Explaining Civil War Severity: A formal model and empirical analysis

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Abstract

What explains variation in civil-war severity? We argue that governments and rebel groups make strategic decisions regarding how much effort to devote to fighting based on their relative and absolute capabilities and the number of groups fighting. We develop a formal model that examines how the number of rebel groups and the resources available to governments and rebels influence conflict severity. The effect of the three parameters is highly interactive. In general, fighting is more severe in conflicts with multiple rebels groups where both sides have more resources compared to other conflicts. The model generates specific predictions about the severity of civil war that we calculate empirically by inserting the number of rebel groups and each side's troop levels directly into the equilibrium equations. We compare these theoretical predictions to actual battle-related deaths in statistical tests and find that the equilibrium-derived variable is a robust predictor of civil war severity.

Keywords: Civil War; Game Theory; Conflict Severity; Security

Why is the fighting so much more intense in some civil wars than in others? Scholars and policymakers have devoted substantial attention in recent years to understanding how international action can alleviate suffering by contributing to the peaceful resolution of civil war. A disproportionate number of the people killed in conflicts die in the most severe wars. Indeed, more than half of people killed in direct battle in all civil wars in 2014 died as a result of the Syrian civil war, and more than three-quarters in Syria, Iraq, and Afghanistan together. In the same period, in contrast, lower-intensity conflicts such as those between Malaysia and the Sultanate of Sulu, Myanmar and rebel groups representing the Shan, and between Algeria and Al Qaeda in the Islamic Maghreb have each resulted in less than a thousand battle-related deaths.[1]

Within the quantitative literature on civil war severity, several studies examine country-level factors such as population, GDP per capita, rough terrain, and fractionalization (Lacina, 2006), ethnic coalition size (Heger and Salehyan, 2007), or economic conditions (Chaudoin, Peskowitz, and Stanton, 2015; Lu and Thies, 2011; Besançon, 2005). Other studies examine the effects of international actions such as military interventions (Heger and Salehyan, 2007), peacekeeping (Hultman, Kathman, and Shannon, 2014), conflict-related sanctions (Hultman and Peksen, 2015), or diplomacy (Beardsley, Cunningham, and White, 2017). Relatively little existing work looks at how characteristics of the conflict and the actors involved affect conflict severity.[2] Only a few researchers have focused on conflict-specific arguments such as the the type of resources within the conflict zone (Lujala, 2009) and the prevailing method of warfare (Balcells and Kalyvas, 2014),

In this article, we develop a parsimonious model from first principles focusing on the most basic conflict-level variables. The model analyzes how variation in the number of rebel groups fighting against the government and in the resources available to both the government and the rebels affects conflict severity. The model shows, broadly, that conflicts are more severe when they involve *more* rebel groups and when the rebel groups and government *together* control higher levels of resources. The effect of these variables on severity is highly interactive.

Some studies have examined the effect of the relative strength between rebels and the government, but the findings of those studies are inconsistent. Heger and Salehyan (2007) find that relative rebel strength is a positive predictor of severity. Lujala (2009) finds that a rebel-parity indicator is a positive predictor of severity but a weak-rebel indicator is insignificant. Balcells and Kalyvas (2014) find that conventional warfare—which may be associated with stronger rebels (cf. Butler and Gates, 2009)—is sometimes a positive predictor of severity. Hultman and Peksen (2015) find that relative rebel strength is rarely significant, but positive when it is significant. Benson and Kugler (1998) find that civil wars are more severe when there is relative parity of resources between the government and opposition, and their measure of resources is conceptually very different than the other, more recent, studies.[3]

Given the strategic interplay involved in the interactions, we are not surprised that earlier research found inconsistent results when estimating the individual effects of state-rebel parity. A significant problem is that much of this literature treats the "opposition" as unified, whereas across civil wars we see substantial variation in the number of rebel groups that challenge the government. Yet, we often see civil wars where the "opposition" groups fight more among themselves than against the government. They certainly are not unified. Indeed, a substantial literature shows that the presence of multiple rebel groups complicates bargaining (e.g. Cunningham, 2006), which suggests they increase severity due to the prolongation of conflict.

Existing literature also fails to account for the strategic interplay between the number of rebel groups and the relative resources available to governments and rebels. Relative capabilities and total resources available affect the strategic decisions of combat, directly affecting conflict severity. The relationship between these factors is highly interactive. Our model explicitly takes into account the interactive relationship between the number of rebel groups and the relative resources available to governments and rebels, and can thus help explain why a conflict with many rebel groups, where the government has a large army but many rebel groups have large number of fighters as well— like the civil war in Syria—is so severe. It can also explain why other conflicts that only involve one rebel group and/or take place in countries with weak militaries experience fewer battle deaths.

Another advantage of the model is that it generates specific predictions about the severity of fighting in years of conflict based on the number of rebel groups, government resources, and rebel resources. We test the equilibrium-derived variable generated from this model directly against actual battle-related deaths and find that it provides predicted levels of conflict severity that are highly correlated with observed severity. We thus follow the "framework for methodological unification" (Empirical Implications of Theoretical Models–EITM) advocated by Granato, Lo, and Wong (2010). We then briefly describe some civil wars where the predictions from the model fit well and, conversely, civil wars where there is a substantial mismatch between the predictions from the model and actual battle-related deaths. We conclude by discussing implications of the model regarding conflict severity and lay out an agenda for future research.

Multiplayer Models of Civil War

Much of the theoretical literature on armed civil conflict assumes two actors consisting of the state and a non-state actor engaged in a deadly contest. However, civil wars often involve more than one rebel group. In Syria multiple rebel groups, all bent on over-throwing the Assad regime, attack each other as well as governmental forces. The civil war in Somalia has also been characterized by as much fighting between rebel groups as between rebel groups and government troops. In Colombia, in certain regions, the FARC and ELN fight bloodier battles than they do with the Colombian Army.

There is a body of literature analyzing multi-party contests. Much of this literature has focused on alliance formation and dissolution. Bapat and Bond (2012) develop game-theoretic models to examine when rebel groups engage in bilateral cooperation and when they form asymmetric alliances. Steinwand and Metternich (2017) examine the formation of tacit coalitions among civil conflict actors. Christia (2012) develops a model of multi-party conflicts that explores both the determinants of fractionalization and alliances. Another strand of work examines how the presence of multiple rebel groups/dissident organizations influences bargaining and conflict (Cunningham, 2006; D. Cunningham, 2011; K. Cunningham, 2011). Some work has examined the determinants of fighting between rebel organizations (Bakke, Cunningham, and Seymour, 2012; Cunningham, Bakke, and Seymour, 2012; Fjelde and Nilsson, 2012).

Finally, some economic theorists have employed contest success function (CSF) models to analyze alliances and coalitions in multi-actor conflicts (e.g., Esteban and Sákovics, 2004; Garfinkel, 2003, 2004). Using the CSF technology, these authors are able to account for the endogenous choice of fighting effort and the decision to form an alliance.

CSFs have been applied to model a variety of forms of armed conflict, including civil war (Hirshleifer, 2000, 2001; Skaperdas, 2001, 2008) and conflict between non-state actors (Butler and Gates, 2012). The model of conflict severity that we develop is a CSF model that incorporates variation in the number of rebel groups participating in civil war. CSF models presume a guns versus butter decision, whereby a choice is made between productive economic effort and fighting over a collective pool of production. In the context of civil war this means that rebel groups as well as the government engage in productive activity. For a rebel group this might entail creating a shadow state that provides public goods for a population in an established territory. Examples include the LTTE is northern Sri Lanka, the Republic of South Ossetia in Georgia, and Eritrea before it became independent. It also might involve activities of the political wing of the movement that serve the community that the group represents. In other cases a group allocates so much effort to fighting that it has little capacity for productive output.

