Third Party Intervention in Civil Wars:
Computational Modeling for Counterfactual Analysis

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Abstract

How does intervention (or the possibility thereof) shape civil conflict? How do third parties make the choice of when, and with what level of investment, to intervene? We discuss the recent case of coalition intervention in Libya as a first step toward an answer. Then, we abstract away from particulars of the Libyan case by developing a computational model of civil war and intervention. Our model consists of three agents with differing identities and strengths. Intervention occurs when: the third party identifies with the rebel group; the rebel group is desperate; and the investment of the third party’s strength can affect the rebels’ long-run probability of success. The conflict itself is modeled as a stochastic process, based on the “gambler’s ruin.” Results from 1,000,000 simulations under perfect and imperfect information show that intervention increases rebels’ chances of success, but it also increases the expected duration of the conflict. We then return to the Libya case, discussing the counterfactual of intervention not occurring, and offer an agenda for future computational models of civil conflict and intervention.

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1 Introduction

When do third parties decide to intervene in civil conflict? How does this intervention affect the outcome? These questions are motivated largely by recent events in North Africa and Southwest Asia. In particular, the intervention of coalition forces in the conflict between Libyan rebels and the government of Muammar Qaddafi presented us with a puzzle. In late spring 2011, the rebel militias were in dire shape; it appeared as if they were just trying to hold on until they received outside help. The rebels’ dire straits indicated to Western leaders that their window of opportunity to remove Col. Qaddafi was narrowing.

On 17 March, 2011, the United Nations Security Council adopted Resolution 1973, which authorized member states to undertake “all necessary measures” to protect Libyan civilians. Military operations involving air and naval forces began two days later. Almost exactly 7 months after international forces intervened, on 20 October, Muammar Qaddafi was killed, effectively solidifying the rebel victory.

Was third party intervention necessary for rebel victory? By how much did it change the expected duration of the conflict? In this paper we develop an agent-based model of civil war focused on three actors and two variables. Governments and rebels differ in their identity (a one-dimensional scale that could be understood as any measure of identity over which groups conflict), and the outside actor is closer to one or the other of them. In the Libya case, international powers sided with the rebels. All three actors also have certain levels of strength, which is allocated to each party independently of the others’ allocations. The outcome of each round of conflict is probabilistic based on the relative power of each side, and eventually results in the total victory of one side when it controls the entire territory. We measure three outcome variables: the percent of rebel-controlled territory at the end of the conflict, the duration of the conflict, and whether the third party chose to intervene.

Specifically, we model the conflict as a “gambler’s ruin,” where intervention can improve rebels’ chances of winning each round, and therefore the whole conflict. Section 2 discusses how our model relates to previous models of civil wars and insurgencies and presents empirical evidence to support several of our assumptions. We present further details of our model in Section 3. Section 4 discusses the results of our simulations. We find that intervention increases the chances of rebel success, but also increases the expected duration of the conflict. In Section 5 we return to the Libyan case to identify what leverage the model gives us in a counterfactual analysis. The paper concludes with policy implications and a discussion of future steps for this research program in Section 6.
2 Previous Research on Foreign Military Intervention

Foreign military intervention (FMI) has been a subject of interest to conflict scholars since Modelski (1964) argued that internal appeals for external intervention were the key threshold for intervention. Since then, many researchers including Small, Singer and Bennett (1982); Rasler (1983); Hermann and Kegley (1996); Huth (1998) and Regan (2002a,b) have made major strides in our understanding of FMI in both interstate and intrastate disputes.

2.1 Defining Foreign Military Intervention

FMI has been referred to as “forceful persuasion,” (George 1991) and “coercive diplomacy” (Hermann and Kegley 1996). It is also often treated as “bargaining by other means” in formal models of war (Amegashie 2009; Carment and James 1996; Carment and Rowlands 1998; Werner 2000). Intervention is a useful policy for powerful states thanks to the relative flexibility of entering and exiting the conflict Hermann and Kegley (1996). In this respect it is a substitute for trade sanctions and embargoes, trading off costs in time for costs in material (and perhaps improving on the former policies’ dubious efficacy). Nevertheless, intervention is still a risky strategy (Carment and Rowlands 1998; Huth 1998).

We define FMI, following Pearson (1974a) and Rasler (1983), as the phenomenon that “occurs when the movement of troops or military forces by one independent country (or a group of countries in concert) cross the border of another country (or colon of an independent country) for the purpose of participating in an ongoing conflict on behalf of one or more domestic political groups.” This definition limits our scope to third party intervention in the civil conflict of a sovereign state. One additional qualification that we make simplifies the domestic politics of the target state into two warring groups—government and rebels.

Rasler (1983) is an important foundational piece for our paper for two reasons. First, she uses quantitative methodology to address a specific conflict, which we do in our counterfactual analysis of the Libyan conflict. Second, she points out that the timing of intervention has not received much scholarly attention (p. 423). Three decades later, this is still largely the case.

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1 Note that this does not apply to nation-building operations, which we view as outside our definition of FMI.

2 This distinction is supported by, e.g., Findley and Teo (2006). For interesting research on the politics of multi-party civil wars, see Cunningham, Gleditsch and Salehyan (2009).
2.2 Who Intervenes and When?

