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Land inequality and conflict intensity

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Abstract This paper investigates the impact of land inequality on conflict intensity. A fundamental distinction with the existing literature lies in the nature of inequality under consideration. We investigate how land inequality *across landlords only* influences the intensity of the fight against a rebel group comprised of landless individuals. We show that conflict intensity is non-monotonic in land inequality. In particular, the most severe conflicts occur for intermediate land inequality levels. Moreover, a Pareto improving—and thus voluntary—transfer of land from the smaller to the larger landlord may exist.

Keywords Conflict · Land redistribution · Inequality

JEL Classification Q15 · D74 · H41

1 Introduction

Land related conflicts represent a cost for society. In addition to the losses caused by diverting productive resources to fighting, there are relevant costs resulting from the uncertain economic environment and physical destruction (Deininger 2003; Binswanger and Deininger 2007). Latin American recent history provides several cases of land related struggles. The on-going Colombian conflict initiated in the early 1950s constitutes perhaps a famous example. Although the *guerrilla* might no longer fight for land nowadays, it is hardly disputable that land redistribution was initially one of its central goals. According to some estimates the FARC (Revolutionary Armed Forces of Colombia) alone consists of some 20,000 people, the ELN (National Liberation Army) around 5,000 more individuals, while the conflict

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has caused several tens of thousand victims over the last decades (Restrepo et al. 2003). In Brazil, a history of failed land reforms along with policies benefiting the wealthy elite, accelerated land concentration and exacerbated rural poverty (Graham et al. 1987). Starting in the mid-1980s, the Landless Farmworkers' Movement (MST) organized to occupy idle farmland and to demand expropriation under the slogan "Agrarian Reform, by law or by disorder" (Hammond 1999). Alston et al. (1999) report a yearly average of 500 land related conflicts throughout the country over the period 1986–1997. The usual response of landlords has been to evict the squatters with greater or lesser violence depending on negotiations between the occupiers and the authorities. Given this unsafe environment, landowners often hire thugs or paramilitary forces to intimidate and harass the occupiers, especially during early occupation. Guatemala's Guerrilla Army of the Poor (EGP), active between 1972 and the peace agreement in the 1990s, and Peru's Shining Path movement constitute other examples of armed rebel groups fighting for land.

A recurrent feature of the aforementioned conflicts is the existence of a wealthy landed aristocracy, typically descending from colonial settlers, owning most of the land (Binswanger and Deininger 1997; Engerman 2000), and of a mass of landless individuals prone to develop antagonistic feelings towards landlords. Inequality as a driving force of conflicts has been widely investigated. One strand of the literature argues that strong grievance feelings may trigger internal conflicts (Gurr 1970; Migdal 1974; Scott 1976; Prosterman and Riedinger 1987). Other scholars rather emphasize the rapacity motivation of the rebels (Collier and Hoeffler 2004).[1]

Esteban and Ray (1999) argue that what matters for the emergence of conflicts is the polarization of the society more than inequality, where polarization is a measure of "the sum of interpersonal antagonisms". In a later article, they show that polarization is also associated with more intense conflicts (Esteban and Ray 2008).

The specific effects of *land* inequality on political violence have been long debated among political scientists. In the mid 1960s, a cross-national study of Russett (1964) identifies a positive linear relationship, i.e., greater land inequality (as captured by the Gini land concentration index) is associated with more instability. This thesis seems to be supported by the findings of Hidalgo et al. (2010) who use Brazilian data to point out that "in highly unequal municipalities, negative income shocks cause twice as many land invasions than in municipalities with average land inequality". Midlarsky (1988) adopts an alternative method to measure land inequality (*patterned inequality*) and reaches similar conclusions for Latin America.

Muller and Seligson (1987), however, running their test on 83 countries, show a weak relevance of land inequality as a driver of political violence. More puzzling, perhaps, are the findings of Mitchell (1968) who identifies the opposite relationship in the case of South Vietnam: greater land inequality is associated with less support for the Marxist revolution.

We propose a potential explanation for the inconclusive empirical evidence found in this literature: the relationship between land inequality and conflict might simply not be linear.

In this study, we investigate the impact of land inequality on conflict intensity. A fundamental distinction with the existing literature lies in the nature of inequality under consideration. While most scholars address the effects of inequality *between* the opposing factions, we focus on the impact of inequality *within* one side of the dispute. More specifically, we study how land inequality across landlords influences the intensity of the fight against a rebel group comprised of landless individuals.

[1] The motivations of rebels are also studied by DeNardo (1985), Gurr and Moore (1997), and Gates (2002).

This work relates to the literature dealing specifically with land related conflicts. In an influential paper Grossman (1994) identifies the conditions under which a class of landlords find it profitable to redistribute land when confronted by landless individuals who optimally allocate their time between wage labor, looting, and farming. He shows that land redistribution occurs only when the costs of being looted and of policing such an activity are too high.

We set up a model in which two landlords face a pool of landless individuals with the same occupational options as in Grossman (1994). Landlords have two instruments for coping with the potential looters: redistributing land in order to reduce the pool of unemployed individuals and protecting their property by investing in defense.[2] Unlike Grossman, in our model land redistribution is the outcome of strategic behavior between landlords. This feature captures the nature of interactions characterizing agrarian societies in weak states. The reduced ability of the central power to provide public goods and to enforce contracts allows a restricted class of landlords to dominate rural affairs. Looting activities are organized by a profit maximizing rebel group which allocates fighters across the two landlords' land. In fact, even if started out of grievances, rebel groups may eventually fight for greed (Collier et al. 2003; Weinstein 2005).

