WHO JOINS AND WHO FIGHTS? EXPLAINING TACIT COALITION BEHAVIOR AMONG CIVIL WAR ACTORS

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Abstract. This paper explores tacit coalition behavior among civil conflict actors. We introduce the concept of tacit coalitions, which pertains to strategic and informal coalition behavior between civil war actors. Our main argument is that armed groups form tacit coalitions because they want to reap benefits from complementarities they may have. Our theoretical model sheds new light on how concerns about sharing the spoils of fighting leads to organizations of equal strength joining forces more often. The model also highlights the role of heterogeneity of complementarities for reducing the equilibrium space of feasible coalitions. The empirical section finds considerable support for our theoretical argument that actors are more likely to engage in sustained coalition behavior if they have high complementarities in a heterogeneous environment.

1. Introduction

The Arab spring, and especially the conflict in Syria, have raised awareness among a wide audience that civil conflicts involving a large number of factions can be protracted and complicated to solve. In fact, scholars of civil conflict have found that this pattern holds more generally (Cunningham, 2006). Despite this empirical regularity, to date we know surprisingly little about how conflicts with multiple actors unfold, when and why actors regroup to form larger coalitions, and under which conditions multi-actor civil war can be brought to an end. While a first wave of quantitative works in the late 1990s and early 2000s has identified general determinants of civil war dynamics on the nation state level (Fearon and Laitin, 2003; Bates et al., 2006; Collier and Hoeffler, 2000; Gleditsch et al., 2002; Hegre, 2001), more recently scholars have begun to pay attention to interactions between specific rebel groups and the government. These dyadic approaches (Cunningham, Gleditsch and Salehyan, 2009; Wucherpfennig et al., 2012) stress that we need to focus our theoretical and empirical attention on the interactions among civil conflict actors. Although the dyadic approach has produced important insights in our understanding of conflict dynamics, it still ignores complex interactions that affect conflict behavior in the presence of multiple actors. Addressing multiple actor settings in civil conflict has produced a new research agenda on rebel coalitions (Bapat and Bond, 2012; Christia, 2012) and fragmentation (Cunningham, 2011; Bakke, Cunningham and Seymour, 2012; Cunningham, Bakke and Seymour, 2012; Pearlman and Cunningham, 2012). A very promising way of analyzing these multiple actors settings theoretically and empirically is a network perspective (Metternich et al., 2013*a*; Metternich and Wucherpfennig, 2009). However, these early network approaches about strategic behavior in the presence of multiple actors do not take into account why rebel organizations join coalitions in the first place.

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Rebel groups frequently form coalitions to fight common opponents, e.g. the government or other rebel coalitions (Christia, 2012). However, rebel coalitions are rarely formalized and common attacks against the government can be the consequence of strategic behavior (e.g. outbidding) rather than coordination. Furthermore, as fortunes change and power shifts between actors, rebel coalitions often are transient and subject to breakup (Christia, 2012). In this article, we introduce the concept of tacit rebel coalitions to analyze and explain coalition behavior between rebel organizations. This article presents to our knowledge the first work that integrates an n-actor game-theoretic approach with k-adic analysis of rebel coalition formation and breakup. The goal is to identify and test which factors systematically contribute to the formation and breakdown of coalitions in civil conflict. We provide an argument that whether rebel organizations form coalitions is dependent on the expectation of (1) whether a particular coalition is able to win a conflict and (2) whether an organization will gain from battle field victory once the spoils are distributed among coalition members. For example, if rebel organizations believe they will not attain an adequate share of political power after the coalitions has won, this coalition might not be attractive to join in the first place. Modeling this dynamic allows us to provide new empirical implications of which rebel organizations are most likely to form coalitions and the characteristics realized coalitions take. We propose that tacit coalitions of rebel organizations are characterized by balanced and viable coalitions against the government.

1.1. *Tacit coalition dynamics in civil wars: Looking at Syria*

To illustrate the importance of coalition dynamics, consider the example of Syria. With up to 1000 active armed groups, the number of actors in the Syrian conflict is staggering.[1] Despite this plethora, clear coalition structures emerged within a year of the original uprising in 2011, and important changes to this structure have occurred since. Early in the conflict, the Free Syrian Army established itself as main opposition force to the Syrian government. Consisting of independent local units at the beginning, after pressure from outside supporters (mainly Saudi Arabia and Qatar), these groups unified in December 2012 under the umbrella of the Supreme Military Council (SMC).[2]

Around the same time, the Syrian Islamic Liberation Front (SILF) formed, unifying up to 20 Islamist rebel groups. Importantly though, the SILF aligned itself with the SMC, resulting in a grand coalition of the main secular and Islamist opposition forces. The SILF went on to become the most effective fighting force in this phase of the conflict. It eventually dissolved, with most of its members joining the newly created Islamic Front in Dec 2013. This event marked the end of the coalition between secular and Islamist forces, as the Islamic Front stopped cooperation with the SMC.[3]

Beside the SILF, the Islamic Front also absorbed another major group of Islamist fighters, the Syrian Islamic Front (SIF), which never had aligned with the SMC. The SIF had formed in December 2012, incorporating around 10 Islamist groups under the leadership of the Salafist group Harakat Ahrar al-Sham al-Islamiyya, unified 10 other Islamist groups. In addition to the major secular and Islamist forces, other important actors in the Syrian theater are Kurdish groups, the al-Qaeda affiliated al-Nusra front, and more recently the

[1]Source: http://www.bbc.com/news/world-middle-east-24403003), accessed July 30, 2014.
[2]Source: http://www.nytimes.com/2012/12/08/world/middleeast/rebel-groups-in-syria-make-framework-for-military.html?_r=0, accessed July 30, 2014.
[3]Sources: http://www.reuters.com/article/2012/10/11/us-syria-crisis-rebels-idUSBRE89A0Y920121011, http://www.bbc.com/news/world-middle-east-25053525, both accessed July 31, 2014.

al-Qaeda offspring Islamic State of Iraq and Syria (ISIS). Neither of the latter has entered a coalition with the former as of yet.

The breakaway of SILF as most effective fighting force from the SMC markedly weakened the secular opposition in the Syrian conflict. In addition, the breakup is a major obstacle for the ability of outside actors such as the US and European countries to facilitate negotiations between the regime and the opposition. It further complicates Western efforts to bolster the military standing of the secular forces. The episode illustrates the importance of understanding the causes of coalition formation and breakup. Of similar importance are the questions under which conditions the Islamic Front would be willing to join forces with ISIS, and to what extent separatist objectives continue to prevent Kurdish groups of aligning with any of the major groups in the conflict. Either of these moves would fundamentally alter the balance of power and the terms of any possible peace deal in Syria. Our theory of coalition formation seeks to provide some answers to these questions.

1.2. *Bringing coalition theory to civil wars*

Our theoretical model draws on a well established body of models of coalition formation (Esteban and Ray, 1999; Ray, 2007; Hyndman and Ray, 2007) and contest games (Hirshleifer, 1989; Tan and Wang, 2010). We assume that coalitions form to increase the chances of winning in a conflict environment. An important insight from the theory of coalition formation is that binding coalitions imply that all members of the coalition need to agree to join forces (Ray, 2007). Once this agreement is in place, we assume that coalition members fight together. Under these conditions, the coalition formation process reduces to a coordination game. Rebel groups propose to join forces in a coalition, but the coalition is only realized when all members agree. We allow the spoils from fighting to be either distributed evenly among coalition members, or to reflect future infighting (in which case expected spoils are distributed according to the relative strength of the coalition members in expectation).

Our main argument is that groups form coalitions because they want to reap benefits from complementarities. That is, fighting together results in increases in military capacity that are greater than the sum of the constituent groups' strengths (super-additivity). Sources of such synergies include geographic advantages and the ability to establish unified control and command structures. For example, groups that recombine to open up a second front will be able to project more power against a common foe than two groups that operate in approximately the same area. Likewise, inter-group coherence allows for executing military maneuvers that rely on a high degree of compliance with a centralized command structure and self-discipline. We explore how variation in the distribution of complementarities across a network of rebel groups affects which coalition profiles are viable in equilibrium. Generally speaking, the greater power differentials between the groups in a conflict and the larger the absolute degree of synergies, the lower becomes the number of coalitions that can be formed. In addition, as complementarities among groups become more heterogeneously distributed, coalitions that were previously tenable become unattractive, and organizations seek out new coalitions with more compatible allies. That means that a shift on any of these dimensions away from a balance of power and towards more heterogeneity (e.g. through the battle fortunes of one party, or changes in the geographic disposition of troops) is likely to undermine existing coalition structures.

We use these theoretical considerations to derive a number of testable predictions how the relative size of groups and their distribution of military capacities vis-a-vis the state affects the formation of tacit coalitions. Our paper contributes to the growing network–theoretic study of civil conflict by paying attention to the strategic incentives and choices that actors pursue when forming coalitions. Thus, tacit coalition behavior is a result of strategic considerations in the context of mutual interdependencies. More generally, our work speaks to demands of paying closer attention to the dynamics of conflicts involving more than two actors (Poast, 2010), by moving beyond dyadic analysis by incorporating coalition structures in our theoretical and empirical models.

Finally, our integration of a game-theoretic coalition model with empirical network analytic tools provides a viable template for other areas of research beyond civil war. Our approach is applicable in a wide variety of settings where actors can gain from recombining forces where relationships are conflictual. Examples include trade block formation in international political economy, interest group politics and party competition in comparative politics, and political participation, friendships, and social engagement on the individual behavioral level.

In the remainder of this paper we first ground our theory in the existing coalition formation and network literature, and develop our formal model of coalition formation. We then present results from the analysis of our game and derive testable hypotheses. In subsequent sections we introduce our empirical approach, discuss our data, and present findings from the statistical analysis. We conclude our paper with a discussion of our results and implications for future research.

2. Formal approaches to coalition behavior

The standard workhorse tools in the study of conflict are bargaining models that attribute fighting to imperfections such as informational asymmetries, commitment problems, principal agent problems and non-continuities in bargaining spaces (e.g. Fearon, 1995, 2004; Walter, 2009). While these approaches have been successfully employed in the study of civil war, they mostly focus on interactions between two actors (for an overview see Blattman and Miguel, 2008). A principal obstacle to extending this agenda to more than two actors is that, as n increases to 3 and larger, non-cooperative bargaining games become more sensitive to specific game forms. A folk–theorem like result due to Herrero (1985) demonstrates that in Rubinstein bargaining with several players,[4] a multiplicity of equilibria exist, including inefficient equilibria in which some or all of the contested pie is destroyed.[5] Not surprisingly, existing works that use a multi-player setup work around this problem by restricting the bargaining protocol, use of history dependent strategies, or doing away with some of the non-cooperative assumptions of Rubinstein bargaining.

An early example of this is Chae and Yang (1994). The authors demonstrate that if players can write binding bilateral contracts to forgo participation in the bargaining process (with a side-payment allocated at the end), a unique equilibrium exists. This model provides a natural mechanism for endogenous coalition formation. It also highlights the ability to write binding contracts as important for the study of coalition formation in the context of civil war since coalitions frequently break up. The issue of binding agreements is also at the heart of Ray's 2007 theory of coalition formation. He deviates from a pure non-cooperative perspective on multi-player bargaining, by allowing for non-cooperative endogenous formation of coalitions with the possibility of binding agreements (the cooperative

[4]Rubinstein bargaining implies infinitely repeated play and allows for use of history dependent strategies.