Having defined intervention, under what circumstances is it likely that a third party will become involved in an ongoing dispute? There are three sets of factors that influence this probability. First, characteristics of the conflicting sides affect the probability of intervention. Third parties are more likely to support the government (Pearson 1974a, b). The target state’s level of economic development does not appear to increase the likelihood that it will be targeted for foreign intervention (Gurr and Bishop 1976; Weede 1978).

Second, characteristics of the potential interveners themselves affect the likelihood of FMI. Wealthier countries are disproportionately active as interveners (Harrison and Wolf 2011). Identity linkages between the intervener and target state such as ethnicity are also important predictors (Carment and James 1996). Outside parties may also have an interest in ending the conflict within a “reasonable time frame” and may not intervene unless they perceive that this goal is achievable (Regan 2002b, a; Thyne 2006).

In our model, the third party only intervenes on behalf of the rebels. Although this represents a minority of FMI cases involving intrastate disputes, it is common for interveners in interstate wars to take up the cause of the weaker side (Pearson 1974a, b; Huth 1998).

2.3 Effects of Intervention on War and Peace

FMI can affect the duration, outcome, and form of civil wars. Military intervention tends to increase the duration of civil wars (Kriesberg 1973; Regan 2002b, a; Thyne 2006). Intervention on behalf of the target state’s government often contributes to the increased probability of human rights abuses, which intervention that is partial to the rebels can increase the probability of their political imprisonment (Peksen 2012). Third parties can also affect the power of rebel groups in the target state relative to one another (Cunningham, Gleditsch and Salehyan 2009; Gleditsch and Beardsley 2004).

Intervention can also shape post-conflict processes including domestic institutions. Large-scale FMI, defined as deployment by the third party of greater than 1000 troops, can help to democratize non-democratic countries, but appears not to impact institutions or economic growth in states that are already democract (Pickering and Kisangani 2006). Previous findings that suggested intervention facilitated democracy were likely biased by the “high propensity of some targets of [foreign-imposed regime change] to democratize absent intervention.” (Downes and Monten forthcoming)
2.4 Computational Models of Civil War

Agent-based modeling has become increasingly popular in political economy and conflict studies since the turn of the century. Reasons for this include the growing availability of computing power, ease of replicability by future researchers, and an increased appreciation for the complexity of multi-agent interactions that are often intractable under analytical models. Our model is on the simpler end of this spectrum, but we hope that by making our assumptions explicit and sharing our code that other researchers will be able to contribute to this research program.\(^3\)

Cederman (2003, 2004, 2007) has been one of the pioneers in bringing computational models to bear on conflict studies. He developed GeoSim, a spatial model of interstate conflict, which has been updated as the National Insurgency Model. The MASON RebeLand platform, with its “bottom-up” approach, represents one of the most sophisticated models of insurgency to date (Cioffi-Revilla and Rouleau 2010). Epstein (2002) also adopts an agent-based computational approach to the study of civil violence. In their model, a central authority seeks to either suppress rebellion or suppress violence between two rival ethnic groups. The latter of these two cases is more similar to the intervention scenario considered here.

Computational models also allow for the modeling of aspects of conflict that are often assumed away in other formal models, such as the time dimension. Smith (1998) and Smith and Stam (2004) model international conflict as a random-walk stochastic process. This allows them to introduce a dynamic element to the process of achieving victory in conflict, which has often been modeled as a one-shot lottery. (Bhavnani and Backer 2000) introduce a dynamic aspect to ethnic conflict in a model based on Fearon and Laitin (1996).

Sentiment affiliation is another dimension that is often ignored in formal models but easily incorporated into computational models. Bennett (2008) models insurgency and counter-insurgency. In his model, counter-insurgency can cause collateral damage, which alienates civilians and helps the insurgents. Findley and Young (2007) compare ‘hearts-and-minds’ to ‘attrition’ approaches in counter-insurgency. Geller and Alam (2010) develop an agent-based model of war in Afghanistan that includes cultural dimensions. These models allow researchers to better understand phenomena underlying the growing consensus that social and cultural differences help to account for the forms and effects of conflict (Geller and Alam 2010; Kalyvas and Balcells 2010; Lyall and Wilson 2009).

In the same way that Rasler (1983) served as a conceptual foundation for this paper, Weidmann and Salehyan (2011) provide the only known example (besides the current paper) of a computational model of conflict developed with counter-factual analysis of a

\(^3\)For helpful introductions to the computational modeling of social processes, see De Marchi (2005); Srbljinović and Škunca (2003) and Lustick and Miodownik (2009).
specific case in mind. They model Sunni-Shia conflict in Baghdad, incorporating actual GIS data, in an attempt to estimate how that dispute might have progressed in the absence of “the surge.” Although their model is different from ours in its spatial applications and the sophistication of its approach, we value their example and their discussion of “generative” social science, which we call the descriptive criterion for the face validity of the model. The next section describes the model in detail.

3 Modeling Foreign Intervention in Civil War

Our model identifies three essential features of potential third party intervention: the actors, the conflict, and the third party’s decision of whether and when to intervene. This section discusses each of these in turn, explaining the decisions we made in creating our agent-based model. Any of our simplifying assumptions or modeling decisions could be relaxed to create a more complex and (perhaps) more realistic model. At this stage, however, we are interested in developing a relatively minimal model in the hopes that it will motivate further thinking along these lines by scholars of civil war. To this end, we find that our model is robust to alternative parameter constraints, allowing it to serve as a foundation for future adaptations.

