# Rebel Governance and Civilian Abuse: Comparing Liberia's Rebels Using Satellite Data

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**Abstract**

Rebel groups exhibit significant variation in their treatment of civilians, with profound humanitarian consequences. This paper proposes a new theory of rebel group behavior based on resources and delegation within rebel organizations. Rebel leaders have incentives to maintain order in their territories but are constrained in their ability to control group members. Leaders establish control through spot payments and promises of future rewards to top commanders. The leader's ability to offer these incentives is determined by the group's partnerships with external patrons. The theory's implications are examined through a spatial analysis of Liberia's civil war using an original dataset derived through remote sensing methods.

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# 1 Introduction

In civil wars over the past half-century, some 18 million people lost their lives. In many of these wars, despite a Mao Tse-tung image of rebels winning hearts and minds, civilians pay the heaviest costs. When rebel groups are highly predatory, civilians struggle to gain access to food and other essentials, resulting in high levels of displacement, malnutrition, and disease. These indirect costs of war are ultimately more damaging than the fighting (Ghobarath, Huth, and Russett 2003).

But there is significant variation in the relative costs paid by civilians and those paid by soldiers during war. In Sri Lanka, for example, the ratio of civilian to soldier deaths was approximately 1:1 and the LTTE rebels created police and judiciary systems to enforce laws and protect civilian property rights;[1] meanwhile in DR Congo, the ratio of civilian to soldier deaths was more than 100:1 and armed groups indiscriminately preyed on local communities.[2] This variation raises a fundamental question regarding civil war: Why do some rebel groups create order in their territories, while others abuse and prey upon the civilian population?

Order and stability benefit rebel groups by allowing for reliable access to food, military intelligence, and new recruits. Order also facilitates large-scale resource extraction, humanitarian aid operations, and other activities. The creation of order in rebel territory hinges on the behavior of rebel commanders. Commanders control significant weapons and resources

[1]The services provided by the LTTE government do not imply that the group was accountable to the Tamil population or protected their human rights. The LTTE was highly authoritarian and silenced all political opponents—often through assassination (HRW 2008; ICG 2007). Nevertheless, civilians in LTTE territory had access to food, education, and healthcare and were arguably better off than civilians in many other conflict areas.

[2]Statistics calculated from battle death estimates in the Correlates of War (Sarkees 2000) and PRIO (Lacina and Gleditsch 2005) datasets and mortality estimates from the United Nations.

and directly monitor the behavior of soldiers. The benefits of order, however, accrue mostly to the rebel leader, who generates revenue as well as military and political leverage from stability in the group's territory. Commanders, on the other hand, might find more benefit in looting or mining than in the complex administrative tasks required to maintain order.

A rebel leader can induce cooperation from group commanders when the leader can offer spot payments and credible promises of future rewards. Future rewards include material benefits and political offices, as well as "ideological" benefits such as social and political change. When leaders cannot offer these benefits, minimal levels of cooperation are induced by allowing the commander use group resources for looting and other self-serving activities. The rebel leader sacrifices group goals and civilian welfare to stay in power.

Not all rebel leaders are capable of offering spot payments or credible promises. Spot payments require that the leader have access to financial resources, which depends on partnerships with external patrons. A leader's credibility might also depend on these external actors. A weak leader who is distrusted by the commanders can be a useful partner for an external patron that hopes to maintain influence over the group's activities. The international dimensions of civil war, through their effects on rebel organization, shape the humanitarian situation on the ground.

This theory of rebel group behavior predicts variation between rebel groups as well as variation within a group's territory. An original dataset of changes in crop area, derived from satellite images from various stages of Liberia's civil war, allows for an analysis of civilian abuse by three of Liberia's rebel groups. These rebel groups exhibited variation along key dimensions and provide a useful test of the proposed theory compared to existing theories of rebel behavior. The analysis provides support for the theory's group-level and spatial implications. For example, I show that Liberia's NPFL rebels provided enough security to

maintain farming at pre-war levels in many areas, while the predatory LURD rebels triggered declines in crop land of 30-70% throughout their territory.

The civil war literature has developed at a break-neck pace in the past decade, shifting from theoretically-informed case studies (e.g. Wood 2003) to cross-national econometric models (e.g. Fearon and Laitin 2003) to within-country spatial analyses (Humphreys and Weinstein 2006; Bohara et al 2006; Hegre et al 2009; Kalyvas and Kocher 2009). Continued progress in the field, however, is constrained by a lack of reliable, micro-level data. Studies of civil war tend to rely on media reports, post-conflict surveys, or other data that can result in misleading or improper inferences (Kalyvas 2008). Remote sensing offers an opportunity to overcome some of these limitations, providing objective, verifiable data on events of profound humanitarian significance. This paper builds on a growing literature that uses remote sensing to study political phenomena (e.g. Min 2009).

The paper proceeds as follows. Section 2 discusses existing theories of rebel group behavior. Section 3 develops a new theory based on access to resources and delegation within the rebel hierarchy. Section 4 draws on extensive fieldwork and interviews with top rebel commanders to describe the key features of Liberia's rebel groups. Three rebel organizations receive special attention: the National Patriotic Front of Liberia (NPFL), the Liberia Peace Council (LPC), and Liberians United for Reconciliation and Democracy (LURD). Section 5 describes the methods for generating and analyzing remotely sensed data and provides a quantitative test of the theory. Group-level differences are examined, followed by spatial variation in civilian abuse within group territories. Section 6 concludes.

# 2 Theories of Rebel Behavior

Much of the early literature on 20th century insurgencies was produced by the revolutionaries themselves. These writers, including Mao Tse-tung (1937), Che Guevara ([1961] 1998), and Vo Nguyen Giap (1970), emphasize the importance of civilian support and cooperation: creating systems of governance is central to the survival of rebel organizations. For decades, scholars assumed that rebel groups would behave with restraint towards civilians (Laqueur [1976] 2004: 335-7; Rice 1990: 59).

The end of the Cold War challenged this romanticized notion of rebellion and led some observers to proclaim the beginning of a new era, in which many rebel groups are simply criminal enterprises rather than political movements with legitimate grievances and ideologies (e.g. Kaplan 1994). This faulty distinction, however, emerged from incomplete and biased information, rather than a substantive change in rebel group behavior (Kalyvas 2001). Throughout history, rebel groups have been known to abuse and prey on civilians.[3]

Rather than focusing on the ideology, or lack of ideology, among rebel groups, recent theories of rebel group behavior focus on the incentives and constraints of rebel organization. These theories can be divided into four categories based on their primary explanatory variable: territorial stability, ethnic homogeneity, adverse selection, and environmental factors.

## 2.1 Territorial Stability

Territorial stability affects both the economic and military incentives of rebel groups. Economically, rebel groups have an incentive to create order and protect civilians in their areas if the expected revenue from taxation exceeds the expected value of looting (Olson 1993).

[3]For example, civilian abuse was rampant among certain militias during the American Civil War (Kalyvas 2006: 108) as well as among royalist forces during the English Civil War (Carlton 1998).

In unstable areas a rebel group has no incentive to create order because this restraint simply creates looting opportunities for rival groups.[4] Militarily, unstable areas prevent rebel groups from acquiring information on government collaborators and other threats while also making cooperation less attractive for the civilians. Mass violence, rather than selective punishment, is used to deter civilian defection (Kalyvas 2006). These theories imply the following hypothesis:

> $\boldsymbol{H_1}$: Greater stability is associated with lower levels of civilian abuse.

## 2.2 Ethnic Homogeneity

Ethnic groups embody pre-existing social and authority relations. By defining who is eligible to receive benefits, ethnicity helps create patron-client networks that secure stable bases of support (Bates 1983; Fearon 1999). Ethnic homogeneity also facilitates the spread of information and serves as a coordination device (Fearon and Laitin 1996; Hayarimana et al 2009). As a result, ethnic homogeneity facilitates monitoring and control within a rebel group. In their study of Sierra Leone, Macartan Humphreys and Jeremy Weinstein (2006) find that ethnically homogenous rebel units were less likely to abuse civilians than ethnically-mixed units. Ethnic ties with the local communities also strengthen a group's incentives to protect civilians through these social mechanisms (Humphreys and Weinstein 2006). Ethnicity-based theories imply the following hypotheses:

> $\boldsymbol{H_2}$: More homogeneous rebel groups—or more homogeneous units within diverse groups—commit lower levels of civilian abuse.

[4] Jean-Paul Azam (2002) presents a model of competitive looting that captures this dynamic.

$\boldsymbol{H_3}$: Greater ethnic ties with the local community results in lower levels of civilian abuse.