This productive output, whether produced by a rebel group or by the state, is capturable. Such things as valuable territory, populations, and resources can be captured. Groups can engage in economic activities that create wealth from these assets or they can fight to protect or capture them. For example, Hamas provides public services to the population of Gaza, while also engaging in armed conflict with Israel. All groups have a resource constraint, and thereby face a dilemma: the more resources they devote to fighting effort the greater the share of total production they can capture. Yet, resources devoted to fighting shrink the pool of total production. The CSF models the conditions under which groups allocate resources to productive output or to fighting (which involves both protecting and seizing these assets).

The CSF's focus on fighting effort provides a way to analyze civil war severity. The severity of a contest (like civil war) is driven both by the total resources available to the groups fighting, as well as by how much of those resources they decide to devote to it. Next, we develop our CSF model which examines how the number of rebel groups and the balance of capabilities between the rebels and the government affect how much of their total resources they devote to fighting, and thus the severity of civil war.

The Model

We start with the standard CSF set up in which each actor, i, invests its resources, $R_i > 0$, between fighting effort, $F_i \in [0, R_i]$ and productive effort, $R_i - F_i$. The actors are presumed to be fighting over a collective pool of income, I, that is the sum of all actors' productive effort, as in Equation 1. The actors' fighting effort choices (which are inherently costly as they detract from total income) determine the proportion of total income that each actor gets, as in Equation 2, where F_j represents the fighting efforts of the other actors. Each actor is assumed to choose its allocation between fighting and production in order to maximize its individual income, as in Equation 3.

$$I = \sum_{i=1}^{N} (R_i - F_i) \tag{1}$$

$$p_i = \frac{F_i}{F_i + \sum_{j \neq i}^{N} F_j} \tag{2}$$

$$I_i = p_i I \tag{3}$$

To accommodate our particular multi-player game, we let the government be subscripted with $i = G$ and the rebel groups be subscripted $i = 1$ to N. Thus, there are N rebel groups and there are $N + 1$ total actors. For simplicity, we assume that each rebel group has the same resource endowment, R_i.[4] Given this set up, each rebel group is specifically maximizing individual income as in Equation 5, where j represents the other rebel groups.

$$I_G = \frac{F_G}{F_G + \sum_{i=1}^{N} F_i} \left((R_G - F_G) + \sum_{i=1}^{N} (R_i - F_i) \right) \tag{4}$$

$$I_i = \frac{F_i}{F_i + F_G + \sum_{j=2}^{N} F_j} \left((R_i - F_i) + (R_G - F_G) + \sum_{j=2}^{N} (R_j - F_j) \right) \tag{5}$$

Equilibria

The equilibrium fighting effort for an actor in a CSF-game is found at the maximum value of that actor's income given that the other actors are maximizing their income as well. Thus, the first step is to take the derivative of each actor's income equation with respect to that actor's fighting effort, set the result equal to zero, and solve for that actor's fighting effort. This gives fighting efforts that are a function of the other actors' fighting efforts (and other parameters). Equation 6 shows this value for the government. Equation 7 shows this value for a rebel group, in which the fighting effort of each of the other rebel groups is F_j.

$$F_G = \sqrt{F_i}\sqrt{N} \left(\sqrt{NR_i + R_G} - \sqrt{F_i}\sqrt{N} \right) \tag{6}$$

$$F_i = \sqrt{F_G + F_j(N-1)}\sqrt{(N-1)R_j + R_G + R_i} - F_G - F_j(N-1) \tag{7}$$

At this point we take advantage of the fact that the fighting effort of all rebel groups will be the same (as we are assuming they have the same resource endowment). Thus, we substitute F_i for F_j and R_i for R_j in Equation 7 and solve for F_i again, resulting in Equation 8.[5]

$$F_i = \frac{\sqrt{4F_GN + (N-1)^2(NR_i + R_G)}\sqrt{NR_i + R_G} - 2F_GN + (N-1)(NR_i + R_G)}{2N^2} \tag{8}$$

Equation 6 is the reaction function for the government. Equation 8 is the reaction function for each of the (identical) rebel groups.

There are three equilibrium solutions for this game. Which solution holds depends on the relative values of R_i and R_G. The "interior" solution—in which each actor has positive fighting effort short of its resource constraint—holds when the actors' resource endowments are not too far apart from one another. When the government's resource endowment relative to the rebels' endowments is large enough, the rebels use all their resources for fighting. Conversely, when the government's resource endowment relative to the rebels' endowments is small enough, the government uses all its resources for fighting. The next subsections show these equilibrium solutions and discuss how they were derived.[6]

The Interior Solution

To find the interior solution, we first substitute the government's reaction function for F_G in the rebels' reaction function and solve for F_i, resulting in Equation 9. We then substitute this value for F_i in the government's reaction function and solve for F_G, resulting in Equation 10.[7]

$$F_i^* = \frac{N(NR_i + R_G)}{(N+1)^2} \tag{9}$$

$$F_G^* = \frac{N(NR_i + R_G)}{(N+1)^2} \tag{10}$$

This equilibrium holds so long as neither actor's fighting effort exceeds its resource endowment. As the government gets stronger (R_G increases), the rebels fight harder (F_i^* increases), but only up to their resource constraint (until $F_i^* = R_i$). The opposite is true as the government gets weaker (or the rebels get stronger). We find these constraints by first setting the right-hand side of equation 9 less than or equal to R_i and solving for R_G and then setting the right-hand side of equation 10 less than or equal to R_G and solving for R_G. This results in the range indicated by equation 11.

$$\frac{N^2R_i}{N^2 + N + 1} \leq R_G \leq \frac{R_i(2N+1)}{N} \tag{11}$$

The severity of the conflict is the sum of all fighting effort. For the interior case, this is given by Equation 12.

$$\text{Severity} = \frac{N(NR_i + R_G)}{N+1} \tag{12}$$

Rebels Fighting All Out

When R_G is large enough (as in Equation 13), each rebel group's fighting effort reaches its resource constraint, $F_i^* = R_i$. When this happens, the government's fighting effort no longer needs to increase at the same rate. Instead (substituting R_i for F_i in Equation 6), the government's equilibrium fighting effort is given by Equation 14.

$$R_G \geq \frac{R_i(2N+1)}{N} \tag{13}$$

$$F_G^* = \sqrt{N}\sqrt{R_i}\sqrt{NR_i + R_G} - NR_i \tag{14}$$

As a result, the severity of the conflict is now given by Equation 15.

$$\text{Severity} = \sqrt{N}\sqrt{R_i}\sqrt{NR_i + R_G} \tag{15}$$

Government Fighting All Out

If the government is sufficiently weak (as in Equation 16), it will allocate all its effort to fighting, $F_G^* = R_G$. When this happens, each rebel group's fighting effort no longer needs to increase at the same rate. Instead (substituting R_G for F_G in Equation 8), each rebel group's equilibrium fighting effort is given by Equation 17.