[5]A good exposition of this result can be found in Ray (2007:section 4.4.3).

part). Drawing on this framework of binding coalitions, Hyndman and Ray (2007) establish broad conditions under which bargaining among 3 players over the division of a pie always converges to an efficient (i.e. non-conflictual) outcome. However, this result does not hold as n increases to 4.

Since binding agreements play such a prominent role, a number of works explore how different decision aggregation rules and payoff structures affect coalition formation and bargaining outcomes. For example, Manzini and Mariotti (2005) show that coalitions drive a harder bargain when coalition decision making follows unanimity instead of majority procedures. At the same time unanimity ensures bargaining efficiency. However, in the presence of asymmetric information about the relative strength of coalition members unanimity might not be sufficient to ensure efficient bargaining outcomes (Manzini and Mariotti, 2009).

The aim of our project is to analyze the strategic considerations that go into the decision to form coalitions in the violent environment of civil conflict. We are particularly interested in the effects that recombining forces has on the relative strength of combatants, and how the decision to pool capabilities is affected by the coalitional choices of other actors. We therefore do not to explicitly model the bargaining processes that drive coalition formation, or the procedures used in collective decision making. Instead we follow the notion of binding coalitions introduced by Ray (2007), and require that a coalition only forms once all members to the coalition agree to join forces.[6] Once that agreement is in place, the coalition acts together. However, we use an additional payoff scheme to model the possibility of future breakup, as we discuss in more detail below. We therefore essentially treat coalition formation as a coordination problem.[7] Rebel groups have strategies over coalitions, and must make coalition decisions in a single-shot normal form game. If there is disagreement about the membership of a coalition, each rebel group implicated in the coalition continues to act independently.

Conflict games form a second important source for modeling civil war. Conflict games depart from the bargaining approach by treating conflict as a given, ignoring the causes of bargaining breakdown. They typically explore how actors optimally choose to allocate their resources to optimize their chances of winning. Beginning with Hirshleifer (1988, 1989), at the core of actors' utilities from fighting is the Contest Success Function (CSF) that maps fighting capability or effort into winning probabilities. A number of works use this analytical framework to explore the propensity for conflict in multi-actor societies, (Esteban and Ray, 1999, 2008), and collective effort exerted in an coalition under threat (Niou and Tan, 2005).

Most interesting to our work are pieces that explore how individual actors strategically form coalitions to recombine forces in a conflict environment. Tan and Wang (2010) study the endogenous formation of coalitions in a conflict game. To relax the assumption of binding coalitions, they allow for continuing conflict, where the members of the winning coalition turn on each other to fight for the spoils. They find that equilibrium coalition structures exhibit balancing behavior as well as a tendency for actors to form not more than

[6]The concept used by Ray (2007) is somewhat stronger in that it requires unanimity of members to dissolve a coalition. Ray uses an infinitely repeated game setup, and this unanimity requirement is therefore necessary to ensure the binding character of agreements. Since we employ a single-shot framework we do not have to make this assumption.

[7]This is similar to the multilateral bargaining setup in Bennett (1997). For our purposes, this is a reasonable approximation, for two reasons. First, we rarely observe the actual process of coalition formation, and thus have not data to study it. Second, the dynamics of the formation process are of secondary importance to the extent that we are interested in how the structure of the conflict influences the incentives of rebel groups to fight as a coalition.

two coalitions. In contrast, Esteban and Sákovics (2003) find the opposite result, where no two players ever pool their resources to form a coalition. Tan and Wang (2010) speculate that these differences are due to whether recombining forces leads to super-additive strength or not. In addition, Esteban and Sákovics model conflict not as contest for a pie, but for positions in a policy space and they endogenize expended effort, whereas Tan and Wang hold effort fixed.

Similarly to Tan and Wang (2010), we embed the coalition coordination problem in a conflict environment. Thus, for individual players payoffs arise from the expected outcome of fighting between the coalition it belongs to and any other players and/or coalitions in the game. The issue of binding agreements versus ongoing conflict is tightly connected to the division of spoils that players can realize. Empirically we observe the existence of stable coalitions. However, frequently those coalitions begin to frail once original military objectives are secured. Similar to experimental results about end-game effects in games of repeated interactions (Ke, Konrad and Morath, 2013), real world rebel groups appear to discount future divisions over spoils to a point that allows coalitions to cohere, but once the end-game comes in sight the time horizon shifts and cooperation breaks down.

Since we model coalition formation as a coordination problem, there exist two limiting scenarios how the possibility of infighting affects payoffs. First, if coalitions are truly binding, and no further fighting can occur, utility is transferable (TU). That is, coalition members can write enforceable contracts to share the gains from fighting in whichever way they wish. For the sake of exploring the full range of possible utility transfers, we entertain a scenario where all members of the coalition receive equal shares of the spoils. Such an agreement requires the most restraint compared with a non-equal division of spoils, e.g. based on relative strength.

In the second scenario that we explore, agreements are only temporarily enforceable, such as in Tan and Wang (2010). Thus coalition member will fight among themselves once the original conflict is won. This scenario corresponds to a division of spoils with non-transferable utility (NTU). Since the ultimately realized division of spoils arises from continued infighting, each coalition member in expectation will receive a share of the spoils that is proportional to its relative strength in the coalition. This division as a function of relative strength constitutes the opposite extreme to the equal division of spoils under transferable utility.

A number of other modeling approaches have been applied to multi-actor scenarios that are of potential relevance of coalition formation. In an application of game theory to networks, one line of inquiry analyzes how network structures affect individual contributions to local public goods that are realized through network linkages (Bramoullé and Kranton, 2007; Galeotti et al., 2010). In such games the existence of stable equilibria is not always guaranteed (Bramoullé, Kranton and D'Amours, 2011), and this insight has been applied to measure the potential for conflictual interactions in rebel networks (Metternich et al., 2013*a*). In these network games actors characteristically use threshold strategies. That is, they choose to contribute or abstain if neighboring contributions surpass a certain threshold, irrespective of the identity of other contributors and non-local actions (i.e. the actions of not connected actors). In contrast to this, the strategic formation of coalitions requires more complex calculations, as payoffs are a function of both, the collective actions of all coalition members, and the formation of coalitions among all other actors in the game. That is, payoffs depend on realized coalition profiles, thus the identity of coalition members matters, and the effects of cooperation are not merely local (limited to connected actors).

Although it is possible to conceptualize coalition profiles as networks with cooperative links between coalition members and externality inducing links between enemies, the formation of such networks cannot be studied with the help of threshold strategies.

Finally, there also exist works that explore the role of coalitions during other phases of the life cycle of civil conflict. Driscoll (2012) presents a coordination game in which rebel leaders must cooperate to end conflict and ensure international recognition of the post-conflict government. This setup differs from our approach in that the coalition between rebel groups is not geared to augment battle field capabilities. Instead, the coalition needs to surpass a critical size to unlock a surplus from cooperation in the form of international aid.

3. A theoretical model of tacit coalitions in civil conflict

To gain insights into which coalitions are realized in civil conflict we are developing a model of coalition formation in the shadow of ongoing fighting. While we are mainly interested in empirical predictions about realized coalitions, this requires paying attention to strategic considerations of individual warring groups. Individual decisions to tacitly join forces with other groups depend on the collective battle field prospects of potential coalitions, and the strategic reactions of adversary groups that also seek to maximize battle field outcomes. Our theoretical model highlights two main factors that drive tacit coalition behavior. First, rebel organizations are aware that they need to form viable coalitions that improve their collective chances to successfully challenge the government. Secondly however, rebel organizations are also concerned with their relative power within the tact coalition, as this determines their post-conflict position. We find that these two factors work together to reduce the number of feasible coalitions as power becomes more concentrated. They also exert pressure on organizations of equal strength to join coalitions, as well as on those groups that enjoy relatively large complementarities.

3.1. *Aggregation of military strength*

We introduce a model of tacit coalition formation that allows for rebel organizations to condition their choice to join a coalition on the spoils they receive from prevailing in a civil conflict. The game has n rebel organizations i. The set of actors is N. Each rebel organization i has a military capacity a_i.[8] Joining a coalition means pooling military capacities, though some coalitions enjoy complementarities when combining their forces. We can describe these complementarities as arising from how compatible the military capacities of pairs of groups i and j are when they form a coalition, and summarize these complementarities in a matrix $C_{n\times n}$. Each entry consists of a value $a_{ji} \geq 0$. [9]

In a dyadic tacit coalition setting, the military strength of rebel organizations i and j (a_i and a_j) and their complementarities α_{ij} map into joint coalition strength through the synergy function

$$h(a_i, a_j) = (a_i + a_j)^{\alpha_{ij}}, \tag{1}$$

[8]We deviate from other conflict games somewhat in that the military strength parameter a_i represents the capacity of rebel group i and is not subject to i's choice. This allows us to focus on coalition choice, while setting intra-coalition dynamics aside. While free-riding within coalitions might be an issue, our analysis subsumes this by focusing on realized complementarities, net of any free-riding.

[9]The complementarity parameter α_{ij} captures the degree of complementary between groups i and j. It is not directed, i.e. $\alpha_{ij} = \alpha_{ji}$.

which follows a typology developed by Hirshleifer (1989) and essentially is derived from a Cobb-Douglas production function.[10] The coalition becomes stronger as a_i and a_j increase. Furthermore, for $\alpha > 1$, pooling resources leads to positive synergies (superadditivity), while for $\alpha < 1$ joining forces leads to reduced outputs. For $\alpha = 1$, we have linear additivity. One central tenet of our analysis is that rebel groups form coalitions that increase their members' ability to successfully challenge the government. Hence, the rebel's fighting abilities and their complementarities determine, at least partially, the set of potential coalitions that are realized. At the outset of our analytical exploration below, we begin with uniform complementarities α that apply equally between all actors, and introduce heterogeneity later.

3.2. *Tacit coalition formation*

We model coalition formation as coordination game in normal form, and hence all actors move simultaneously. A strategy for actor i is a choice of a coalition κ_i, $\kappa_i \subseteq N$. We require that actor i can only choose among coalitions that contain i itself. A realized coalition that contains i is called k_i, and might differ from the choice of κ_i. In order for a coalition k_i to be realized, all members of the coalition need to propose the same κ_i. For example, an coalition (A, B, D) only forms if A, B, and D all choose (A, B, D). A deviation by either of the players implies the creation of singleton coalitions $(A), (B), (D)$. Deviations occur if one or more of the players chooses a more inclusive coalition (e.g. (A, B, D, E)) or a less inclusive coalition (e.g. (A, D)). We believe that the singleton outcome is reasonable even if some, but not all, of the players manage to coordinate. In our example, if D proposes (A, B, D, E), while A and B propose (A, B, D), the result is the singleton outcome. This makes sense because D might very well prefer to be included in the larger coalition but not the narrower one. At the same time, it might make sense for A and B to pool their forces if they can bring D on board, but not otherwise. The realized coalitions k form an coalition structure π.