### 2.3 Adverse Selection

Personal characteristics of rebel members also shapes group behavior. Jeremy Weinstein (2007) argues that rebel groups with access to economic resources attract opportunistic recruits who are driven by short-term goals. These recruits are difficult for the rebel group to control and are more likely to abuse civilians. Rebel groups that lack resources rely instead on appeals to shared identity and attract committed, disciplined recruits. This theory implies the following hypothesis:

$\boldsymbol{H_4}$: Greater dependence on economic resources results in higher levels of civilian abuse.

### 2.4 Environmental Factors

Factors outside of the rebel organization affect the group's incentives to create order. Competition with the government or other armed groups may encourage the rebel group to abuse civilians as a way of attracting recruits (Azam 2006). Civilian abuse may also result from rebel groups attempting to prove their commitment to external patrons (Hovil and Werker 2005). These theories, however, do not offer generalizable predictions of rebel group behavior.

## 3 Resources, Delegation, and External Patrons

Existing theories of rebel group behavior ignore the role of incentives and delegation within rebel organiztaions. For example, theories of territorial stability focus on how instability

reduces the economic and military incentives to create order. But instability also makes monitoring and controlling rebel members more difficult for rebel leaders. Rather than exerting control over their members, rebel leaders might use unstable areas as a means of rewarding commanders and soldiers without jeopardizing the governance structures in more stable areas.

In a similar way, theories of ethnic homogeneity and adverse selection ignore the role of commanders in recruiting, training, and deploying rebel forces. Military training, if done properly, largely overcomes the problem of adverse selection. Military organizations such as the United States Marines can take nearly any young man off the street and transform him into a soldier, with all the right reflexes and attitudes, within a matter of weeks (Dyer 2005). By creating soldiers who identify with the group and their comrades, military organizations can induce high levels of commitment and effort with few external incentives (Akerlof and Kranton 2005). And commanders can reap the benefits of ethnic social networks even in diverse rebel groups by deploying soldiers in homogeneous units.

Control within the rebel group begins and ends with the actions of commanders. To control soldiers, rebel commanders must set up rigorous training and socialization programs and organize systems of food distribution that do not rely on looting the surrounding population. Commanders also have access to resources and manpower that can be used for personal enrichment at the expense of group goals. A commander who controls a diamond field, for example, might be tempted to keep the diamonds rather than hand them over to the rebel leader. The question then becomes: How do rebel leaders control their commanders?

## 3.1 Controlling Commanders

Commanders operate autonomously and do not respond to the intense social pressures that motivate soldiers in small, tight-knit groups. Instead, commanders must be motivated by individual sanctions and incentives. Rebel leaders have three tools for controlling commander behavior: punishment, spot payments, and promises of future rewards.[5] Punishment might include expulsion, imprisonment, or execution. Because rebel groups are inherently violent organizations, all rebel leaders can threaten some form of punishment. Variation between groups arises instead from the leader's ability to offer spot payments and future rewards.

### 3.1.1 Spot Payments

Spot payments operate in the same way as salaries or performance-based bonuses in business firms. By providing money to commanders, rebel leaders can encourage commanders to deploy their weapons and manpower towards achieving group ends, rather than personal profit. The effectiveness of these spot payments depends on the commander's opportunity cost for following orders. Ceteris paribus, higher payments are required to induce commanders to undertake actions that involve higher levels of effort or greater risk.

The resources available in the group's territory also affect the efficacy of spot payments. A commander with authority over an area that contains valuable goods or easily exploitable resources requires higher payments, ceteris paribus, than a commander in a low-value area. When extremely valuable lootable resources are involved, such as alluvial diamonds, exerting

[5] One might argue that commanders could be motivated by a desire for social status or a commitment to an ideology. Both of these motivations, however, are contingent on the formal incentive structures of the group. For example, a rebel commander will only gain status from society if the rebel group has a reputation for discipline or beneficial behavior. Status as a motivation, therefore, depends on the commander's expectation that the leader can control *other* commanders in the group. In a similar way, a commander might want to achieve some social or political change related to an ideology. Ideology, in this sense, is a promise of future rewards. Ideology can only serve as a motivation device if the leader's promises are credible.

a high-level of control over commanders in the resource areas becomes nearly impossible. The rich alluvial diamond fields in Sierra Leone, for example, exacerbated tensions within the RUF rebels. In 1999 RUF leader Foday Sankoh accused his top commander, Sam Bockarie, of stealing diamonds, sparking an armed confrontation that killed several RUF members (UNSC 2000b: 17).

Spot payments also depend on monitoring. The leader has little incentive to reward a commander when the leader cannot verify whether the commander followed orders. For example, if a commander failed to capture a certain town, the leader cannot be sure that the commander failed because of unforeseen circumstances or because he was looting rather than engaging the enemy. Additionally, commanders have little incentive to control their troops in remote areas, far from the leader's view. When leaders rely heavily on spot payments, the ability to control commanders is limited to areas where the leader can effectively monitor the behavior of rebel members. The importance of monitoring implies that control based on spot payments will be most effective near rebel bases and in populated, easily accessible areas.

To provide spot payments, the rebel leader must have independent access to financial resources. The leader must be able to provide funds to the rebel commander that the commander would not be able to access on his own by looting or breaking off from the group. The UNITA rebels, for example, controlled nearly all of Angola's Kimberlite diamond deposits during 1992-7. The largest mining operation in UNITA territory was run by the Cuango Mining Corporation and used teams of specially trained divers to strip the Cuango river of its underwater deposits. UNITA provided security for this and other operations in exchange for a 50% share of the revenue, which amounted to hundreds of millions of dollars per year (UNSC 2000a: 40-1). Renegade UNITA commanders might have earned

some money by looting the mining company's equipment, but this revenue would pale in comparison to the finances controlled directly by Jonas Savimbi, the group's leader.

### 3.1.2 Future Rewards

Civil wars end either through military victory or negotiated settlement. Unless defeated, a rebel leader will have some ability to allocate positions in a post-conflict government. A top rebel commander, therefore, might expect to earn a position in the government or military, or gain access to lucrative commercial opportunities in the post-conflict period. Alternatively, commanders might hope that the rebel group will implement ideologically-driven policies for social and economic change, once the group assumes power. The extent to which these future rewards motivate commander behavior depends on the credibility of the rebel leader's promises. A top commander might hope to become Minister of Defense, but the rebel leader could instead appoint a family member or political crony to the position.

The credibility of the leader's promises is determined by the relationship between the commander and the leader, and on the commander's relative strength in the group. A commander with family or social ties to the rebel leader has more reason to trust the leader's promises of a position in the post-conflict government than a commander who lacks such a connection. Personal affinity, therefore, is an important aspect of leader-commander relations. Alternatively, credibility can be established through the threat of force. A powerful commander has the ability to break from the group and scuttle a peace agreement. If the leader hopes to reap the benefits of a post-conflict government, the leader must provide a sufficient reward to convince the commander to lay down arms. By providing sufficient weapons and manpower to certain commanders, leaders increase the credibility of their

promises.[6]

## 3.2 External Patrons

Control within rebel groups depends on a leader's ability to provide spot payments and credible future rewards. Not all rebel leaders, however, have access to the financial resources necessary for spot payments or the social ties for credible promises. Rebel groups cannot rely on credit markets or bank loans to generate cash reserves. Local taxation might supplement a group's income but cannot form the basis for effective control. The commanders responsible for collecting taxes would benefit more by keeping the taxes for themselves unless the leader can induce them to cooperate through other means. Revenue for spot payments must be generated through partnerships with external patrons such as resource-extraction corporations, foreign governments, or diaspora communities.

External patrons supply cash to rebel groups when they have a commercial relationship with a group, have an incentive to strengthen control in the group, or both. Resource-extraction firms provide an example. Suppose an iron mining firm could profit by exporting iron ore from rebel territory. The firm is willing to pay royalties on the iron extracted, but also has a need for security. If a rebel group cannot control its members, the firm's operations would be threatened by looting and extortion. By providing cash to the rebel leader, the firm not only gains the opportunity to extract iron but also strengthens the rebel leader's ability to control his troops and provide security for the firm's operations.

[6]The importance of commander threats leads to an interesting implication: The announcement of a peacekeeping operation should be followed by a rise in civilian abuse in the rebel areas—but only among rebel groups in which the leader and commander do not share personal ties and the leader cannot induce compliance through spot payments. Peacekeeping missions reduce the commander's ability to break from the rebel group and weakens his leverage vis-à-vis the rebel leader. This decrease in commander bargaining power reduces the pressure on the rebel leader to reward commanders when peacekeepers are present. Consequently, the credibility of the leader's promises decreases and control becomes more difficult.