$$R_G \leq \frac{N^2 R_i}{N^2 + N + 1} \tag{16}$$

$$F_i^* = \frac{\left(\sqrt{N^3R_i + N^2(R_G - 2R_i) + N(2R_G + R_i) + R_G} + (N-1)\sqrt{NR_i + R_G}\right)\sqrt{NR_i + R_G} - 2NR_G}{2N^2} \tag{17}$$

As a result, the severity of the conflict is now given by Equation 18.

$$\text{Severity} = \frac{\left(\sqrt{N^3R_i + N^2(R_G - 2R_i) + N(2R_G + R_i) + R_G} + (N-1)\sqrt{NR_i + R_G}\right)\sqrt{NR_i + R_G}}{2N} \tag{18}$$

Empirical Implications

This model leads to various implications about decisions by governments and rebel groups related to how much effort to devote to fighting in civil war. In this article, we focus on explaining why the fighting in some civil wars is more intense than in others, and the model indicates that three main parameters affect severity–the number of rebel groups, the government's resources and the average resources that rebel groups have. The solution to the model shows that fighting will be more severe in civil war when there are more rebel groups, when the government has more resources, and when average rebel resources are greater (all compared to other conflicts). Thus, it is a parsimonious model.

It is important to point out that these are not ceteris paribus predictions. Our intent is to use the model to understand conflict severity. The model shows that these three parameters interact to determine both the equilibrium–whether the government or rebels are fighting all out or both the government and rebels split their resources between fighting and production–as well as the specific prediction for severity given that equilibrium. As such, to properly test the implications of the model for conflict severity, we need an approach that deals with the inherently interactive relationship between government resources, rebel resources, and the number of rebel groups

In developing our empirical strategy, we follow the "framework for methodological unification" (EITM approach) advocated by Granato, Lo, and Wong (2010).[8] Our theoretical model links our theoretical parameters to predicted behavior regarding total fighting effort.[9] For methodological unification, we now link our theoretical parameters to empirical variables. In doing so, we are able to generate a predicted severity variable from the linked empirical variables while using the equations from our CSF model.

The theoretical analysis is based on knowing three parameters: the number of rebel groups, the resource constraint of the government, and the average resource constraint for the rebel groups. Given these parameters, *the theoretical analysis makes a single, point prediction regarding behavior*, including conflict severity. The first aspect of this single prediction is the type of equilibrium that is predicted: an interior solution, the rebels fighting at maximum effort, or the government fighting at maximum effort. While there are three types of equilibrium, only one type is predicted *given particular values for the three parameters.*[10] Once the type of equilibrium has been determined, the predicted conflict severity is calculated. Again, this is a point prediction that has a unique value *given particular values for the three parameters.*

To test how well the theoretical prediction of the model relates to the severity of actual civil wars, we operationalize the three parameters using what we argue are the best available variables. (See Table 1.) The number of rebel groups is directly measured as the number of rebel groups from the Uppsala/PRIO Armed Conflict Data. The resource constraint of the government is measured as the number of government troops. Similarly, the average resource constraint of rebel groups is measured as the average number of rebel troops per rebel group.[11]

Table 1: Operationalization of Parameters into Variables

Parameter	**Theoretical Meaning**	**Empirical Meaning**	**Variable**
N	Number of rebel groups	Number of rebel groups	Rebel groups
R_G	Government resource constraint	Number of government soldiers	Government troops
R_i	Rebel resource constraint, assumed the same for each group	Number of soldiers *each* rebel group has	Troops per rebel group
F_i^*	Equilibrium fighting effort for each rebel group	Rebel troops allocated to fighting	
F_G^*	Equilibrium fighting effort for the government	Government troops allocated to fighting	
Sum of F^*	Total equilibrium fighting effort	Total troops allocated to fighting	Predicted severity

Note that the troop variables are less direct measures of the parameters of the model than the number of rebel groups. To more directly test the formal model, we would want measures that capture all the resources each type of group could bring to bear on the conflict. On the government side, some of these additional resources are measurable in the form of armaments and revenue. On the rebel side such variables are neither generally nor consistently available. Even if such variables were available, there would be the added difficulty of being measured in different units.

Civil war severity is the focus of this analysis and we argue these measures are good proxies of the theoretical parameters in the model for examining severity. The troop variables are all measured in the same units as our measure of conflict severity–annual battle-related deaths. In addition, the size of government and rebel troops are generally observable in a way that resources (particularly rebel resources) may not be. As such, these measures allow us to examine how conflicts vary in their severity as a result of the interactive relationship between the size of the government troops, the average troops held by each rebel group and the number of groups.

One thing we should point out is that because we are measuring actors' resource constraint with the number of troops they have in each year the model will systematically over-predict actual conflict severity. From the model, fighting effort could be thought of as *how many troops to commit to actual fighting.* Not all of these troops will die in battle as a result of this choice. Nevertheless, we expect these troop commitment choices to be positively correlated with battle deaths and specifically that the way they are correlated will be as predicted by the theoretical model. This is our main hypothesis: predicted severity (using the theoretical formulas and the operational measures) is positively related with annual battle deaths.[12]