3.3. *Tacit coalition strength and rebel organizations' utilities*

At this point we need to specify how joining a specific tacit coalition affects the utility of a rebel organization. As always in normal form games, the utility an actor obtains is a function of her strategy and those of all other actors. Importantly though, individual strategic choices give rise to a coalition profile, which in turn determines payoffs. Thus, strategy profiles map into coalition profiles, and it is useful to characterize payoffs as a function of coalition membership and the rule by which coalition members divide gains. We begin the analysis with transferable utility. This implies that parties can write a credible contract about how potential spoils from fighting together can be shared. To develop an ideal type, we assume the most cooperative possible outcome, where all coalition members split the gains from fighting evenly. In this setting, payoffs for each individual rebel organization i in coalition k are given by

$$U_i(k_i, k_{-i}) = P_{k_i} \frac{1}{|k_i|}, \tag{2}$$

where P_{k_i} is the probability of prevailing in the conflict and $|k_i|$ is the size (cardinality) of coalition k_i. The payoff from the contested pie is normalized to 1. Hence, the utility of

[10] In the following, we refer to complementarities and synergies interchangeably.

joining a specific coalition is dependent on the size of the coalition and the probability of winning, which is governed by the conflict success function (CSF),

$$P_{k_i} = \frac{\left(\sum_{j \in K_i} a_j\right)^{1/(k-1)\sum_{j \in K_i} \alpha_{i,j}}}{\sum_{k \in \pi} \left(\sum_{j \in k} a_j\right)^{1/(k-1)\sum_{j \in k} \alpha_{i,j}}}. \tag{3}$$

The CSF contains information about the entire coalition structure π, and sums up the strength of each coalition k in π. The probability of coalition k_i prevailing is the ratio of its strength relative to this sum. When coalitions have more than two members, we need to aggregate their respective pairwise complementarities α_{ij}. In principle, aggregating across binary links could be subject to higher order network effects. For example, if groups A and B are very similar, and both enjoy high complementarities with C, adding A to an existing coalition between B and C might not increase total complementarity by the same amount as adding A to C without the presence of B. Since there potentially exist a plethora of such third order effects, we take a pragmatic approach and assign a coalition the average of all binary complementarities between its members, $1/(k-1)\sum_{j \in K_i} \alpha_{i,j}$.

3.4. *Potential for infighting*

In our analysis of coalition formation, we also account for the often argued inability of reaching credible agreements in the context of civil wars (Bapat and Bond, 2012; Christia, 2012). That is, once a coalition achieves its objective, it is likely that individual rebel organizations will renege on their promises. Accordingly, we expect that relatively strong rebel organizations within a coalition should be able to extract larger shares of the spoils. We model this expectation with non-transferable utilities, where the spoils from winning are not divided evenly. Instead, they reflect the expected outcome from infighting between the coalition members after winning the original conflict. Thus actor i's payoff becomes a function of its relative strength in the coalition k_i

$$U_i(k_i, k_{-i}) = P_{k_i} \frac{a_i}{\sum_{j \in k_i} a_j}, \tag{4}$$

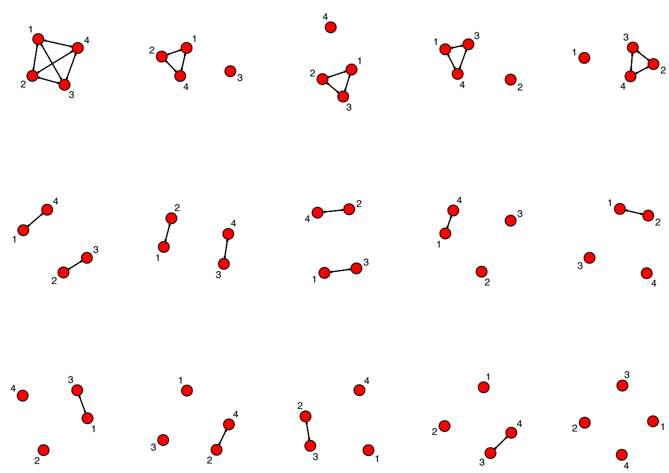
where the probability of winning the conflict P_{k_i} is given by the same CSF as before. This utility function captures an important trade-off. Pooling power in a coalition increases the overall chances of prevailing against the government. At the same time, banding together with others exposes rebel organizations to the risk of future conflict under a markedly different distribution of power. As we will see, this is an important driver of the choice of coalition partner.

3.5. *Predicting tacit coalitions*

The strategy space of our normal form game grows quickly, confronting us with real computational hurdles. The set of feasible strategies for i, K_i is of size 2^{n-1}. It includes the singleton coalition (i) and the grand coalition $(1, 2, \ldots, i, \ldots, n)$. The strategy space of the game is then given by the Carthesian product $K = K_1 \times K_2 \times \ldots \times K_n$. It is of size $2^{n(n-1)}$. This means that with 5 actors, there are already 1,048,576 possible strategy combinations, and more than 1×10^9 combinations for $n = 6$. To deal with these computational challenges, we turn to numerical methods. We rely on the Gambit software (McKelvey, McLennan and Turocy, 2013) and use the pure strategy equilibrium routine.[11] The limitation to pure strategy equilibria is justified because we are substantively not interested in mixed equilibria.[12] Even with this numerical approach, solving for all equilibria and 5 actors takes roughly 3 weeks.[13] We therefore concentrate our analysis on the four actor case, which is still above the average number of active rebel organizations in a country. The competitive incentives that drive coalition formation apply equally to rebel groups and the government. Accordingly, we designate one of the actors as government and endow it with greater power resources than the other players. The government is free to form coalitions with rebel groups, a feature frequently observed in civil conflict dynamics.

Given our numerical approach to finding equilibria, we use a simulation strategy to explore how equilibrium coalition structures change along with key parameters. We are interested in the effects of three factors that underly relations in a multi-actor network. First is the distribution of power among actors, second the rules by which coalitions members share the spoils of battle field victory, and additionally we analyze how the distribution of synergies affects tacit coalition formation.

FIGURE 1. Equilibrium Profiles, Distribution of Power (.25, .25, .25, .25), $\alpha = 1.3$. Size of nodes corresponds to the actor's power.



3.5.1. *Even power distribution.* We begin with the distribution of power. To establish a baseline for comparison purposes, we compute all equilibria coalition structures (in pure strategies) for a counterfactual case in which all actors, including the government, have the same power ($a = 0.25$). Synergies are uniformly distributed and of moderate strength, with $\alpha = 1.3$. We can think of the distribution of payoffs as either reflecting relative strength in the coalition (the NTU case) or as equal divisions (the TU case), since with equally strong

[11]For combinatorics and analysis of results we use R, while we run Gambit under Python.

[12]We concentrate on pure strategy Nash equilibria and ignore other solution concepts such as strong equilibrium. Strong Nash equilibrium requires that no coalition of players can profitably deviate as a group from equilibrium play, and therefore is a refinement of Nash play. By ignoring strong Nash, we therefore do not 'lose' any equilibria.

[13]Under Mac OS X, with a dual-core 2.66 GHz Intel Xeon processor.

rebel organizations the two scenarios are equivalent. With $n = 4$ actors, the number of possible permutations of coalition profiles is 15. Figure 1 shows that with even distribution of power all 15 coalition profiles can occur in equilibrium, including the grand coalition. The intuition behind this is straightforward. Forming any kind of a coalition is superior than going it alone in securing overall victory because all actors are of equal strength and coalition membership unlocks synergies. Furthermore, actors receive equal shares of the spoils of fighting. Deviating from an equilibrium coalition means a return to singleton payoffs (leaving other coalitions in the structure intact), and therefore does not occur in equilibrium.

TABLE 1. Equilibrium Analysis,
Homogenous α, Non-Transferable Utility

Distribution	# of Equilibria			Mean Gini			
of Power α	1.1	1.3	1.5	1.1	1.3	1.5	*HHI*
All even							
25 – 25, 25, 25	15	15	15	0	0	0	0.25
Rebels even							
40 – 20, 20, 20	11	8	8	0.08	0.04	0.04	0.28
60 – 13, 13, 13	5	5	5	0	0	0	0.411
Two strong, one weak							
40 – 22, 22, 16	10	10	8	0.09	0.09	0.08	0.282
40 – 26, 26, 8	9	9	10	0.2	0.2	0.2	0.302
60 – 15, 15, 10	5	5	5	0.07	0.07	0.07	0.415
60 – 17, 17, 6	5	5	5	0.2	0.2	0.2	0.421
One strong, two weak							
40 – 30, 15, 15	9	9	9	0.1	0.1	0.1	0.295
40 – 36, 12, 12	6	8	8	0.1	0.2	0.2	0.318
60 – 20, 10, 10	5	5	5	0.1	0.1	0.1	0.42
60 – 28, 6, 6	5	5	5	0.3	0.3	0.3	0.44

Government power share in *italics*

3.5.2. *Concentrated power distribution.* This situation quickly changes once the distribution of power becomes more concentrated. Even weakening only one actor by a small amount rules out the grand coalition. We begin the analysis with non-transferable utilities, a scenario that requires only low commitment on part of the rebels. Table 1 summarizes the number of equilibrium profiles for a variety of power distributions and increasingly greater complementarities α. We vary the relative strength of the government between moderate-weak (40% of total power) and moderate-strong (60%), and investigate relative rebel strength with evenly matched rebel groups, two strong and one weak group, and one strong group and two weak groups. The first three columns show the number of coalition profiles that are feasible in equilibrium for different values of α. In the next three columns we report how equal power is distributed in the coalitions that form in equilibrium. To this end we calculate the Gini coefficient of power shares for each coalition in a given profile, and then average the resulting values over all coalition profiles that can arise in equilibrium.[14] Finally, the last column reports a measure of power concentration for all groups in the analysis, the Herfindahl-Hirschman Index (HHI) of relative power shares. The index ranges between 0 and 1, with higher numbers indicating a greater power concentration.[15]

A number of patterns emerge. Beginning with low complementarities ($\alpha = 1.1$), we see that when holding the number of weak and strong actors constant and moving towards greater power concentration, the number of possible equilibria profiles drops monotonically. For example, when rebel groups are evenly matched (40 – 20, 20, 20), moving form a moderate-weak to a moderate-strong government (60 – 13, 13, 13) reduces the number of feasible equilibria from 11 to 5. With two strong rebel groups, one weak rebel group, and a moderate-weak government, 10 equilibrium profiles are possible when power is split (40 – 22, 22, 16). Further weakening the weak group to (40 – 26, 26, 8) lowers the number of equilibria to 9. Once we give the government moderate-strong power, only 5 profiles remain feasible in equilibrium. The same reduction of equilibrium profiles occurs when we consider the case with one strong rebel group and increase the dominant's group power.

3.5.3. *Increasing complementarities.* When increasing complementarities to $\alpha = 1.3$ we observe the same monotonic relationship between greater power concentration and a reduction in equilibrium profiles (column 2). This relationship begins to fray for large values of α. With $\alpha = 1.5$ and a moderate-weak government, going from (40 – 22, 22, 16) to (40 – 26, 26, 8) increases the number of equilibrium profiles from 8 to 10. For even larger α we find other areas of non-monotonicity, but the relationship never fully breaks down or reverses. [16] We conclude that there is a tendency of larger power concentration to reduce the number of equilibrium coalition profiles.

