A model of resources and rebel organization

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Abstract

Rebel groups, like states, must rely on self-enforcing agreements. Rebel groups have military and political objectives, but a group cannot survive unless it effectively mobilizes economic resources. This paper offers a model of rebel organization that shows how different resources result in different self-enforcing contracts within the organization. These contracts shape the rebel group's behavior, which in turn affects civilian welfare and the success of war-to-peace transitions. Ethnic composition, level of training, and co-optation of government bureaucracies arise endogenously.

NOTE: This paper is a modified excerpt of my dissertation proposal, "Resources and control in rebel organizations."

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1 Introduction

The RUF rebels in Sierra Leone are known mostly for their drug-addled, costume-clad fighters who pillaged and mutilated the civilian population. But this choatic violence contrasts sharply with the efficient organization of the diamond fields under RUF control. The RUF leadership earned hundreds of millions of dollars through the extraction and sale of diamonds, but earned little from the countryside, where RUF soldiers looted with impunity. Why did the RUF leadership control the diamond fields but fail to set up any form of governance in their territory?

Other rebel groups also exhibit surprising behavior during war. In Liberia, the LURD rebels could not prevent their soldiers from looting, even when the leaders themselves faced food shortages in the rebel headquarters. In Sri Lanka, the LTTE has waged a twenty-five year struggle for a separate state, yet the group allows government bureaucrats to work in rebel-controlled areas. In eastern Congo, the CNDP rebels set up efficient systems of taxation within days of capturing new territory, even as government soldiers loot the surrounding areas.

What explains these variations in rebel behavior? Why do some rebel groups restrain their actions and behave similarly to states, while other rebel groups are highly predatory and ill-disciplined?

More than 127 civil wars in 73 states have occurred since World War II, resulting in the deaths of more than 16.2 million people (Fearon and Laitin 2003). This death toll is astounding, but is ultimately overshadowed by the indirect costs of war—war-induced malnutrition and disease (Ghobarah, Huth, and Russett 2003). Even after peace agreements are signed, the risk of returning to war remains high and post-conflict societies must often cope with significant levels of violent crime (Stedman 2002). Civilian welfare during war and afterwards depends on how rebel groups govern the territories under their control, but this

topic remains largely unexplored in the literature.

Rebel groups, like states, must rely on self-enforcing agreements. Rebel groups have military and political objectives, but a group cannot survive unless it effectively mobilizes economic resources. I argue that different resources result in different self-enforcing contracts within the organization. These contracts shape the rebel group's behavior, which in turn affects civilian welfare and the success of war-to-peace transitions.

This paper formalizes the challenges faced by rebel leaders. The leader seeks to maximize his revenue and maintain control of the group. But the leader must delegate power to commanders who have preferences different from his own. Resources affect leader control by shaping the bargaining power of different commanders.

Different resources lead to three theoretically significant "types" of rebel organizations. The first type depends primarily on "bottom-up" natural resources—resources that are extracted and sold directly by the rebel group. The second type of rebel group depends exclusively on civilian resources, either through looting or taxation. The third type depends mostly on "top-down" resources—resources that produce revenue that accrues directly to the rebel leader.

Rebel leaders of bottom-up natural resource groups effectively control the resource areas but lose control of resource-poor areas. Leaders of these groups are threatened by commander collusion, so leaders favor ethnically-divided troops and low levels of training. The need for control over the resource areas leads to frequent commander purges and instability in the organization; the risk of civilian abuse is high.

Leaders of groups that depend on civilian resources must generate gains from cooperation to maintain control of the group. Leaders in this case have an incentive to encourage commander cooperation. Leaders promote ethnic

homogeneity and training within the group. Commander stability is favored, so taxation and protection of civilians becomes more likely. But if leaders cannot provide sufficient gains from cooperation, the group will succumb to looting and instability.

Top-down rebel leaders face fewer control problems. By providing salaries greater than the commanders could earn on their own, leaders of top-down groups secure compliance. But this pay-as-you-go system is sensitive to changes in monitoring capabilities and does not foster trust within the organization. Top-down leaders have great flexibility to optimize their revenue streams: training and group structure will reflect the leader's cost-benefit analysis. Since trust is unimportant, top-down leaders are more likely to co-opt existing government bureaucracies as a cost-effective way of establishing governance.

The paper proceeds as follows. Section 2 reviews the relevant literature on civil war and organizational theory. Section 3 presents the basic model. Section 4 applies the model to rebel groups that depend on bottom-up natural resources. Section 5 applies the model to rebel groups that depend on civilian resources. Section 6 applies the model to top-down rebel groups. Where applicable, I draw upon case study evidence to support the structure and implications of the models. Section 7 concludes. An appendix includes proofs of all propositions.

2 Conflict, Resources, and Hierarchy

The literature on civil war places much emphasis on two attributes of civil war: (1) violence, and (2) the presence of natural resources. The focus on violence is intuitive: violence is the most striking outward feature of civil war and results in the most negative normative consequences of war. Studies of civil war onset (Fearon and Laitin 2003), duration (Fearon 2004), and termination (Walter 2002) seek to identify the factors that either prevent or contribute to large-scale

violence.

Although violence is appropriate for macro-level studies, violence is a problematic dependent variable when applied at the micro- or meso-levels of analysis. Violence can occur for many reasons. A rebel group may commit violence because of tactical objectives (Lacqueur 2004; Kalyvas 1999), looting opportunities (Keen 1998), ill disciplined and opportunistic members (Weinstein 2007), social or psychological factors (Abdullah 1998; Kaplan 1998; Leon 1969), or simply because of a chance encounter with a government contingent. Because of these competing motivations, violence is difficult to incorporate into a rational choice framework.

Scholars face similar problems when analyzing the role of natural resources in civil war. Although Collier and Hoeffler's (2000) study of "greed and grievance" identifies a link between primary commodity exports and violent conflict, these findings remain contentious (Fearon 2005). Nevertheless, the perception that "blood diamonds" and other resources are the driving force behind many civil wars remains common in the literature. Rather than linking resources directly to civil war onset, these studies focus on how natural resources *prolong* conflict by providing valuable rents to armed groups and other special interests (Pugh and Cooper 2004).

Despite the intuitive appeal of natural resources, the causal mechanisms through which resources influence civil war remain poorly understood. Macartan Humphreys (2005) lists six mechanisms by which natural resources might contribute to civil war onset and seven mechanisms by which resources might affect war duration. Compounding this identification problem is the variation between natural resources themselves: oil, for example, may influence conflict differently than minerals or agricultural commodities. Although cross-national data lend support to some mechanisms and discount others, the results are

limited (Ross 2004; Humphreys 2005; Fearon 2004).

Natural resources, by themselves, cannot affect civil war; people are not killed by diamonds or oil. The connection between natural resources and conflict must be analyzed at the level of the organizations that extract and fight over those resources. Philippe Le Billon (2001) argues that the geography of resources shapes the ability of armed actors to capture and exploit those resources. Lootable resources concentrated in areas far from the capital city create the greatest risk of conflict. Snyder and Bhavnani (2005) point out that many states with lootable resources have not collapsed into civil war—Ghana and Brazil, for example. The connection between lootable resources and conflict depends on the government's ability to control the mode of extraction and also on patterns of state spending.

Natural resources affect rebel group organization through variation in modes of extraction and the amount of revenue generated. But focusing specifically on natural resources is too narrow. Rebel groups may rely on other sources of revenue, such as taxation, external financing, looting, smuggling, and agricultural production.

Studying resources at the organizational level pushes the focus away from violence; the amount of revenue has no direct connection with a group's propensity to commit violent acts. Rather, resources shape the incentives of different members within the rebel organization, as well as the structure of the organization itself. More appropriate measures of variation within rebel organizations involve economic outcomes that affect civilian welfare: private property protection, provision of public services, etc... The question becomes whether or not a rebel organization will create *order* in the territory it controls.

Mansur Olson (1993) argues that an authority will provide order when it has an "encompassing interest" to do so. A rebel group, therefore, will refrain

from looting, protect civilians, and provide services when these actions further its economic interests. Whether or not the group controls natural resources is irrelevant: a rational rebel group will optimize all sources of income. The determining factor is the group's time horizon. If a rebel group expects to control a territory for long enough, the group always has an incentive to promote the economic activity of the civilians under its authority; taxation is more profitable than looting in the long-term.

Although Olson's model is attractive for its simplicity, the theory assumes the authority is a unified actor, rather than an organization with competing interests. During conflict, rebel superiors may be unable to prevent their subordinates from acting opportunistically; even if the rebel leader favors the creation of order, he may be unable to prevent his subordinates from looting or disobeying his commands. The creation of order in rebel territory, therefore, depends on the rebel superior's ability to control his subordinates. And this depends on the hierarchical structure of the rebel organization.