3.1 Three’s a Crowd: Relevant Actors

Conflict requires a minimum of two actors; intervention requires a minimum of three. In our model these actors are referred to as the government of the country (c), the rebels (r), and the third party (i). All three actors have an identity (I) and a level of strength (S). Because we take conflict as a given in the model, \( I_c \neq I_r \). In particular, all three actors’ identities are drawn from uniform distributions over the intervals \( I_c \in (0, 0.25) \), \( I_r \in (0.75, 1) \), and \( I_i \in (0, 1) \). Thus, rebel and government identities are taken to be incommensurable, while the third party can be closer to a particular side. In fact, the third party could be even less amenable to one side than its opponent is (e.g. \( I_i < I_g < I_r \)). However, we limit the third party’s intervention to the side of the rebels. We discuss plausibility constraint in more detail below.

Similarly, the strength of all three actors is drawn from uniform distributions over \( S_c, S_r \in (0, 1) \); \( S_i \in (0.5, 1) \). The third party’s greater than average strength used in order not to “waste” simulations and as a plausibility constraint. Although formal theory can identify situations in which a weak party at or near the median can play “king-maker,” we are more interested in scenarios where intervention has a decisive impact. However, running the simulations with third party strength drawn from the full unit interval did not change our results.
3.2 Conflict and Territory: Adapting the Gambler’s Ruin

The object of conflict in our model is most readily understood as territory, although it could represent any divisible good over which two parties might contest. In the story of the gambler’s ruin, the good is identified as a collective pot of money. A fraction of the money (say, a dollar) goes to the winner of each successive bet, but the total amount stays fixed until one player wins the entire amount. In the most basic version, the players are a single gambler versus the casino. Because the casino has access to more resources (a higher proportion of the pot at $t = 0$) and because the game is usually unfair (probability $p$ of winning a given round, $p < 0.5$), the gambler’s long-run odds of “beating the house” are typically very slim. This long-run probability $A$ of the gambler winning the entire pot given share $k$ of the total pot (normalized to size 100) and $p \neq 0.5$ can be calculated by

$$A_k = \frac{(1-p)^{100-k} - 1}{(1-p)^{100} - 1},$$

and in the special case $p = 0.5$, $A_k = \frac{k}{100}$.

How does this relate to civil war? If we think of the pot as a territory, $k$ as the frontier of rebel-government battle, and $p$ as the ratio of each side’s strength, the model comes into focus. By substituting $p = \frac{S_r}{S_r + S_c}$ (ratio of rebel to total strength, without intervention) and rebels’ proportion of territory $T$ at time $t$, $T_{r,t} = k$ into Equation 1, we obtain:

$$A_{r,t} = \frac{(\frac{S_r}{S_c})^{100-T_{r,t}} - 1}{(\frac{S_r}{S_c})^{100} - 1},$$

again with the constraint that $S_c \neq S_r$. Figure 1 shows the long-run probability of rebel victory at several levels of $p$.

Before examining how intervention affects the probability of rebel victory, we first explain the decision rules for when intervention occurs.

3.3 Decision Rules

In the absence of intervention, rebel victory is largely determined by two factors: their proportion of starting territory, $T_r, 0$, and their strength relative to the government, $p$. To model intervention, we introduce the identity term into the mix by using a measure of “identity proximity.” This proximity term serves as a multiplier for how much of their strength the third party is willing to invest on behalf of the rebels. The third party considers the conflict through the lens of the gambler’s ruin model explained above, estimating
how their intervention would change the probability of rebel victory. Under perfect information the third party can calculate this analytically; in the imperfect information scenario they rely on a maximum likelihood estimate of $p$. This section discusses each of these terms and how they are incorporated into our agent-based model.

### 3.3.1 Identity

It is implausible to think that third parties would intervene on behalf of a rebel group when their identity term is closer to that of the government. (Recall that in this model we do not include the possibility of intervening on behalf of the government.) But rather than make identity affiliation a simple binary variable, we created an index of identity proximity, equal to $(I_i - I_c)^4 - (I_i - I_r)^4$. This term exhibits several desirable properties, which can be seen in Figure 2. First, its value is zero if the third party is indifferent between the two combatants. Values less than zero indicate greater proximity with the government (i.e. the difference between the third party and the rebels is greater, $I_i - I_r$ than between the third party and the government, $I_i - I_c$). Values greater than zero indicate the opposite: the third party sympathizes with the rebels.

Since the positive values are constrained to the interval $(0, 1)$, we use the identity proximity term as a multiplier for how much of the third party’s strength it is willing to invest if it decides to intervene. Strong affiliation with the rebels (values near one)
Intervener Ideology
Intervener Ideological Proximity to Rebels Relative to Government

Rebel and Government Ideology Scores

Reb Low
Govt Hi
Reb Med
Govt Med
Reb Hi
Govt Low

Figure 2: Identity proximity is a measure of how close the third party is to the rebel group, relative to the government. Negative values indicate greater proximity to the government, in which case the third party will not intervene. Positive values indicate greater proximity to the rebel group, and indicate the proportion of the third party’s strength that they will invest if they intervene.

indicates near-total commitment. Values closer to zero mean that the third party sympathizes with the rebels, but is willing to invest only a small proportion of its own strength in the conflict.