A second important observation is that for all combinations of rebel group forces and values of α, the number of equilibrium coalition profiles is 5 whenever the government's share of power crosses 50 percent. Inspection of the realized coalitions reveals that in this configuration the government never aligns itself with any rebel group, but instead fights alone (see the lower panel in figure 2). This result holds for large values of α as well. It occurs because under super-additivity, adding additional capabilities to a coalition that possesses 50 percent of overall power or more leads to declining marginal gains in expected utility.[17]

Figure 2 shows the equilibrium coalition profiles for two situations with one strong and two weak rebel groups. In the first panel the government is moderate-weak and in the second moderate-strong. In the former case we observe that all coalitions have at most two members. The constellations include several instances of bandwagoning coalitions, and one example of balancing behavior. Bandwagoning occurs if a weak actor joins a strong actor

[14] The Gini coefficient ranges between 0 (perfect equality) and 1 (perfect inequality). However, with fewer individuals, the upper bound can be as low as 0.5 (perfect inequality with two individuals).

[15] The index is calculated by taking the sum of squared power shares, $HHI = \sum_i (a_i / \sum_j a_j)^2$.

[16] For example, for $\alpha = 2.5$, going from (40 – 30, 15, 15) to (40 – 36, 12, 12), the number of equilibrium profiles increases from 8 to 10 and for $\alpha = 3.5$ from 7 to 9. At the same time, the decrease that we observed with $\alpha = 1.5$ disappears, so the tendency of larger power concentration to reduce the number of equilibrium coalition profiles holds more generally. For $\alpha = 2.5$, going from (40 – 22, 22, 16) to (40 – 26, 26, 8), the number of equilibrium profiles stays the same in both cases, and for $\alpha = 3.5$ the number decreases from 8 to 6.

[17] For a dominant actor that surpasses the 50 percent threshold, adding a coalition partner therefore does not increase the overall expected pie enough to compensate for giving up a share of it.

to benefit from this actor's strength. Examples are weak group 3 joining the stronger group 2. A similar profile has group 4 joining 2.

The first equilibrium shows a coalition between the government (group 1) and the strong group 2, which are opposed by a coalition of weak groups 3 and 4. This is an instance of balancing, even though the government joins forces with the biggest group to gang up on two smaller opposition forces. Similar behavior arises in the second equilibrium, where the two largest actors form a coalition, but without a counter-coalition by the two small actors. Since the government and the large rebel group already enjoy a considerable power advantage over the smaller two groups, their coalition is remarkable. It resembles a situation where the state sponsors a major armed group to fight against two minority groups. The analysis shows that such behavior can be explained in terms of the competitive pressures that characterize internal armed conflict.

Overall, there is only one example of balancing, and notably there are no symmetrically balanced coalitions that combine the government with one of the weak opposition groups and the strong opposition group with the remaining weak one. As power gets more concentrated, this dramatically changes. In the second panel of figure 2 the government has a power share of 60 percent, and never enters in coalitions with any of the opposition groups. Instead, all feasible coalitions are balancing coalitions between the three weaker players. The power advantage that the larger of the rebel groups enjoys relative to the two smaller groups (20 to 10) is inconsequential. It is just as likely to join arms with either of the two smaller groups as a three-way coalition between all opposition groups.

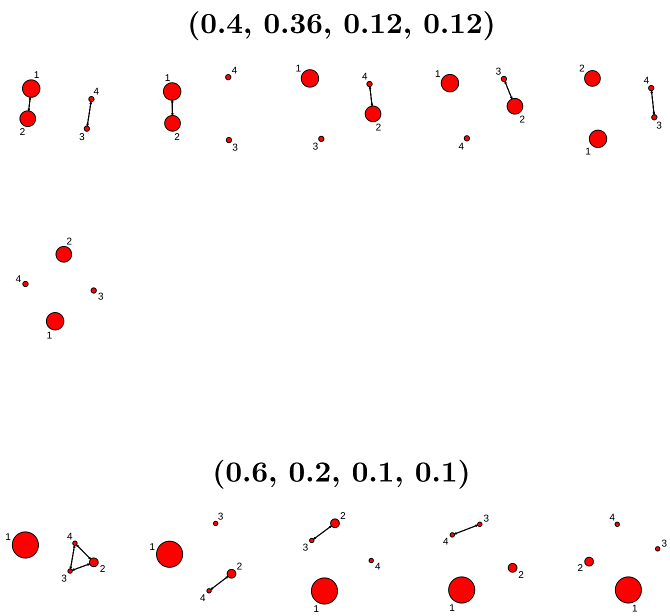
A more formal approach lets us summarize the prevalence of balancing versus bandwagoning. Focusing on the previous examples, column 5 in table 1 reports a Gini coefficient of power inequalities between coalition partners. The number averages over all coalitions that can be realized in equilibrium.[18] For the more moderate power distribution of (40 – 36, 12, 12), the Gini coefficient is 0.2, whereas for the more concentrated distribution (60 - 20, 10, 10) it is only 0.1. Thus, the realized coalitions in the first scenario are considerably more unequal in terms of their internal distribution of power than those in the second scenario. We can see that relatively high values of the Gini coefficient pick up the prevalence of bandwagoning whereas lower values are associated with balancing behavior. There is no clear tendency how prevalent both behaviors are as power becomes more concentrated among all actors and and as complementarities α increase. However, we will find much clearer patterns when we turn to the transferable utility scenario below.

How much leverage does the equilibrium analysis provide us to explain coalition formation and breakup as a function of power concentration? From the perspective of the government, we have some descriptive insights about when it is willing to align itself with individual groups to fight other rebels. As long as the government does not dominate the battle field with more than 50 percent of power resources, it makes sense to enter coalitions of this type. Both bandwagoning and balancing can occur in equilibrium. Once the government dominates, it forgoes coalitions with opposition groups, and balancing becomes the norm.

Looking at possible coalition profiles as a whole, we observe that the number of feasible equilibrium conditions tends to decrease as we move from relatively equal distribution of capabilities to greater power concentration. This has important implications for coalition stability as the relative power of actors changes as a result of battlefield outcomes. Coalitions that form at the outset of a conflict might become unsustainable as power divisions grow more concentrated. While we are not able to make predictions about which specific

[18]The average leaves out singleton coalitions which have a Gini of 0 per definition.

FIGURE 2. Equilibrium Profiles, Non-Transferable Utility, $\alpha = 1.3$. Size of nodes corresponds to the actor's power.



coalition breaks up, fewer coalitions will survive as battlefield fortunes lead to the ascend of individual actors. This proposition can be tested in a larger setting, resulting in our first hypothesis.

Proposition 1: With greater concentration of power, coalitions are more likely to break up.

The results summarized in proposition 1 reflect non-transferable utility (NTU), assuming actors anticipate the possibility of future coalition breakup and infighting. What if rebel groups are able to come to binding agreements? To evaluate the effect of transferable utility (TU) on coalition formation we investigate a counterfactual scenario in which all coalition members agree to share the spoils of fighting equally. Though real rebel groups rarely will embrace such an equalitarian approach, pledging equal shares is the largest deviation from the division of spoils that reflects relative power, which characterized the NTU case. The NTU and TU cases therefore represent ideal types. Most coalitions in the real-world will fall somewhere in between those cases.

3.5.4. *Transferable Utility.* Table 2 summarizes the number of feasible equilibrium conditions in the transferable utility scenario. Several regularities emerge. First, the absolute number of feasible coalition profiles is dramatically lower with TU compared to the NTU case. The reason for this is that strong actors receive lower expected payoffs when the spoils of war are shared more evenly. Combining forces with weaker counterparts therefore becomes unattractive. This logic generates a strong drive to only combine forces with groups that are similar in size. Generally speaking, coalition formation only is possible as long at

Table 2. Equilibrium Analysis,
Homogenous α, Transferable Utility

Distribution	# of Equilibria			Mean Gini			
of Power α	1.1	1.3	1.5	1.1	1.3	1.5	*HHI*
All even							
25 – 25, 25, 25	15	15	15	0	0	0	0.25
Rebels even							
40 – 20, 20, 20	5	5	5	0	0	0	0.28
60 – 13, 13, 13	5	5	5	0	0	0	0.411
Two strong, one weak							
40 – 22, 22, 16	2	3	5	0	0.03	0.06	0.282
40 – 26, 26, 8	2	2	2	0	0	0	0.302
60 – 15, 15, 10	2	3	5	0	0.04	0.07	0.415
60 – 17, 17, 6	2	2	3	0	0	0.09	0.421
One strong, two weak							
40 – 30, 15, 15	2	2	2	0	0	0	0.295
40 – 36, 12, 12	2	2	2	0	0	0	0.318
60 – 20, 10, 10	2	2	2	0	0	0	0.42
60 – 28, 6, 6	2	2	2	0	0	0	0.44

Government power share in *italics*

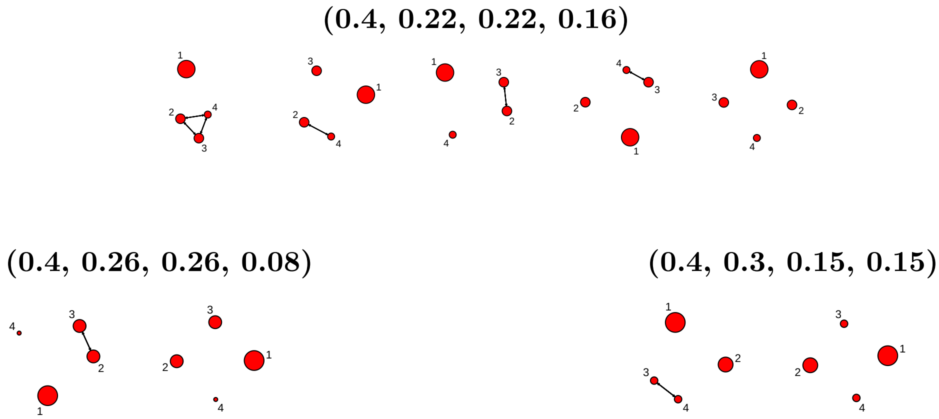
the gains from realizing complementarities outweigh the disadvantages of having to share the spoils more widely. This is why the number of feasible equilibrium profiles increases with larger complementarities α. For example, with power distributed $(40 - 22, 22, 16)$, moving from $\alpha = 1.1$ to $\alpha = 1.3$, and then to $\alpha = 1.5$, the number of equilibrium coalition profiles first increases from 2 to 3, and then to 5.

As an example of actors that are similar, but not equal in size, consider the same case with $\alpha = 1.5$. The realized coalitions are shown in the first panel of figure 3. There are five equilibrium coalition profiles. In all of them the rebel groups balance to fight the government, either by forming two-way coalitions leaving out the third opposition group, or by forming a three-way coalition.

Turning to the second observable regularity, the smallest number of feasible equilibrium coalitions in the TU case is two, whereas in the NTU case it was five. The reduction in the size of the equilibrium space is also due to pressures for coalition partners of equal size. The two lower panels of 3 illustrate the results. In both instances it is the two equally sized rebel groups that form a balancing coalition. The third rebel group is left out in both cases, despite the fact that it is less powerful than the coalition members in the left panel and more powerful in the right panel.