As in Grossman (1994), we disregard land markets. Typically, credit constraints underlie the malfunctioning of such markets, particularly in conflict-ridden regions where the risk of looting or trespassing makes the value of collateralized land highly uncertain (Deininger 2003; Cotula et al. 2004). In section four we discuss the consequences of relaxing this assumption on our results.

The main result of this paper is that conflict intensity may be non-monotonic in land inequality. In particular, the most severe conflicts occur for intermediate land inequality levels. Because of the public good nature of land redistribution, rising inequality from an initially symmetric distribution of land ownership also increases the degree of free-riding from the smaller landlord. For intermediate levels of land inequality, the burden for the larger landlord of scaling down conflict through redistribution exceeds the cost of fighting the rebels. Consequently, in this range, total land redistribution experiences a substantial drop. Since defense and land redistribution are substitutes, this implies an increase in the intensity of conflict. For greater land inequality levels, however, the larger landlord internalizes sufficiently the public good to redistribute land on his own. This echoes Olson's (1965) result on inequality and public good provision.

A second result follows directly. We show that it may be in the smaller landlord's interest to transfer land to the larger landowner in order to increase the latter's incentive to redistribute land. This constitutes a Pareto improvement, as both landlords and landless individuals are better-off. By endogenously concentrating land ownership, the landlords overcome the under-provision of the public good in a decentralized manner. A similar solution is proposed in Grossman (2002) where producers empower a tax-imposing king to protect their properties from a group of predators.

The remainder of the paper is organized as follows. We first present the model and characterize the equilibria. We then discuss the results of the comparative statics with respect to land inequality. In section four we discuss the consequences of relaxing our assumptions. The last section concludes.

[2] In Sect. 4.2 we discuss alternative tools that could be used to contain conflict.

2 The model

2.1 General setting

Two landlords, 1 and 2, owning respectively land plots of size T_1 and T_2, face an external threat stemming from a group of n unemployed individuals.[3] The landlords can redistribute land and/or protect their properties by the use of force. The value of non-farmed land is nil. Landlords simultaneously decide in an initial stage the amount of non-farmed land, r_1 and r_2, they respectively transfer to each unemployed individual. The total amount of land redistributed therefore equals $n(r_1 + r_2)$. After redistribution the landlords spend all of their available time, that we normalize to unity, in farming. We assume a one-to-one production function so that the production of landlord i equals $T_i - nr_i$ ($i \in \{1, 2\}$). Each unemployed agent specializes either in farming the plots of land transferred by the landlords ($r_1 + r_2$), or in migrating to the city to obtain the market wage w, or in fighting within an organized rebel movement. Non farmed land eventually returns to the landlord who provided it. The organized rebel group optimally allocates fighters across landlords. In particular, t_i rebels loot the production of landlord i. Landlord i chooses his defense level, m_i, given a unit cost of defensive equipment c. We assume that the allocation of fighters and the landlords' defense decisions are taken simultaneously and that the fighting technology is described by a Contest Success Function (Tullock 1967; Hirshleifer 1989; Hirshleifer 1995; Skaperdas 1992, 1996; Grossman and Kim 1995).

The timing can be summarized formally as:

Stage 1

- Each landlord $i \in \{1, 2\}$ decides the amount of land to redistribute to every unemployed individual, r_i, and farms the remaining land, $T_i - nr_i$.

Stage 2

- Each landlord i chooses his defense level, m_i.
- Unemployed individuals decide whether to become peasants, P, migrants, M, or fighters, F.
- The rebel group decides the number of fighters t_i to send against each landlord i, given the total pool of fighters, n_F.
- Non farmed land returns to the landlord who provided it.

The expected utility of landlord i is given by:

$$U_i = \frac{m_i(T_i - nr_i)}{m_i + t_i} - cm_i \tag{1}$$

where $\frac{m_i}{m_i+t_i}$ is the probability of landlord i successfully protecting his property against t_i looters, given a defense level of m_i.

Let us denote by j the generic unemployed individual. If j decides to farm the plot of land that the landlords redistributed, his utility equals his farming product:

$$U_{P_j} = r_1 + r_2 \tag{2}$$

[3] To avoid any problem linked to the discrete nature of n, we solve the problem as if it was a continuous variable since proceeding otherwise would add unnecessary complications.

where subscript P_j captures j's specialization as a peasant. Equivalently, if j migrates (subscript M_j), his utility equals:

$$U_{M_j} = w \tag{3}$$

Similarly, the utility of j when specializing as a fighter (subscript F_j) is given by:

$$U_{F_j} = \frac{1}{t_1 + t_2}\left(\frac{t_1(T_1 - nr_1)}{m_1 + t_1} + \frac{t_2(T_2 - nr_2)}{m_2 + t_2}\right) \tag{4}$$

where the term in brackets represents the total returns from fighting for the rebel group that are shared equally among fighters.

2.2 Analysis

We solve the game using backward induction, starting from the last stage.