3.3.2 Intervention as a “Game-Changer”

Once the third party decides how much of its strength it is willing to employ on behalf of the rebels, it can see how this action will affect the rebel group’s long-run probability of success. If we let \( D = (I_i - I_c)^4 - (I_i - I_r)^4 \) denote the ideological proximity term, then intervention changes the rebels’ probability success in each round of conflict from \( p \) to \( p' = \frac{S_r + DS_i}{S_r + DS_i + S_c} \), and the long-run probability from Equation 2 to:

\[
A'_{r,t} = \frac{\left(\frac{S_r}{S_r + DS_i}\right)^{100 - T_{r,t}} - 1}{\left(\frac{S_c}{S_r + DS_i}\right)^{100} - 1},
\]

which is strictly greater than \( A_{r,t} \) if \( D > 0 \), as can be seen in Figure 1.

The third party’s decision heuristic has four key elements:

1. Intervention will occur only if \( D > 0 \). Third parties intervene on behalf of rebels only when they prefer rebels to the government.
2. Condition 1 implies \( p' > p \) and \( A' > A \). In other words, third parties choose intervention when it increases the probability of rebel victory, conditional on rebels being their preferred party.

3. Intervention will not occur when the chances of rebel victory without intervention are already high (i.e. if \( p > 0.5 \), intervention will not make much of a difference).

4. Even when the short-run probability of rebel victory is low (\( p < 0.5 \)), if rebels seem poised to win the conflict due to their position within the territory (\( A_{r,t} > c \) from some constant \( c \)), intervention will not occur. This can be interpreted as third parties preferring to intervene when the rebels are “desperate.”

Fortunately, there is a more straightforward way to relate these conditions to the gambler’s ruin model than through equations directly. Recall that \( p = 0.5 \) is a special case, in which \( A_{r,t} = \frac{k}{100} \). It is also a critical point in our decision heuristic. If we draw a line from zero to 100 with slope \( \frac{k}{100} \) in Figure 1, we can identify all points for which \( p = 0.5 \). At all points above this line, the third party is unwilling to intervene on behalf of rebels by Condition 3. Drawing a separate line with intercept and slope \( 1 - \frac{k}{100} \) identifies all critical points below which rebels are “desperate,” i.e. unlikely to win regardless of \( p \) (Condition 4). Thus, we can divide Figure 1 into four quadrants determined by these two lines, as shown in Figure 3.

In Figure 3, each quadrant has a unique meaning. In the left-hand quadrant, rebels are strong (\( p > 0.5 \) but at a disadvantage given their position within the territory (low \( A_{r,t} \)). The top quadrant represents a scenario in which rebels are strong (\( p > 0.5 \)) and confident in their impending victory (high \( A_{r,t} \)). When rebels are in the right-hand quadrant, they are weak (\( p < 0.5 \)) but success is possible due to their position within the territory (high \( A_{r,t} \)). Finally, in the bottom quadrant rebels are weak (\( p < 0.5 \)) and likely to lose the conflict (low \( A_{r,t} \)).

Our model posits that intervention is most likely to occur when the rebel group is in the bottom quadrant; in other words, if they are weak and desperate. However, even when the rebels are in this least desirable of situations, the third party does not want to intervene unless it can move them out of it, into the left or top quadrants (by conditions 1, 2, and 4). Thus, the heuristic for the third party becomes, “can I move the rebels from the bottom to the left or top quadrants?”

### 3.3.3 Perfect and Imperfect Information

The answer to this question requires knowing (or estimating) \( p, p', A, \) and \( A' \). Under conditions of perfect information, this does not present a challenge: the third party can observe the strength of both sides necessary for calculating \( p \), and knows its own strength
Figure 3: The third party’s decision in our adapted gambler’s ruin model of conflict can be reduced to a simple heuristic. The outside state will intervene if it can move the rebels from the bottom quadrant to either the left-hand or top quadrants. Note that intervention only directly affects $p$, the rebels’ probability of success in each individual round, by shifting it to $p' > p$. This constitutes a vertical shift; interveners cannot directly affect the proportion of territory controlled by the rebel group (i.e. a horizontal shift).
and the proportion of rebel-controlled territory necessary for calculating the other variables. Perfect information is typically unrealistic in models of conflict, though (see, e.g., Fearon 1995).

When we introduce imperfect information, the third party must estimate \( p \) from the history of the conflict. In particular, we wish to relate this estimate to \( \frac{\#\text{RebelWins}}{\#\text{Battles}} \equiv \frac{W_r}{B} \). Although \( \frac{W_r}{B} \) serves as a maximum-likelihood estimate of \( p \), it can also lead to highly unrealistic values when the battle history is short (including \( \hat{p} = 0 \) or \( 1 \)). To correct for this, we model third parties’ estimation of relative strength by:

\[
\hat{p} = \frac{W_r + 1}{B + 2},
\]

which can be thought of as a maximum-likelihood estimator with a continuity correction, or a Bayes’ estimator with a Beta(1,1) (i.e. uniform) prior and a squared-error loss function. This estimator can then be shown to minimize the Bayes’ risk of over- or under-estimating \( \hat{p} \) while starting from an uninformative prior. This estimate of \( \hat{p} \) can then be used to estimate the remaining variables (\( \hat{p}', \hat{A}, \) and \( \hat{A}' \)) in a straightforward manner. Note that we do not require the third party to be unaware of either the battle history or of the proportion of rebel-controlled territory.