External patrons—especially foreign governments—also shape the credibility of the leader's promises by influencing which individuals become rebel leaders. Foreign governments have access to the military supplies and logistics necessary for reliable, large-scale weapons shipments that are vital for participating in civil war. Without external support, few rebel groups emerge from obscurity.[7] Considering this, many rebel groups select their leaders based on the external support the leaders bring with them.[8] Sudan's SPLA rebels, for example, selected John Garang as their leader because of his links with the Ethiopian government, even though other candidates had stronger ideological credentials and more support from group members (Arop 2006: 67-75).

Not all external patrons have an incentive to provide financial resources or support leaders who are trusted by their commanders. A foreign government, for example, might simply want to destabilize a neighboring state. Providing weapons to a rebel group is sufficient for starting an insurgency; no cash is required. The patron benefits little from the discipline of the rebel group, so long as the war continues.[9] Even patrons with more sophisticated policy objectives may not have an incentive to support strong leaders or provide funds for spot payments. By providing just enough support to keep the leader in power, the external patron ensures that the leader will continue to obey the patron's orders in the future, even as the rebel group becomes more powerful. If the patron ever withdraws support, the

[7]Statistics on state support for insurgencies provides some indication of the importance of external patrons. Of the 331 non-state armed groups that were active during 1945-2003 (excluding coups) according to the EACD dataset, 146 groups (44.1%) received military assistance from a foreign government (Cunningham et al 2009). RAND's (2001) survey of insurgent movements finds that 44 of the 74 rebel groups (59.5%) active during 1991-2000 received state support that was crucial for their survival. These figures ignore the role of corporations, arms dealers, and other economic actors in civil war.

[8]Alternatively, one could imagine this as a selection bias in the observed characteristics of rebel groups. Groups that form and grow into a rebellion tend to be headed by leaders that can attract external support. Groups that are not headed by such leaders do not grow into rebellion and remain unobserved.

[9]This dynamic is explored in Hovil and Werker (2005).

leader would be immediately overthrown. In this situation, weak leaders who are distrusted by their commanders are ideal partners.

## 3.3 Implications

When control fails, rebel groups engage in high levels of civilian abuse. Effective control within a rebel group depends on the leader's ability to make spot payments and credible promises to the top commanders. These inducements, in turn, depend on the objectives of external patrons. The primary implication of this theory is as follows:

> $\boldsymbol{H_A}$: Civilian abuse is lower in groups in which the leader has greater access to financial resources and/or can make more credible promises to the top commanders.

The theory also implies a spatial variation to civilian abuse. When leaders cannot effectively control their top commanders, rebel members engage in predatory activities. Among these groups, civilian abuse will be higher in areas with higher concentrations of rebel members:

> $\boldsymbol{H_B}$: Civilian abuse is higher near rebel bases for groups in which the leader has limited access to spot payments or credible promises.

But when leaders have access to financial resources, the effectiveness of spot payments depends on the ability to monitor the behavior of rebel members. This implies an opposite prediction to the above:

> $\boldsymbol{H_C}$: Civilian abuse is lower near rebel bases for groups in which the leader can make regular spot payments to the commanders.

The presence of lootable resources also affects control within rebel groups. The opportunity cost of following orders depends on the commander's access to resources in his territory. Commanders will be less inclined to follow orders when they can reap large profits through looting, mining, or other non-military activities:

$\boldsymbol{H_D}$: Civilian abuse will be higher in areas that contain lootable resources.

The following sections examine Liberia's rebel groups with respect to existing models and the theory proposed here.

# 4 Liberia's Rebel Organizations

On Christmas Eve, 1989, some 100 rebels crossed into Liberia from Côte d'Ivoire and captured the border town of Butuo. The soldiers aimed to overthrow the military dictatorship of Samuel Doe and were led by Charles Taylor, a former government official who had secured the backing of Libya, Burkina Faso, and Côte d'Ivoire. The National Patriotic Front of Liberia (NPFL), as the group was called, rapidly advanced across Liberia, gaining momentum as new recruits swelled its ranks and government forces collapsed. Six months after the invasion began, Charles Taylor's NPFL controlled more than 80% of Liberia, including Liberia's second-largest port, Buchanan, and all of Liberia's iron ore and timber resources. Nearly all of NPFL's top commanders shared ethnic ties. But below the top level of the organization, the NPFL's units were extremely diverse.[10]

Even before invading Liberia, Charles Taylor established relationships with leading Ivorian, French, and Lebanese business people (Ellis: 1999: 89). By late 1990, capital-intensive resource extraction was up and running in Taylor's Greater Liberia. The Liberian

[10] James Pugel's (2007) survey of ex-combatants provides some indication of this diversity.

Minerals Company (LIMINCO) reportedly paid Charles Taylor $10 million per month for the opportunity to extract and export iron ore from NPFL territory (Reno 1998: 100).[11] Another mining operation in Nimba County netted Taylor about $80,000 per month (Ellis 1999: 164; Reno 1998: 100). During 1992 alone, logging firms removed an estimated 200,000 cubic meters of hardwood, valued at $20 million, from NPFL territory (Reno 1998: 97). From late 1990 through 1993, Charles Taylor generated revenues estimated at $75-250 million per year.[12]

From his headquarters in Gbarnga, Charles Taylor ordered his troops to protect civilians and encourage market activity. Taylor often gave stern speeches to his commanders and warned against harassing civilians (C26).[13] Civilians held the key not only to NPFL's food supply, but also to Taylor's legitimacy as a leader. Foreign firms could justify their business with Taylor only if Taylor maintained the appearance of a responsible leader (Reno 1998: 102). A large civilian population in NPFL territory also gave Taylor more leverage during peace negotiations.

Other rebel groups emerged in the 1992-93 period to challenge the NPFL's dominance of the Liberian countryside. Most of these rebel groups received weapons from the West African peacekeeping mission (ECOMOG) in exchange for coordinating their military activities with the peacekeeping forces. One of these groups, the Liberia Peace Council, was composed almost exclusively of ethnic Krahn soldiers and commanders (C42). Although the

[11] This figure, which is also cited by Liberia's Truth and Reconciliation Commission (TRC 2009: Vol. III, Title III, par. 83) and Pham (2004: 122), derives from a report by the Economist Intelligence Unit in 1992. The reliability of this figure is questionable, but the estimate remains the best available.

[12] The lower estimate of $75 million per year comes from congressional testimony from William H. Twaddell, Acting Assistant Secretary of State for African Affairs (USDS 1996) and is reproduced in Ellis (1999: 90-1). Scholar Will Reno (1998: 99) surveys the available secondary sources to produce the high estimate of $200-250 million per year.

[13] Interviews are cited by letter and number. See the Appendix for a description of each informant cited.

LPC seized control of rich timber areas, the group failed to develop any partnerships with foreign firms. To purchase ammunition from the peacekeepers, the group looted machinery and engaged in ad hoc trade in rubber and gold (C42; Ellis 1999: 167; Reno 1998: 105). Although relatively small in size, the LPC quickly gained a reputation for terrorizing civilians in its territory (TRC 2009).

Unlike the other rebel leaders, Charles Taylor provided cash payments to his top commanders as reward for following orders. Payments of $10-25,000 in cash were not unusual (C19). Commanders could also keep any revenue they earned through taxation, although they were expected to share some of these funds with their soldiers. NPFL commanders who abused civilians and failed to control their soldiers were removed from stable areas and either punished or transferred to the frontline, where looting was less damaging to the group (B43, C08, C24, C39). Top NPFL commanders could also expect to benefit after the war. When Charles Taylor was elected president in 1997, two of his top four commanders received high-level positions in the Liberian armed forces; the other two commanders received lucrative commercial contracts (C15, C24). Lower-level commanders also received positions in the civil service (C26, C27).

Soon after Taylor took office as president, Liberian exiles in Guinea and Sierra Leone began seeking support to overthrow his repressive, although democratically elected, regime. Guinean President Lansana Conté eventually became sympathetic to the exiled Liberians' goals and began providing limited weapons and ammunition to the Liberian dissidents. Prominent Liberians competed with each other to lead the nascent rebel organization, but were eventually forced to accept Sekou Conneh—a former used car salesman with no political or military experience—as their chairman. Conneh was married to the spiritual advisor of the Guinean president, and President Conté had insisted on Conneh as leader if the group

hoped to receive any military assistance. After several false-starts, LURD expanded beyond its headquarters in Voinjama in 2002 and captured much of northern Liberia. Although the leadership and top commanders were mostly ethnic Mandingo and Krahn, LURD units were composed of individuals from a variety of ethnic backgrounds (Pugel 2007).