Stage 2

Landlord i chooses $m_i \geq 0$ to maximize (1). That yields:

$$m_i(t_i, r_i) = \sqrt{\frac{t_i(T_i - nr_i)}{c}} - t_i \tag{5}$$

At the same time, the rebel group allocates t_1 and t_2 to maximize (4). At optimality the marginal returns to fighting either landlord are equal:

$$m_1 \frac{(T_1 - nr_1)}{(m_1 + t_1)^2} = m_2 \frac{(T_2 - nr_2)}{(m_2 + t_2)^2} \tag{6}$$

Using (5) and (6) we derive the optimal allocation of fighters as a function of the total number of fighters n_F:

$$t_i = \frac{T_i - nr_i}{T_1 + T_2 - n(r_1 + r_2)} n_F \tag{7}$$

Substituting (5) and (7) in (4), we obtain the utility for a fighter j of joining the rebel group:

$$U_{F_j} = \sqrt{\frac{c(T_1 + T_2 - n(r_1 + r_2))}{n_F}} \tag{8}$$

Unemployed agents individually specialize in the highest yielding activity by comparing the returns (2), (3), and (8). The total number of fighters n_F that follows determines t_i (r_1, r_2) in equation (7). Given the complexity of the problem, we make the following assumption:

Assumption 1 $w > \sqrt{\frac{c(T_1+T_2)}{n}}$.

This rules out the case where all unemployed individuals join the rebel group. This implies that $n_F < n$ at the optimum. In other words, even in the absence of redistribution, the urban wage is sufficiently high to dissuade some unemployed individuals from fighting.[4]

[4] In the earlier version of this paper (De Luca and Sekeris 2008) we address the consequences of relaxing this assumption, and show that our findings remain unaltered.

Depending on the redistribution levels chosen by landlords, two different allocations of unemployed individuals can therefore arise. If farming is more profitable than migration ($r_1 + r_2 > w$), then unemployed individuals specialize exclusively in farming or fighting. At equilibrium the returns to both activities are equalized. Indeed, if for instance the return to fighting is higher than farming, some farmers find it profitable to switch activity, thus reducing the utility of fighting until returns are equalized. Setting (8) equal to total redistribution ($r_1 + r_2$) yields the total number of fighters, n_F. Substituting this value in (7) we obtain the number of fighters looting i's production:

$$t_i = t_i^P = \frac{c(T_i - nr_i)}{(r_1 + r_2)^2}, \quad i \in \{1, 2\} \tag{9}$$

where superscript P refers to the scenario in which some individuals become peasants.

For wage levels exceeding the returns to farming, all unemployed individuals either migrate or join the rebel group. Accordingly, t_i equals:

$$t_i = t_i^M = \frac{c(T_i - nr_i)}{w^2}, \quad i \in \{1, 2\} \tag{10}$$

where superscript M refers to the scenario in which some individuals migrate.

Notice that the optimal value of $m_i\,(r_1, r_2)$ is obtained by substituting the corresponding value of t_i in (5).

From the above analysis a first intermediate result follows:

Lemma 1 *Total resources allocated to conflict* (m_i, m_j, t_i, t_j) *are decreasing with land redistribution*, (r_1, r_2).

All the proofs of this paper can be found in De Luca and Sekeris (2008).[5]

Having fully described the players' behavior in the second stage of the game, we climb up the decision tree and derive the optimal levels of land redistribution r_1^* and r_2^*.

Stage 1

Landlord i maximizes his utility as described in (1), given $m_i\,(r_1, r_2)$ as determined in (5), and $t_i\,(r_1, r_2)$ as described by (9) and (10), depending on the redistribution levels.

This yields the following problem:

$$\max_{r_i} \left[\frac{t_i(r_1, r_2)}{c} \left(\sqrt{\frac{c(T_i - nr_i)}{t_i(r_1, r_2)}} - c \right)^2 \right] \quad \text{where } t_i = \begin{cases} t_i^P & \text{if } r_1 + r_2 \geq w \\ t_i^M & \text{if } w > r_1 + r_2 \end{cases} \tag{11}$$

The best response function of landlord i is therefore given by:

$$r_i = \begin{cases} r_i^P(r_{-i}) = \max\left\{\sqrt{\frac{c(cn+8nr_{-i}+8T_i)}{4n}} - \frac{c}{2} - r_{-i}; 0\right\} \quad \text{if } r_i^M(r_{-i}) + r_{-i} \geq w & (11.1) \\ r_i^M(r_{-i}) = 0 \quad \text{if } r_i^P(r_{-i}) + r_{-i} < w & (11.2) \\ \operatorname{argmax}\left\{U_i(r_i^\vartheta(r_{-i}), r_{-i})\right\} \quad \text{if } r_i^P(r_{-i}) + r_{-i} \geq w > r_i^M(r_{-i}) + r_{-i} & (11.3) \end{cases}$$

where $r_i^\vartheta(r_{-i}) = \{r_i^M(r_{-i}), r_i^P(r_{-i})\}$.

[5] Available for download at http://petros.sekeris.org/landinequality.pdf.

Let us consider more closely the conditions in (11.1), (11.2), and (11.3). Notice first that if total land redistribution is not sufficient to induce unemployed individuals to farm, the optimal redistribution is nil since transferring land is costly. This implies $r_i^P \geq r_i^M$. When the condition in (11.1) is fulfilled, $t_i = t_i^P$ even if landlord i provides r_i^M. In other words, even if i does not redistribute land, total redistribution is enough for some unemployed individuals to become farmers ($r_{-i} > w$). Consequently, $r_i = r_i^P$. The condition in (11.2) captures the opposite situation. Indeed, if redistribution r_i^P does not induce any unemployed individual to farm, then i instead provides r_i^M. Finally, when the landlord's redistribution choice determines the rebels' behavior (t_i^P or t_i^M) for a given r_{-i}, he follows the utility maximizing strategy (r_i^P or r_i^M). In this last case the best response function displays a discontinuity.