4 Simulation Results

To evaluate the theory introduced in Section 3, we developed a series of computational models in Python. Python was chosen both for its popularity in the agent-based modeling community and its readability, even for scholars who do not program in it. Based on our theory and the empirical research discussed above, we set forth the following hypotheses:

**H1**: Outside intervention on behalf of rebels (with perfect information) will increase the average duration of conflict

**H2**: Outside intervention on behalf of rebels will increase the average percent of rebel-controlled territory

**H3**: When interveners’ beliefs are inaccurate, intervention on average will lead to less rebel success than when they are accurate

**H1** seems counter-intuitive at first, given that intervention increases the odds of rebel success in any given round of the conflict. However, recall that intervention moves rebels from the bottom quadrant of Figure 3 to either the left or top quadrants. In the bottom quadrant, the rebels are weak and desperate—the end of the conflict is near, but it means
their defeat. After intervention their long-run success is more likely, but they have to regain a substantial proportion of the conflict. Thus, the final outcome of the conflict is more desirable for the rebels and the third party (if they intervened), but conflict duration is increased. By the same reasoning, H2 is rather straightforward; sometimes intervention may be “too little, too late,” but on average it should improve rebels’ chances of success. H3 introduces the possibility that third parties may make mistakes under imperfect information, which is expected to still help the rebels but to a lesser extent. Mistakes could also occur in the rebels’ favor, but we predict that in the aggregate they will not. The remainder of this section presents the results of 1,000,000 simulations each under perfect and imperfect information that help to evaluate these three hypotheses.

4.1 Conflict Dynamics

Our basic model of conflict, adapted from the gambler’s ruin, was described in Section 3. However, that discussion was largely in static form. Figure 4 helps to illustrate the conflict dynamics. As the conflict progresses, the proportion of rebel-held territory varies as the result of a series of Bernoulli($p$) contests, with $p = \frac{S_r}{S_r+S_c}$ (for illustration we ignore the possibility of intervention in these two example scenarios). Even when rebels are relatively weak and disadvantaged by starting with a small proportion of territory (recall that their initial allocation can vary from 10 to 40 percent), they still win some rounds of the conflict (the left pane of Figure 4).

When rebels are stronger and have a better initial position within the territory, their success is more likely (the right pane of Figure 4). The duration is longer, though, because rebels have to wrest control of the remaining territory from the government to ensure their victory. Note that even when the victory of one side seems extremely likely a priori, our probabilistic model of conflict allows the other side to win some of their contests. We consider this realism an advantage of the agent-based modeling approach.

4.2 Intervention with Perfect Information

In the perfect information setting, intervention occurred in 6.7 percent of all conflicts. All of these interventions involved the third party assisting rebels when they were in the bottom quadrant of Figure 3 and moving them into the left quadrant. To use our earlier terminology, this means that rebels were weak ($p < 0.5$) and desperate ($A_{r,t} < \frac{T_{r,t}}{100}$), but intervention made them stronger ($p > 0.5$).

The increase in rebel success attributable to intervention is shown in Figure 5. Change in proportion of rebel-held territory is the difference between the final amount of rebel-held territory (either 0 or 100 percent) and the rebels’ initial allocation of territory (between 10 and 50 percent). Positive values indicate rebel victory, and negative values indicate a
Figure 4: These panes show the proportion of rebel-held territory as conflict progresses in two scenarios in the absence of intervention. In the pane on the left, the rebels are weak and start with a small percentage of the territory. In the pane on the right they are stronger relative to the government, and control a larger fraction of the territory at \( t = 0 \). Although the simulation on the left is short, both plots show that the conflict is not entirely linear or deterministic, which is an advantage of the agent-based modeling approach.

rebels’ chances of success; it also helps them to win even when they start the conflict at a disadvantage. However, Figure 5 shows that territorial allocations still matter. The peak around -0.1 of the darker line indicates more rebel defeats when they start off with a low proportion of territory, as does the downward slope between 0.5 and 0.9. Thus, even though rebels might be encouraged to fight despite a weak starting point, third parties should still bear this in mind as an important predictor of eventual victory.
Figure 5: Outside intervention increases average gains in rebel-controlled territory from 21.9 to 59.1 percent. The change in rebel-held territory is the difference between their final territorial control (either 0 or 100 percent) and their initial allocation (between 10 and 50 percent). Rebel success or failure without intervention is not heavily dependent on the initial allocation (i.e. relatively flat lines at the top of each density). When intervention occurs (the darker line), the initial proportion of territory matters more. The upward-sloping line on the left side of the figure and the downward-sloping line on the right indicate that small initial allocations of territory impede rebel victory even when a third party takes their side.

Intervention has its downsides, too. Figure 6 shows that intervention increases conflict duration, as predicted by H1. Average conflict duration without intervention is 309.1 rounds, with a median of 128 rounds. With intervention, this increases to a mean of 875.9 rounds and a median of 533 rounds. The counter-intuitive logic behind this hypothesis seems more reasonable now that we have explored how initial territorial allocations shape the conflict. Even though intervention increases the likelihood of eventual rebel success, it occurs when they are weak and desperate. Intervention can strengthen rebels (a vertical shift in Figure 3), but it does not automatically change the circumstances of the conflict (i.e. no horizontal shifts occur in Figure 3 without conflict). It is foreseeable that intervention could lead to a negotiated bargain, which our model does not account for, rather than a protracted conflict. For now, though, we are satisfied with understanding situations under which bargaining has already broken down.
Figure 6: Outside intervention increases the average conflict duration by more than double, from 309.1 to 875.9 rounds. This is because intervention occurs when rebels are at a disadvantage, and it takes a significant amount of fighting to help them achieve victory.