LURD captured areas rich in timber, rubber, and other resources, but failed to form any partnerships with foreign corporations. Almost immediately after LURD's invasion, a series of incidents in which LURD soldiers looted property and machinery forced all companies to cease operations in LURD areas (UNSC 2003a: 13). LURD territory also included diamond fields, and LURD soldiers immediately went to work shoveling gravel and sifting for diamonds. Diamond revenue would have provided LURD with greater autonomy from Guinea (UNSC 2001: 34). The LURD leadership, however, could not gain control over the diamond trade and worried that diamond mining would distract their troops from fighting. Senior LURD officials issued a ban on diamond mining in LURD territory, but this did little to discourage the motley crew of soldiers and civilians in the diamond fields (B48, C30, C32; ICG 2002: 7; Brabazon 2003). This mining, however, remained small-scale and relatively insignificant.

With no money or food provided by the organization, LURD soldiers and commanders preyed on civilians. LURD members stripped buildings of their zinc roofs and electrical wiring, and looted anything of value. Facing severe food shortages, the LURD leadership in Voinjama attempted in mid-2001 to protect civilians. LURD soldiers began to receive a "political education" that stressed the necessity of avoiding civilian casualties. At least one LURD soldier was executed for killing a civilian, and forums for hearing local grievances were created. This period of restraint was brief, however, and by the end of 2001 human rights violations were again commonplace (ICG 2002: 9-10).

A high level of distrust characterized the LURD organization, and top commanders knew that Sekou Conneh's promises were not credible. In advance of LURD's invasion of Monrovia in June 2003, Sekou Conneh ordered the Guinean military to arrest the group's top commander, Prince Seo, because Conneh feared the commander would become too powerful if the capital city fell into LURD hands (C2). After Charles Taylor was forced from power, Sekou Conneh filled LURD's positions in the transitional government with family relatives and cronies; none of LURD's top commanders received positions in the post-war government.

# 5 Quantitative Analysis

## 5.1 Remote Sensing and Civilian Abuse

The Liberian conflict produced countless stories of atrocities, but few data exist that can provide a systematic picture of civilian abuse. Satellite imagery collected during the conflict, however, can shed light on the situation on the ground. Crop land is a suitable proxy for civilian abuse because the incentive to clear crop land depends on the security of the surrounding area: a farmer will not spend the energy to clear land if he expects his crops to be looted upon harvest—or if he might be killed or displaced in the meantime. Higher levels of civilian abuse and insecurity will be correlated with larger decreases in crop area.

Analyzing crop area in a country such as Liberia presents certain challenges. First, the majority of Liberians outside the capital city depend on small-scale, subsistence agriculture which can be difficult to identify in a satellite image. Second, Liberia experiences nearly constant cloud cover, which makes it possible to obtain satellite images only during the brief dry season (January-March). Third, crop land can be difficult to distinguish from the surrounding vegetation, or from cleared areas such as villages, roads, and sports fields.

Fortunately these challenges can be overcome. Two satellite programs, LANDSAT and SPOT, provide images with 20-30m resolution—sufficient for identifying the small fields. Further, the dry season (when all cloud-free images are collected) is the time when farmers slash and burn the areas they intend to plant, making crop land easily identifiable against the surrounding vegetation. And because farmers clear the land before the first rains of the season, measuring cleared land has the added advantage of being insensitive to annual variation in rainfall or other climatic events. Finally, new land is cleared each year in an eight-year fallow cycle. Layering multiple satellite images highlights changes in land use and allows the shifting crops to be easily identified and measured.

To measure changes in crop area in NPFL territory, I compare four LANDSAT images from January 1991 to four images of the same region from January 1986. The coverage area includes neighboring agricultural areas in Guinea and Sierra Leone, which provide a comparison. Figure 1 depicts the coverage area for NPFL territory. LURD territory is covered by three LANDSAT images from March 2003, which are compared to three corresponding images from February 2001. Figure 2 depicts the coverage area, which covers all of LURD territory, as well as large tracts of government territory and neighboring areas of Guinea and Sierra Leone. Four SPOT images, two from January 1993 and two from January 1995, are combined with the LANDSAT images to provide additional information on a small but significant area of Liberia, depicted in Figure 3. These data provide information on changes in crop area in LPC territory, as well as a robustness check by examining NPFL territory over time.

For each image, a certain number of pixels are classified manually by the researcher.[14]

[14] A typical image might contain 12-30 classes, including, for example, "forest", "dark forest", "river", "road", and so on.

These “training pixels” provide the input necessary for computer software such as ENVI to categorize the remaining pixels in the image based on maximum likelihood estimators. The resulting classified image is then adjusted iteratively until no major errors can be determined through inspection (CI 2006). The classified image provides a simple raster dataset that allows for crop area measurements in a GIS.

Assessing the accuracy of classification images is a vital part of land-use research and the subject of a large literature in the earth sciences (for an overview see Foody (2002) and Stehman and Czaplewski (1998)). Best practices involve selecting a random sample of pixels from the classified image and then comparing them manually to the original images (Hess and Bay 1997). This process allows for an accurate assessment of measurement error for the image as a whole. Unfortunately, accuracy assessments can be misleading because errors in crop measurements may be spatially concentrated. Error propagation caused by these issues continues to pose a fundamental challenge to spatial analyses (Haining 2003: 126).

For this project, 600 randomly-selected pixels were manually assessed for each pair of LANDSAT images and 300 random pixels were assessed for each pair of SPOT images, stratified between crop and non-crop areas. These error matrices were then used to estimate crop areas, standard errors, and statistical significance using bootstrap simulations (B=100,000). One downside of this method is that the measurement error for the entire image is used to estimate crop area at lower levels of aggregation, such as the village level. This extrapolation is not ideal but provides a better estimate than the raw measurements, which have known biases.

## 5.2 Group-level comparisons

Group-level comparisons are a useful starting point for a quantitative look at the competing theories. Theories of adverse selection predict that some groups, especially those with access to economic resources, are dominated by opportunistic members who are more likely to abuse civilians. In Liberia, only the NPFL had access to any significant economic resources, though all of the rebels groups offered the opportunity to loot. Adverse selection, therefore, predicts that the NPFL committed at least as much civilian abuse as LURD or LPC. Theories of ethnic heterogeneity would expect high levels of abuse from the NPFL and LURD, both of which were ethnically diverse, and less abuse from the homogeneous LPC rebels. By contrast, the theory of organizational control, proposed here, predicts that the NPFL committed lower levels abuse than either LURD or LPC, due to Charles Taylor's access to financial resources and credible promises. Figure 4 summarizes these predictions.

Between 1986 and 1991, crop area is estimated to have increased 4.8% in the NPFL areas covered by the study area. This difference, however, is not statistically significant ($p = 0.35$) when compared to the null hypothesis of no change in crop area.[15] Crop area in neighboring regions of Guinea remained constant with 0.0% change during this period, while crop area in neighboring regions of Sierra Leone decreased 16.1% ($p = 0.09$).

The situation in LURD areas between 2001 and 2003 was dramatically different. Overall crop area decreased by 37.1%, which is significant at $p = 0.028$. Neighboring regions of Guinea, where LURD forces were also active, decreased by 38.9%, while neighboring government-controlled areas decreased by 34.6%. Crop area in neighboring regions in Sierra Leone—where a decade-long civil war ended in 2002—increased by 120.9% during this period.

[15] The significance values are best interpreted as the probability that the difference in crop area is purely the result of measurement error.

Crop area declined more in LURD territory than in NPFL territory, but these data do not necessarily imply that LURD was more abusive than NPFL. The declines in LURD territory could be caused by larger, systemic forces that were also responsible for the large declines in neighboring government areas and in Guinea. Rather than LURD abuse, the declines in crop area could be caused by instability and fighting. For example, crop area in relatively stable government-controlled areas such as Bong County declined by only 6.2% during this period ($p = 0.33$). Unstable government areas, such as Nimba County, experienced 45.8% declines in crop area ($p = 0.008$). The effects of instability are also apparent in LURD territory. LURD struggled to maintain control of the areas around Zorzor, in Lofa County. Between 2001 and 2003, crop area in this region declined by 65.7% ($p = 0.0004$). But even in stable LURD regions, crop area declined 30-40% or more, which suggests that LURD abuse was significant throughout its territory.

Although fewer data are available for the LPC rebels, some comparisons can be made. The study area depicted in Figure 5 was controlled by the NPFL until 1994, when the LPC captured part of the region. Between 1991 and 1995, crop area declined 18% in LPC areas ($p = 0.396$) while neighboring NPFL areas benefitted from an increase of 30.8% ($p = 0.237$). Due to the poor quality of the images, however, this difference could be explained by measurement error ($p = 0.240$).