Lemma 2 *Landlords' reaction functions exhibit at most a single discontinuity.*

We construct a graphical representation of landlord i's potential best response in Fig. 1. The reaction function is segmented into two parts, r_i^M and r_i^P. The downward sloping line $r_1 + r_2 = w$ describes the set of redistribution levels that would make the unemployed individuals indifferent between farming and migrating. Any redistribution (r_i, r_{-i}) below this line represents a waste of land, as no unemployed individuals would farm it. Regions I and III correspond to the conditions in (11.2) and (11.1), respectively. If a discontinuity in the reaction function occurs, it is necessarily in zone II (boundaries included).

An outward or inward shift of the w-line (large or low wages) may reduce, or even eliminate zone II, which in turn would grant continuity to the reaction function.

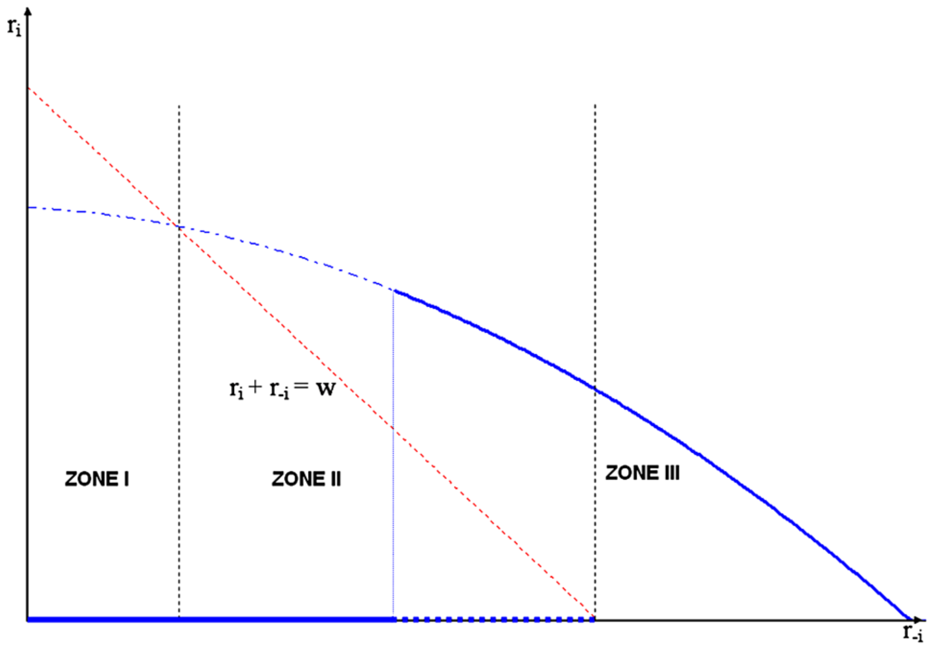


Fig. 1 'Redistribution' best response function of landlord i

2.3 Equilibria

The above discussion indicates that the reaction functions might be non-monotonic. As a consequence, multiple equilibria may arise. In the remainder of this section we describe the possible equilibria in pure strategies. We do not consider mixed strategy equilibria as they do not add any major insight to our results.

P-equilibrium: positive land redistribution
A P-equilibrium is defined as a pair (r_i^{P*}, r_{-i}^{P*}) satisfying the following two conditions:

$$\begin{cases} U_i(r_i^{P*}, r_{-i}^{P*}) \geq U_i(r_i, r_{-i}^{P*}) \quad \forall r_i,\ i \in \{1, 2\} \\ r_1^{P*} + r_2^{P*} \geq w \end{cases} \tag{12}$$

There exists no profitable deviation from the equilibrium strategy, and total land redistribution guarantees the specialization of some individuals in farming.[6]

Notice that the smaller landlord redistributes land at equilibrium only if

$$c > \frac{(T_i - T_{-i})^2}{n(T_i + T_{-i})} \tag{13}$$

Condition (13) follows directly by imposing a non negativity constraint on the land redistribution level in a P-equilibrium:

$$r_{-i}^{P*} = \frac{T_{-i} - T_i + \sqrt{cn(T_i + T_{-i})}}{2n} > 0 \tag{14}$$

Only if condition (13) is fulfilled do both landlords provide a positive land redistribution in a P-equilibrium. Notice that for symmetric initial land ownership ($T_1 = T_2$) this condition is always fulfilled. Greater inequality in land ownership across the two landlords violates the condition. For these levels of inequality, a P-equilibrium may exist in which only the larger landlord redistributes land.

M-equilibrium: no land redistribution
A M-equilibrium is defined as a pair (r_i^{M*}, r_{-i}^{M*}) satisfying the following two conditions:

$$\begin{cases} U_i(r_i^{M*}, r_{-i}^{M*}) \geq U_i(r_i, r_{-i}^{M*}) \quad \forall r_i,\ i \in \{1, 2\} \\ r_1^{M*} + r_2^{M*} < w \end{cases} \tag{15}$$

There exists no profitable deviation in terms of land redistribution, and total redistribution makes migration always superior to farming. By using (11.2) we can conclude directly that the second condition will necessarily hold if the first one is satisfied since $r_1^{M*} + r_2^{M*} = 0$.

The following proposition establishes equilibrium existence:

[6] In the remainder of the paper we adopt the following notation: U_i^{P*} denotes the utility of i in a P-equilibrium when such an equilibrium exists, r_i^{P*} is the redistribution value such that $r_i^{P*} = r_i^P(r_{-i}^{P*})$. Similarly, U_i^{M*} denotes the utility of i in a M-equilibrium when such an equilibrium exists, and r_i^{M*} is the redistribution value such that $r_i^{M*} = r_i^M(r_{-i}^{M*})$.