4.3 Intervention with Imperfect Information

We now introduce imperfect information about the strength of the government into the intervener’s decision calculus. Imperfect information about opponents’ strength is thought to play an important role in decisions about whether to engage in conflict (Fearon 1995). In our simulations, imperfect information makes third parties about five times more likely to intervene: intervention occurred 33.0 percent of the time, versus 6.7 percent of the time with perfect information.

As discussed in Section 3, imperfect information requires the third party to estimate the relative strength of the rebels and government based on the outcome of successive rounds of the conflict. These beliefs can be accurate or mistaken. For the analysis here, we calculated the accuracy of beliefs using the difference between the third party’s estimation of $p$ and its actual value. The results of our 1,000,000 simulations gave us a distribution of accuracy. We then considered beliefs about $p$ that were within half a standard deviation above or below the true value to be “accurate.” Using this calculation, 64.3 percent of third parties’ beliefs were considered accurate.

Figure 7 shows how intervention affects rebel success under imperfect information. Without intervention, rebels win 50.7 percent of all conflicts, about the same number as in the perfect information simulations. When intervention occurs based on inaccurate beliefs, this modestly increases to a 59.9 percent success rate. Intervention based on accurate beliefs has the greatest effect: the rebel success rate increases to 73.4 percent.
Why does inaccurate intervention not help rebels very much? The ‘bulge’ in the lower-left portion of Figure 7 indicates an interesting finding. Recall that victory is binary—rebels either gain control of the entire territory, or lose it all. The bulge at -0.10 indicates that when rebels were disadvantaged territorially at the beginning of the conflict, their defeat was almost guaranteed. This is likely a result of the imperfect information constraint: when rebels have a small initial allocation of territory and are weaker than the government, their defeat tends to come quickly (see Figure 4). Since the third party is relying on the conflict history to estimate rebels strength, and has a uniform prior, by the time they realize the rebels need help it is already too late. Although this finding surprised us, in retrospect it has face validity based on the empirical literature. For example, there were a number of conflicts ignited by the Arab Spring that were quickly shut down by governments without a chance for outside parties to become involved.

**Figure 7:** When third parties’ beliefs about rebel and government strength are accurate, intervention increases the proportion of rebel victories from 55.9 to 73.4 percent of conflicts. Inaccurate beliefs are not as helpful to the rebels. Intervention based on inaccurate beliefs yields only a 53.2 percent success rate. However, this is still an improvement, because rebels only win 26.5 percent of contests in which inaccurately-informed third parties choose not to intervene.

In Figure 8 the difference between accurate and inaccurate beliefs is clear. With accurate information, intervention increases duration to an even greater extent an under perfect information (Fig 6). When the third party has inaccurate information and chooses to intervene, duration still increases, but much less than in the perfect information scenario or when the third party’s beliefs are accurate. This may be because inaccurate intervention can still be followed by a rapid rebel defeat. This scenario—intervention, inaccurate beliefs, and increased conflict duration—represents a “worst-case” example of intervention. Table
1 summarizes these results.

**Accurate Intervention and Duration**

![Graph showing intervention and duration]

**Figure 8:** Intervention based on accurate beliefs about rebel and government strength increases the average conflict duration from 306.4 to 870.1 rounds, which is about the same effect as intervention with perfect information. With inaccurate beliefs, intervention increases the average conflict duration from 87.1 to 300.4 rounds. This much shorter average duration is likely due to the fact that rebels still lose many conflicts when intervention is based on an inaccurate assessment of combatant strengths.

**Table 1:** Effects of Intervention: Summary Statistics

<table>
<thead>
<tr>
<th>Information</th>
<th>Perfect</th>
<th></th>
<th>Imperfect, Accurate</th>
<th></th>
<th>Imperfect, Inaccurate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Rebel Success (%)</td>
<td>51.9</td>
<td>89.0</td>
<td>55.9</td>
<td>73.4</td>
<td>26.5</td>
</tr>
<tr>
<td>Mean Rebel Territory Chg (%)</td>
<td>21.9</td>
<td>59.1</td>
<td>25.3</td>
<td>43.4</td>
<td>-1.1</td>
</tr>
<tr>
<td>Mean Duration</td>
<td>309.1</td>
<td>875.9</td>
<td>306.4</td>
<td>870.1</td>
<td>87.1</td>
</tr>
</tbody>
</table>

5 Case Study: Libya, 2011

What can our computational model tell us about the effect of intervention in the Libyan revolution of 2011? This section gives a brief background of that conflict, describes the decision to intervene, and discusses the counterfactual of what might have happened without intervention. The expected duration of the conflict would have been reduced by BLANK, but the probability of rebel victory would have been substantially lower.
5.1 Libyan Revolution and the Decision to Intervene

The Libyan revolution unofficially began with protests in Benghazi, the country’s second largest city, during January and February, 2011. Activist Jamal al-Hajji was arrested after calling for political demonstrations “in support of greater freedoms in Libya” modeled after recent events in Tunisia and Egypt. Protests turned violent in mid-February and spread to other cities in northwestern Libya. By late February, the army had withdrawn from Benghazi, Bayda, and Misrata, leaving them in control of rebel militias. On 5 March rebels formed the National Transitional Council (NTC), temporarily headquartered in Benghazi, which would comprise the post-Qaddafi government until August, 2012.