The group-level comparisons are suggestive, but do not necessarily support the theory proposed here. Any number of potential theories could offer an explanation for the lower declines in crop area in NPFL territory. The data are consistent with theories of territorial stability, although it is unclear whether the decline in crop area in unstable regions was caused by displacement due to fighting, mass violence to deter civilian defection, shortened time horizons, or loss of control within the rebel organizations.

## 5.3 Within-Group Spatial Variation

To measure within group variation, crop area is aggregated at the village level by constructing Thiessen polygons around villages identified during the 2008 census.[16] The dependent variable is a log ratio of crop area in $t_1$ to crop area in $t_0$ for each village. Figure 6 depicts the change in crop area in NPFL and LURD territories.

The theory of rebel group control has several spatial implications. Rebel leaders with finances or credible promises are able to control their subordinates, but this control depends on effective monitoring. Civilian abuse, therefore will be lower near rebel bases—especially the rebel headquarters—and in other, easy-to-monitor locations. By contrast, when leaders cannot control their subordinates, civilian abuse will be *higher* near rebel bases due to the higher concentration of predatory rebels. Abuse will also be higher in areas that contain lootable resources such as alluvial diamonds or rubber and in unstable areas.

As a first-cut towards assessing this spatial implication, imagine that a rebel group's territory can be divided into two zones, a "close" zone where effective control is possible and a "far" zone beyond the view of the rebel leader. When rebel leaders can exercise control, we expect to see smaller declines in crop area in the close zone than in the far zone. For groups that cannot exercise control, we expect larger declines in crop area in the close zone than in the far zone. At the most basic level, the close zone can be defined by a cutoff distance from the rebel headquarters. For example, if the cutoff point is 30km, all villages within 30km of the rebel headquarters are considered "close" and all villages beyond 30km are considered

[16] Very small settlements were combined with larger neighbors to ensure that all villages are separated by at least 500 meters. Village locations did not change significantly in Liberia between the pre- and post-war periods, so the data do not suffer from selection bias due to destroyed or newly-formed settlements.

"far".[17] This relationship can be estimated with an OLS model:

$$y_i = \beta C_i + \gamma \boldsymbol{x}_i + \epsilon_i$$

The dependent variable is the log ratio of crop area in $t_1$ to crop area in $t_0$ for village $i$. $C_i$ is a binary variable that equals 1 if village $i$ is in the "close" zone and $\boldsymbol{x}_i$ is a vector of control variables. To keep the analysis simple, only two controls are used: (1) the number of battles within 30km since $t_0$, coded from the ACLED dataset (Raleigh and Hegre 2005); and (2) percent crop area at $t_0$ (logged) in village $i$, which accounts for local, idiosyncratic differences in agriculture.

By systematically varying the cutoff distance for villages in the close zone, it is possible to measure the region over which control is effective. For the theory of rebel control to be plausible, we should see positive values of $\beta$ for villages close to Gbarnga during NPFL rule, and negative values for villages close to Voinjama during LURD rule. Figure 7 plots the values of $\beta$ with 95% confidence intervals for cutoff values ranging from 10km to 200km, at 10km intervals. As predicted, a significant positive effect is demonstrated for close villages in NPFL territory over a range of cutoff values (20km-170km). A strong negative effect is observed for villages close to Voinjama in LURD territory over a similar range (30km - 200km).

### 5.3.1 Spatial Model

Other factors might affect civilian abuse or changes in crop area. For example, monitoring might be more effective near a major road, or civilians might be more likely to abandon their

[17] It is also possible to define a "middle" zone of villages that can be excluded from the analysis to buffer against the spatial dependence between villages. This approach yields similar results.

farms if they are near an international border or humanitarian aid operations. The theory proposed here also predicts higher levels of abuse in areas that contain lootable resources, as well as in unstable areas. Perhaps more importantly, changes in crop area exhibit strong spatial dependence: if one village is attacked, people in neighboring villages are more likely to flee. To account for these influences, a spatial model is necessary.

A simultaneous autoregressive model (SAR) accounts for spatial dependence by using a regression on values from other areas in the vicinity of village $i$ (Bivand et al 2008). The spatial error model takes the following form:

$$\mathrm{Y} = \mathrm{X}\beta + \lambda \mathrm{W}\xi + \epsilon$$

where W is a matrix of spatial dependence and $\xi$ is the spatial component of the errors (Ward and Gleditsch 2008). To account for spatial dependence, I construct a neighbor matrix in which village $i$ is considered to neighbor all villages within 15km.[18] The influence of each neighbor on village $i$ is assumed to be equal, but I relax this assumption with alternate spatial weights in the robustness tests.

The dependent variable remains the log ratio of crop area, but the key independent variable is now the distance to rebel headquarters (in km). To account for how the effectiveness of control changes over distance, I model this variable as a polynomial. I also include the distance to the rebels' second largest bases—Buchanan for NPFL and Tubmanburg for LURD—although neither of these bases was fully established at the time the satellite images were taken. To account for the effects of lootable resources, villages are coded for whether they contain diamonds or rubber. The information on diamond locations comes from DI-

[18] I choose 15km as a cutoff because it is a half-day's walk for a civilian on foot and ensures that all villages are connected to at least one neighbor, a requirement of spatial models.

ADATA, while I coded the location of rubber plantations based on the satellite images. A non-lootable resource, timber, is also included. The locations of both active and potential timber areas are coded based on information from Conservation International. Figure 8 depicts the distribution of these resources.

To examine the effects of ethnic social networks on rebel behavior, I code villages that are predominately ethnic Mandingo. These villages are most likely to share social and family ties with LURD members. The coding is based on linguistic characteristics of Mandingo village names,[19] as well as survey data from Lofa County, where all Mandingo villages are located (Fearon et al 2009).[20]

Distance to the capital city Monrovia and distance to the nearest land border are included to control for the cost of displacement among civilians. Civilians might be more inclined to abandon their farmland if they can easily access the refugee camps of neighboring countries or reach the capital city, the only location where humanitarian aid organizations operated during the war. Distance to a major road is included to control for ease of access. Locations near major roads might be easier for rebel groups to monitor—or to loot. This variable is coded from a road network dataset compiled by the Liberian Institute of Statistics and Geo-information Services.

Battles within 30km of village $i$ since the date of the first image, $t_0$, measures the effect of instability on crop area and is coded from the ACLED data. Figure 9 depicts the locations of battles during January 1990 to January 1991 and during February 2001 to March 2003. For the LURD rebels, a dummy variable is included that marks villages that were under LURD control in February 2001, when the first satellite image was taken, coded based on

[19]Nearly all Mandingo village names end in -du or -dou.

[20]I am in the process of coding ethnic Gio villages using the 2008 Liberian census data to measure social ties with the NPFL rebels.

U.N. security council reports as well as field interviews with LURD commanders.

A measure of the number of households (logged) in a village was derived from a 2005 United Nations study that provides rough estimates of the number of housing structures in a given location. By focusing on structures (both destroyed and intact) the study includes data on villages that were depopulated during the war. In this way, the data mitigate the problem of population movements caused by civilian abuse. Finally the percent crop area at $t_0$ and a measure of village area (in pixels, logged) is included to account for unique village characteristics not related to the conflict. To limit the effects of measurement error caused by noise in the satellite images, I exclude villages with 20 pixels or less of crop land in either image (each pixel measures 30m by 30m). These villages are essentially non-agricultural locations.[21] Figure 10 presents descriptive statistics of the variables.

The same model was run for both NPFL and LURD areas (except for the *LURD 2001* variable), and Figure 11 presents the results side-by-side. As predicted, when villages are closer to the NPFL headquarters at Gbarnga (smaller distance) they experience lower declines in crop area. The effect is large and substantive. Holding constant other factors, if a civilian living in the NPFL headquarters moved 100km away, his crop area is expected to decrease 62%. The opposite effect is observed in LURD territory: a civilian moving to LURD headquarters from 100km away experiences a catastrophic 97% decline in crop area. Proximity to LURD's secondary headquarters in Tubmanburg also corresponds to significant declines in crop area, as does proximity to a major road in LURD areas. No significant effect was observed for NPFL's secondary headquarters in Buchanan.

In terms of lootable resources, no significant effect is observed for diamonds, but dia-

[21] This restriction excludes 11% of villages in the NPFL sample and 38% of villages in LURD territory. Running the regressions without this restriction does not substantively affect results. Including these villages does, however, introduce spatial autocorrelation caused by the measurement error.

mond mining was relatively insignificant during the conflict. The presence of rubber has a strong negative effect in NPFL territory and a significant, although smaller, negative effect in LURD territory. In NPFL territory, being in a rubber area corresponds to a 25% decline in crop area; in LURD territory the decline is 9%. These effects possibly reflect the black market trade in rubber, especially during the early years of the war, in which rebel soldiers and civilians sold rubber to Nigerian peacekeepers (C09). A truckload of rubber could fetch $300 on the black market (Ellis 1999: 167). The effects of ethnic networks and instability are not significant in the model, although the coefficients are in the predicted directions. The high $\lambda$ value indicates that spatial autocorrelation exists between the observations. But a Moran's I test on the residuals reveals that the spatial model reduced the autocorrelation to the point where it is no longer significant.