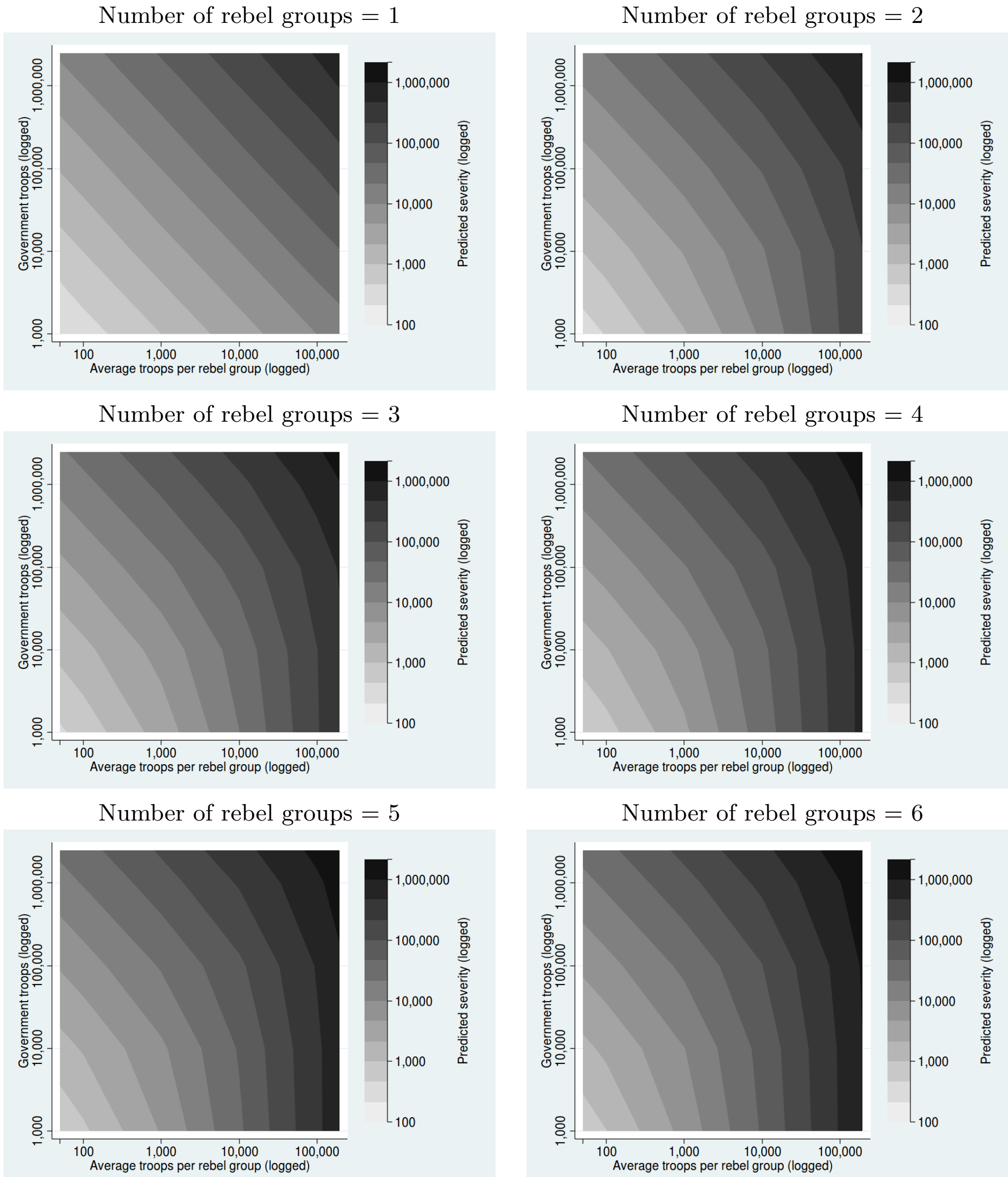
Visualizing Predicted Severity

To better understand the theoretical model, Figure 1 maps predicted severity (logged) over the empirical range of its input variables of government troops (logged), average troops per rebel group (logged), and number of rebel groups.[13] This is done as a series of contour graphs for the different numbers of rebel groups. The contour scale has been held constant over the different sub-graphs; as a result, not all of the scale's levels appear on each sub-graph.

When there is only one rebel group, the average troops per group is exactly the number of troops of the one rebel group. In this case, we see a simple pattern such that increases in either government or rebel troops have the same effect on predicted severity.

Adding a second rebel group shows how the effect of average troops per rebel group becomes greater (for higher levels of troops) than comparable increases in government troops. That curvature on the right of the sub-graph is the combined effect of both more aggregate troops on the rebel "side" and the greater predicted severity resulting from the rebels' lack of coordination. This greater curvature and further

Figure 1: Predicted Severity



increased predicted severity is more pronounced as we increase the number of rebel groups.

These contour graphs, then, demonstrate the effect of the three parameters identified in the formal model–the number of rebel groups, government resources, and rebel resources. They also demonstrate the inherently interactive nature of the relationship between these variables and conflict severity, as the effect of changes in each of these parameters is conditional on the value of the others.

Empirical Analysis

Research Design

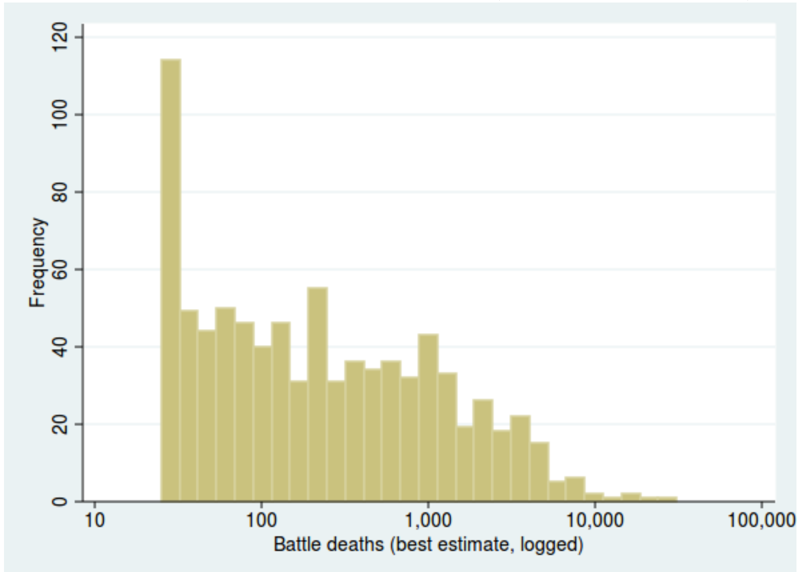
We examine the severity of conflict in all internal armed conflicts identified by the Uppsala Conflict Data Project (UCDP)/Peace Research Institute Oslo Armed Conflict Dataset (ACD) for the period 1989–2012 (Gleditsch et al., 2002; Themnér and Wallensteen, 2013). The ACD defines internal armed conflicts as conflicts between a state and one or more organized rebel group(s), taking place primarily within one state, fought over government or territory, that results in at least 25 battle-related deaths in a calendar year.[14] Within a given country, the data classify all groups engaged in center-seeking conflict as one conflict. Groups engaged in conflicts over separate pieces of territory are classified as separate conflicts. This means that a country (like India or Myanmar) facing separate territorial disputes can have multiple conflicts in the same year. This division into separate incompatibilities is quite appropriate because our formal model focuses on conflict involving a set of actors fighting over the same pie, and actors engaged in separate territorial disputes are not fighting over the same set of issues. We use the conflict-year (or incompatibility-year) as the unit of analysis.[15]

Our dependent variable is the severity of conflict, and we operationalize severity as the number of battle-related deaths in each conflict year, log-transformed. To measure the number of battle deaths, we use the UCDP battle deaths data, which provide "low", "best", and "high" estimates for the number of people—both soldiers and civilians—killed in battle specific to the incompatibility (Sundberg, 2008). We use the best estimate for each year, although in robustness checks we use the low and high estimates as well. Figure 2 presents a histogram of this variable.

The histogram shown in Figure 2 exhibits substantial variation in the severity of conflict. Because there is a lower-threshold of 25 battle-related deaths for conflicts to appear in the ACD, that is the lower-bound on the data here. Approximately 25% of conflict-years have between 25 and 50 battle-related deaths, and the median is 182. The variable has a substantial skew (which is why we log-transform it), with the mean number of annual battle-deaths being 796, the 75$^{\text{th}}$ percentile is 725, and the maximum over 30,000.

As described above, our theoretical model focuses on three parameters as determinants of conflict severity—the number of rebel groups, the resources available to the government (measured as total governmental troops) and the resources available to the rebels (measured as average troops per rebel

Figure 2: Histogram of Battle Deaths (best estimate, logged)



group). We measure the number of rebel groups by using a count of the number of actors listed on Side B in the ACD. This variable excludes other potential participants in conflict, such as external states which have intervened in the conflict. To address the potential effects of external influences, we include a variable in the analysis below measuring the number of conflict actors receiving external troop support.

We used the UCDP Conflict Encyclopedia to measure the total resources available to the government and the rebels (Uppsala Conflict Data Program, 2015). The UCDP Conflict Encyclopedia contains troop estimates for the government and for each rebel group for many of the conflict years. The resources available to the government is simply the total number of troops the government possesses. To get the average resources available to the rebels, we add together all the troop counts for the rebels active in that conflict year and divide by the number of rebel groups. We have measures of the total resources available to the government for 849 conflict-years, and for the rebels for 898 conflict-years.[16] More information on the coding of government and rebel troops is in the appendix.