Control is difficult in a hierarchy because subordinates always possess a certain amount of private information and have an incentive to misrepresent that information. This asymmetry creates two fundamental problems: adverse selection and moral hazard (Moe 1984). In firms, adverse selection occurs because an employer cannot know the "type" of a potential employee, i.e. whether he is a hard worker or a shirker. Moral hazard occurs because an employer cannot directly observe employee behavior at all times, so there is a risk the employee will act opportunistically. This control problem is especially acute in rebel organizations, since rebel groups cannot rely on third-party enforcement of contracts or external judicial systems to punish members who misbehave.

Jeremy Weinstein (2007) applies adverse selection to the study of rebel organizations. He argues that the initial resource base of a rebel group influences

the type of member it attracts, which then shapes the group's behavior throughout the war. Rebel groups with access to economic resources, such as external financing or diamonds, will attract opportunistic recruits who are more difficult to control. Rebel groups that lack economic resources rely instead on long-term promises and appeals to shared ideals or identity. These groups attract committed members who are willing to sacrifice short-term benefits for the good of the organization and the local community. Adverse selection, therefore, explains why some groups fail to constrain the opportunistic behavior of their members, resulting in a lack of order and suboptimal outcomes for the group and the civilian population.

Adverse selection, however, is only a partial explanation for a loss of control in rebel organizations. Adverse selection cannot explain why highly opportunistic groups such as the RUF can control their members in the diamond fields. Nor can adverse selection explain why highly disciplined groups such as the LTTE use forced recruitment to fill their ranks. Economic models of firms often assume employees are "self-interest seeking with guile," but nonetheless propose incentive contracts for controlling their behavior (e.g. Williamson 1983: 354). Many organizations that suffer from adverse selection, such as police departments and government militaries, can still function effectively and behave with restraint. Control depends on monitoring, incentives, and punishment within the rebel hierarchy.

Rebel group behavior also depends on informal structures within the group; formal incentives alone are not sufficient for understanding group dynamics. Gary Miller (1992) shows that it is impossible to design a perfect incentive structure. Akerlof and Kranton (2005) argue that monetary rewards and punishments are often ineffective at motivating subordinates; more important is the extent to which subordinates identify with the organization. And Granovetter

(1985) argues that interpersonal relations and social obligations within organizations discourage inappropriate behavior separately from the institutional structures. Social characteristics, such as ethnic composition and training may influence the organization and behavior of a rebel group.

Ethnic homogeneity facilitates the spread of information and serves as a coordination device (Fearon and Laitin 1996; Habyarimana et al 2005). Rebel members can more easily monitor and coordinate actions when the group is composed largely of co-ethnics. Humphreys and Weinstein (2006) focus on the internal cohesion of units within armed groups to explain variation in civilian abuse. Their study of Sierra Leone finds that ethnically heterogeneous units without mechanisms to discipline internal behavior are more likely to abuse the civilian populations; homogeneous units composed of members with common goals that set in place disciplinary structures are less abusive towards civilians.

Ethnic homogeneity may facilitate monitoring within a hierarchy, but it also increases the risk of collusion within the organization. As demonstrated by de Figueiredo and Weingast's (2005) model of self-enforcing federalism, bargaining power within a hierarchy depends to a large extent on coordination. Ethnicity affects coordination, thus rebel superiors have an incentive to shape the ethnic composition of their organization. When group revenue depends on high levels of coordination, leaders and commanders promote ethnic homogeneity. But when leaders are threatened by the possibility of collusion among their subordinates, leaders have an incentive to encourage ethnic fragmentation.

Ethnicity is just one element that affects coordination and communication in rebel groups. Group training serves a very similar function. Training creates common expectations and dense social networks, which facilitate the transfer of information through the organization (Granovetter 1973; Watts et al 2002). This socialization process can be beneficial to rebel leaders. Information net-

works allow rebel leaders to "search" for information regarding the behavior of rebel members. And common expectations and social networks allow for the formation of reputations, which are easier to monitor than particular actions (Kreps 1990). But these common expectations and social networks can also threaten rebel leaders. The mutual trust developed through training creates a risk that commanders will support each other at the expense of the rebel leader. Ethnic composition and training are endogeneous implications of the control challenges within rebel organizations.

A focus on resources overcomes these endogeneity problems to a large extent. Although rebel groups may use resources differently—groups may choose to either tax or loot, for example—the distribution of resources creates certain incentives that do not depend on ethnicity, ideology, or any other socially constructed trait of rebel organization. The challenge is to understand exactly how resources shape the organization of the rebel group.

Examining *transactions* within a rebel organization allows for a precise understanding of the incentives created by different resources. Transactions can be characterized by the direction of net revenue transfer. A commander in charge of a diamond field, for example, must hand over diamonds to the rebel leader. Even if the leader pays the commander a wage, the leader would not pay the commander the full value of the diamonds. Thus the net transfer of revenue flows from the commander *up* to the rebel leader. Diamonds, in this case, can be labelled a *bottom-up* resource. Similarly, a rebel leader who receives external financing from a foreign patron might pay salaries to his commanders: external financing is a *top-down* resource. All resources can be classified as either top-down or bottom-up.

The difference between top-down and bottom-up resources is theoretically significant because rebel groups operate in an environment without externally

enforced contracts. Traditional principal-agent models assume the agent has no independent access to the firm's resources. When contracts are externally enforced, there is no difference between bottom-up and top-down resources; the agent's salary is determined by other factors, such as the cost of effort.[1] In a civil war, however, commanders who preside over bottom-up resources can threaten to withhold those resources for personal benefit. The temptation to defect depends on the value of the resources and the credibility of punishment.

Some resources respond to the behavior of the rebel organization. Civilians, for example, can flee the conflict area or alter their level of production. Although taxes on civilians are "bottom-up" resources, these resources create different incentives for rebel groups than bottom-up natural resources. This theoretical distinction does not generally apply to top-down resources. Rebel leaders must fulfill certain obligations to gain access to top-down revenue, thus top-down resources always depend on rebel behavior to some extent. A logging company, for example, will only deposit money in the leader's bank account if the leader successfully provides security for the logging operation. In a similar way, financing from a foreign government depends on the rebel group furthering that government's foreign policy objectives.

The challenge for rebel leaders, therefore, is to structure their organizations in a way that maximizes their utility, according to the nature of the resources available. Leaders may sacrifice control over some resources in order to generate more revenue from other resources. When resources react to rebel behavior, such as civilians leaving the conflict area, leaders may have to exert full control over their subordinates to generate any revenue at all.

[1] For an excellent treatment of the foundational principal-agent model, see Mas-Collell, Whinston, and Green (1995).

3 The Basic Model

Consider an ongoing civil war. The leader of the rebel group must generate revenue to buy enough weapons and logistical support to continue the armed confrontation with the state. The leader may also want to generate revenue for personal enrichment. Unfortunately for the leader, he can't fight the war without the help of commanders and soldiers. The leader must give weapons and delegate power to a group of commanders who each preside over some territory and soldiers. To maintain control, the leader must be able to credibly punish troublesome commanders. But the leader does not personally control any forces: to remove a dishonest commander, the leader depends on the cooperation of other commanders. Three assumptions characterize the challenges faced by rebel leaders:

(1) The rebel leader seeks to maximize the revenue under his personal control;[2]

(2) The rebel leader controls no forces of his own and must rely on commanders to enforce his policy preferences;

(3) All agreements within the group must be self-enforcing.

The basic model of rebel organization formalizes these assumptions and analyzes how different resources affect organizational outcomes.

Suppose there exists a Leader, L, and two commanders, C_1 and C_2. Each commander presides over a territory, which may contain either civilians or natural resources.

The stage game proceeds in the following steps:

(1) Each commander simultaneously selects an action $a_i \in \{a_{1i}, a_{2i}\}$.

(2) The leader decides for each commander whether to: pay a wage, w_i;

[2]The leader's personal revenue could be interpreted as group revenue—i.e. revenue to be used for procuring weapons and supplies necessary to carry out the group's campaign against the state. This personal revenue is distinct, however, from total revenue produced by the group because it does not include the revenue that accrues to each commander.

withhold the wage but allow the commander to remain, nw_i; or attempt to replace the commander, r_i. Replacement involves one commander assuming the place (and the resources) of the other commander.

(3) If the leader attempts to replace one of the commanders, the other commander must decide whether or not to cooperate with the replacement. If the commander agrees to cooperate, the commander pays cost c and assumes the new post. A new recruit from an endless pool of potential commanders fills the vacancy left behind, and the replaced commander is demoted, expelled, or killed, resulting in zero future payouts. If the commander decides not to cooperate, both commanders maintain their current positions.[3]

The stage game is repeated indefinitely with discount factor, δ.