A comparison of the Gini coefficients in tables 1 and 2 confirms that moving from non-transferable utility to transferable utility dramatically reduces power inequalities in equilibrium coalitions. No bandwagoning happens under transferable utility, as Gini values drop to zero or close to zero, and only groups of similar size enter coalitions. Since we believe that most tacit coalitions in the real world fall somewhere between the ideal-typical NTU and TU cases, the strong equalizing pressures we observe in the TU case have an important implication for observable coalition behavior. Any movement away from pure non-transferable

FIGURE 3. Equilibrium Profiles, Transferable Utility, $\alpha = 1.5$. Size of nodes corresponds to the actor's power.



utility will make it more likely that groups of similar capabilities form coalitions, leading to our second hypothesis.

Proposition 2: Actors with similar power capabilities are more likely to form coalitions than groups that are dissimilar in power.

Returning to table 2, the final observable regularity is that greater power concentration is associated with fewer feasible equilibrium coalitions. This is similar to the NTU case, and confirms the insight summarized in proposition 1. Consider the case of strong complementarities, with $\alpha = 1.5$. With rebel groups of equal power, all 5 balancing coalitions are feasible in equilibrium. As power becomes more concentrated among two equally strong rebel groups, the number of feasible equilibrium profiles ranges between 2 and 5. Finally, with power most concentrated in one strong rebel group, only 2 coalition profiles remain feasible in equilibrium.

3.5.5. *Heterogeneous complementarities.* We next explore the role of complementarities for coalition formation in more depth. As we have shown above, increasing complementarities interrupt the monotonic relationship between increasing power concentration and the reduction in the number of equilibrium profiles. At the same time, as opposition groups arrive at more equal divisions of spoils, greater complementarities increase the number of feasible coalitions. Overall these results show that as complementarities increase, our ability to predict the formation of particular coalitions declines. However, synergies across all groups in a conflict are unlikely to be distributed evenly, or move up or down in lockstep. To further differentiate the effects of a heterogenous distribution of synergies, in the next step we explore what happens when some groups enjoy higher synergies than others.

To this end, we slightly lower the synergy parameter α for some connections and increase it for others. We begin with $\alpha = 1.3$ and then multiply it with either factor 0.9 or 1.1. With $n = 4$ actors there exist 6 dyads with associated complementarity linkages. For reference, we use the homogenous case where all six linkages have value $\alpha = 1.3$. We then give three actors greater complementarities, setting $\alpha = 1.3 \times 1.1 = 1.43$. In the last iteration, we decrease the remaining three linkages to $\alpha = 1.3 \times 0.9 = 1.17$. We concentrate on the NTU case.

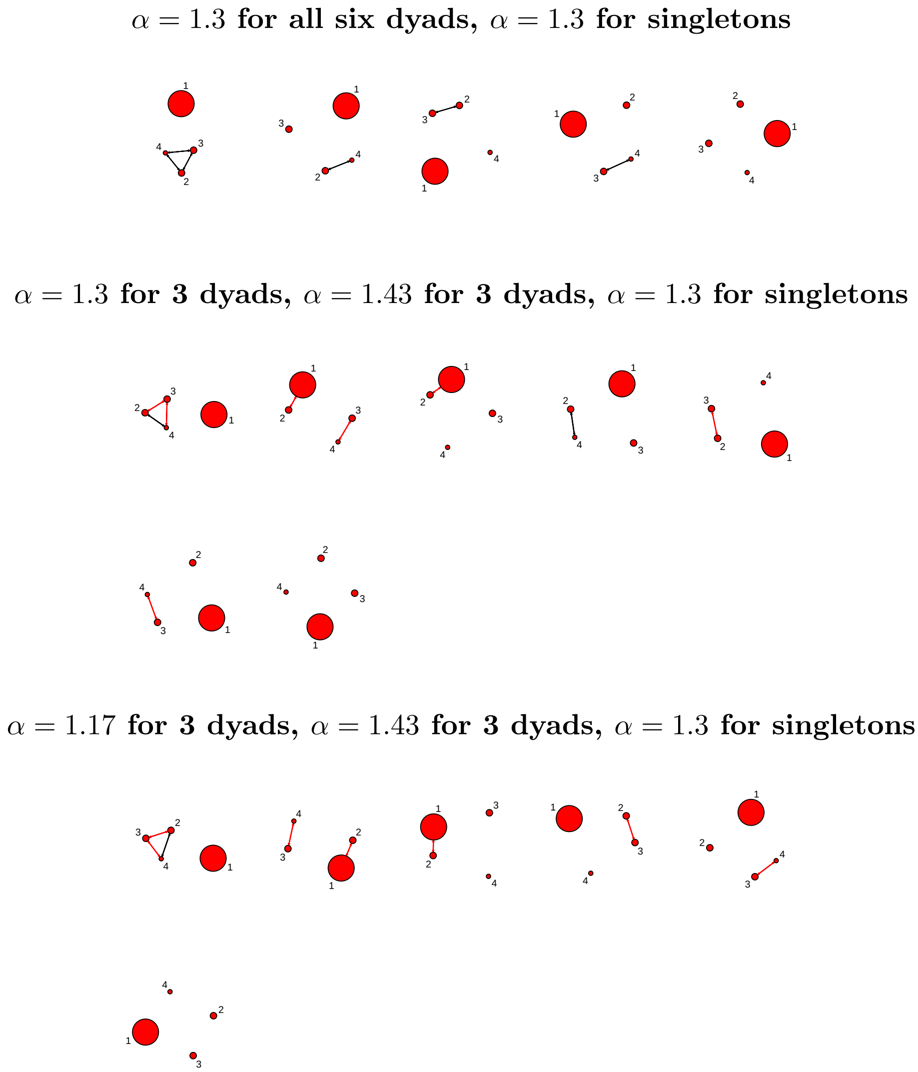
TABLE 3. Number of Equilibrium Profiles, Heterogenous α, Non-Transferable Utility

Distribution of Power	*HHI*	α: 6×1.3	α: 3×1.43, 3×1.3	α: 3×1.43, 3×1.17
All even				
25 – 25, 25, 25	0.25	15	15	10
Rebels even				
40 – 20, 20, 20	0.28	8	9	6
60 – 13, 13, 13	0.411	5	7	6
Two strong, one weak				
40 – 22, 22, 16	0.282	10	12	6
40 – 26, 26, 8	0.302	9	12	7
60 – 15, 15, 10	0.415	5	7	6
60 – 17, 17, 6	0.421	5	7	6
One strong, two weak				
40 – 30, 15, 15	0.295	9	11	6
40 – 36, 12, 12	0.318	6	11	6
60 – 20, 10, 10	0.42	5	7	6
60 – 28, 6, 6	0.44	5	7	5

Table 3 summarizes the resulting equilibrium profiles. Since we allow for differences in pairwise complementarities, we also need to take into account the relative power of the connected actors. For example, increased synergies could have a different effect if the connected actors are equal or very unequal in power. With 6 bilateral links between actors, assigning 3 high and 3 low values of α can be done in $\binom{6}{3} = 20$ ways. We compute the number of equilibrium profiles for each of these combinations and report in table 3 the median of the resulting distribution.

Allowing for heterogeneity of synergies leads to two important observations. First, greater concentration of power still tends to lead to lower numbers of equilibrium coalition profiles, but the relationship becomes much less pronounced. For the case with most heterogenous complementarities (3rd column), the number of feasible profiles remains essentially the same for different power distributions. Second, when comparing changes in the equilibrium space across columns, we note that increased heterogeneity has no monotonic effect on the number of equilibrium profiles. Moving from $\alpha = 1.3$ for all links (first column) to three bilateral links with higher complementarity ($\alpha = 1.43$, second column), more profiles become feasible in equilibrium. But increasing heterogeneity further by lowering three more bilateral links to $\alpha = 1.17$ (column 3), the number of equilibrium profiles drops again. In direct comparison between the homogenous case in column 1 and the heterogeneous case in column 3, we cannot distinguish a clear pattern. Sometimes a greater number of profiles is feasible under homogeneity, sometimes in the heterogenous scenario.

FIGURE 4. Equilibrium Profiles, Heterogeneous Complementarities. Size of nodes corresponds to the actor's power.



These non-monotonicities mean that in order to predict coalition formation and breakup, we cannot just look at overarching characteristics of the coalition structure but we need to pay attention to individual pairs of actors. We would like to know which dyads are more likely to form coalitions than others, and to what extent this propensity is affected by variation in complementarities. Figure serves to 4 illustrate some of the apparent trends. We concentrate on a case with a moderate-strong government, and two strong and one weak rebel group. The distribution of power is (60, 15, 15, 10). In panels two and three we endow three pairs of actors with increased complementarities $\alpha = 1.43$. These are actors 1 and 2, i.e. the government and a strong rebel group, the two strong rebel groups 2 and 3, and the weak rebel group 4 and strong group 3.

The first panel shows all coalitions that occur in equilibrium with homogenous complementarities set to $\alpha = 1.3$. The feasible coalitions all are rebel groups balancing the government plus the all-singleton coalition. The government itself does not join forces with any of the opposition groups. In the second panel, 3 dyads are endowed with larger complementarities. Coalition links within those dyads are highlighted in red. As a result of introducing heterogenous complementarities, two coalition profiles become feasible that were not part of the equilibrium space before. In these profiles, the government joins forces with actor 2, with which it shares higher complementarities, and groups 3 and 4 can either balance against their pooled forces or choose to fight individually.

In panel three, we lower the three complementarities that where previously set to 1.3 to $\alpha = 1.17$. This reduces the equilibrium space by one coalition profile. The profile that drops out had a coalition of groups 2 and 4, the two actors who only share low complementarity. In the remaining six profiles, all coalitions involve at least one or two high-complementarity links.

These examples illustrate a clear pattern. With increasing discrepancies in complementarities, pairs of actors that enjoy greater complementarities become more likely to be part of a coalition, whereas less well connected actors become more likely to fight on their own. Differences in the distribution of complementarities therefore have a similar refining effect on equilibrium coalitions profiles as an increase in the concentration of power. Following the same logic as before, we can formulate our third hypothesis.

Proposition 3: With increasing discrepancies in complementarities, pairs of actors that enjoy greater complementarities become more likely to be part of a coalition.

When considering the TU case, the observed patterns remain the same. Increasing the heterogeneity of complementarities between actors reduces the number of feasible equilibrium profiles and privileges actors that enjoy greater complementarities.[19]

4. Empirics

The empirical section focuses on our initial goal to identify the realization of tacit coalitions in the context of civil wars. The theoretical section implies that under a range of conditions, tacit coalitions with a more equal distribution of power have a greater number of feasible equilibria and should therefore be a associated with higher probability of being realized. Tacit coalitions that realize should be characterized by more balanced power distributions, because relatively powerful rebel organizations benefits insufficiently from cooperation with smaller partners. We also theoretically demonstrate that coalitions need to be powerful enough to challenge its non-members, which means that larger actors should on average be more likely to join coalitions. However, because of balancing dynamics very large and very small actors should be less likely to join tacit coalitions. This implies that on an actor level, we expect an inverse U-shape relationship between the power of individual actors and their probability of joining tacit coalitions. Finally, we analyze how increases in heterogeneity among actors decreases the overall likelihood of tacit coalition behavior, as coalition partners with suitable complementarities become more difficult to find.

[19]A table with frequencies of equilibrium profiles can be found in the supplementary online appendix.