Five days later, on 10 March, France recognized the NTC as the legitimate government of Libya—the first outside power to do so. By that time it was widely known that US and British special forces were already on the ground in Libya assisting rebels, and NATO air forces had begun round-the-clock surveillance. NATO Secretary General Anders Fogh Rasmussen did not commit to any course of action but declared that “demonstrable need” would accompany a “clear legal basis” and “firm regional support” as three guiding principles for a potential intervention. In terms of our theoretical model, this could be understood as the need for rebels to be in the lower-left half of Figure 3 before they could receive NATO assistance. It was already widely known that Western governments were not friendly to Qaddafi and had the power to increase the rebels’ chances of success; by this time three of the four conditions in the decision heuristic from Section 3 were satisfied.

Beginning on March 6, Qaddafi forces launched a counterstrike against the rebels, advancing on Brega and the rebel strongholds of Ajdabiyah and Benghazi. During this time Misrata was not firmly in control of either side. Loyalist airstrikes on Ajdabiyah began on 12 March, and shelling from land- and sea-based artillery was added three days later. An artillery barrage on Misrata began on 16 March, which was by this time under siege by loyalist forces. It had become clear that rebels would not succeed without outside help, satisfying the final condition of our proposed decision heuristic.

On 17 March the United Nations Security Council passed Resolution 1973, imposing a no-fly zone and authorizing member states to undertake “all necessary measures” to protect Libyan civilians. The Qaddafi regime responded by declaring a ceasefire but its forces continued attacking Misrata and Ajdabiyah. Coalition airstrikes in support of the Libyan rebels began on 19 March, when French air forces began patrols over Benghazi. NATO took control of the operation on 25 March, a change that was welcome to US taxpayers.

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5http://www.nytimes.com/2011/03/11/world/europe/11france.html?_r=0
7http://uk.reuters.com/article/2011/03/18/us-libya-misrata-bombard-idUKTRE72H4L520110318
diplomats. The handover had been delayed by Turkey’s reticence to support the rebels’ ground operations.\textsuperscript{8} Table 2 summarizes major events in the conflict.

\begin{table}[h]
\centering
\begin{tabular}{|c|p{10cm}|}
\hline
Date & Event \\
\hline
15 Feb. & Riots begin in Benghazi \\
24 Feb. & Rebels gain control of Misrata \\
26 Feb. & UN Security Council imposes sanctions on Qaddafi regime \\
5 Mar. & Rebels form National Transitional Council in Benghazi \\
17 Mar. & UN Security Council authorizes no fly zone \\
19 Mar. & Coalition airstrikes begin \\
26 Mar. & Rebels gain control of Ajdabiya \\
7 Apr. & Rebels withdraw from Brega \\
23 Apr. & Qaddafi forces withdraw from Misrata \\
\text{May} & NATO airstrikes intensify, especially in Tripoli \\
27 May & Rebels repel attack on Misrata \\
3 Jun. & British and French forces begin Operation Unified Protector \\
13 Jun. & Rebels push Qaddafi forces away from vicinity of Misrata \\
16 Jun. & Rebels reject offer of elections by Saif al-Islam; NATO forces resume bombardment of Tripoli \\
31 Jul. & NATO airstrikes help rebels break the stalemate west of Misrata \\
13 Aug. & Rebels begin seige of Tripoli \\
21 Aug. & Rebels enter Tripoli; Saif al-Islam arrested \\
1 Sep. & Rebel leaders begin a conference in Paris \\
15 Sep. & Nicolas Sarkozy and David Cameron welcomed in Libya \\
16 Sep. & UN Security Council relaxes sanctions \\
20 Sep. & Barack Obama calls for surrender of remaining Qaddafi forces \\
12 Oct. & Mutassim Qaddafi captured escaping Sirte \\
18 Oct. & US Secretary of State Hillary Clinton urges rebel militias to unite in a surprise visit to Libya \\
20 Oct. & Col. Qaddafi captured and killed in Sirte \\
31 Oct. & Abdul Raheem al-Keeb elected interim prime minister \\
\hline
\end{tabular}
\caption{Timeline of Conflict in Libya, 2011}
\end{table}

Between 11 April and 20 October, coalition forces completed over 14,000 sorties hitting over 3,000 targets. Targets included ammunition storage sites, bunkers, command and control facilities, and anti-aircraft batteries. The locations and density of these airstrikes are displayed in Figure 9. US personnel comprised the bulk of the task force, peaking at about 8,000 troops out of a total of 13,000. In total 18 countries participated, including Jordan, Qatar, and the UAE in addition to numerous European nations.\textsuperscript{9}

The initial intervention helped relieve the rebels’ desperate situation, but by late July it seemed as if the revolution had lost its momentum. British, French, and Canadian diplomats began to doubt whether the rebels could take control of Tripoli, and openly

\textsuperscript{8}http://www.bbc.co.uk/news/world-africa-12856665
\textsuperscript{9}http://www.guardian.co.uk/news/datablog/2011/may/22/nato-libya-data-journalism-operations-country
Figure 9: Location and Number of Coalition Airstrikes, 11 April-20 October, 2011. Darker points indicate more strikes. Strike counts range from a minimum of 1 in Dur at Turkiyah (south of Sirte) to a maximum of 716 in Tripoli. Major cities are also labelled.
considered allowing Qaddafi to stay in Libya if he was willing to give up power. However, things began to turn around on 31 July as NATO airstrikes helped rebel forces break through the front line west of Misrata, rapidly advancing nearly 9 miles and capturing supplies and vehicles left behind by retreating loyalists. In early August they enjoyed a string of successes leading up to gaining control of Tripoli on 21 August. Rebel victory was definitively secured on 20 October with the capture of Muammar Qaddafi.