Payoffs are as follows: Action a_{11} produces revenue Π_1 for the rebel leader and 0 for C_1; action a_{12} produces Π_2 for the leader and 0 for C_2. Actions a_{21} and a_{22} produce 0 for the rebel leader and V_1 and V_2 for each of the commanders, respectively.[4] Thus the leader has an incentive to induce his commanders to choose a_{1i}, but the commanders have a personal incentive to choose a_{2i}.[5] Other payoffs include wages, w_i, and the cost of replacing a commander, c.

Each player is risk-neutral and has a reservation utility equal to zero.[6]

Shifting the relative values of the two parameters results in the three different "types" of rebel groups:

[3]I assume the leader controls access to weapons, but relies on commanders to supply manpower. Thus a rebel leader could distribute weapons in such a way as to make it possible for one commander to overthrow another, despite disparities in wealth, but the leader is not able to replace a commander without cooperation.

[4]The assumption that commanders can unilaterally decide to keep the resources generated in any given period is an important departure from traditional principal-agent models, which typically assume a negative cost of effort rather than a positive payout. The ability of commanders to secure this payoff results from the lack of externally enforced contracts.

[5]A note on the interpretation of "action": I assume each commander extracts resources in a way that is optimal for the territory, given the discount factor. Thus a commander that chooses a_{2i} in a civilian territory does not necessarily loot; his action, however, does represent a loss of control on the part of the rebel leader.

[6]For a discussion of risk-neutrality as an appropriate assumption, see Allen and Lueck (1995).

(1) Rebel groups that depend on bottom-up natural resources can be modeled by assuming $\Pi_i = V_i$ and $V_1 > V_2$. All revenue in the group is generated by the actions of the commanders and there exist disparities in wealth between commanders.

(2) Groups that depend on civilian resources can be modeled by assuming $\Pi_i = V_i$ and $V_1 \approx V_2$. As before, all revenues are "bottom-up" but commanders are relatively homogenous with respect to wealth.[7]

(3) Groups that depend on top-down resources can be modeled by assuming $\Pi_i > V_i$. The actions of the rebel commanders—providing security for a logging company, for example—create revenues that accrue directly to the rebel leader.

The following sections will look more closely at each of these rebel types to determine equilibria and observable implications.

4 Bottom-Up Natural Resources

The challenges faced by rebel leaders are especially acute in groups that control lootable natural resources. A leader must convince commanders in resource-rich areas to hand over the valuable minerals in exchange for a wage. The leader's pledge to pay the commanders, like the leader's threat to punish the commanders, may not be credible.

Commanders who control diamond fields are especially threatening to rebel leaders. The high value of diamonds makes it easy for corrupt commanders to generate large amounts of wealth. Wealthy commanders pose a threat to the rebel leader since they could buy off the support of other commanders and seize control of the group's primary source of revenue. These resource-rich commanders are potential rivals for wealth and power. Creating a self-enforcing

[7] Additional assumptions, such as gains from cooperation, will be added to the civilian resource model in the sections below.

payment and punishment scheme fundamentally shapes the organization and the behavior of the rebel group.

The three players in this game are the rebel leader, L, a commander who controls civilian resources—labeled T for notational clarity—and a commander, D, who controls a valuable resource, such as a diamond field.

To model the dynamics of a bottom-up natural resource group, I modify the basic model by assuming $\Pi_i = V_i$ and $V_D > V_T$.

Payoffs are as follows: Action a_{1T} produces revenue V_T for the rebel leader and 0 for the territory commander; action a_{1D} produces V_D for the leader and 0 for the diamond commander. Actions a_{2T} and a_{2D} produce 0 for the rebel leader and V_T and V_D for the territory and diamond commanders, respectively. As in the basic model the leader has an incentive to induce his commanders to choose a_{1i}, but the commanders have a personal incentive to choose a_{2i}. Other payoffs include wages, w_i, and the cost of replacing a commander, c.

Initially all players have perfect information and the commanders can only interact with the rebel leader, not with each other. Section 4.2 introduces the possibility of commander collusion; Section 4.3 analyzes a setting with imperfect information.

4.1 Equilibria under Perfect Information

Consider the following strategies:

S_L: Pay w_D if D chooses a_{1D}; If D chooses a_{2D}, don't pay w_D and attempt to replace. Never pay a wage to T regardless of action; don't attempt to replace T regardless of T's action. Do not replace commanders two rounds in a row.

S_D: Begin by choosing a_{1D}. Continue playing a_{1D} if wages w_D are received from the leader. Play a_{2D} in all future rounds if the leader ever fails to pay. Never cooperate with a replacement. If a replacement occurs, begin playing T's

strategy.

S_T: Play a_{2T} in every round. Always cooperate to replace the diamond commander. If replacement occurs, choose a_{2D} in the first round after the replacement and then begin playing D's strategy.

Any new commander drawn from the pool of potential commanders will choose a_{2i} immediately after the replacement and then begin playing the strategy of the replaced commander in all subsequent rounds.

The strategies result in the following payoffs:

$$U_L = \frac{1}{1-\delta}(V_D - w_D) \tag{1}$$

$$U_D = \frac{1}{1-\delta} w_D \tag{2}$$

$$U_T = \frac{1}{1-\delta} V_T \tag{3}$$

Under these strategies, the rebel leader effectively controls the resource areas, but loses control of the countryside. These strategies are significant if they constitute a robust equilibrium. This leads to the following proposition:

Proposition 4.1. *These strategies comprise an equilibrium under reasonable restrictions on the model parameters.*

Proof. See Appendix. □

The rebel leader maintains control over the diamond commander because the leader's threat to replace the diamond commander is credible: so long as the costs of replacement, c, are not too high, the territory commander will benefit by gaining access to more valuable resources. By playing one commander against another, the leader maximizes his revenue from the resource area.

The leader's threat to replace the territory commander, however, is not credible. The leader needs the cooperation of the diamond commander, but the

diamond commander has no incentive to take over a resource poor area and settle for a lower income.

Can the leader take any actions to induce the diamond commander to cooperate with replacement and thereby keep the territory commander in line? The leader has two options: (1) the leader can promise to transfer some of the diamond resources to the resource-poor areas; or (2) the leader can threaten *second-order* punishment: the leader can threaten to have the diamond commander replaced if the diamond commander refuses to replace the territory commander.

The first option for the rebel leader fails because he cannot promise to pay a higher wage in the future; once the diamond commander assumes her new post, her wages will fall until she is indifferent between choosing a_{1T} and a_{2T}. This efficiency wages will not be enough to compensate the diamond commander's lost diamond revenue. The second option seems more plausible: if the rebel leader can credibly threaten to remove the diamond commander in the next round, the diamond commander should try to protect a future stream of income by cooperating in the present round. But second-order punishment fails when the natural resources are sufficiently more valuable than the civilian resources.

Without a credible threat to replace the territory commander, the leader has two choices: the leader can pay a wage, w_T, to the territory commander such that $w_T = V_T$; or the leader can pay 0 to the territory commander and accept the loss of control. This leads to the following proposition:

Proposition 4.2. *Any equilibrium in which the leader exerts control over the territory commander is a knife-edge equilibrium and only exists under perfect information.*

Proof. See Appendix. □

In groups dependent on bottom-up resources, the territory commander has

free-reign over the countryside while the diamond-rich commander is forced to cooperate with the leader's requests. The leader keeps the diamond-rich commander in line by credibly threatening to replace her with the territory-based commander—who is always willing to cooperate.

Given this situation, the diamond-rich commander has an incentive to collude with the territory commander: the diamond-rich commander could offer payments to the territory commander in exchange for the territory commander's refusal to cooperate with any replacement. The territory commander would benefit from extra payments (since replacement does not occur in equilibrium) and the diamond-rich commander would be able to loot the diamond fields without fear of losing her post.

4.2 Side-Payments and Commander Collusion

Consider some side payment, b, that the diamond commander offers to the territory commander. What kind of payment would be required to form a collusive agreement?

The diamond commander must pay a transfer that equals the territory commander's future expected revenue from the diamond fields, minus the costs of replacement, c. The diamond commander would be willing to spend up to the point where she is indifferent between accepting w_D in every round or earning V_D in every round minus the side-payment, b. Would the diamond commander be willing to make a transfer large enough to prevent T from replacing her?

Proposition 4.3. *A mutually beneficial side-payment always exists.*

Proof. See Appendix. □

Commander collusion is always beneficial for the commanders. Both the diamond commander and the territory commander would benefit by some transfer

of wealth. Some b always exists that allows the diamond commander to seize control of the diamond wealth without fearing replacement by the territory commander. But there is a problem in this logic: If D provides a large sum of money up front to buy T's support, T can renege on the agreement and replace D in the next round. The absence of enforceable contracts limits the ability of these commanders to collude.