## 5.4 An Additional Test

Additional information can be gained by examining change over time in crop area in the smaller study area depicted in Figure 3. SPOT images from 1993 and 1995 allow for a comparison of crop area in NPFL during 1991, 1993, and 1995. The model also allows for an analysis of spatial variation within LPC territory during 1995. Ideally these observations would be combined into a panel model, but spatial panel models are difficult to specify with existing statistical tools because the spatial weights must include a time component. The geographically-compact nature of the study area allows several control variables to be dropped, which also prevents singularity in the model.[22] Figure 12 depicts the results of the analysis. The first three columns apply to NPFL territory while the final column describes

[22]In addition, the model relaxes the restriction of villages with less than 20 pixels in both time periods to include villages that contain more than 20 pixels of crop land in *either* $t_0$ or $t_1$.

the situation in LPC territory.

The NPFL was in the process of reorganizing its forces in January 1991, depicted in the first column. The effect of distance to Buchanan, its secondary base, has the expected sign but fails to reach statistical significance. In January 1993, however, there is a strong, positive effect on crop area near the Buchanan base. This effect disappears in January 1995, in the third column, which is expected since the NPFL lost control of Buchanan in 1994. Civilian abuse is higher in the rubber areas in 1991 and 1995, but the coefficient switches signs in 1993, which is puzzling. Being closer to a main road is beneficial for civilians in NPFL territory during 1993 and 1995, which could imply better monitoring and control of rebel forces near the highway.

The estimates for the LPC must be treated with caution due to the small coverage area, but the results support the theory of organizational control. Greater declines in crop area occurred closer to the LPC's secondary base in Buchanan.[23] Greater declines also occurred closer to the main roads in LPC territory, which could indicate a greater opportunity for looting. Thus even though the LPC was ethnically homogeneous, the group exhibits the characteristics of a predatory organization, as predicted. For both groups, battles had a negative effect on civilians, but the coefficient only reaches statistical significance in 1993.

## 5.5 Robustness

Spatial models depend on assumptions regarding the structure of the spatial dependence. Examining the results under a variety of spatial weights and specifications provides some insight into the robustness of the results. In addition to the 15km neighbor matrix, I constructed matrices that weighted neighbors according to the inverse distance between them

[23]The rebels were headquartered in Greenville, Sinoe County.

and the inverse distance squared. These weights imply that villages farther apart have less influence on each other. Each of these weights, including the basic neighbor matrix, was also extended to the 30km range.

The effects of proximity to rebel bases and rubber areas in NPFL territory remain as predicted, and their statistical significance increases under these alternative specifications. The effect of battles remains negative and becomes statistically significant, but the increased significance could be explained by the spatial autocorrelation that remains in the model under these alternative spatial weights. In LURD territory, distance to rebel headquarters remains significant in the predicted direction for all weights matrices. Rubber and battles are significant and negative in the basic 30km neighbor matrix, but lose their significance in models using the distance-based weights.

A major challenge of spatial analysis is the Modifiable Areal Unit problem (Haining 2003). Statistical results may be sensitive to how the variables are spatially aggregated (Kalyvas 2008). To address this issue, I aggregate crop area at the level of clans, the smallest administrative unit in the Liberian government, as an alternative to the village-level analysis.[24] Distance to Rebel Headquarters remains statistically significant in the predicted direction for NPFL territory, as does the presence of rubber plantations. In the LURD model, the coefficient for distance to headquarters loses statistical significance but retains the predicted sign. The presence of rubber is negative and statistically significant at the clan level in LURD territory.

[24]There are 832 clans in Liberia. Village-level household figures were replaced by the number of households in each clan, according to the 2008 census conducted by the Liberian government. Several variables, including distance to capital and distance to secondary base, had to be removed to prevent singularity.

# 6 Conclusion

A spatial analysis of Liberia's civil war supports a theory of organizational control. Rebel group behavior is shaped more by internal organizational constraints than by the group's ethnic composition, the selection of its members, or the stability of its territory. Rebel leaders have strong incentives to create order and stability in their territories, which leads to lower levels of civilian abuse. When rebel leaders have access to financial resources, they use these resources to induce cooperation from their top commanders, who in turn make efforts to monitor and control their soldiers. Likewise, when leaders share bonds of trust with their commanders they can make credible promises of future rewards, which also serves as a motivating device. When leaders lack such resources, they are forced to allow commanders to use group resources to pursue opportunistic, short-term goals. In such groups, even commanders who want to protect civilians are unable to do so due to the predatory behavior of their comrades.

But this model suffers from an identification problem: Why do some leaders have access to financial resources and credible promises while other leaders do not? I argue that the role of external patrons is key. When external patrons benefit from disciplined groups with strong leaders, they are motivated to supply financial resources to leaders who are trusted by their men. But other patrons, motivated by a desire to manipulate the rebel group to achieve policy goals, have incentives to support weak leaders and withhold money and other resources that could strengthen leader control. Testing this aspect of the theory cannot be done within the Liberian case study.

In other work, I analyze a cross-national, rebel-year dataset covering 74 armed groups

that were active in 41 countries during 1980-2003.[25] The data show a strong relationship between the goals of external patrons and the leader's access to financial resources and credible promises. Foreign states and other patrons that seek to manipulate group behavior tend to support less trustworthy leaders and provide less cash than diaspora networks or patrons that benefit from strong rebel groups. The data also support the model's predictions regarding incentives and group behavior: leaders with more access to cash and more credible promises are associated with groups that commit less civilian abuse, while valuable lootable resources are associated with higher levels of abuse. These results are preliminary, but combining theories of micro-level behavior with cross-national variation in this way is a promising avenue of future research.

[25] A research note describing the data and preliminary results is available upon request.

# A Interviews Cited

| ID | Description | Faction(s) | Location | Date |
|---|---|---|---|---|
| B43 | Soldier | NPFL | Monrovia | 21 Aug 2007 |
| B48 | Civilian | NPFL, ULIMO, LURD | Lofa Bridge, Cape Mt | 23 Aug 2007 |
| C02 | Senior Commander | ULIMO/J, LURD | Monrovia | 4 May 2009 |
| - | - | - | (via telephone) | 8 May 2009 |
| - | - | - | - | 20 Jun 2009 |
| - | - | - | - | 13 Aug 2009 |
| C08 | Sr. Political Official | NPFL, NPFL-CRC | Monrovia | 13 May 2009 |
| C15 | Senior Commander | NPFL | Monrovia | 27 May 2009 |
| C19 | Commander | INPFL, NPFL | Monrovia | 1 Jun 2009 |
| C24 | Senior Commander | NPFL, AFL | Monrovia | 15 Jun 2009 |
| C26 | Senior Commander | NPFL | 15 Gate | 18 Jun 2009 |
| C27 | Commander | NPFL | 15 Gate | 18 Jun 2009 |
| C30 | Commander | LURD | Monrovia | 2 Jul 2009 |
| C32 | Sr. Political Official | MODEL | Monrovia | 4 Jul 2009 |
| C39 | Sr. Political Official | NPFL | Monrovia | 14 Jul 2009 |
| C42 | Commander | LPC | Monrovia | 13 Aug 2009 |
| - | - | - | (via telephone) | 14 Aug 2009 |

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Figure 1: Study area (bold line) for analysis of crop area in NPFL territory (shaded region).


Figure 2: Study area (bold line) for analysis of crop area in LURD territory (shaded region).


Figure 3: Study area (bold line) for change-over-time analysis of crop area in NPFL territory (shaded region).

| Theory | Civilian Abuse |
|---|---|
| Adverse Selection | NPFL $\geq$ LURD $\approx$ LPC |
| Ethnic Heterogeneity | NPFL $\approx$ LURD $>$ LPC |
| Organizational Control | LURD $\approx$ LPC $>$ NPFL |

Figure 4: Competing predictions of rebel behavior in Liberia.


Figure 5: Study area (bold line) for comparison of crop area in NPFL territory (shaded region) and LPC territory (striped region).