We test our implications on different levels of analysis. First, we conduct a k-adic analysis (Poast, 2010) on the coalition level to test whether coalitions of similar strength and higher combined strength (cumulative and through complementarities) are more likely to form. In a second step, we test on the level of individual rebel organizations, whether rebel organizations that can form balanced coalitions are more likely to join coalitions and whether heterogeneity in complementarities decreases tacit coalition behavior.

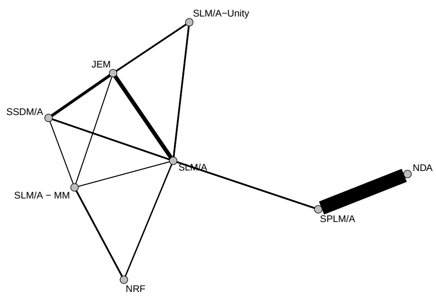
4.1. *Outcome variable: Tacit coalitions*

While we frequently observe coalition behavior among rebel organizations, these coalitions are usually informal. For example, based on the Uppsala Conflict Data Project (UCDP) data, we can only identify four formal rebel coalitions in Africa between 1989 and 2010. Similarly, Akcinaroglu (2012) finds that formal rebel coalitions are relatively rare. Hence, to measure coalitions we take a behavioral approach (compare Metternich et al., 2013*b*) using the UCDP-Georeferenced Event Data version 1.5 (UCDP-GED) (Sundberg and Melander, 2013), which covers violent events in the context of civil conflicts in Africa between 1989 and 2010. In doing so we exploit the dyadic structure of the UCDP-GED data. For each violent event, the UCDP-GED data identifies an Actor A and B that are involved in fighting activities. On a monthly basis, we extract government-rebel and rebel-rebel dyads from this data and compute for each rebel organization dyad whether, in a particular month, they have been fighting the same government without fighting each other.

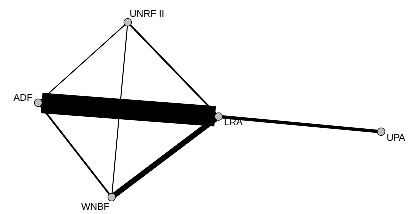
To illustrate our coding, let us imagine that three rebel organizations (A, B, C) are active against the government according to UCDP's dyadic dataset (Harbom, Melander and Wallensteen, 2008). They can form the following potential coalitions: A, B, C, AB, AC, BC, ABC. If A and C fight the government in month t without fighting each other and B does not fight the government, tacit coalition AC is realized. We then aggregate the monthly realizations to the yearly level. Thus, our dependent variable is a count ranging from 0 to 12, where potential coalitions take the value 0 if they have never been realized in a specific year, while a tacit coalition that has been realized in every month would take the value of 12. Technically, we identify realized coalitions through the concept of subgraphs. This means that we allow for multiple coalitions to be realized in a particular month. In the above example if A and C fight the government in month t without fighting each other and B fights against A and C while fighting the government, tacit coalitions AC and B are realized.

For a visualization of our dependent variable, we aggregate the number of months that two actors fight together in a tacit coalition over the total observation period (1989-2014). While our dependent variable used in the analysis varies over time, an aggregate visualization provides insights to the face validity of our measure. In Figure 5, we provide the aggregate measure of our dependent variable for Sudan in the left panel and Uganda on the right. When we consider the rebel organizations in Sudan and Uganda that have fought the government most often in the same month without fighting each other (Sudan: National Democratic Alliance (NDA) and Sudan People's Liberation Movement/Army (SPLM/A) and; Uganda: Allied Democratic Forces and Lord's Resistance Army (LRA)), we find evidence that these organizations had alliance or alliance-like relationships. [20]

[20] There is widespread agreement that the NDA and the SPLM/A acted as allies in Sudan's civil war (**?**). The ADF and the LRA were both supported by Sudan (**?**) and there are several reports of cooperation between the two rebel organizations (**??**).



(A) Sudan



(B) Uganda

FIGURE 5. Tacit coalitions: Aggregate measure for Sudan (left panel) and Uganda (right panel) between 1989-2014. Thicker edges represent more months in which two rebel organizations fought in the same tacit coalition.

4.2. *Estimation*

Our theoretical framework highlights that tacit coalition behavior is driven by both actor and coalition characteristics. Empirically, we take into account actor and coalition characteristics by implementing a k-adic research design, which allows us to analyze which potential tacit coalitions are being realized more frequently. Poast (2010) demonstrates that such an approach is more adequate than a simply dyadic approach, which does not allow for coalition characteristics. In our specific setting a k-adic research design is also more appropriate than a complete network perspective (Cranmer and Desmarais, 2011; Ward, Stovel and Sacks, 2011; Metternich et al., 2013*b*), because by design we are dealing with local coalitions that are not connected to a larger network. For example, a rebel organization in, e.g., Sudan cannot form a coalition with an organization in, e.g., Indonesia. From a network perspective, this implies that a majority of connections have a formation probability of zero. Our application is also suited for a k-adic approach, because local coalitions are relatively small, which means that the number of potential coalitions is fairly small in comparison to other applications (Poast, 2010). Hence, we are not confronted with rare events problems that can be challenging for a k-adic research design in other empirical settings. As our dependent variable is a time varying count variable, we estimate negative binomial models and capture time-dependency with lagged dependent variables and unobserved country specific factors with random effects.

A further advantage of the k-adic research design is that it can effectively deal with changes in the number of rebel organizations that can become members of tacit coalitions. Rebel organizations are not active throughout the whole conflict and might appear at different phases of the conflict according to the UCDP dyadic dataset. This means we have not only an unbalanced dataset in regard to time (conflicts start and end at different points), but also in regard to actor configurations that are possible throughout the conflict (we exclude

Table 4. Upper table shows the outcome variable distribution for tacit coalition years. Lower table provides aggregate realizations across tacit coalitions.

(a) Outcome Variable: Months potential tacit coalition realized per year (min=0, max=12)

Months realized	0	1	2	3	4	5	6	7	8	9	10	11	12	Total Obs.
Frequency	89	37	25	10	7	11	5	5	5	1	2	2	2	201

(b) Months potential tacit coalitions realized across years

Months realized	0	1	2	3	4	6	7	8	9	11	13	18	34	37	51	59	Total Coalitions
Frequency	65	20	8	4	5	5	1	2	2	1	1	2	1	1	1	1	120

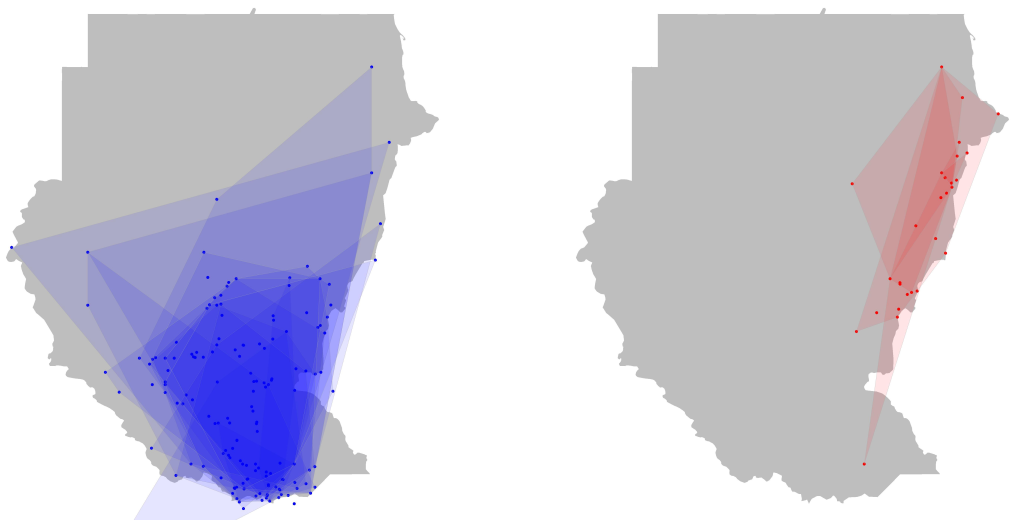
rebel organizations in a particular year if no activity is recorded according to UCDP-GED). Overall, our analysis includes 201 observations pertaining to 120 potential tacit coalitions. Table 4 presents both the distribution of our dependent variable and how often specific tacit coalitions are realized in our data.

4.3. *Explanatory variables*

Our theoretical argument suggests that tacit coalition behavior is a function of power relationships (similar strength within tacit coalition) and overall coalition strength (which is a function of combined military power and its complementarity). In the following, we discuss the operationalization for the k-adic analysis and return to the measurements of the monadic analysis in a later section.

4.3.1. *Distribution of power within tacit coalitions.* We expect that potential coalitions with equal distributions of power are more likely to be realized. In fact, we argue that the formation and fragility of tacit coalitions is greatly dependent on temporal changes in this distribution. This provides the empirical challenge of measuring the military power of rebel organizations over time. While there are existing attempts to measure the military power of rebel organizations (e.g. Cunningham, Gleditsch and Salehyan, 2009), these projects do not focus on variation over time. Therefore, we suggest a new measure of rebel strength that draws on recent work exploiting geographic data to infer rebel characteristics and conflict dynamics (e.g. Beardsley, Gleditsch and Lo, 2015; Greig, 2015). We capture the military strength of rebel organizations by calculating the geographic area in which they are active.

We calculate that active area of rebel organizations by the following procedure. First, we extract, for each rebel organization in a particular year, all locations that are recorded in UCDP-GED. This provides us with a yearly list of coordinates (latitude/longitude) for each rebel organization. Based on these coordinates, we compute a convex hull using the algorithm by Eddy (1977) which is implemented in the R package grDevices. The resulting polygons are projected on the earth's surface, which allows us to calculate the actual geographic area of the convex hulls. Figure 6 shows plots for the active areas of two Sudanese rebel organizations according to our measure, SPLM/A (left panel) and NDA (right panel), over time.[21]



(A) SPLM/A (B) NDA

FIGURE 6. Overlay of yearly active areas (attained by computing convex hulls around rebel organization events) for SPLM/A (left panel) and NDA (right panel). Points represent UCDP-GED events involving the respective rebel organizations during these time periods.

Based on this geographic measure of rebel strength, we calculate the power distribution within each potential tacit coalition. To this end, we determine the Gini coefficient for each potential tacit coalition using the R package ineq. The Gini coefficient takes the value of zero when all rebel organizations within a potential coalition are active in a similarly sized area. At the most unequal distribution of power, the value of the Gini coefficient is one.

4.3.2. *Overall coalition strength.* We argue that the realization of a tacit coalition is not only dependent on the distribution of power within the coalition, but also vis-à-vis the government. Hence, we sum the active area of all rebel organizations in a potential coalition and divide it by the size of the respective country. This relative measure allows us to measure the overall coalition strength and to identify tacit coalitions that have a greater chance of succeeding against the government. We expect that stronger tacit coalitions are realized more frequent than relatively weak ones.

4.3.3. *Complementarity.* Our theoretical argument alludes to fact that coalition power is not only additive, but also a function of complementaries. In measuring complementarity, we argue that the average distance between rebel organizations will impact on their incentives to join common coalitions. Rebel organizations that fight in different locations can engage the government at different fronts and diminish the government's ability to concentrate

[21]In the calculation we include areas that fall outside of the respective country. See south-western corner of SPLMA/A plot in Figure 6.