Collusion becomes more feasible if the diamond commander can rely on social institutions—such as shared ethnicity, friendships, kinship networks, etc...—to make credible the promise of future payments to the territory commander. These enforcement mechanisms would allow both commanders to benefit, while starving the rebel leader of income. Considering the potential for collusion, a rebel leader in a resource-rich environment has an incentive to *prevent* the formation of linkages and social networks between his commanders. Instead, the leader would promote ethnic heterogeneity and discourage training or any forms of socialization. Commanders would tend not to have common histories or prior friendships, and social networks between commanders would be limited.

4.3 Imperfect Information and Noisy Observables

Rebel leaders often lack good information about the actions of their commanders. The problem of imperfect information is especially acute when dealing with valuable natural resources. A rebel leader can observe the amount of diamonds he receives each period, but may be uncertain as to whether the diamond commander is actually sending all the diamonds up the chain of command. Low diamond output may result from corrupt behavior on the part of the diamond commander, or may be due to natural causes.

To model this uncertainty, suppose that when the diamond commander chooses a_{1D}, the rebel leader only receives the payout V_D with some probability,

p, and receives nothing with probability $(1-p)$. If the diamond commander chooses a_{2D}, the leader receives 0 with certainty. Assume that the leader can perfectly monitor the territory commander, as before.[8]

Consider an equilibrium similar to the one above, but where the rebel leader withholds payment and attempts to replace the diamond commander whenever the leader receives 0. Under what conditions will this equilibrium hold?

Proposition 4.4. *Under imperfect information, an equilibrium exists in which the rebel leader controls the diamond commander by employing a trigger strategy, replacing the commander whenever diamond revenue falls below V_D.*

Proof. See Appendix. □

Under conditions of imperfect information, the leader has a more difficult time exerting control over his commanders. The territory commander remains beyond the leader's control, but now the diamond commander has a greater incentive to withhold revenue from the rebel leader. To maintain credibility, the leader must replace the rebel commander whenever diamond revenue falls below a critical threshold, in this case V_D. Commander replacements occur in equilibrium even though the diamond commander's behavior on the equilibrium path involves always choosing a_{1D}.

4.4 Discussion

The model yields several observable implications for conflicts rich in lootable natural resources. First, we should expect to see a lack of control and leader oversight in resource-poor areas. Whether or not this results in predatory behavior depends on the time horizon of the commander. Second, resource-rich areas should be tightly and effectively controlled by the rebel leader. Third,

[8] Of course it is possible to introduce imperfect information for all commander actions, but this becomes notationally tedious without adding any insight.

resource-rich groups should be ethnically-heterogeneous and display low levels of training. Fourth, imperfect information results in a periodic replacement of diamond commanders. Fifth, imperfect information makes territory commanders more likely to engage in predatory behavior. Although the leader has limited control over the territory commander even when information is perfect, the periodic replacements mean that territory commanders will expect to assume control over the diamond fields at any moment. The incentives to create effective systems of taxation and governance are severely reduced; looting and predation become dominant strategies.

Periodic replacement of diamond commanders benefits the leader by reducing the threat of rivals and allowing for firm control over the diamond fields. Similar replacement strategies are observed in government foreign services and corporate programs to limit white-collar crime. This implication should be observable in actual conflicts. The Truth and Reconciliation Committee report on Sierra Leone describes several incidents where RUF commanders were dispatched to arrest or punish other RUF officials accused of stealing diamonds. In one instance, senior RUF commanders arrested Johnny Paul Koroma, the former head of the AFRC government, and forced him to hand over US$15,000 in stolen diamonds. On another occasion, two high-level RUF commanders, Sam Bockarie and Mike Lamin, fought Issa Sesay, the overall RUF commander, because of suspicions that Sesay stole 14 diamonds (TRC 2004: Vol 3B, p. 29).

A brief look at available quantitative data also provides some support for this prediction. Humphreys and Weinstein's (2006) randomized survey of excombatants in Sierra Leone provides annual location information for approximately 391 RUF fighters for the period 1996-2000. Combining these surveys with GIS data on diamond field locations (DIADATA) reveals that RUF fighters in diamond-rich chiefdoms experienced a 59.1% annual transfer rate out

of the diamond areas; fighters in diamond-poor chiefdoms only faced a 47.7% transfer rate. Using a two-sample t-test, this difference is statistically significant (p=.007). Although provocative, these data do not necessarily support the model proposed here; rebels in diamond areas may face higher transfer rates for a number of reasons. Additional work is required to assess these competing hypotheses.

5 Civilian Resources

Rebel leaders that possess only civilian resources must decide how to optimally extract revenue from civilians who may flee or halt productive activities. Depending on the leader's time horizon, either looting or taxation could be optimal strategies. The leader's time horizon, however, does not ultimately determine how the group will behave vis-a-vis the civilian population. The leader must delegate authority to commanders to collect revenue from the citizens in the rebel territory. These commanders may have preferences different from those of the rebel leader, and always have an incentive to withhold payment.

Returning to the basic model of rebel organization, suppose there exists a Leader, L, and two commanders, C_1 and C_2. Both commanders preside over a territory containing civilians and all resources come through either taxing or looting the civilian populations.

To model the exclusive reliance on civilian resources, I assume $\Pi_i = V_i$. For simplicity I assume each commander presides over equal civilian resources, thus $V_1 = V_2 = V$.

Notice that the rebel leader adds no resources to the group; the leader can only generate revenue by extracting resources from his commanders. The commanders only have an incentive to turn money over to the rebel leader if they fear being replaced. This depends on the leader being able to *credibly* threaten

to replace a particular commander if that commander chooses a_{2i}.

Is the leader's threat to replace a commander credible? If both commanders possess equal resources, neither commander has an incentive to bear the costs of replacing the other. The leader, therefore cannot credibly threaten replacement. This lack of punishment implies the following class of equilibria:

S_{Ci}: Choose a_{2i} always; never agree to cooperate with replacement.

S_L: Never pay a salary.

These equilibria are fairly pessimistic. Is there any way for the leader to exert control? The leader can induce both commanders to choose a_{1i} only if the leader pays a wage $w_i = V$ to each commander. To maintain control, the leader must transfer all revenue back to his commanders.

Control only occurs in a *knife-edge* equilibrium. Both the leader and the commanders are indifferent between a_{1i} and a_{2i}. More importantly, the equilibrium collapses in the presence of imperfect information. The leader cannot induce his commanders to choose a_{1i} unless: (1) The leader transfers all the revenue back to the commanders; and (2) the leader can perfectly monitor the actions of the commanders. These conditions will never hold in reality.

Rebel groups that depend exclusively on civilian resources must exhibit additional characteristics that are not expressed in this model. Identifying these characteristics is the key to understanding this type of rebel organization.

5.1 Gains from Cooperation

Civilian resources are fundamentally different from natural resources. Unlike the extraction of natural resources, generating revenue from civilian populations depends on a variety of factors. For example, the costs of collecting taxes may depend on the legitimacy of the leader and the rebel organization; civilians would be more willing to pay taxes voluntarily to a leader or group they believe

in. Faced with an illegitimate or violent group, civilians may flee to safer areas, draining the area of civilian resources. Additionally, systems of taxation or even looting may benefit from economies of scale. Coordinating actions across a larger territory could increase total revenue. Considering these benefits, it is reasonable to assume that some additional revenues accrue to the rebel group if the commanders obey the authority of the rebel leader and coordinate their actions.

To model these gains from cooperation, I assume that if both commanders choose a_{1i}, the leader receives a payout of $2(1+\alpha)V$ where $\alpha \geq 0$. If any commander chooses a_{2i}, the payoffs are the same as the basic model. This addition to the model provides a "bonus" when both commanders yield to the rebel leader's control. The leader can maintain control by redistributing some of this bonus, and keeping some for himself. I will first analyze the case of perfect information, and then address commander collusion and imperfect information.

Consider the following equilibrium:

S_{Ci}: Choose a_{1i} in the first round; continue choosing a_{1i} as long as the leader pays w_i in each round. Choose a_{2i} forever if the leader ever fails to pay. Never cooperate with a replacement.

S_L: Always pay w_i after observing a_{1i}. If a_{2i} is observed, attempt to replace C_i.

This equilibrium is sustained so long as the commanders earn $w_i \geq V$ in each round. Commanders have no incentive to disobey the rebel leader. The leader exerts full control, even though his threat to replace the commanders is not credible.