We use these three variables—the number of rebel groups, government troops, and average rebel troops—as measures of the theoretical concepts of number of rebel groups, government resources, and average rebel resources, and plug them directly into the CSF. So doing, we generate predictions for the number of battle-deaths in each conflict year.[17] These measures account for both absolute and relative government and rebel resources measured along the same scale.[18] In addition, we measure the number of rebel groups directly and account for the effect of variation in the number of groups on relative resources.[19]

We contend that some of the inconsistencies in existing research on the effect of resources and number of rebel groups on conflict severity arise from not properly measuring these concepts.

As described earlier, generating the theoretical prediction involves two steps. In the first, these parameters determine which of the three equilibrium types is present. Then, given the equilibrium type, a prediction is generated for conflict severity. Table 2 provides a cross-tabulation of the number of cases of territorial and center-seeking wars falling into each of the three equilibrium types. We divide the cases here based on incompatibility because we may see different behavior by actors in each of these types. Table 2 shows that, in the great majority of cases (89%) in our data, the rebels-fighting-all-out equilibrium is predicted. This is particularly true in territorial wars, where over 96% of conflict years are predicted to be in that equilibrium, but also true for center-seeking wars, where the prediction is rebels fighting all out in over 82% of cases. Of the remaining cases, most are expected to be in the interior—in only 11 conflict years do we expect to see the government fighting all out.[20]

Table 2: **Equilibrium type by Conflict incompatibility**

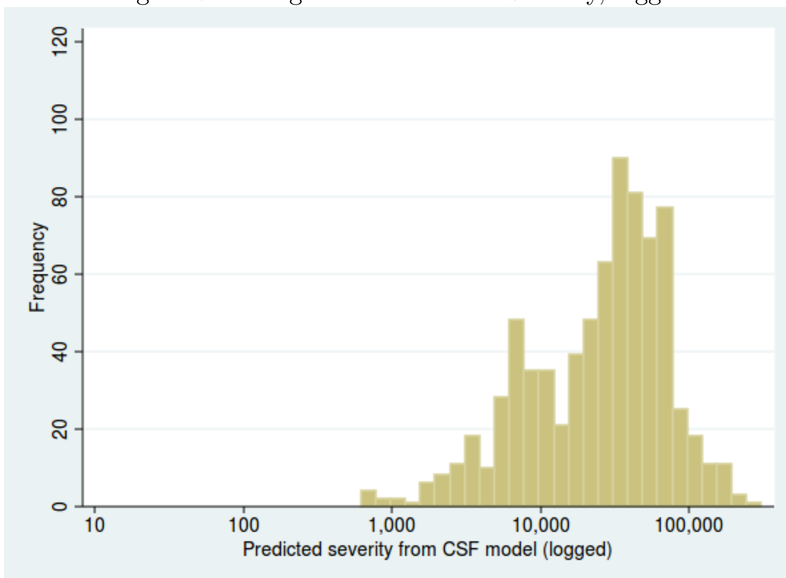
	Conflict incompatibility		
Equilibrium type	Territorial	Governmental	Total
Rebels at max	393	355	748
Interior	13	66	79
Gov't at max	1	10	11
Total	407	431	838

The means of actual battle-deaths by incompatibility are statistically different (628 for territorial conflicts and 1,054 for center-seeking conflicts). The average predicted severities by incompatibility are also significantly different, but in the opposite direction (41,678 for territorial conflicts and 34,655 for center-seeking conflicts).

Figure 3 shows the histogram of this log-transformed predicted severity variable. The histogram in Figure 3 shows a different distribution than that in Figure 2. Predicted severity has a higher mean than actual battle-deaths (38,072 versus 849). Recall, however, that we expect the model generally to over-predict battle-deaths since it is generating predictions about troops deployed for fighting. Predicted severity (log-transformed) is also more normally distributed than actual battle-deaths (also log-transformed).

We next compare the predictions generated by the theoretical model to the actual observed values. Figure 4 presents a scatterplot with predicted severity on the x-axis and actual battle-deaths on the y-axis.

Figure 3: Histogram of Predicted Severity, logged



As we can see, there is a positive correlation between the two. Also as expected, Figure 4 shows that the model substantially over predicts severity.

We examine this relationship more closely using Ordinary Least Squares (OLS) regression. OLS allows us to determine how well the predictions generated by the theoretical model fit the data while controlling for other factors that could potentially affect the relationship between the equilibrium-derived variable and battle-deaths.

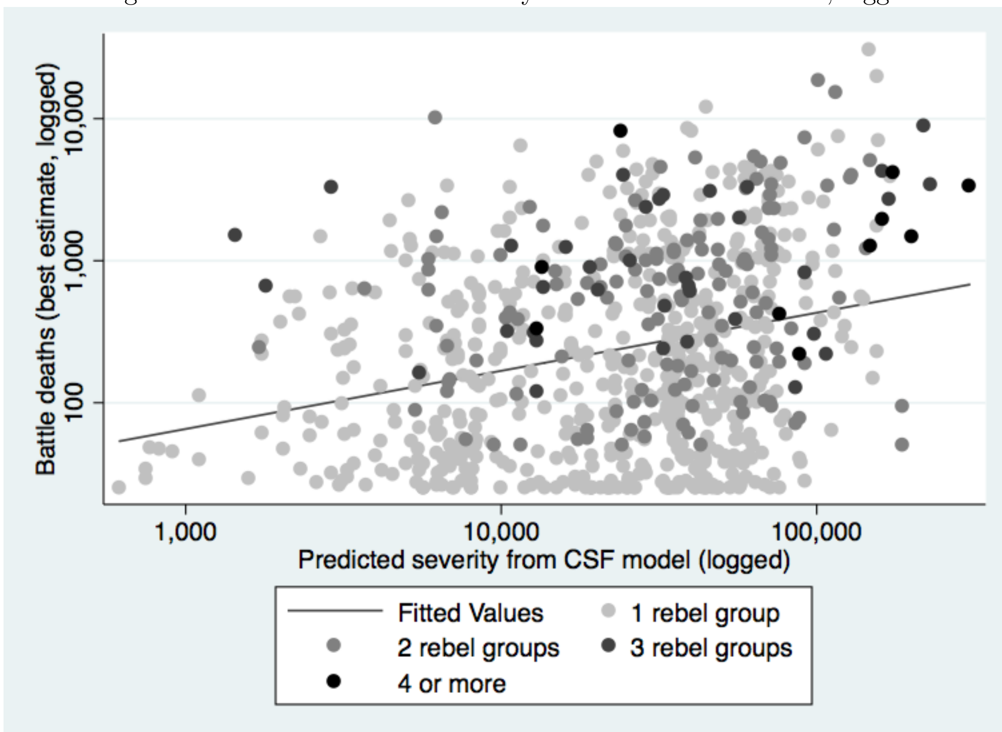
Analysis

We examine how well the predictions from the theoretical model fit the observed data in six models. Table 3 reports the results of these OLS estimations. In the table, we report coefficients with robust standard errors clustered on the ACD conflict ID in parentheses.

The first model examines all internal armed conflicts with two independent variables: predicted severity from the theoretical model and incompatibility (i.e., conflict over territory or government). We include the incompatibility variable because some of the key concepts here—in particular the total number of troops possessed by the government—may work differently in governmental and territorial conflicts.