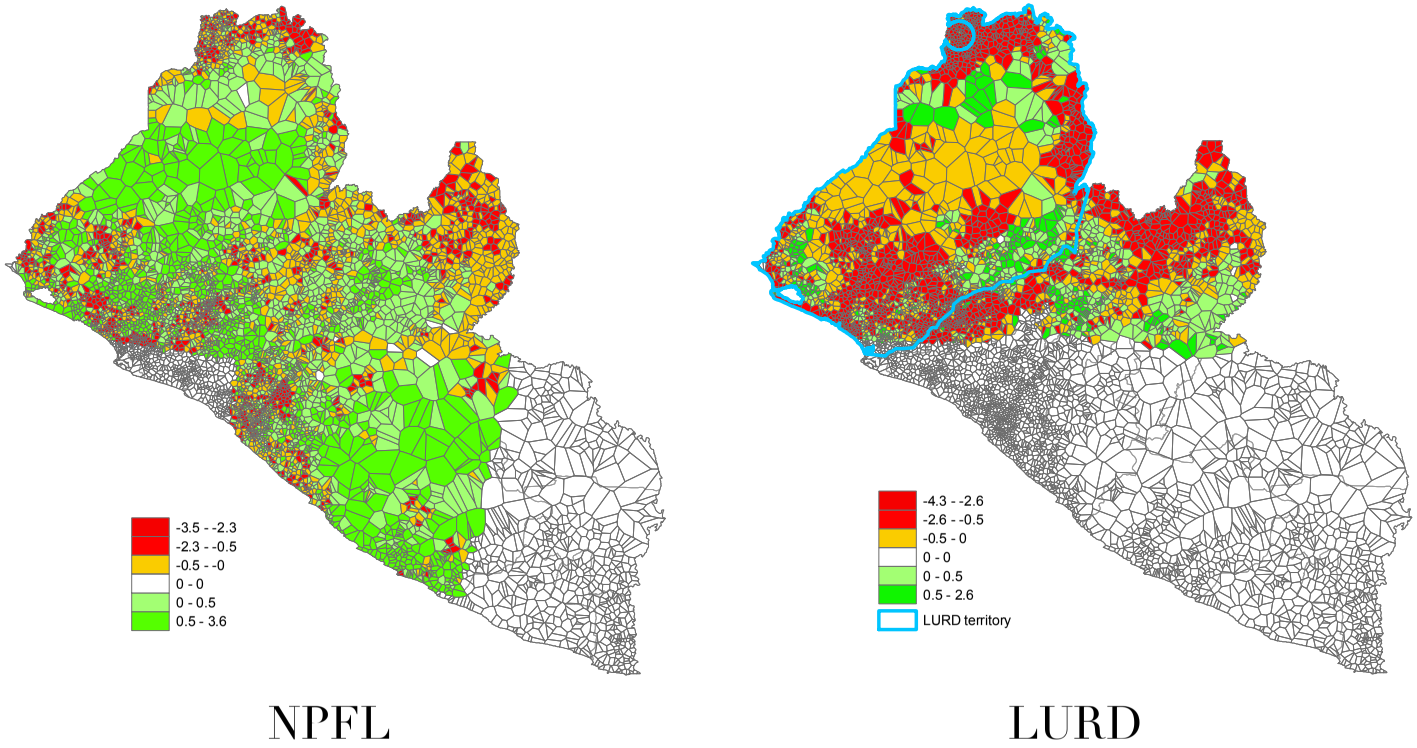
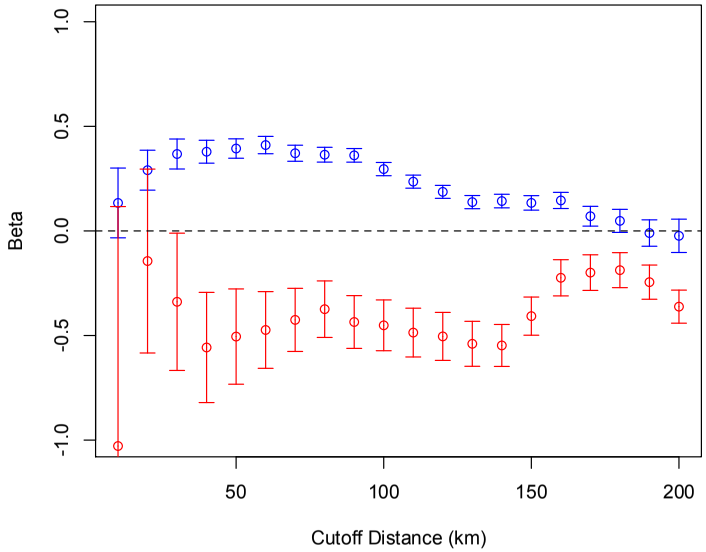



Figure 6: Changes in crop area at village level (log ratio) in NPFL territory (1986 v. 1991) and LURD territory (2001 v. 2003).




| | NPFL | | LURD | |
|---|---|---|---|---|
| Cutoff Distance (km) | $\beta$ | S.E. | $\beta$ | S.E. |
| 10 | 0.13 | 0.085 | -1.03 | 0.58 |
| 20 | 0.29 | 0.049 | -0.14 | 0.22 |
| 30 | 0.37 | 0.037 | -0.34 | 0.17 |
| 40 | 0.38 | 0.028 | -0.56 | 0.13 |
| 50 | 0.39 | 0.024 | -0.51 | 0.12 |
| 60 | 0.41 | 0.021 | -0.47 | 0.094 |
| 70 | 0.37 | 0.020 | -0.43 | 0.077 |
| 80 | 0.36 | 0.018 | -0.37 | 0.069 |
| 90 | 0.36 | 0.017 | -0.44 | 0.064 |
| 100 | 0.30 | 0.016 | -0.45 | 0.062 |
| 110 | 0.24 | 0.016 | -0.49 | 0.059 |
| 120 | 0.19 | 0.016 | -0.50 | 0.059 |
| 130 | 0.14 | 0.016 | -0.54 | 0.055 |
| 140 | 0.14 | 0.017 | -0.55 | 0.051 |
| 150 | 0.13 | 0.018 | -0.41 | 0.047 |
| 160 | 0.15 | 0.020 | -0.22 | 0.044 |
| 170 | 0.070 | 0.024 | -0.20 | 0.043 |
| 180 | 0.048 | 0.028 | -0.19 | 0.043 |
| 190 | -0.010 | 0.032 | -0.24 | 0.042 |
| 200 | -0.023 | 0.041 | -0.36 | 0.040 |

Figure 7: The effect of proximity to rebel headquarters for villages in NPFL territory (blue) v. villages in LURD territory (red), with 95% confidence intervals. Positive values of $\beta$ correspond to lower declines in crop area.

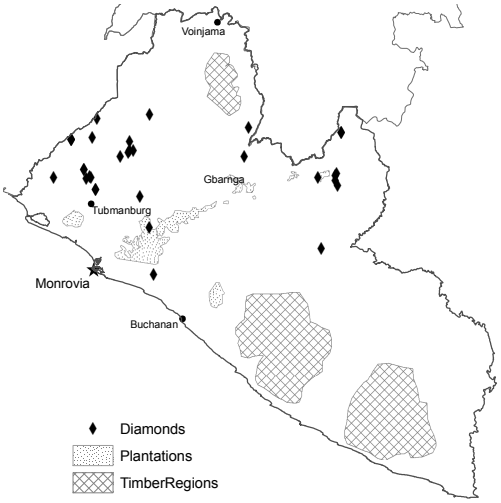



Figure 8: Natural resources in Liberia. Source: DIADATA, Conservation International, satellite imagery analysis.

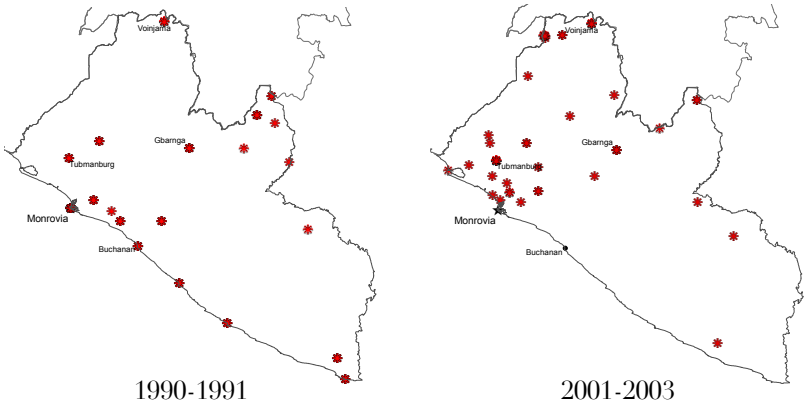



Figure 9: Locations of battles, 1990-91 and 2001-03. Source: ACLED.