The perfect information model works because the incentives are perfectly aligned. This utopian scenario, however, does not reflect the reality of rebel organizations. Leaders struggle to maintain control of their movement in the

face of imperfect information and potential rivals. The model addresses these concerns by relaxing the assumption of perfect information and assuming commanders can collude to increase their own payoffs.

5.2 Imperfect Information and Collusion

Consider the model above but where choosing action a_{1i} only produces revenue for the rebel leader with some probability, p. Thus if both commanders choose a_{1i} the leader receives expected revenue $p^2 2(1+\alpha)V + 2p(1-p)V$. If only one commander chooses a_{1i} the leader receives expected revenue pV. The leader can observe the payouts from each commander—thus if the leader receives V he knows that a particular commander chose a_{1i} with certainty—but the leader cannot observe the actions of the commanders. Choosing a_{2i} results in payout V to the commander with certainty; in this case the leader receives 0 revenue from that commander.[9]

To add depth to the model, I will add two more modifications.

(1) The commanders can perfectly observe each other's actions;

(2) In every round, each commander can recommend to the rebel leader that the other commander be replaced.

This model creates an information asymmetry between the rebel leader and his commanders: each commander has better information of his own actions, as well as of the actions of the other commander.[10] Commanders therefore can condition their strategies based on the actions of the other commander. Side payments and any type of collusion are allowed, so long as all agreements are

[9]This assumption is reasonable if we expect that commanders would only defect when they are certain to receive a payout. Since commanders are the ones responsible for collecting revenue, they have better information than the rebel leader on the true state of the world regarding payouts in each period. In a repeated context this might overestimate the commander's utility from defecting, since I assume the commander could earn V in every period so long as the commander is not replaced. But since this bias goes *against* my argument, it is not theoretically significant.

[10]This assumption is inspired by Itoh's (1993) model of agent side-contracting with information asymmetries.

self-enforcing.

Consider the following strategies:

S_{Ci}: Choose a_{1i} in the first round and continue choosing a_{1i} so long as the leader pays w_i in each round. Choose a_{2i} forever and refuse to cooperate in future replacements if the leader fails to pay. Recommend that C_{-i} be replaced if C_{-i} chooses a_{2i} but not otherwise. Cooperate with replacement if C_{-i} chooses a_{2i} and the leader has always paid but not otherwise.

S_L: Pay w_i to each commander in every round unless attempting replacement.[11] Never attempt to replace a commander unless replacement has been recommended by the other commander. Always attempt to replace a commander after a recommendation from the other commander.

Any new commander drawn from the pool of potential commanders will begin playing C_i's strategy.

These strategies result in the following payoffs:

$$U_{Ci} = \frac{1}{1-\delta} w_i \tag{4}$$

$$U_L = \frac{1}{1-\delta}(p^2 2(1+\alpha)V + 2p(1-p)V - 2w_i) \tag{5}$$

According to these strategies, the rebel leader maintains control over both commanders. These strategies are significant if they constitute an equilibrium:

Proposition 5.1. *These strategies constitute an equilibrium so long as the gains from cooperation offered by the leader exceeds a critical threshold, $\alpha*$.*

Proof. See Appendix. □

Leaders of rebel groups that depend on civilian resources can control their commanders so long as the leader can create sufficient gains from cooperation,

[11] Since all players are risk-neutral, it doesn't matter if the leader pays an average w_i each period or if the leader pays different $w_i \in W$ depending on the revenue earned in a given period. For simplicity assume the leader pays an average wage regardless of revenue.

either through ideology, foreign connections, or otherwise. Leaders of these groups, therefore, serve mostly as coordination devices between commanders. Notice that with imperfect information and noisy observables, no replacements occur in equilibrium. This stability contrasts with the model of bottom-up natural resources.

The equilibrium where the leader exerts full control over his commanders is not the only theoretically significant outcome of this model. If the gains from cooperation do not exceed a critical threshold, the leader loses control of both commanders. Since the model assumes the rebel group already exists, a loss of control means that the rebel leader is nominally in charge of the group but cannot coordinate its economic activities.

One may argue that this second outcome reveals a weakness of the model: a rebel group is unlikely to form at all if the leader has no control over his subordinates. I argue, however, that this secondary equilibrium sheds light into real world dynamics. Relaxing the assumption of perfect rationality and foresight, a rebel group may be unaware, *ex ante*, of the critical level of gains from cooperation required to maintain a coherent, coordinated group. A rebel group may choose the leader that maximizes α only to discover later that these gains are not enough to constrain their own opportunistic tendencies.

Further, this model only applies to the economic functions of rebel organizations. Even when leaders are not able to control their subordinates' economic activities, they may be able to coordinate tactical offensives—especially when coordinated military operations increase the commanders' opportunities for personal enrichment. Such structurally weak rebel groups are more likely to exist in situations where the startup costs of rebellion are very low (Weinstein 2007). In these situations, a rebel group can destabilize a weak state and capture territory without having to fully resolve the coordination problem among its members..

5.3 The Absence of Commander Coordination

Suppose the commanders cannot observe each other's actions. Assume each commander never recommends replacement, but always cooperates when the leader attempts replacement. The lack of commander recommendations decreases the information available to the rebel leader. To compensate, the leader will play a trigger strategy and attempt to replace a commander whenever revenue from that commander falls to 0. For the threat of replacement to be credible, the leader must pay each commander enough for the commanders to bear the cost of replacement, taking into account that each commander will expect to be replaced in the near future.

How does the lack of commander coordination affect the leader's utility? Under reasonable restrictions, the leader's utility *decreases* when commanders cannot coordinate their strategies in groups that depend on civilian resources. This leads to the following proposition:

Proposition 5.2. *In rebel groups that depend solely on civilian resources, the leader benefits from commander coordination so long as the leader's ability to monitor exceeds a certain threshold,* $p*$.

Proof. See Appendix. □

Rather than being threatened by commander side-agreements, leaders of groups that depend on civilian resources *benefit* from commander coordination. This dynamic differentiates civilian resource groups from groups that depend on bottom-up natural resources.

5.4 Discussion

Information flows between commanders results in credible signals that the leader uses to more effectively pay and punish. Without such coordination, both com-

manders and leader suffer.

Considering the benefits, leaders of rebel groups that depend on civilian resources have incentives to *encourage* cooperation and communication between commanders. These incentives suggest that groups dependent on civilian resources will exhibit traits conducive to information flows and cooperation. These groups will tend to be ethnically homogenous and engage in collective training, with the goal of creating long-term relationships between rebel members. Also, since no replacements occur in equilibrium—even under conditions of imperfect information—these rebel groups will exhibit high levels of stability. This stability induces long time horizons and leads to taxation across the rebels' territory.

The model also implies that rational rebel groups will select leaders who can maximize α. For a group to form, leaders must have some quality that provides advantages for cooperation. If α is not sufficiently large, the leader will lose control of the group.

This model applies well to classic guerrilla insurgencies. Mao Tse Tung and Che Guevara offered ideologies that served as coordination mechanisms between commanders and facilitated tax collection. Training and ideological indoctrination both play a role in fostering commander trust and allowing gains from cooperation to be realized. Rebel groups often select leaders for pragmatic reasons. For example, John Garang assumed control over the SPLA in South Sudan largely because of his links with Ethiopia: Garang could secure training facilities and access to weapons for the incipient rebel group. Even though other potential leaders offered an ideological advantage over Garang, the training allowed the SPLA to create a fairly unified organization in which commanders shared information and coordinated their activities according to Garang's plan (Arop 2006: 67-75).

The model reveals that leaders have incentives to select recruits who are more

likely to foster trust within the organization. Screening mechanisms and costly induction are likely to be part of the training of these groups, which supports Jeremy Weinstein's (2007) theory of rebel organization and recruitment.

Not all leaders, however, are able to solve these control problems. The LURD rebels in Liberia provide an example of how leaders are selected for their group benefits, but also how difficult it is to effectively generate revenue from civilian resources. For their leader, LURD selected Sekou Conneh—a former car salesman with no military experience—because of his links with the Guinean government. Sekou Conneh could purchase weapons and secure a safe haven across the border. He was also less socially divisive than the alternative, Al-Haji Kromah, an intellectual who led the ULIMO rebels during the 1989-1996 conflict.

In the context of the model, Sekou Conneh provided the largest α available to the incipient rebels. Conneh, however, did not add much to the rebel movement besides a steady stream of weapons. Conneh's Mandingo ethnicity and lack of ideology did not encourage civilian cooperation. Conneh and the LURD leadership soon lost control over their commanders and soldiers, who pillaged the countryside. Farming collapsed and domestic trade reduced to a trickle due to the intensity of predation in LURD areas. In 2001, facing a food shortage in Voinjama, the LURD headquarters, the LURD leadership tried to implement a system of passes to encourage trade. The attempt failed; commanders and soldiers continued to loot despite the leadership's direct command to provide safe passage for traders.