Conflicts over center control are closer to our theoretical argument than conflicts over territory. For conflicts over territory, the government may choose not to commit the same level of troops as it would to

Figure 4: Actual versus Theoretically Predicted Battle Deaths, logged



conflicts over center control, especially if the territory in question is small and remote from the capital. For conflicts over center control, the government itself is being contested, which is the starting point of our theoretical argument. Thus, we expect incompatibilities over government to have higher battle-deaths than those over territory.

In the second model, we add four control variables that could influence both the theoretical variables and the severity of conflict. The first two are conflict-level measures. We control explicitly for the number of internal armed actors who have external support in the form of troops. These data are from the UCDP External Support Dataset (Pettersson, 2010) and cover the years 1975 to 2009.[21] This provides a proxy for the number of foreign troops engaged in the contest alongside the various internal actors.

The second conflict-level variable measures whether there was a negotiated agreement signed in the conflict in the previous year. The negotiation process can directly affect conflict intensity, as conflicts may become less intense as a settlement is reached. Additionally, that process can directly affect the number of actors, either by leading to some actors signing settlements and exiting the conflict or to splintering of existing groups. We code agreements from the UCDP Peace Agreement Dataset, which identifies all agreements signed in conflicts in the ACD between 1975 and 2011 (Harbom, Høgbladh, and Wallensteen, 2006; Høgbladh, 2012). The variable is a dichotomous measure of whether an agreement of any type (including a ceasefire agreement) was signed.[22]

We also include country-level control variables of population (log-transformed) and Gross Domestic Product (GDP) per capita (log-transformed) from Gleditsch (2002). Both population and average income have been shown to be related to a variety of civil war dynamics.

[Table 3 about here]

The analysis in Model 1 shows that predicted conflict severity derived from the theoretical model is a positive and statistically significant predictor of actual conflict severity in these conflicts. It also shows that years in governmental conflicts, on average, have considerably higher numbers of battle-deaths than conflict years in civil wars over territory. Model 2 shows that more internal actors receiving external troop support leads to significantly higher battle-deaths, which can be seen as consistent with a large literature that demonstrates that civil wars are longer, deadlier, and more resistant to resolution when they contain a significant external dimension. Additionally, governmental conflicts continue to be more severe, although the coefficient is considerably smaller, and we find that civil wars result in, on average, lower annual battle-deaths when they take place in more populous countries. Neither the measure of a peace agreement in a previous year nor GDP per capita is a significant predictor of conflict severity.

Models 1 and 2 show, then, that the CSF developed here generates reasonable predictions of actual battle-deaths in civil wars years. They also show that levels of severity are substantially different in governmental and territorial wars. To test whether the model works well across incompatibilities, in Models 3–6 we replicate the analyses in Models 1 and 2 in separate samples of territorial and governmental civil wars, respectively.

Table 3 shows that the equilibrium-derived variable continues to be a good predictor of actual severity across both governmental and territorial conflicts. The equilibrium-derived variable is positive and significant in all models, and the coefficients are similar to those in Models 1 and 2. Among the control variables in Model 4, only the external support variable is significant. In Model 6, the external support and population variables have the same sign and significance as in Model 2, and GDP per capita is negative and now statistically significant. These differences suggest that the controls are better predictors of conflict severity in center-seeking than in territorial wars. Importantly for our theoretical framework, however, the predicted severity from the CSF works across both incompatibility types.

The analyses in Table 3 provide strong support that the CSF presents a good model of conflict severity. Below we describe several cases based on the parameters in the model and the severity of conflict to illustrate the model in practice. Before doing so, however, we conduct several additional analyses to examine the robustness of the statistical results here.

Additional Analyses

We conduct four types of additional analyses to gauge the robustness of the results presented above. We describe each of these additional analyses briefly here and present regression tables in the Appendix. First, we examine the possibility and implications of heteroskedasticity of the errors in the regression. We would expect that the variance of observed severity would increase as predicted severity increases, meaning the regressions violate the assumption of homoskedasticity of errors. To deal with this heteroskedasticity, we conducted Weighted Least Squares (WLS) regression, weighting on the equilibrium-derived variable. (See Table A1.) In all six models, the predicted severity variable was significant and the coefficients were similar to those in the OLS but the standard errors were much smaller (clustering is not allowed in WLS models). The other variables showed similar patterns across the WLS and OLS analyses, with the exception that log GDP per capita in Model 2 and log population in Model 4 became statistically significant.

Second, in Table 3, we use the "best" estimate of annual battle-related deaths from the UCDP battle-deaths data. Those data also provide "low" and "high" estimates for each year, and we re-ran the analyses with them. (See Tables A2 and A3.) In all twelve of these analyses, predicted severity was positive and statistically significant. We also re-ran the analyses using the "best" estimate from the Lacina and Gleditsch (2005) data.[23] (See Table A4.) In all six models with the Lacina and Gleditsch (2005) data, the predicted severity measure was positive and statistically significant. These analyses show that the predictive power of the equilibrium-derived variable is not limited to one specific estimate of conflict severity.

Third, in Models 2, 4, and 6 in Table 3, we control for factors that could influence our theoretical parameters and the severity of conflict. In additional analyses, we control for other factors that have been shown to influence the dynamics of intrastate conflicts. (See Tables A5, A6, and A7.) These variables are the duration of the conflict (in years), the number of other ACD conflicts in the country-year, and the country's Polity score from the Polity IV project. (We also tested for a curvilinear effect of Polity by adding its square term). We added each of these variables to the controlled models in Table 3 (Models 2, 4, and 6) individually, and then in combination. In all of these additional analyses, the predicted severity variable remained positive and significant with a coefficient similar to those reported in Table 3. These additional controls revealed a few interesting patterns. First, the duration of the conflict was insignificant in all tests. Second, the number of other conflicts was only sometimes significant and negative when significant. Third, the Polity variables were not significant in the analyses of all conflicts or of government conflicts. For territorial conflicts, the Polity variables showed a generally inverted U-shape relationship.

Finally, there was some missing data in the government and rebel troop estimates in the UCDP Conflict Encyclopedia. We dealt with that missing data through interpolation. To test if the results obtained above are affected by this interpolation, we re-ran the analyses excluding all cases of missing data. (See Table A8.) In all these analyses, the theoretical prediction was statistically significant with a coefficient very similar to those reported above.

In the next section, we examine the predictions of the model more directly by discussing specific cases and comparing their predicted and actual levels of severity. Doing so allows us to move beyond abstract discussions of concepts such as governmental and rebel resources and large analyses of severity on average, and to examine more directly how the model works in cases of actual civil war. In addition, we examine some cases that deviate from the pattern to analyze other factors that could affect conflict severity outside of the theoretical parameters.

Examining Model Predictions in Cases

Cases of good fit

Examining predicted battle-deaths (logged) from the model and comparing them to the theoretical parameters and to actual battle-deaths in some conflict years reveals some interesting patterns. In general, the lowest predicted conflict severity comes from two-party (i.e., government and one rebel group) civil wars that take place in countries that have smaller militaries. These include two-party conflicts in Papua New Guinea, Trinidad and Tobago, Comoros, and Haiti. In each of those conflicts, the government only had a few thousand troops, and rebel forces numbered in the hundreds. These cases demonstrate the importance of the absolute resources available to governments and rebels. In essence, for wars to generate a high number of battle-deaths, there has to be a large number of troops participating in the fighting.

