regions of Brazil. The government has to preserve the highly productive areas from disruption caused by land invasions. The protection of highly productive areas is explained by its economic importance. Commercial agriculture in Brazil evolved over the past three decades from being extensive to intensive—that is, production per hectare has increased significantly (IBGE 2011).

As a result Brazil has become not only one of the world's largest producers of many important agricultural commodities but also a major exporter. For instance, Brazil is the largest producer and exporter of sugar, coffee, and orange juice; it is the second largest producer and largest exporter of ethanol, beef, tobacco, and chicken. It is one of the five largest exporters of soybeans, leather and fur, soybean oil, corn, pork meat, and cotton (MDIC 2011). Therefore, any

³Our policy prescription does not consider a political equilibrium. In Alston, Libecap, and Mueller (2010), the political equilibrium is that the government will concede to the MST given its ability to mold information available to urban voters so as to generate broad urban support for its land reform agenda.

changes in the land tenure of these highly productive areas will have enormous costs in terms of forgone income and employment of capital and labor, disrupting how this modern agricultural sector relates with the rest of the economy.

There are several ways to minimize violence related to the equity-efficiency trade-off in this case. The government can assist the landless peasants without violating the farmers property rights by providing land located in appropriate areas—that is, low productivity areas or unproductive and publicly owned land. This would minimize the disruption of the commercially productive agricultural sector and, at the same time, satisfy the demand for land ownership from landless peasants. If the MST leadership refuses this alternative and exerts pressure to invade productive lands, it shows its political character aiming at imposing serious economic damage on the modern agricultural sector without properly addressing the needs of landless peasants. The government should aim at satisfying individuals that want to have access to land, not the MST's political agenda.

How does the present research compare with previous research on Brazilian land reform? It provides a specific and unique insight into the land reform movement, based on the actions of the Landless Peasants Movement, focusing on contextual and conflict variables, giving a clear view of the factors that influence violence. Compared with earlier research on Brazilian land reform, this article's use of data for the entire country and estimation methods that take account of heterogeneity, endogeneity, and dynamics enables a more accurate view of the land reform movement.

Conclusion

This article analyzes land occupation and land reform in Brazil for the period 2000–08. It is the first study to be undertaken at a national level, with a contemporary data span, using a count data model that allows for heterogeneity, endogeneity, and dynamics. It studies contextual variables that affect land occupation, such as political, institutional, conflict, and socioeconomic variables. It shows that political and institutional variables have a positive effect on land occupation. However, the socio-economic variables have a mixed effect, with rural population density increasing land occupations, while poverty and land productivity reduce land occupations.

Conflict variables also have mixed effects, with resistance movements, demonstrations, and generic conflicts increasing land invasion and occupation, while water-related conflicts, murder attempts, and death threats cause their decrease.

In order to minimize conflict, we recommend that the government minimize land invasion and occupation and follow the rule of law. We also suggest that the government should focus on the needs of individuals that want to have access to land, not on the MST's political agenda. In this regard, the government should provide landless peasants with land located in low productivity areas or unproductive and publicly owned land. Brazil's land reform should reinforce private property rights, not destroy them.

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