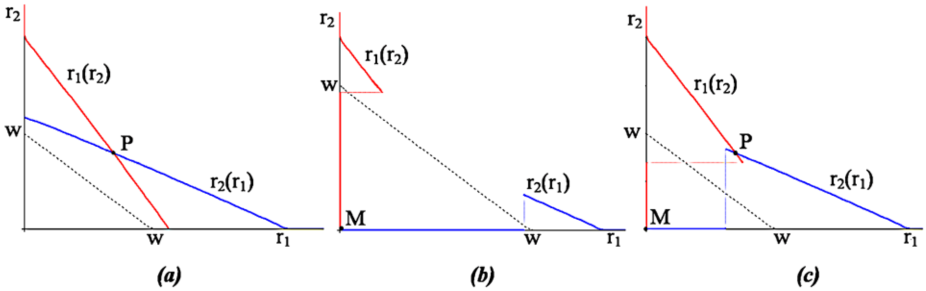


Fig. 2 Equilibrium configurations

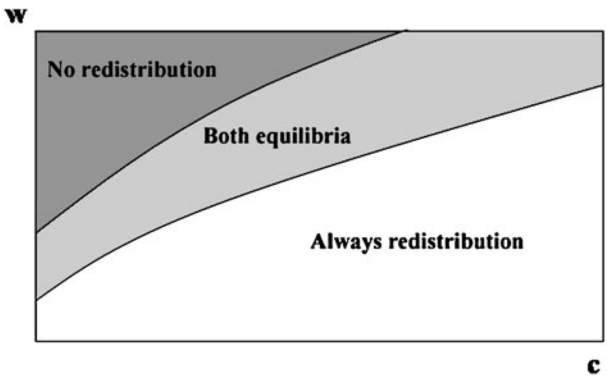


Fig. 3 Equilibria—a simulation

Proposition 1 *A P-equilibrium exists if and only if* $U_i^{P*} \geq U_i(r_i^{M*}, r_{-i}^{M*})$, *with* $T_i \geq T_{-i}$. *If a P-equilibrium does not exist, then a M-equilibrium exists.*

The two pure strategy equilibria may combine yielding three different equilibrium configurations: a P-equilibrium, a M-equilibrium, or the co-existence of both equilibria. On Fig. 2 we have drawn the landlords' redistribution reaction functions for different parameters of the model.

The downward sloping line ww represents all combinations of r^1 and r^2 such that total redistribution equals w. Any redistribution level lying below ww will not induce any unemployed individual to become a farmer as migrating would guarantee a larger payoff. Low wage rates (w), together with relatively large costs of defense (c) always result in positive land redistribution at equilibrium, as depicted on Fig. 2a. On the contrary, high wages and low costs of defense make redistribution a non-profitable option for landlords, and are thereby always associated with the M equilibrium alone (Fig. 2b). Lastly, for intermediate values of the parameters, both equilibria co-exist as shown on Fig. 2c. To help the reader visualize the realization of the three equilibrium configurations, we report on Fig. 3 the results of a simulation for symmetric land ownership ($T_1 = T_2$), where w and c vary in the range of admissible values.

In the next section we conduct comparative statics to highlight the effects of land inequality.

3 Effect of inequality

For the purpose of this section, it is useful to report the utility of landlord i in the three potential equilibria. Using (11), and r_1 and r_2 as given by (14) we obtain i's utility in a P-equilibrium with both landlords redistributing positive amounts of land.

$$U_i^{P*} = \frac{(\sqrt{T_i + T_{-i}} - \sqrt{cn})^3}{2\sqrt{T_i + T_{-i}}} \tag{16}$$

If condition (13) is fulfilled, then $r_{-i}^{P*} = 0$. By (11) and (11.1) we obtain i's utility in a P-equilibrium:

$$U_i^{P*} = \frac{5cn}{2} + T_i - \sqrt{cn(cn + 8T_i)} + \frac{(cn)^{3/2}}{\sqrt{cn} - \sqrt{cn + 8T_i}} \tag{17}$$

Finally, using (11) and (11.2) we obtain:

$$U_i^{M*} = \frac{T_i\,(w - c)^2}{w^2} \tag{18}$$

We model inequality in land ownership by increasing landlord i's land, keeping fixed total land T. We represent landlord i's share of total land by τ. In other words we run comparative statics by varying τ between $1/2$ (symmetric land ownership), and 1 (highest inequality).

A first result of this exercise is presented in the following proposition.

Proposition 2 *Total land redistribution can be non-monotonic in land inequality.*

Proposition 2 focuses on values of parameters for which a P-equilibrium exists under symmetric land ownership. When increasing τ, the utility of i in the P-equilibrium as displayed in (16) remains constant. This results from two offsetting effects. On the one hand i's utility increases as a result of having more land. On the other hand, however, as the other landlord's plot is smaller than in the symmetric case, the rebel group has an incentive to reallocate some fighters against i. This, in turn, pushes the smaller landlord to reduce his land redistribution. Indeed, in our model land redistribution may be interpreted as a public good, as it reduces *for both landlords* the number of fighters in the rebel group. The smaller the landlord, the smaller the share of public good enjoyed, the lower the individually optimal land redistribution. As a consequence, i's optimal redistribution increases, thereby reducing his utility.