| | NPFL | | | | LURD | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Min | Mean | Max | St.Dev. | Min | Mean | Max | St.Dev. |
| DV | -2.45 | 4.4e-2 | 3.06 | 0.66 | -2.93 | -0.366 | 2.05 | 0.71 |
| Dist. Rebel HQ | 0.45 | 112.3 | 246.9 | 50.0 | 3.5 | 190.2 | 257.7 | 50.8 |
| Dist. 2nd Base | 3.9 | 132.0 | 294.9 | 68.9 | 3.3 | 66.1 | 220.2 | 43.5 |
| Diamonds | 0 | 5.4e-3 | 1 | 7.3e-2 | 0 | 7.7e-3 | 1 | 8.8e-2 |
| Rubber | 0 | 8.4e-2 | 1 | 0.28 | 0 | 0.10 | 1 | 0.30 |
| Timber | 0 | 3.0e-2 | 1 | 0.17 | 0 | 1.1e-2 | 1 | 0.10 |
| Mandingo | 0 | 1.2e-2 | 1 | 0.11 | 0 | 3.9e-3 | 1 | 6.2e-2 |
| LURD 2001 | - | - | - | - | 0 | 1.2e-2 | 1 | 0.11 |
| Dist. Capital | 14.2 | 141.8 | 290.5 | 70.3 | 14.9 | 89.9 | 271.7 | 52.6 |
| Dist. Border | 0.10 | 73.3 | 172.6 | 49.5 | 0.10 | 62.5 | 122.8 | 33.8 |
| Dist. Road | 0.0 | 7.9 | 50.3 | 8.1 | 0.0 | 7.4 | 39.4 | 6.6 |
| Battles within 30km | 0 | 2.1 | 21 | 3.4 | 0 | 3.5 | 11 | 3.1 |
| Village Households | 1 | 63.2 | 5241 | 174.9 | 1 | 62.2 | 2051 | 128.9 |
| % Crop Area $t_0$ | 2.6e-3 | 4.3e-2 | 0.23 | 3.0e-2 | 3.6e-3 | 3.7e-2 | 0.28 | 2.5e-2 |
| Village Area | 7.4e5 | 1.5e7 | 1.5e8 | 2.5e7 | 1.1e6 | 1.5e7 | 3.3e8 | 2.6e7 |

Figure 10: Descriptive statistics.

| | NPFL 1986 v. 1991 | LURD 2001 v. 2003 |
|---|---|---|
| | Estimate (S.E.) | Estimate (S.E.) |
| Dist. to Rebel Headquarters | -1.3e-2*** | 5.7e-2** |
| | (3.3e-3) | (2.0e-2) |
| Dist. Rebel HQ$^2$ | 3.2e-5* | -2.1e-4*** |
| | (1.3e-5) | (4.4e-5) |
| Dist. to Rebel Secondary Base | 2.0e-3 | 2.0e-2** |
| | (3.8e-3) | (7.6e-3) |
| Dist. 2nd Base$^2$ | 5.4e-6 | -4.7e-5 |
| | (1.0e-5) | (1.0e-4) |
| Diamonds | -6.9e-2 | 9.4e-2 |
| | (7.9e-2) | (1.3e-1) |
| Rubber | -2.9e-1*** | -9.3e-2* |
| | (3.1e-2) | (5.6e-2) |
| Timber | 5.2e-2 | 1.9e-1 |
| | (6.1e-2) | (2.2e-1) |
| Mandingo | -3.6e-2 | 1.3e-1 |
| | (6.5e-2) | (4.3e-1) |
| LURD 2001 | - | 1.7e-1 |
| | - | (2.7e-1) |
| Distance to Capital | -4.4e-3 | -5.3e-2*** |
| | (3.0e-3) | (1.1e-2) |
| Dist. Capital$^2$ | 1.7e-6 | 1.6e-4 |
| | (9.9e-6) | (1.0e-4) |
| Distance to Border | 5.1e-3 | 2.4e-2* |
| | (3.1e-3) | (1.3e-2) |
| Dist. Border$^2$ | -3.6e-5* | -1.4e-4* |
| | (2.0e-5) | (7.5e-5) |
| Distance to Road | 2.3e-3 | 2.2e-2*** |
| | (2.7e-3) | (6.2e-3) |
| Dist. Road$^2$ | -2.5e-4* | -9.6e-4** |
| | (1.1e-4) | (3.0e-4) |
| Battles within 30km since $t_0$ | -4.3e-3 | -2.6e-3 |
| | (2.8e-3) | (7.2e-3) |
| Village Households (log) | 4.1e-3 | -9.3e-4 |
| | (4.7e-3) | (1.0e-2) |
| % Crop Area $t_0$ (log) | -8.4e-1*** | -8.0e-1*** |
| | (1.3e-2) | (3.0e-2) |
| Village Polygon Area (log) | -7.9e-2*** | -1.4e-1*** |
| | (9.2e-3) | (2.0e-2) |
| (Intercept) | -5.1e-1 | -3.3e0 |
| | (5.0e-1) | (3.5e0) |
| $\lambda$ | 0.888 | 0.967 |
| LR Test Value | 1059 | 254 |
| p-value | <2.22e-16 | <2.22e-16 |
| Moran's I Std. Deviate | 0.8824 | 0.6885 |
| p-value | 0.1888 | 0.2456 |
| N | 4430 | 1293 |
| *** $p < 0.001$; **$p < 0.01$; | * $p < 0.1$ | |

Figure 11: Spatial model of changes in crop area for NPFL (1986 v. 1991) and LURD (2001 v. 2003). The dependent variable is the log ratio of crop area.

| | NPFL 1991 | NPFL 1993 | NPFL 1995 | LPC 1993v. 1995 |
|---|---|---|---|---|
| | Estimate (S.E.) | Estimate (S.E.) | Estimate (S.E.) | Estimate (S.E.) |
| Dist. to Rebel Secondary Base | -7.9e-3 | -2.9e-2*** | -5.6e-3 | 4.4e-2* |
| | (7.7e-3) | (8.5e-3) | (1.9e-2) | (1.8e-2) |
| Dist. 2nd Base$^2$ | 1.0e-4* | 1.5e-4* | 1.8e-4 | -4.5e-4* |
| | (5.9e-5) | (6.3e-5) | (1.2e-4) | (2.7e-4) |
| Rubber | -2.5e-1** | 2.4e-1* | -3.3e-1*** | -1.7e-1 |
| | (9.4e-2) | (1.1e-1) | (9.6e-2) | (1.8e-1) |
| Timber | 1.0e-1 | -9.2e-2 | 2.6e-1 | -1.3e-1 |
| | (1.0e-1) | (1.2e-1) | (1.8e-1) | (1.7e-1) |
| Distance to Road | -1.1e-2 | -5.2e-2*** | -2.6e-2* | 3.5e-2* |
| | (8.9e-3) | (8.8e-3) | (1.0e-2) | (1.9e-2) |
| Dist. Road$^2$ | 2.2e-4 | 2.3e-3*** | 9.3e-4* | -9.9e-4 |
| | (4.5e-4) | (4.3e-4) | (5.2e-4) | (1.1e-3) |
| Battles within 30km since prev. | - | -5.6e-2** | -1.3e-2 | -4.7e-2 |
| | - | (1.8e-2) | (3.5e-2) | (6.3e-2) |
| Village Households (log) | 1.3e-4 | -8.0e-3 | -1.7e-3 | -5.3e-3 |
| | (1.3e-2) | (1.2e-2) | (1.6e-2) | (2.0e-2) |
| % Crop Area Previous (log) | -5.4e-1*** | -9.0e-1*** | -9.0e-1*** | -4.8e-1*** |
| | (4.0e-2) | (3.6e-2) | (4.8e-2) | (5.1e-2) |
| Village Polygon Area (log) | -1.3e-1*** | -8.0e-2** | -8.8e-2** | 2.0e-2 |
| | (2.6e-2) | (2.6e-2) | (2.8e-2) | (4.2e-2) |
| (Intercept) | 6.4e-2 | -1.2e0** | -2.4e0** | -3.3*** |
| | (4.0e-1) | (4.4e-1) | (8.7e-1) | (6.9e-1) |
| $\lambda$ | 0.736 | 0.795 | 0.948 | 0.831 |
| LR Test Value | 20.9 | 36.3 | 80.7 | 9.88 |
| p-value | 4.9e-6 | 1.7e-9 | ¡2.22e-16 | 1.7e-3 |
| Moran's I Std. Deviate | -0.836 | 0.420 | 1.66 | 1.34 |
| p-value | 0.798 | 0.337 | 0.0483 | 0.0905 |
| N | 615 | 436 | 409 | 258 |
| | *** $p < 0.001$; | ** $p < 0.01$; | * $p < 0.1$ | |

Figure 12: Change over time in a section of NPFL territory and spatial variation within a section of LPC territory . The dependent variable is the log ratio of crop area.