6 Top-Down Resources

Top-down resources generate revenues that accrue directly to the rebel leader without risk of expropriation by commanders or other rebel subordinates. Top-

down resources include capital-intensive extraction of kimberlite diamonds, iron ore, or other minerals; large-scale timber operations; or external financing.

Returning to the basic model of rebel organization, suppose there exists a Leader, L, and two commanders, C_1 and C_2. Both commanders preside over a territory. Suppose for the sake of exposition that some foreign firm—a diamond extraction company, for example—operates in the group's territory. The rebel leader has committed to providing security for the firm, which involves restraining the opportunistic behavior of the commanders. Although the commanders have a private incentive to loot the machinery or vehicles of the foreign firm, more revenue can be generated by allowing the firm to operate and extract diamonds on a large scale.

To illustrate the top-down nature of this resource distribution, I require $\Pi_i > V_i$. For simplicity, I assume $\Pi_1 = \Pi_2 = \Pi$ and $V_1 = V_2 = V$.

Payoffs are as follows: Action a_{11} produces revenue Π for the rebel leader and 0 for C_1; action a_{12} produces Π for the leader and 0 for C_2. Actions a_{21} and a_{22} produce 0 for the rebel leader and V for each of the commanders, respectively. As always, the leader has an incentive to induce his commanders to choose a_{1i}, but the commanders have a personal incentive to choose a_{2i}.

6.1 Perfect Information

Consider the following class of strategies:

S_{Ci}: Choose a_{1i} in first round and continue choosing a_{1i} so long as the leader always pays. Choose a_{2i} forever if leader fails to pay. Never cooperate with replacement.

S_L: Pay w_i to C_i whenever a_{1i} is observed. Pay 0 forever if a_{2i} is observed.

Any new commander drawn from the pool of potential commanders will begin playing C_i's strategy.

These strategies result in the following payouts:

$$U_L = \frac{1}{1-\delta} 2(\Pi - w_i) \tag{6}$$

$$U_{Ci} = \frac{1}{1-\delta} w_i \tag{7}$$

Proposition 6.1. *Under perfect information, all equilibria involve leader control over both commanders.*

Proof. If $\Pi > V$, the leader always has an incentive to induce compliance by paying $w_i \geq V$. Both commanders are always weakly better off choosing a_{1i}.[12] Whether or not the leader attempts to replace commanders off the equilibrium path has no effect on payouts since this threat in never credible. □

The rebel leader can induce compliance so long as the wage is *at least as great* as the payoff from defecting. The leader's control over his troops depends on repeated one-shot interactions. Trust is non-existent.

This model, however, fails to consider rivalries and deception within the group. A more realistic picture of rebel behavior emerges under imperfect information.

6.2 Imperfect Information

In the previous equilibrium, the leader could not credibly threaten to replace a commander because the other commander has no incentive to cooperate with the replacement. This lack of enforcement does not affect the leader's payout under perfect information because the leader can always induce compliance. When information is imperfect, however, the leader has a greater need for credible threats.

[12] It may be possible to construct a knife edge equilibrium in which the leader offers $w_i = V$ and the commanders decline this offer, but the leader could simply counter with an offer of $w_i = V + \epsilon$.

Consider the model above but where choosing action a_{1i} only produces revenue for the rebel leader with some probability, p. The rebel leader observes the revenue produced by the commanders but cannot observe the actions directly. If the leader observes 0 payout from a particular commander, what should the leader do? One option for the leader is to only pay a commander when the leader receives Π from that commander's action. This strategy, however, can only induce partial compliance. If a leader simply withholds salaries when commanders' actions do not produce a profit, commanders have a strong incentive to choose a_{2i} whenever they believe their actions will fail to produce Π for the leader.

Commanders possess better information than the rebel leader. For example, if fighting disrupts a train carrying iron ore through a commander's territory, the commander will have good information that the leader will not receive large revenues from iron exports in the near future. Complying with the leader's orders in the near future, therefore, is not in the commander's interests and looting becomes more attractive.

Without a credible threat of replacement, the effectiveness of control in top-down rebel groups depends directly on the monitoring capabilities of the group—represented by p in the model. Where p is high, rebel leaders can rely exclusively on payment schemes, rather than threats to induce compliance. In groups where p is low—because of ethnic fragmentation, rough terrain, etc...—rebel leaders need to be able to enforce their will when necessary. A rebel leader's threat to replace a commander is credible when the *other* commander has an incentive to cooperate. The leader can create these incentives through an additional payment scheme.

Since all agreements within the group have to be self-enforcing, the leader must compensate the commander *in the same round* as the replacement oc-

curs. In addition to w_i, the leader pays the commander a side-payment b to induce cooperation. Since by assumption both commanders receive equal w_i in each round, this side payment is equivalent to the costs of replacement, c. Commander C_i will agree to cooperate with replacement if:

$$b \geq c \tag{8}$$

So long as the rebel leader provides an additional one-time payment, the leader's threat to replace commanders is credible.

Does a leader have an incentive to replace a commander in every round where revenue is 0? Replacing cooperative commanders is a deadweight loss to the rebel leader. If commanders possess better information on the ground, it might make sense for the rebel leader to listen to their suggestions. If a commander reports that another commander is misbehaving, the leader could authorize a replacement.

The problem is that the leader's additional payment to these commanders creates perverse incentives. If a commander can profit by dislodging another commander, the commander's recommendations may not be credible. For example, a commander who controls more resources and therefore earns a higher w_i would be the target of other commanders looking to take his place. Also, a commander might be attracted by the possibility of earning b, even if the payment is intended simply to defray the costs. Top-down leaders cannot trust their subordinates.

6.3 Discussion

Leaders of top-down groups face a shortage of credible information. Leaders control their commanders in a pay-as-you-go system that does not foster trust or mutual cooperation. This equilibrium models the NPFL rebels in Liberia. In

areas of political or economic importance, NPFL commanders were instructed by Charles Taylor to protect civilian property rights in towns and to encourage market activity. In exchange for their compliance, Taylor allowed these commanders to retain *all the revenue* earned through taxation. Occasionally, Taylor would provide additional "tokens" to these commanders—extra payments to reward compliance with particularly costly orders.

What are the implications for training and ethnic heterogeneity in top-down groups? The leader has the incentive and capability to structure his group in any way that maximizes his revenue stream. If better-trained recruits produce more income, the leader will create training programs. But training is costly, so recruits and commanders will only be trained to the extent necessary. The leader therefore might *seek out* commanders with prior training and experience. Since the leader does not rely on trust and is not threatened by the possibility of commander collusion, the leader can recruit skilled subordinates without worry.

This cost-effective recruitment strategy implies top-down groups are more likely to co-opt *existing* government bureaucracies. Top-down groups, even though they are fighting against the state, are likely to allow government bureaucracies to continue to function in their territories—so long as the bureaucrats understand who they are taking orders from. In Liberia the NPFL rebels often recruited former bureaucrats from the Doe regime, using them to administer important towns such as Gbarnga and Robertsport. In Congo, Laurent Nkunda's CNDP rebels allowed government immigration officials to continue their duties. In Sri Lanka, the LTTE coopted large pieces of the government bureaucracy in rebel areas and exert strong influence over government bureaucrats even in government-controlled territory.

To summarize the observable implications, top-down groups will exhibit wide variation in ethnic homogeneity and training, and are more likely than other

types of groups to co-opt government bureaucracies that fall into rebel hands.

7 Conclusion

Rebel groups operate in uncertain, insecure environments. Directly opposed to the state, rebel groups cannot rely on external legal systems to enforce contracts. Self-enforcing contracts must balance the relative power of rebel members, which is determined by the resources each member controls. Leaders have some ability to shape the organization, but a rebel leader must always delegate to commanders who have preferences different from his own.

Different resources create different incentives for group members. Bottom-up resources create strong incentives for commanders to withhold resources for personal enrichment. To maintain control, leaders of bottom-up groups rely on a divide-and-conquer strategy. The leader maximizes his income by encouraging ethnic fragmentation and organizational instability.

Civilian resources respond to rebel behavior. Rebel groups must overcome substantial coordination problems to survive off these resources, especially in poor countries. Where coordination is not sufficiently profitable, fractionalized, predatory groups will emerge.

Top-down resources strengthen leader control. Leaders of these groups secure compliance through payments and monitoring. Trust is unimportant to the group, so leaders may recruit government bureaucrats or previously-trained soldiers to fill their ranks. The leader's control over his subordinates, however, depends on his control over the resources. When rebel commanders establish their own links to top-down financing, the group will fractionalize.