In the middle of the range for predicted severity are primarily three main types of conflicts: (1) two-party conflicts fought between governments and large rebel groups, (2) conflicts with multiple rebel groups that take place in states with smaller armies, and (3) multi-party conflicts fought between powerful states and small rebel groups. An example of the first type is the civil war between Angola and the rebel group UNITA. Angola has one of the larger armies in Africa and fielded nearly 100,000 troops in the early 1990s. UNITA had a large number of troops (around 40,000) as well. Both sides had a large resource base that they could devote to fighting. The Angolan conflict had a moderate to high level of severity, with 1,000 plus battle-related deaths in many years and a peak of over 12,000 in 1993.

An example of the second type is the Burundian civil war in the early 2000s. Burundi is a small country with a moderate sized army (around 45,000 troops in this period). From 1998 to 2003, Burundi faced two rebel groups—CNDD-FDD and Palipehutu-FNL—which combined for over 20,000 troops. Fighting in the conflict was fairly intense, with an average of more than 1,000 battle deaths a year from 2000 to 2003.

Several multi-party conflicts were fought between powerful states and relatively weak rebels. These include some periods of conflict between Israel and Palestinian groups such as Hamas and Palestinian Islamic Jihad, as well as the Mindinao conflict in the Philippines and the civil war in Colombia. Each of these conflicts are more intense than two-party wars in similar states, but the conflicts do not reach a very high level of severity because of the relative weakness of the rebels.

Several civil wars in the middle range of severity, then, demonstrate the importance of the interactive aspects of the model. Civil wars often reach a moderate level of severity when they have high values on either the number of rebel groups or on both government and rebel resources, or moderate values on all three of them.

At the high end, many of the most extreme conflicts (both in terms of predicted severity from the model and actual severity) are civil wars with a large number of rebel groups and a large number of troops on both the government and rebel side. The highest predicted severity comes from the Afghan civil war in the 1990s. The Afghan government fought as many as six rebel groups at a time, there were many troops participating in the conflict, and the rebels collectively outnumbered government forces. Throughout the 1990s, the Afghan civil war was incredibly intense, with more than 3,000 annual battle-related deaths on average.

The theoretical model developed here, then, can give a clear picture of the types of conflicts associated with low levels of severity. Two-party civil wars, fought in states with small armies and relatively weak rebels, are likely to be associated with a low-number of battle deaths. Two-party wars in more powerful states, multi-party wars in weaker states, or wars between powerful governments and a series of weak rebels, are more intense, but do not reach the highest level of severity. The most severe conflicts are wars fought between governments with large armies and a range of well-resourced rebel groups.

Cases that do not fit

Outlier cases in which the number of battle-deaths was either much higher or much lower than the predictions of the model can help to illustrate additional factors that influence conflict severity, as well as to show areas where the model here could be extended. Tajikistan and Republic of Congo (ROC) are two civil wars in which the model substantially under-predicts battle-related deaths. In both, weak government armies were matched against one (Tajikistan) or more (ROC) rebel groups, each of which was also relatively small. In Tajikistan, the government was estimated to have between 2,500 and 8,000 troops between 1992 and 1998, with the rebel group UTO having a similar number. In ROC, in the late 1990s, UCDP reports at most 20,000 troops active across all the warring parties. Yet, in both conflicts, more than 3,000 battle-related deaths were reported in a year (1992 in Tajikistan and 1998 in ROC) and, in 1997, over 10,000 battle-related deaths were reported in ROC.

Given the small number of forces deployed, how were these conflicts so intense? In both cases, the external dimension played an influential role. Tajikistan received heavy backing from Russia, meaning the forces fighting the rebels were much greater than those actually included in the army. A similar situation occurred in ROC, where Angolan military support meant the army was much stronger than it otherwise would have been. In both cases, external support for the government meant there were more resources available to devote to fighting than those within the domestic conflict, leading to a spike in severity.

In many cases the model predicts high conflict severity, but we actually observe a low level of battle-related deaths. In the Iraqi Kurdish conflict from 1989–1992 and 1995–1996 a large Iraqi military faced one or two rebel groups (the KDP and the PUK from 1989–1991 and the PUK from 1992 on) which also had a substantial number of troops. Yet, conflict never exceeded 600 battle-related deaths in a year in this period. In Ethiopia, a large army (over 100,000 troops) has faced a low-level insurgency from the Oromo Liberation Front, which has a few thousand troops, but conflict has generally stayed around the 25 battle-death threshold in a year. The large Indian army has battled the United Liberation Front of Assam, which at times has numbered 3,000 troops. Yet, conflict severity has generally ranged between 25 and 100 battle-deaths in a year.

In each of these cases, while the country has a large army, conflicts take place in peripheral parts of the country or at times when the country's attention is diverted towards other internal or external threats. India faces a series of territorial wars, as well as a center-seeking conflict with Maoist rebels. Ethiopia fought a war with Eritrea from 1998–2000, and tension along that border diverts a large part of its military attention. The Kurdish conflict took place in the context of the Persian Gulf War and subsequent sanctions against Iraq, including a no-fly zone.

These cases of large over-prediction suggest the model might perform better with data on the number of troops deployed to peripheral conflicts. These data are not currently available systematically. With better data on resources available to government for specific civil wars, we could improve our prediction of conflict severity.

Conclusion

Over the past five years, hundreds of thousands of people have been killed in fighting between the Syrian government and a proliferation of rebel groups, many of which receive substantial levels of external support. Russia's support for the Assad regime has led to ever increasing casualties. The war shows no signs of ending soon, and it is likely that many more will die in fighting before some resolution is reached.

At the same time, many other civil wars continue at a much lower level of severity. We present a parsimonious formal model built from first principles that examines how actors in conflict make decisions about allocating their resources to fighting or productive economic activity. From this model, conflict severity results from the total resources available to actors and the amount of those resources they devote to fighting. These allocation decisions are affected by the number of rebel groups and the resources that the government and rebels possess.

The theoretical model generates empirical predictions that are robust predictors of severity across conflicts. In addition, the model provides insights on the types of conflicts that are likely to be high intensity. Wars involving multiple rebel groups that are fought between states with large armies and rebels that can field many troops are likely to be extremely high intensity—as is the case in the Syrian conflict. This could also be the case in societies that currently experience some stability like Saudi Arabia or Nigeria if events led to the outbreak of conflict. The insights of the model are important for policy-makers, who have shown an interest not only in resolving civil wars generally, but in seeking to reduce the death toll of conflicts. Achieving this goal requires paying particular attention to cases where wars are likely to involve multiple rebel groups that can field large forces, either through securing civilian support and participation or through external support.

The theoretical model also has the potential to contribute to understanding of civil war in other areas. A key finding has been that external involvement in civil war, particularly military intervention, can make conflicts longer, deadlier, and more resistant to resolution. The model can help to understand why it has this effect on severity. External involvement can both increase the amount of resources available to groups, as well as to add actors to the conflict (Cunningham, 2010), two parts of the model that make fighting more intense.

In addition, there is growing interest among scholars in the conditions under which rebel groups engage in activities that benefit the local population (see, for example Mampilly, 2011). In the CSF framework, these activities are the alternative to fighting. We have focused on the effect of allocation decisions on conflict severity, but in future research the model could be used to examine rebel governance to help explain why some rebels provide public goods in the areas where they operate while others do not.