5.2 Counterfactual Analysis

At the time the UN Security Council voted to intervene, rebels controlled only the area from Ajdabiya west and were under siege in Misrata. The population of rebel-controlled areas was less than two million out of the country’s total of about 5.8 million. We can use this figure for our counter-factual analysis by limiting our attention to the subset of cases in which rebels initially control 30-35 percent of the territory. We further confine ourselves to scenarios in which the intervention force was stronger than the government, which was itself stronger than the rebels. These constraints seem plausible for the Libyan case and lend realism to the results, but are not essential for the analysis that follows.

How much did intervention help the rebels’ chances of success? By quite a lot, according to our model. When we include only the territory restriction, rebels succeed without outside assistance in about 52 percent of cases. Under perfect information, intervention increases the probability of success to 91 percent. Intervention based on inaccurate beliefs only increases it to 61 percent, while accurately informed intervention helps rebels win 75 percent of the time.

The impact of outside support is even more dramatic when we consider only cases with the strength ordering detailed above. Rebels win less than 0.01 percent of conflicts under this constraint without assistance. When they receive aid, however, their chances of success increase to 33 percent under inaccurate information, 67 percent under accurate but imperfect information, and 93 percent under perfect information. These results suggest that outside intervention was a significant determinant of rebel success in Libya.

What impact did intervention have on the duration of the Libyan revolution? To answer this question we again limit cases first based on the level of starting territory. In the absence of intervention, conflicts last an average of 322.5 (interquartile range [IQR]: 75-296) rounds under perfect information and 281.7 rounds (IQR: 70-245) under imperfect information. Intervention increases the average duration under perfect information to 903.8 periods (IQR: 306-1068)—an increase of 280 percent. Inaccurate intervention increases the duration only about 10 percent (mean: 308.6, IQR: 115-305), but accurately information intervention under imperfect information has a similar effect to that.

under perfect information: a 324 percent increase in average duration (mean: 918.8, IQR: 345-2069).

These effects are slightly different when we limit our attention to cases with relative strength similar to the Libyan case. In these scenarios the average duration without intervention is about 200 rounds (perfect information mean: 195.7, IQR: 49-161; imperfect information mean 207.8; IQR: 45-157). When inaccurately informed third parties intervene this increases by 214 percent (mean: 444.6, IQR: 118-461), while accurate intervention under imperfect information increases the average duration by 471 percent (mean: 978.7, IQR: 322-1162). Perfectly-informed intervention increases conflict duration by a similar amount–409 percent (mean: 801.2, IQR: 264-919).

In substantive terms, these results suggest that intervention virtually guaranteed the Libyan rebels’ success but tripled or quadrupled the conflict’s duration. So how might the conflict have turned out in the absence of intervention? Rebel defeat would have been almost certain, and it would have come quickly. The actual duration of the Libyan conflict was 248 days (taking 15 February and 20 October as the end points). Without intervention our model predicts that this would have been reduced to between 53 and 116 days. When coalition airstrikes began on 17 March the conflict had already lasted 30 days–thus rebels may have had barely more than three weeks before their defeat at that point.

6 Conclusion

We have presented a computational model that relies on three key variables to simulate foreign military intervention in civil conflicts: the strength of each side, the relative proximity of their identity measures, and the initial proportion of rebel-controlled territory. From this starting point we were able to obtain several interesting results. Intervention on behalf of rebels increases the average duration of conflict, as well as their chances of winning the conflict by controlling more territory. However, intervention based on inaccurate beliefs about the strength of the conflicting sides is less successful that accurately informed intervention.

We also proposed a decision heuristic for potential interveners. Third parties intervene on behalf of rebels only when they are closer on an identity dimension to rebels than to the government. Conditional on rebels being the third party’s preferred side, they will intervene only when it increases the probability of rebel victory. However, we also argue that intervention will not occur if the chances of rebel victory without intervention are already high. Our model is based on intervention when rebels are weak and desperate.

These four conditions were satisfied during the Libyan revolution of 2011. Western governments and organizations preferred rebel militias to the government of Muammar
Qaddafi, yet they waited until rebels were in dire straits until they intervened publicly. A counterfactual analysis based on our computational model suggests that rebels may have had as little as three weeks before their defeat if intervention had not occurred.

In our analysis we encountered a trade-off to intervention: stay out and let the conflict come to a quick but undesirable end, or send aid to increase rebels’ chances of victory but significantly increase the conflict’s duration. Prolonged duration often also means more casualties. This result suggests that the decision to intervene is a careful balancing act for third parties.

Although our model seems to have some purchase for explaining both stylized facts about civil war intervention and the specific case of Libya, it is far from complete. Rather than argue that any of the findings here are conclusive, we encourage further work along these lines using our model as a starting point. From our simple three-sided model there are numerous complexities that could be introduced to explain a wider class of conflicts. For instance, the addition of multiple outside powers would make the decision to intervene more complicated due to considerations of how other states might react. For now we hope to have shown that counterfactual analysis using computational models is both a useful and an attainable goal.
References