If no land redistribution occurs, i's utility as reported in (18), increases in τ. Indeed, the increment in land is only partially offset by the increase in fighters looting i's land.

We plot (16) and (18) in Fig. 4. On the x-axis τ ranges from $1/2$ to 1. On the y-axis, i's utility is reported. The flat dashed line illustrates (16), while the positively sloped solid line stands for (18).

From the above discussion it follows that increasing inequality in land ownership makes it more likely for the larger landlord not to redistribute. Proposition 1 shows that whenever the larger landlord finds it optimal not to redistribute, the smaller landlord does not redistribute either. In Fig. 4, $\tau = \tau'$ depicts the land inequality level, for which landlord i is indifferent between redistributing or not. For values of τ slightly larger than τ', no landlord redistributes land.

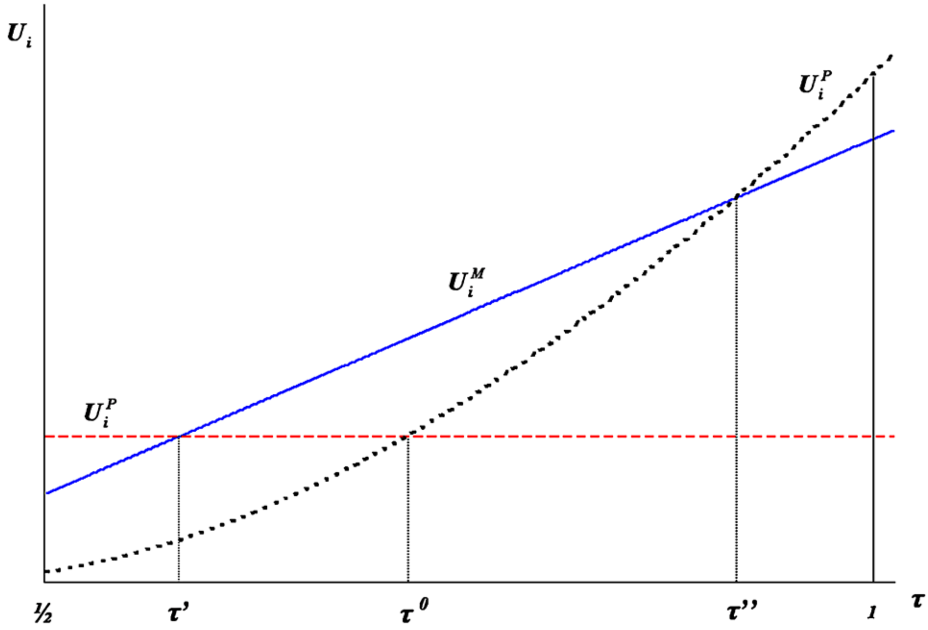


Fig. 4 Utility of modifying inequality in land ownership

Interestingly, land redistribution decreasing with inequality contradicts Mancur Olson's intuition, according to which public good provision increases in inequality (Olson 1965). The availability to landlords of two instruments (land redistribution and defense) serving the same purpose explains this divergence in results. In fact, as land inequality rises, the smaller landlord increasingly free-rides on the public good provision of the larger landlord. Eventually, land redistribution becomes too costly as compared to defense.

In Proposition 2 we show that if the P-equilibrium collapses for some inequality level, then it *always* exists for some larger level of inequality. Indeed, further increasing inequality makes condition (13) binding. The smaller landlord's optimal land redistribution level becomes nil irrespectively of i's behavior. For this inequality level depicted by τ^0 in Fig. 4, the smaller landlord fully free-rides on the land redistribution of i. Landlord i's utility of redistributing positive amounts of land is then given by (17) instead of (16). It can be shown that (17) is increasing and convex in τ. Indeed, when condition (13) is binding, further increasing τ implies that i enjoys larger shares of the public good, without affecting the degree of free-riding by the other landlord. This explains why i eventually finds it profitable to redistribute land on his own, thus implying the existence of a P-equilibrium.

In Fig. 4, i's utility of redistributing alone is illustrated by the convex dotted curve. In τ'', landlord i is indifferent between redistributing land or not. Any larger inequality level makes i better off by redistributing alone.

The non-monotonicity of land redistribution in inequality implied by Proposition 2 leads to the following result.

Corollary 1 *Most intense conflicts occur for intermediate levels of land ownership.*

This follows directly from Proposition 2 and Lemma 1. Recall that defense and land redistribution are substitutable instruments for coping with potential looting. More land redis-

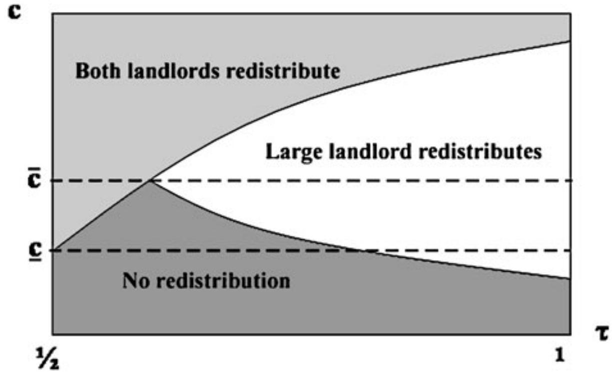


Fig. 5 Equilibria under different inequality levels

tribution reduces the pool of potential fighters, hence decreasing the optimal defense level. For intermediate levels of inequality, the burden for the larger landlord of scaling down conflict through redistribution exceeds the cost of fighting the rebels. Since the smaller landlord never redistributes on his own, conflict intensity peaks for this range of inequality.