The model we develop can serve as a building block for greater theoretical and empirical understanding of why the civil wars that occur take the shape that they do. Understanding the logic by which actors make decisions as to how many resources to devote for fighting and for governance can help scholars and policy-makers understand the dynamics of conflicts and how to respond appropriately to them.

Notes

[1]These figures are drawn from battle casualty estimates from UCDP. See Pettersson and Wallensteen (2015).

[2]There is a growing literature analyzing why some civil wars see greater levels of one-sided violence or mass killing than others. Unlike the studies of civil war severity, these studies tend to examine more directly the influence of actor-level characteristics on the level of civilian victimization. See, for example, Stanton (2013); Wood (2010); Eck and Hultman (2007).

[3]Many of these studies rely on the relative rebel strength measure from Cunningham, Gleditsch, and Salehyan (2009). Benson and Kugler (1998) measure relative resources by constructing a measure of the ratio between the relative political extraction (defined as actual revenue extraction divided by predicted revenue extraction) of the opposition and the government.

[4]This assumption allows us to rely on symmetry among the N rebel groups to find the best-reply function of the government and the *identical* best-reply functions of the (identical) rebel groups. Relaxing this assumption by allowing each rebel group to have its own, unique resource endowment would require numeric analysis for each distribution of resource endowments, $\{R_G, R_1, R_2, \ldots R_N\}$. We find the closed-form solution for the particular distribution $\{R_G, R_1 = R_2 = \cdots = R_N\}$ and argue that this is an approximation of the numeric solution. (See Note 17.) Our approximation will be furthest away from the numeric solution when the resource distribution among the rebel groups is itself highly asymmetric.

[5]Had we made the substitutions earlier—i.e., in income equation 5, we would have been assuming a *coordinated* maximization of income that is at odds with the multiple, independent player framework we are analyzing. The result of this coordinated maximization is the following reaction function for the rebel groups: $F_i = \left(\sqrt{F_G}(\sqrt{NR_i + R_G} - \sqrt{F_G})\right)/N$. Notice that this is the mirror of the government's reaction function in equation 6.

[6]Fighting efforts of zero are not in equilibrium here. While the government's reaction to $F_i = 0$ is $F_G = 0$, the rebel's reaction to $F_G = 0$ is $F_i = ((N-1)(NR_i + R_G))/N^2 > 0$.

[7]To double check that these values are in equilibrium, substitute the government's equilibrium fighting effort into the rebels' reaction curve. Equation 9 again results.

[8]See also Riker (1977); Morton (1999); Granato and Scioli (2004); Grofman (2007).

[9]We agree with Clarke and Primo (2012) and Johnson (2014) that formal models have several uses in social scientific research beyond prediction. In this case, the purpose of our model is prediction and we have the "tighter fit" between the formal model and empirics to allow for a reasonable test (Clarke and Primo, 2012, p. 111).

[10]The predicted type of equilibrium is determined by the threshold equations 11, 13, and 16.

[11]We have created a STATA do-file that will generate the equilibrium and point prediction for any dataset containing information on the number of rebel groups and government and rebel troop strength, and will make this do-file available as part of the replication materials for this article upon publication.

[12]Because of this over-prediction, in the empirical analysis below we think of the coefficient on the theoretical prediction as a re-scaling parameter rather than an actual effect size.

[13]Government troops range from 1,000 to 2,480,000. Average troops per rebel group range from 50 to 194,000.

[14]We use the phrases "conflict over government" and "center-seeking conflict" interchangeably.

[15]More disaggregated data are available (e.g., Hultman and Peksen, 2015) but the inputs for our equilibrium-derived variable do not change very often; so, we focus on more aggregated (annual) severity.

[16]Due to the effect of other missing data for other variables, the N in our analyses never comes up to 849.

[17]Recall that these predictions are based on the assumption that rebel groups have the same resource constraint. As such, they assume a maximal coordination problem as each rebel group calculates how much fighting effort to commit against the government *and the other rebel groups*. The other extreme would be to assume that all rebel troops were under one command directed against the government. A hypothetical numeric calculation of predicted fighting effort for each *unique* rebel group (based on their actual troop values) would be somewhere between these two extremes, as stated in Note 4. As the theoretical prediction is generally higher than the other extreme (as demonstrated in Figure 1 by comparing the subgraph with one rebel group against the other subgraphs), we are compounding our over-estimate of severity. This should bias against us finding a strong relationship between the theoretical prediction and actual battle deaths. See Steinwand and Metternich (2017).

[18]This is in contrast to existing measurements of rebel and governmental resources. Many studies use an ordinal measure from Cunningham, Gleditsch, and Salehyan (2009) that is measured for each rebel group individually, relative to the government, and does not take into account absolute capabilities. When studies do measure government strength, they typically use a different measure from how the same work measures rebel strength.

[19]Very few existing studies measure the number of rebel groups, those that do only include it as a control variable.

[20]These cases are Afghanistan from 1997–1998, Somalia from 1999–2001, Papua New Guinea in 1992, Sierra Leone in 1998–2000 and Tajikistan in 1992–1993. In each case, the average number of troops per rebel group is greater than the estimate for the government forces.

[21]We would prefer the number of troops bolstering each internal armed actor, but this level of accuracy is not yet available. Furthermore, we also conducted the analyses with four related "external support" variables: number of internal actors receiving any kind of external support, a dummy variable indicating whether any internal actor received any kind of external support, a dummy variable indicating whether any internal actor received external troop support, and a dummy variable indicating whether both the government and at least one rebel group received external troop support. In unreported tests, these variables performed similarly to the one discussed here and did not affect our findings regarding predicted severity.

[22]Often, peace processes take multiple years and result in multiple agreements, thus there can be several years of "1s" on this variable in the data. In unreported tests, we also included a measure of whether there was an agreement signed in the conflict-year (rather than the lag), and the results were very similar to those reported below.

[23]The Lacina and Gleditsch (2005) data stop in 2008, so our analyses using those data are limited to the 1989–2008 period. Additionally, while UCDP provides a "best" estimate for every conflict year, the Lacina and Gleditsch (2005) data is more conservative and the "best" estimate is missing for 200 conflict years.

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Table 3: OLS Models of Log Battle Deaths

	All conflicts		Territorial only		Center control only	
	(1)	(2)	(3)	(4)	(5)	(6)
Predicted severity from CSF model (logged)	0.477***	0.660***	0.505**	0.648***	0.457**	0.653***
	(0.103)	(0.088)	(0.148)	(0.142)	(0.141)	(0.110)
Incompatibility (Govt=1, Terr=0)	1.085***	0.649*				
	(0.300)	(0.283)				
Number of conflict actors receiving troop support		0.665**		0.790*		0.578*
		(0.218)		(0.375)		(0.270)
Peace agreement in the previous year		-0.217		-0.509		-0.221
		(0.192)		(0.418)		(0.214)
GDP per capita (logged)		-0.195		0.022		-0.397*
		(0.114)		(0.153)		(0.170)
Population (logged)		-0.285***		-0.216		-0.290**
		(0.082)		(0.130)		(0.100)
Constant	0.114	2.936*	-0.174	0.564	1.398	5.231**
	(1.027)	(1.424)	(1.454)	(2.266)	(1.308)	(1.597)
R^2	0.178	0.297	0.099	0.200	0.117	0.304
Adjusted R^2	0.176	0.291	0.097	0.188	0.115	0.294
Conflict Clusters	104	104	51	51	53	53
Observations	689	689	334	334	355	355

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$