The way in which resources shape self-enforcing agreements has important implications for civilian welfare during conflict and the success of war-to-peace transitions. Why do some rebel groups provide services to the civilian pop-

ulation in exchange for taxes, while other groups are highly predatory? If a rebel leader signs a peace agreement in good faith, will his troops put down their weapons? How do demobilization programs, natural resource embargoes, and other international programs affect conflict? Further research is necessary, but these questions can be answered by examining the ways in which resources shape the organization of rebel groups. The recent shift towards an organizational approach to understanding conflict offers the potential for sustained progress in a new research program, as well as useful insight for mitigating the tragic humanitarian consequences of civil war.

8 Appendix

8.1 Proof of Proposition 4.1

To show that these strategies constitute an equilibrium, I will consider the most profitable one-round defections.

Scenario 1: The Diamond Commander Deviates

Suppose D defects by choosing a_{2D} in the first round. This defection would result in a payoff of V_D the first round, but then the rebel leader and territory commander would replace the diamond commander, yielding a payoff of 0 in subsequent rounds. D's total expected payout for defecting is therefore $U_D = V_D$.

The equilibrium will hold if the defection payout is less than or equal to the equilibrium payout. Thus, $V_D \leq \frac{1}{1-\delta} w_D$.

This implies:

$$w_D \geq (1-\delta)V_D \tag{9}$$

If the rebel leader pays the diamond commander a sufficient wage in each round, the diamond commander can be deterred from looting the diamonds.

But for this to work, both the leader and the territory commander must have an incentive to cooperate with the replacement of the diamond commander, otherwise the threat is not credible.

Consider first the leader's situation: If the leader does not order a replacement, he will expect D to choose a_{2D} in all subsequent rounds, in accordance with equilibrium strategy.[13] Thus the leader must expect higher returns, on the equilibrium path, if he authorizes a switch. The equilibrium holds if:

$$\frac{\delta^2}{1-\delta}(V_D - w_D) \geq 0$$

This condition always holds; the leader's threat to replace the diamond commander is always credible.

The territory commander must also have an incentive to cooperate with the switch. He must bear a cost to replace the diamond commander, but would expect higher returns in subsequent rounds, once in control of the diamond fields. T will cooperate with the switch so long as:

$$V_T - c + \delta V_D + \frac{\delta^2}{1-\delta} w_D \geq \frac{1}{1-\delta} V_T$$

The replacement will occur if the cost is low enough. Specifically:

$$c \leq \delta V_D + \frac{\delta^2}{1-\delta} w_D - \frac{\delta}{1-\delta} V_T \tag{10}$$

Scenario 2: The Rebel Leader Deviates

The rebel leader may be tempted to deviate by attempting to replace the diamond commander after observing a_{1D} and receiving V_D. The leader benefits by withholding w_D from the diamond commander, but will lose some income

[13] Equilibrium strategy dictates that L does not pay D for choosing a_{2D} in round 1 and thus D will choose a_{2D} in all subsequent rounds since the leader failed to pay.

when the next commander chooses a_{2D} in the round following the replacement. The equilibrium will hold if:

$$V_D + \frac{\delta^2}{1-\delta}(V_D - w_D) \leq \frac{1}{1-\delta}(V_D - w_D)$$

Rearranging yields:

$$V_D \geq \frac{1+\delta}{\delta} w_D \tag{11}$$

Scenario 3: The Territory Commander is Replaced

Would the diamond commander ever have an incentive to replace the territory commander? The diamond resources are more valuable that the territory resources, but in equilibrium the diamond commander only receives w_D, not the full value of the diamonds. If the diamond commander has an incentive to replace the territory commander, the equilibrium will not hold. The diamond commander's expected payout for replacing the territory commander must be less than or equal to her expected utility from staying put:

$$w_D - c + \frac{\delta}{1-\delta} V_T \leq \frac{1}{1-\delta} w_D$$

This implies:

$$w_D \geq V_T - \frac{1-\delta}{\delta} c$$

Substituting the minimum wage from inequality (4), $w_D = (1-\delta)V_D$, yields:

$$V_T \leq (1-\delta)V_D + \frac{1-\delta}{\delta} c \tag{12}$$

The diamond commander is less likely to cooperate with a replacement as the value of the diamonds relative to the territory increases, or as the cost of the switch increases. Even if replacement is costless, the diamond commander

will refuse to cooperate if the per-period value of the diamond fields exceeds the total expected revenue from taxing or looting the civilian population.

To summarize, the equilibrium will hold if the following inequalities are satisfied:

$$w_D \geq (1-\delta)V_D$$

$$c \leq \delta V_D + \frac{\delta^2}{1-\delta} w_D - \frac{\delta}{1-\delta} V_T$$

$$V_D \geq \frac{1+\delta}{\delta} w_D$$

$$V_T \leq (1-\delta)V_D + \frac{1-\delta}{\delta} c$$

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How robust is this equilibrium? Consider a situation where the value of the diamonds greatly exceeds the value of taxing or looting the territory. Substituting $V_T \approx 0$ and the minimum wage, $w_D = (1-\delta)V_D$, into the relevant constraints yields:

$$c \leq \delta(1+\delta)V_D$$

$$\delta^2 + \delta - 1 \geq 0$$

The equilibrium will hold when the diamond fields are sufficiently valuable and when the discount rate is reasonably high: $\delta \geq .62$.

8.2 Proof of Proposition 4.2

If the leader's threat to replace the territory commander is not credible, the leader would have to pay the commander enough in each round to make the commander indifferent between choosing a_{1T} and a_{2T}. This payment would be equivalent to V_T in each round. To exercise control over the commander, the leader would have to hand over *all* the revenue generated by the commander.

Thus any equilibria involving the territory commander choosing a_{1T} are *knife-edge* equilibria in which both the commander and the rebel leader are indifferent between action choices. More importantly, these knife-edge equilibria only exist under conditions of perfect information. Any imperfect monitoring or noisy observables create a situation where the leader must pay a wage $w_T > V_T$ whenever V_T is observed. The leader cannot exercise control without decreasing his utility. Control in the countryside is simply too costly to achieve.

But perhaps there is a way for the leader to credibly threaten to replace the commander; the leader could adopt a strategy of *second-order* punishment. Suppose the leader approaches the diamond commander with an ultimatum: Agree to replace the territory commander in this round, or I will ask the territory commander to replace *you* in the next round.

Does this second-order punishment create a credible threat and increase the leader's control?

Assuming the diamond commander believes the leader's threat, he faces a choice between one shot at looting the diamond fields, or bearing the costs of replacement and assuming the resources of the territory commander. The job of the territory commander is less appealing in this scenario, since this new equilibrium assumes both commanders choose a_{1i} and receive w_i in compensation; the territory commander can no longer loot with impunity, except for the first round after the replacement. The diamond commander will cooperate with replacement if:

$$w_D - c + \delta V_T + \frac{\delta^2}{1-\delta} w_T \geq w_D + \delta V_D$$

Rearranging yields:

$$w_T \geq \frac{1-\delta}{\delta}(V_D - V_T) + \frac{1-\delta}{\delta^2} c$$

After assuming the territory commander's post, the diamond commander can only expect to receive the minimum wage necessary to induce him to choose a_{1T} in each round: $w_{Tmin} = (1-\delta)V_T$. Substituting this minimum wage into the above expression results in a condition on V_T:

$$V_T \geq \frac{1}{1+\delta}V_D + \frac{1}{\delta(1+\delta}c \tag{13}$$

As the diamond fields become more valuable relative to the value of the territory, and as the cost of replacement increase, the diamond commander is less likely to cede to the leaders demands.

But the question still remains: is the leader's threat for second-order punishment credible? The leader will earn additional revenue from the territory commander if he can credibly threaten to replace him. But the leader will lose revenue from the round of looting that follows the replacement. For the leader's threat to be credible the following condition must hold:

$$V_D - w_D + \frac{\delta^2}{1-\delta}(V_D + V_T - w_D - w_T) \geq \frac{1}{1-\delta}(V_D - w_D)$$

Rearranging and substituting the minimum wages, $w_i = (1-\delta)V_i$, yields:

$$\frac{\delta}{1-\delta}V_T \geq V_D \tag{14}$$

The leader's threat of second order punishment is only credible is the discounted total revenue stream from the territory exceeds the per-period value of the diamond fields. If diamonds are much more valuable than the revenues from taxation and looting, the leader cannot credibly threaten to punish the diamond commander for failing to replace the territory commander. As before, the diamond commander remains in her post, choosing a_{1D} in exchange for a

wage, while the territory commander controls the countryside without leader interference.