In the above discussion we pointed out a discrepancy between our findings and Olson's intuition. The following proposition partly reconciles the two results.

Proposition 3 *Total land redistribution is greater when provided by a single landlord.*

For large land inequality, landlord i's stake in the public good is sufficiently important for his land provision to exceed any land redistribution supported by the two landlords. The Olson effect indeed prevails as soon as the cost for the larger landlord of fighting the rebels is higher than the cost of providing land on his own.

As in the previous section, we show on Fig. 5 the model's equilibria for different parameter values. On the x-axis we represent the inequality levels, whereas on the y-axis the cost of defense is depicted. The non-monotonicity of land redistribution presented in Proposition 2 occurs when the cost of defense ranges from $\underline{c}$ to $\bar{c}$. For larger costs, land redistribution is implemented at equilibrium irrespectively of the inequality level. Sufficiently low costs, finally, induce landlords to confront the fighters without redistributing land.

An interesting implication of the non-monotonicity in land redistribution is that inequality may be welfare improving. The next proposition addresses this issue.

Proposition 4 *If land redistribution is non monotonic in land inequality, then there always exists an inequality-increasing land transfer which is Pareto improving.*

Proposition 4 states that for some intermediate inequality levels, inducing no land redistribution at equilibrium, a transfer from the smaller to the larger landlord represents a Pareto improvement. It thus follows that in the absence of transaction costs both landlords agree on implementing this mutually beneficial transfer. The intuition behind this result lies once again on the public good nature of land redistribution. If the transfer induces the large landlord to start redistributing land on his own ($\tau \geq \tau''$), then the small landlord also enjoys this public good. Therefore, if the cost of the land transfer supported by the small landlord does not exceed the benefit derived from the public good, its implementation is Pareto improving. Indeed, the large landlord's utility increases in land. Moreover, unemployed individuals experience an increase in welfare as more land is redistributed. Finally, conflict intensity drops as fewer resources are wasted in fighting.

The scope and relevance of our results merit some qualifications. The next section is devoted to this task.

4 Discussion

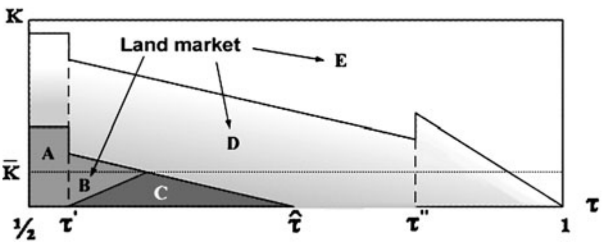
4.1 Land market

Throughout the analysis we have disregarded the existence of a land market. The assumption precluding agents from buying land from each other certainly represents a rough simplification that aims at better highlighting the model's main mechanisms. Nevertheless, credit market imperfections necessarily arise in conflict-ridden areas, thus hampering the emergence of land markets. Indeed, the value of land used as collateral in rural areas is subject to important fluctuations because of potential looting and trespassing, thus increasing the risk for financial institutions of lending capital. Rural agents consequently face credit constraints which reduce the scope for land transactions (Deininger 2003; Cotula et al. 2004). Moreover, in weakly institutionalized settings property rights are imperfectly enforced, thereby reducing the scope for land markets or even completely precluding their emergence.

To study the implications of the existence of land markets, we consider the whole array of credit supply spanning from a total absence of credit markets to perfect markets.[7] On Fig. 6 we plot, for various levels of capital supply, K, and of initial land inequality, τ, both whether or not a transaction takes place between the two landlords, and the landlords' joint utility after land transactions took place, if any.[8] For a transaction to be implemented, it must be mutually profitable. This implies that a necessary condition for a land market to exist is that the landlords' joint utility increases with the transaction. Without any loss of generality, we assume that the buyer captures all the surplus of the transaction, hence leaving the seller at his reservation utility. The landlords' joint utility is represented by the intensity of the shading, with darker colours designating lower levels of utility.

The inequality levels τ' and τ'' represent the same thresholds used throughout Sect. 3. Whenever the initial land ownership lies between those two thresholds, in the absence of any transaction no land redistribution occurs. According to Corollary 1 the landlords' *joint* utility is at its minimal level. In the absence of capital markets ($K = 0$) only voluntary transfers are

Fig. 6 Land Market



[7]Since our aim is to understand how land markets are hindered by credit constraints, throughout the present analysis we make the extreme assumption of 0% interest rates. Allowing for positive interest rates would simply widen the no-market areas, without qualitatively affecting the results.

[8]The simulation is run for the range of parameter values for which land redistribution is non-monotonic in land inequality.

possible. Proposition 4 states that such transfers always exist for $\tau \in]\hat{\tau}; \tau'']$. Accordingly, for $K = 0$, all points between $\hat{\tau}$ and τ'' in Fig. 6 belong to region D, in which a land market exists. When the initial distribution of land is sufficiently symmetric ($\tau \in [1/2; \tau']$), both landlords redistribute land conditionally on the other landlord acting likewise. The landlords' joint utility is therefore higher in region A as compared to region C. Lastly, for a sufficiently unequal initial land ownership ($\tau > \tau''$), the large landowner redistributes land on his own, and, following Proposition 3, the joint utility is larger than in area A.