	Base Model	DV-lag Model	RE Model
Intercept	3.26^{***}	2.71^{***}	2.45^{**}
	(0.60)	(0.59)	(0.76)
Coalition Gini	-2.18^{***}	-2.01^{***}	-2.21^{***}
	(0.52)	(0.49)	(0.49)
Coalition Size	-0.67^{*}	-0.57^{*}	-0.65°
	(0.29)	(0.28)	(0.36)
Possible Coalitions	-0.64^{***}	-0.50^{***}	-0.54^{***}
	(0.13)	(0.13)	(0.14)
Average Distance in Coalition	0.15^{*}	0.12°	0.16
	(0.07)	(0.07)	(0.11)
Ethnic Linkage	0.28	0.18	0.26
	(0.18)	(0.17)	(0.28)
Proportion of Area Active	0.98^{***}	0.76^{***}	0.88^{***}
	(0.23)	(0.22)	(0.24)
Dependent Lag		0.10^{***}	0.00
		(0.03)	(0.02)
AIC	637.71	626.29	615.38
BIC	664.14	656.02	648.42
Log Likelihood	-310.85	-304.14	-297.69
Deviance	195.48	199.84	
Num. obs.	201	201	201
Variance: coalID.factor			0.71
Dispersion: parameter			21.72
Dispersion: SD			30.83
Num. groups: coalID.factor			120

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\circ}p < 0.1$

Table 5. Statistical models

its forces. In the context of international wars, it is widely accepted that states engaged at multiple fronts face a far greater challenge to succeed and we transfer this notion to intra-state conflicts. Hence, we measure the average inversed distance of the rebels' mean fighting locations within potential coalitions using the UCDP-GED data. We first calculate the mean fighting location for each rebel organization by taking the mean longitude and latitude of all their fighting locations. Taking these mean fighting locations we create a matrix W and calculate logged distances between mean fighting locations for each w_{ij}.

4.3.4. *Control variables.* In our theoretical argument we focus on how power relations among actors determine the formation of tacit coalitions. However, there is reason to believe that ideology or ethnic similarity might also impact on the probability of joining in a coalition. Ethnic ties could either increase the probability of tacit coalition formation because of similar objectives, but could also decrease the probability of tacit coalition formation if out-bidding dynamics take place between groups. More crucially, ethnic linkages could be highly correlated with complementarities that we try to capture through distance measures. Assessing the ethnic dimension of rebel organizations forming coalitions, we leverage information from the Actor Conflict Data to Ethnic Power Relations dataset (ACD2EPR Version 2014) (Wucherpfennig et al., 2012; Vogt et al., 2015) to identify which rebel organizations recruited or fought on behalf of the same ethnic groups. We aggregate this information to the coalition level and code whether a potential coalition includes ethnically linked rebel organizations. We also control for the number of actors in each potential tacit coalition and how many other potential coalitions exist at each time period.

5. K-adic Negative Binomial Model Results

We first discuss the negative binomial estimates from the k-adic analysis that are provided in Table 5. This analysis especially shed light on Proposition 2, which proposes that realized tacit coalitions are more likely to be characterized by balanced power relationships. We first provide a baseline model that does not account for any temporal dynamics (Base Model). The second model (DV-lag Model) includes a lagged dependent variable and the third model (RE Model) includes random effects for potential coalitions. Our sample includes 120 African rebel organizations and 201 observations from 1989-2014.

5.1. *Estimates*

We begin discussing our results by focusing on the effect of power distribution on the realization of tacit coalitions. Across all models the estimated effect of the Coalition Gini coefficient is negative and significant at conventional levels. This implies that potential coalitions with unequal distribution of power are on average less frequently realized. To attain a substantive interpretation of the estimated effects, we plot the predicted number of tacit coalition months per year at different levels of the Coalition Gini coefficient (Figure 7) holding all other variables at their median value. Figure 7 pertains to our most conservative model estimate (DV-lag Model) and shows that moving from a relative unbalanced coalitions (coalition gini = 0.5) to a very balanced coalition (coalition gini = 0) increases the number of months in a tacit coalition by more than 2.5 months on average. Thus, the left panel in Figure 7 largely supports our proposition that, on average, potential coalitions with equal power distribution are realized more often than coalitions with unequal power distribution. The right panel in Figure 7 provides the distribution of the Gini Coalition coefficient in our data. Given that our main results are robust to a DV-lag and random effects specification on the potential coalition level, we find overall strong support for our theoretical argument that coalition with equal power distribution are more likely to form because rebel organizations are concerned about having to share the spoils of victory.

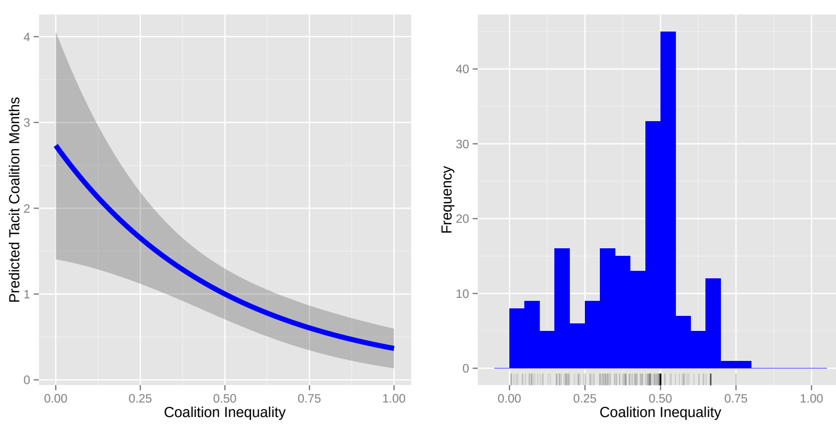


Figure 7. Left panel: Effect of coalition gini (coalition power distribution) on tacit coalition behavior. Shaded area represents 95% confidence interval. Right panel: Distribution of coalition gini in the analyzed data.

Our main argument not only focuses on the role of power distribution within tacit rebel coalitions, but also the coalition's ability to succeed against the government. An important assumption in our theoretical analysis is that potential coalitions only realize if they increase the chance of succeeding against the government. Indeed, we find that the larger the combined area of rebel activity, relative to a country's size, the more often a potential tacit rebel coalition is realized (Table 5). Again, the estimated effect is highly robust to the DV-lag and random effects specification and in line with our argument that rebel organization join coalitions that have a greater chance of winning against the government.

We now examine the effect of the average fighting distance on tacit coalition realization as a measure of complementarity. We expect that coalitions with higher complementarities are more often realized, because they increase the probability of winning against the government. Table 5 provides some empirical support for this argument. In the Base Model, the effect is positive and significant at standard levels of significance. However, in the DV-lag Model and especially in the random effects model, the estimated effects become less precise. Since the average fighting distance is a time invariant measure, this loss of precision is not unexpected, and we are careful not to over-interpret the results as support for our theoretical argument.

Turning to our control variables, we can identify a number of interesting patterns. First, coalition size is negatively associated with the realization of a tacit rebel coalition. Coalitions of fewer members seem to be favored over larger tacit coalitions. This is in line with standard insights that collective action becomes more difficult to achieve in larger groups. Though we did not introduce rebel capacity for cooperation, such as the ability to monitor other groups, into our formal analysis, it is interesting to observe collective action dynamics in the empirical record. Second, the number of possible coalitions is also negatively related to tacit coalition formation. This implies that a potential coalition is less likely to be realized if many other candidates exist. While this finding might not be too surprising, it is interesting that it robust to the random effects specification. Finally, we find that ethnic linkages within a potential coalition are positively related to its realization, but the estimated effect is not very precise. We therefore have no strong evidence that ethnicity acts as additional source of complementarities in coalition formation.

5.2. *Predictive Performance*

We now assess the predictive performance of our k-adic negative binomial models. Figure 8 presents quartile prediction plots for our DV-lag Model and random effects Model. Quartile prediction plots are generated by first calculating the quartiles of the outcome variable. The predicted values of an estimated model are then assigned to these quartiles and plotted against the true quartiles of the outcome variable. A quartile prediction plot for a 'perfect' model would have positive entries only across the diagonal. The left panel in Figure 8 displays a quartile prediction plot for the DV-lag Model, while the right panel pertains to the RE Model. Both models slightly over-predict the number of months potential coalitions are realized (more pronounced in the DV-lag Model) for lower quartiles and slightly under-predict for higher quartiles (more pronounced in the RE Model). Overall, when considering the Root Squared Mean Error (RSME), the DV-lag Model (RMSE=1.98) is slightly outperforming the RE Model (RMSE=2.36). For comparison, the Base Model's RMSE is 2.16.

6. Monadic Negative Binomial Model Results

The k-adic analysis focused on potential coalitions, leaving out the decision of individual rebel organizations to join tacit coalitions. On the monadic level, we focus on the remaining

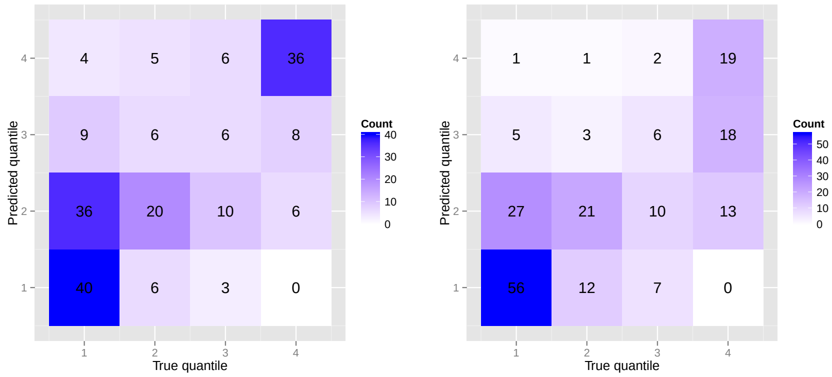


FIGURE 8. Quartile prediction plots. Left panel pertains to the DV-lag model, while the right panel shows predictions for the RE Model. Values correspond to predicted cases in each quartile. Higher values (dark blue) across the diagonal correspond to better model predictions.

empirical implications of our theoretical model. First, individual rebel organizations should on average form fewer tacit coalitions if power is concentrated in a given conflict setting (Proposition 1). Second, rebel organizations are more likely to join if they can find coalition partners with high complementarities (Proposition 3). We also provide some additional insights on the strength of rebel organizations that increase their probability of joining tacit coalitions.

The monadic level outcome variable measures how many months per year an individual rebel organization engages in tacit coalition behavior. This variable takes a value of zero when an organization never joined a tacit coalition and a value of twelve if an organization showed coalition behavior throughout the year. In the analysis, we only include rebel organizations that can potentially form a tacit coalitions. That is, we only take into account rebel organization years where there is at least one other rebel organization active in the respective country.

To test the extent to which decreases in power concentration on the country level increases the probability of individual groups joining tacit coalitions, we calculate the HHI index for all active rebel organizations in a given year using our geographic measure of rebel power. Hence in line with our theoretical section, we calculate the HHI on the yearly country level considering all active rebel organizations in that particular year. In our sample the lowest power concentrated country-year has an HHI of 0.3615, while the most power concentrated country-year has an HHI of 1. The distribution of the HHI in our sample is displayed in the right panel of Figure 10

We analyze whether individual rebel organizations are more likely to join tacit coalitions if complementarities exist on the country level by calculating the mean distance between rebel organizations in a country. Again, opportunities to form tacit coalitions with organizations that are further away positively impact complementarities and should increase the probability of coalition behavior.