8.3 Proof of Proposition 4.3

If T expects a switch to occur, T will expect to earn V_D in the next round (after bearing cost c), and w_D every round thereafter. Thus to make T indifferent between cooperating in a switch or not, D must offer T a transfer that satisfies the following:

$$b \geq V_T - c + \delta V_D + \frac{\delta^2}{1-\delta} w_D - \frac{1}{1-\delta} V_T$$

Simplifying and substituting the minimum wage, $w_D = (1-\delta)V_D$, determines the following condition on b:

$$b \geq \delta(1+\delta)V_D - \frac{\delta}{1-\delta} V_T - c \tag{15}$$

Would D be willing to spend this amount? The diamond commander would be willing to spend up to the point where she is indifferent between accepting w_D in every round or earning V_D in every round minus the side-payment, b. Thus:

$$b \leq \frac{\delta}{1-\delta} V_D$$

These two conditions on b imply that mutually beneficial bargaining should occur so long as:

$$c \geq \frac{-\delta^3}{1-\delta} V_D - \frac{\delta}{1-\delta} V_T$$

The right side of the inequality is less than zero for all $\delta, V_i \geq 0$, thus the condition always holds. Commander collusion is always beneficial for the commanders.

8.4 Proof of Proposition 4.4

In each period that the diamond commander chooses a_{1D} the diamond commander will expect to receive w_D with probability p. The commander will also only expect to advance to the next period with probability p. The diamond commander's expected utility from choosing a_{1D} is therefore:

$$U_D = \frac{p}{1-\delta p} w_D$$

The diamond commander will choose a_{1D} so long as this exceeds her payoff from choosing a_{2D} and being immediately replaced. Equilibrium will hold, therefore, if:

$$\frac{p}{1-\delta p} w_D \geq V_D$$

Which implies a wage:

$$w_D \geq (\frac{1}{p} - \delta) V_D \tag{16}$$

Notice that this is higher than the wage under perfect information, $w_{Dpi} \geq (1-\delta)V_D$, since $p \in [0,1]$.

As before, the rebel leader and the territory commander must each have incentives to replace the diamond commander for the leader's threat to be credible.

Consider first the rebel leader. Suppose the leader observes 0 and replaces the diamond commander. In the next round he will earn 0 with certainty, followed by an expected payout of $p(V_D - w_D)$ in the third round, and so on. This utility must be at least as great as the utility from allowing the commander to stay and receiving nothing in all rounds. Not surprisingly, this condition holds for all $V_D \geq w_D$. The leader always has an incentive to attempt to replace the diamond commander.

The territory commander's decision is more difficult. If the territory com-

mander agrees to replace the diamond commander, the territory commander will control more valuable resources, but will expect to eventually be replaced.

If the territory commander agrees to cooperate in the replacement, the commander will earn:

$$U_T = V_T - c + \delta V_D + \frac{\delta^2 p}{1 - \delta p} w_D$$

For equilibrium to hold, this value must exceed his expected utility from staying put: $\frac{1}{1-\delta} V_T$. Equilibrium is maintained so long as the cost of replacing the diamond commander is not too high:

$$c \leq \delta V_D + \frac{\delta^2 p}{1 - \delta p} w_D - \frac{\delta}{1 - \delta} V_T \tag{17}$$

Is the leader's promise to pay the diamond commander credible? As before, the leader's most profitable deviation is to withhold payment and replace the diamond commander after observing V_D. The leader would earn V_D the first round, 0 the second round due to the replacement, and then return to normal equilibrium payouts. Thus the leader's utility from deviating can be written:

$$V_D + \delta^2 U_{Leq}$$

This utility must not exceed equilibrium payout, thus:

$$V_D + \delta^2 U_{Leq} \leq U_{Leq}$$

Rearranging yields:

$$V_D \leq (1 - \delta^2) U_{Leq}$$

The leader's equilibrium utility is[14]:

$$U_{Leq} = \frac{p}{1 - \delta p - \delta^2(1-p)}(V_D - w_D)$$

Combining these expressions and simplifying gives:

$$w_D \leq (\frac{1+2\delta}{1+\delta} - \frac{1}{p})V_D \tag{18}$$

Substituting the minimum wage, $w_D = (\frac{1}{p} - \delta)V_D$, gives the final constraint for equilibrium to hold:

$$p \geq \frac{2(1+\delta)}{1+3\delta+\delta^2} \tag{19}$$

The equilibrium is supported by an increase in monitoring abilities (i.e. the leader's ability to detect commander corruption) or an increase in the discount factor.

8.5 Proof of Proposition 5.1

To show that these strategies indeed constitute an equilibrium, I will consider possible one-round defections for each player.

Scenario 1: Commanders collude by both choosing a_{2i} ***and not cooperating with replacement***

If both commander choose a_{2i} they can collude against the leader and maintain their positions, earning V every round. But for this collusion to hold, neither commander must have an incentive to replace the other. If the leader can pay a high enough wage, he can create an incentive for the each commander to police the other commander and cooperate in the replacement of troublesome commanders. This implies that the expected payout of cooperation, minus the

[14]The leader's equilibrium utility can be derived from a recursive expression: $U_{Leq} = p(V_D - w_D) + \delta p U_{Leq} + \delta^2(1-p)U_{Leq}$

costs of replacement, must be at least as great as the chance to earn V in every period.[15] This implies:

$$\frac{1}{1-\delta}w_i - c \geq \frac{1}{1-\delta}V$$

Rearranging yields:

$$w_i \geq V + (1-\delta)c \tag{20}$$

Notice that this wage is higher than the amount the commander could earn in each period by defecting. The leader, however, faces a liquidity constraint: he cannot pay the commanders more than he earns. His total wage bill for both commanders, therefore, cannot exceed his total expected revenue. This implies:

$$U_L = \frac{1}{1-\delta}(p^2 2(1+\alpha)V + 2p(1-p)V - 2w_i) \geq 0$$

Substituting the minimum wage, $w_{i,min} = V + (1-\delta)c$, yields the following condition on α:

$$\alpha \geq \frac{1-\delta}{p^2}\frac{c}{V} + \frac{1-p}{p^2} \tag{21}$$

The leader can only maintain control of the group if the value added from his coordinated efforts is sufficiently large. Control becomes easier as δ, p, and V increase, or as c decreases.

What other defections might undermine the equilibrium? Notice that neither commander has an incentive to replace the other commander unless the commander defected; the commanders need not fear being double-crossed. The leader, however, may have an incentive to withhold payment to one or both commanders.

Scenario 2: The leader defects by withholding payment

The leader may defect by withholding payment from one or both comman-

[15] Again, since players are risk-neutral it doesn't matter if the rebel leader pays an average wage or a revenue dependent wage. For simplicity assume an average wage.

ders. If the leader withholds payment from both commanders, his future revenue stream will go to zero in the next round, since the commanders will both revert to a_{2i} and will refuse to cooperate in replacements.

A better defection involves the leader withholding payment from one commander and then replacing the commander in the next round. The leader has to wait for the commander to choose a_{2i} before replacement in order to gain the cooperation of the other commander. For equilibrium to hold, the savings from withholding w_i cannot exceed the lost revenue from the round in which a_{2i} is chosen:

$$w_i \leq p^2 2(1+\alpha)V + pV$$

Substituting the minimum wage, $w_i = V + (1-\delta)c$, yields:

$$\alpha \geq \frac{1-\delta}{2p^2}\frac{c}{V} + \frac{1-p}{2p^2} - 1 \tag{22}$$

Notice that this condition on α is strictly smaller than the previous condition on α. This implies:

$$\alpha* = \frac{1-\delta}{p^2}\frac{c}{V} + \frac{1-p}{p^2} \tag{23}$$

So long as $\alpha \geq \alpha*$, the leader's promise to pay the commanders is credible.

8.6 Proof of Proposition 5.2

For the threat of replacement to be credible, the leader must pay each commander enough for the commanders to bear the cost of replacement, taking into account that each commander will expect to be replaced in the near future. This implies:

$$\frac{1}{1-\delta p}w_i - c \geq \frac{1}{1-\delta}V$$

Rearranging yields:

$$w_i \geq \frac{1-\delta p}{1-\delta} V + (1-\delta p)c \tag{24}$$

Notice that this wage is higher than the wage required under commander collusion. The leader, however, does not expect to pay this wage in every round. The leader's expected utility is:

$$U_L = \frac{1}{1-\delta}(p^2(2(1+\alpha)V - 2w_i) + 2p(1-p)(V - w_i))$$

Rearranging yields:

$$U_L = \frac{1}{1-\delta}(p^2 2(1+\alpha)V + 2p(1-p)V - 2p(1+p)w_i) \tag{25}$$

The leader's utility is *higher* under commander collusion so long as $p(1+p) \geq 1$, or $p \geq .62$.

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