Allowing for capital markets ($K > 0$) modifies the picture to some degree. Indeed, consider the situation when the landlords have access to a credit line $K \in [0; \bar{K}]$. For sufficiently symmetric initial land ownership patterns, i.e., for $\tau \in [1/2; \tau']$, the available credit is not sufficient for a land market to emerge. Notice that the only transactions that would increase the joint landlords' surplus are those increasing land inequality at least to τ''. The capital supply is, however, not sufficient to finance any of these land transactions. Similarly, in region C of Fig. 6, no transaction takes place. The available credit is neither sufficient for the large landlord to buy enough land to reach an inequality level $\tau > \tau''$, nor is it enough for the smaller landlord to purchase the necessary amount of land to establish the P-equilibrium with both landlords redistributing land (i.e., $\tau \leq \tau'$). Regions B and D present a particular interest since they permit an improvement of the landlords' joint utility, and by consequence—through the redistribution mechanism—of the society's welfare. In zone B the smaller landlord purchases the minimal amount of land allowing the P-equilibrium to emerge. Indeed by securing a sufficient level of symmetry (τ') for both landlords to find it optimal to redistribute land conditionally on the other acting likewise, total welfare is enhanced. In area D the larger landlord purchases enough land to implement redistribution on his own. For initial land inequality larger than τ'' a land market always exists, where the large landlord centralizes as much land as possible given the available credit line.

Interestingly, therefore, in the presence of sufficiently dysfunctional capital markets ($K \in [0; \bar{K}]$) the result embedded in Proposition 2, namely that land redistribution is non-monotonic in land inequality, remains valid. In the extreme case of perfect markets (perfect information, complete markets, zero transaction costs) efficiency will naturally always be achieved, thus implying that the socially optimal land ownership shares emerge endogenously (Feder 1985). In our setting this translates in full centralization of land, and the associated maximal utility is depicted in white on Fig. 6 (area E).

In summary, conflict-ridden places are likely to suffer heavily from credit market imperfections. A limited credit supply may marginally improve the society's welfare as compared to a total absence of credit. The main finding of this paper remains, however, true: land redistribution may be non-monotonic in land inequality. Should capital market imperfections be overcome despite the surrounding conflict, some of the conflict related inefficiencies would be settled through the centralization of land ownership.

4.2 Alternatives to land redistribution

In our model the only device available to landlords for reducing the pool of potential fighters is land redistribution. In reality, however, we also observe alternative tools for scaling down the intensity of land related conflicts. Indeed several alternatives may serve the same purpose: monetary transfers, wage employment, or sharecropping contracts.

The first two options are subject to commitment problems. In fact buying-off the fighters with direct monetary payments does not deter the recipients from looting the landlords. Similarly, landless individuals might keep looting landlords' properties while employed as wage laborers (for conflict related commitment problems see Fearon 1995 and Powell 2006). Moreover, when effort in agricultural production is not observable, output is characterized by uncertainty, and stealing or sabotage may occur (see, for instance, Platteau 1992: 211–213, for the example of Mauritania in the 1980s).

Sharecropping contracts partially address the commitment issues since they induce the sharecroppers to farm instead of fighting by providing them with the right incentives. Under some circumstances, however, sharecropping could have the adverse effect of creating insecure property rights for landlords. Binswanger and Deininger argue that “the fear of impending land reform prompted landowners to reduce their dependence on hired or tenant labor through large-scale eviction ... [Owners] converted their farms to undertake extensive livestock ranching, which requires very little labor” (1997: 1968).

While enabling landlords to offer sharecropping contracts certainly brings additional insights to the dynamics of land redistribution, it unfortunately makes the model intractable. If included as a fourth potential activity for the unemployed individuals, sharecropping would grant the same payoff as any other alternative selected at equilibrium. This, in turn, would affect the optimal land redistribution levels. Indeed, land redistribution exerts an upward pressure on the equilibrium payoff to the unemployed individuals, and thereby also increases the cost of sharecropping to both landlords. In other words, in this enriched setting land redistribution generates a negative externality since the higher sharecropping costs are supported by both landlords, irrespectively of the landlord redistributing.

The outcome of the interplay of these forces is certainly intriguing and worth exploring. Extending the model in this direction, however, would require major simplifications in other features of the analysis. This task is left for future research.

5 Conclusions

In this paper we investigate the relationship between land inequality, land redistribution, and conflict intensity. Because land redistribution is a public good, strategically interacting landlords underprovide it. This results in overspending on defense and inefficient fighting. We show that conflict intensity is non-monotonic in land inequality. In particular, the most severe conflicts occur for intermediate land inequality levels. In this range, the smaller landlord’s free riding may trigger a total collapse of land redistribution. For large land inequality the Olson effect prevails: the large landlord internalizes sufficiently the benefits of the public good so as to provide it on his own. Interestingly, starting from an intermediate land inequality level, a Pareto improving land transfer from the smaller to the larger landlord may exist, which induces the latter to redistribute land. The gain in utility that follows from the provision of the public good is larger than the loss incurred by the unilateral transfer of land.

Totally overcoming the inefficiencies linked to the under-redistribution of land can be achieved in two different ways. An even larger Pareto improvement would occur if the two landlords coordinated their land redistribution choices. Therefore, if a sufficiently powerful institution (e.g., a strong state) was able to coordinate the landlords’ decisions by acting as a central planner, the problem of under provision of the public good would be solved. Alternatively, full efficiency could also be achieved in the presence of land markets backed by well functioning capital markets and an absence of transaction costs. While unlikely to be observed in conflict-ridden areas, these conditions would enable a full internalization of the conflict-reducing externality.

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