Our theoretical model only indirectly speaks to the strength of individual rebel organizations that should make them more likely to join tacit coalitions. We would expect that relatively strong and relatively weak organizations are less likely to join tacit coalitions. The tendency of rebel organizations to join forces with partners of equals strength (proposition

	Model 1	Model 2	Model 3
Intercept	2.47^{***}	4.33^{***}	5.26^{*}
	(0.52)	(1.07)	(2.07)
Possible Coalitions	-0.65^{**}	-1.31^{***}	-1.02^{**}
	(0.20)	(0.39)	(0.34)
Proportion of Area Active	2.02^{*}	1.83^{*}	2.13^{*}
	(0.89)	(0.89)	(0.89)
Proportion of Area Active (sq)	-1.90^{*}	-1.66	-2.00^{*}
	(0.96)	(0.97)	(0.96)
Mean Distance in Country (log)	0.27^{*}	0.79^{**}	0.20
	(0.12)	(0.29)	(0.14)
Ethnic Linkage	0.51^{***}	0.41^{**}	0.47^{***}
	(0.13)	(0.14)	(0.13)
Dependent Lag	0.00	0.00	0.01
	(0.01)	(0.01)	(0.01)
Country HHI	-1.19^{**}	-1.27^{**}	-1.07^{*}
	(0.42)	(0.42)	(0.43)
SD Distance		-0.44^{*}	
		(0.22)	
Gini Distance			-3.06
			(2.18)
AIC	981.75	979.58	981.78
BIC	1011.88	1013.05	1015.25
Log Likelihood	-481.88	-479.79	-480.89
Deviance	230.33	228.69	229.89
Num. obs.	210	210	210

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table 6. Statistical models

2) means that particularly weak or strong groups will have fewer opportunities to form coalitions as those groups at the upper and lower bounds of the size distribution are less likely to find a similarly sized coalition partner. In addition, we found in our theoretical analysis that powerful rebel organizations are less likely to joint coalitions because they stand to gain little from cooperation with weaker partners. While we have not focused on organizational capacity in our theoretical analysis, small organizations should be less capable to overcome collective action problems since those require the ability to devote resources to identify potential collaborators and monitor their behavior. As a result of these probabilistic and theoretical considerations, we expect medium sized rebel organizations to have the easiest time finding tacit coalition partners. To test this implication on the monadic level, we calculate the strength of each rebel organization relative to all other organizations active in a particular country-year.

6.1. *Estimates*

Table 6 provides the estimates for the monadic negative binomial model. We first turn our attention to the effect power concentration on a country-year level has on rebel organizations joining tacit coalitions. Across all estimated models the HHI power index on the country level is negatively related with the number of months rebel organizations join tacit coalitions. This implies that, in line with our theoretical argument, higher power concentration on the country level leads to a lower probability of tacit coalition formation, while lower power concentration is associated with more tacit coalition behavior. The left panel in Figure 9 demonstrates the effect increasing levels of the HHI power index (country-level) has on the number of predicted months an individual rebel organization engages in tacit coalition behavior. Rebel organizations in the context of an empirically low power concentration (Country HHI=0.5) engage, on average, about 3.5 more months in tacit coalition behavior than rebel organizations in high power concentration settings (Country HHI=1).

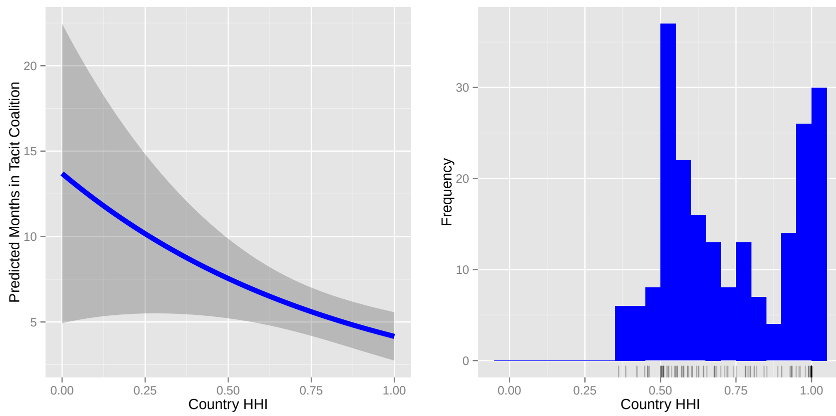


FIGURE 9. Left panel: Country Gini Right panel: Distribution of relative rebel organization strength in the analyzed data.

We also find support for our second empirical implication that opportunities to enter coalitions with distant partner increases the probability of tacit coalition behavior. Rebel organizations that have the opportunity to join geographically distant organizations are more likely to engage in tacit coalition behavior. In combination with the k-adic analysis, these monadic level results provide further support for our theoretical model and its empirical implications.

In line with our theoretical discussion, we find a inverse U-shape effect of relative rebel strength on the number of months a rebel organization joins tacit coalitions. The left panel in Figure 10 plots the effect over increasing values of relative strength holding all other variables at their median values. This empirical finding strongly supports our theoretical argument that rebel organizations are more likely to join tacit coalitions when they have opportunities to form them with equally strong organizations. Rebel organizations that are medium sized relative to all other rebel organizations in a country (Area/Total Area = 0.5) are on average five more months in tacit coalitions than very large or very small rebel rebel organizations.

Turning to the control variables, we want to highlight that on the country level ethnic linkages seem to associated with a number of tacit coalitions months. This implies that if there are any ethnic linkages between rebel organizations on the country level, individual rebel organizations are more likely show tacit coalition behavior. At this point, we believe that the estimated effect speaks to contexts where ethnicity matters and dynamics of toppling oppressive regimes becomes a common cause among rebel organizations. However, given our estimates from the k-adic analysis there is very little evidence that rebel organizations linked through the same ethnic group are more likely to join. We propose further research to unveil whether patterns of exclusion or inclusion of ethnic groups might explain the country level effects that we find.

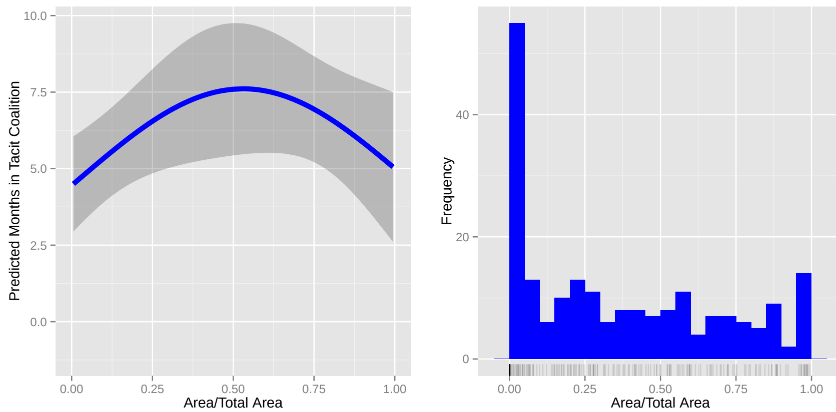


FIGURE 10. Left panel: Effect of relative rebel organization strength (active area of rebel organization relative to all other rebel organization in a country) on tacit coalition behavrion. Shaded area represents 95% confidence interval. Right panel: Distribution of relative rebel organization strength in the analyzed data.

7. DISCUSSION

In this paper we integrated a game-theoretic coalition model with empirical network analytic tools. Our integrated approach allows us to identify structural factors facilitating coalition formation that could not be analyzed in a purely dyadic setup. Since we are interested in coalitions that form with the express purpose of fighting together against a common foe, we can only theorize and test how the distribution of power and complementarities matter when we pay attention to the context of the entire network of actors.

We find strong evidence that the distribution of power, ethnic composition of rebel groups and geographic distance affect coalition behavior. Powerful rebel groups are more likely to fight alone, while evenly matched groups tend to join their forces. Together this behavior is consistent with balancing. In addition, not all rebel groups are alike. Groups that recruit from the same ethnicity are more likely to join forces in an ethnically heterogeneous environment.

To return to the example from the introduction, our analysis points to a shift in the balance of power as a possible cause for the breakup of secular and moderate Islamist opposition forces in Syria. The secular Free Syrian Army had been one of the principal fighting forces carrying out operations against the government beginning in 2011. When the Syrian Islamic Liberation Front originally joined the FSA under the umbrella of the Supreme Military Council, the SILF had enjoyed their first military successes. The two groups appeared evenly matched in terms of fighting ability. This picture changed in the course of 2012, as Islamist forces made headways in the north-east, but the FSA met stiffer government resistance. In line with our findings, the SILF left the coalition with the FSA as its military capacity began to outpace the FSA's. At the same time, the Syrian Islamic Front also had shown to be an effective fighting force, making it an equitable new coalition partner for the SILF. Again in line with our predictions, the affinity between SILF and SIF also was helped by a shared Sunni Arab ethnic background. Though the majority of

FSA members is also Arab Sunni, other ethnic groups also fight under the FSA umbrella, including Curds and Turkmen.

The network analytic approach to the study of civil war presents an exciting new research frontier. While we uncover some of the empirical variation in coalition behavior, our empirical analysis also shows that there remains a large amount of unmodeled variation in coalition formation. This implies that future research has much potential to further add to the explanation of coalition formation and breakup. However, the large unmodeled variation also demonstrates that we are at the very beginning of understanding one of most persistent and pertinent features of armed civil conflict. We very much believe that in addressing these important processes, researchers need to use theories and empirical approaches that take strategic incentives and the networked environment of armed groups seriously.

8. Appendix

Table 7. Summary table k-adic

Statistic	N	Mean	St. Dev.	Min	Max
count	201	1.891	2.694	0	12
coalition.size	201	2.303	0.568	2	5
count.possible.coalitions	201	3.075	0.990	2	5
W.centdist.fight	201	626.035	681.154	0.000	3,234.757
gini.coalition	201	0.396	0.173	0.005	0.750
ethnic.linkages	201	0.667	0.929	0	6
sum.area	201	21.026	30.136	0.00002	189.124
area	201	87.663	57.425	2.212	213.513
count.l1	201	1.264	2.591	0	12
country.gini	201	0.464	0.188	0.007	0.750
hconc.coalition	201	0.774	0.200	0.361	1.000
country.hconc	201	0.691	0.219	0.361	1.000

Table 8. Summary table join models

Statistic	N	Mean	St. Dev.	Min	Max
months.in.coalition	210	3.867	3.159	0	12
count.possible.coalitions	210	2.486	0.714	2	5
sum.area	210	14.077	25.523	0.000	189.089
sum.area.possible	210	30.819	35.378	0.026	189.124
W.centdist.fight.max	210	2.443	1.024	1.159	4.969
ethnic.linkages.max	210	0.971	1.229	0	6
months.in.coalition.l1	210	6.790	4.642	0	12
country.hconc	210	0.728	0.208	0.361	1.000
W.centdist.fight.sd	210	3.116	0.635	2.008	4.345
W.centdist.fight.ineq	210	0.585	0.115	0.312	0.667

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