ANALYTICAL ESSAY

An Ontology of Peace: Landscapes of Conflict and Cooperation with Application to Colombia

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International relations scholarship on intrastate peace and conflict largely conceptualizes peace as an absence of war and, to some extent, the presence of a minimal degree of democracy. Empirically, scholars treat peace as a non-event, identifying it as the absence of military battles rather than (or in addition to) the presence of conflict-mitigating institutions or activities. This approach hearkens back to a bygone debate about negative and positive peace, and illustrates that negative peace conceptualizations dominate existing scholarship. In this article, we unpack the conceptual foundations of peace to account more fully for cooperation, rather than just violent conflict. We then operationalize this expanded conceptualization of peace through a latent variable measurement approach that carefully aggregates both conflict and cooperation events. We ground the measurement model in data from Colombia for the period of 1993 to 2012. In so doing, we present a new, empirically grounded ontology of peace that we expect could be useful for causal theorizing and testing in other work.

Keywords: intrastate peace, ontology, conceptualization of peace, Civil war, Cooperation, Conflict

Introduction

During civil war, conflict and peaceful cooperation coexist and coevolve at the subnational level. Violence typically occurs in highly localized areas and, even in these locations, does not directly affect most people. Take, for instance, the war in Darfur that led to the death of an estimated 300,000 people between 2003 and 2006,

wherein despite substantial violence, much of the east and center of Sudan remained peaceful. On the other hand, during periods of supposed peace, violent conflict often continues, affecting significant segments of the population. During Burundi's peaceful period (2005 to 2014), for example, extrajudicial killings and other human rights abuses gradually increased, culminating in a state crackdown on all potential opposition in 2015 (Human Rights Watch 2009). These highly variable and heterogeneous contexts, which are neither full war nor durable peace, are the rule and not the exception. A casual look demonstrates this in contexts as diverse as Burundi, Nepal, the Democratic Republic of the Congo, Syria, Sudan, South Sudan, Colombia, Mali, Senegal, Sierra Leone, Liberia, Uganda, and Palestine.

Despite this highly variable scholarly terrain, existing quantitative scholarship largely neglects conceptualizing or operationalizing peace and violence in nuanced ways. In so doing, scholars focus almost singularly on negative peace, conceptualizing and measuring peace as the absence of war (Galtung 1969), specifically when violence drops below arbitrary, blunt death thresholds. Scholarship largely ignores the existence of conflict-mitigating institutions and behaviors, or "positive peace." Most studies of intrastate war and peace focus on war onset (or not), war intensity measured in terms of battle-related deaths, the duration or recurrence of war, and the implementation of peace agreements. In these literatures, conceptualization and measurement are overwhelmingly binary: war begins or not; once started, war either continues or falls below standard thresholds and stops; war either stops or not, either through government or rebel victory, negotiated agreement, or otherwise; and then either peace is implemented successfully or war recurs by violence again exceeding some threshold. This binary outcome is primarily measured in terms of the number of battle-related deaths.

To be sure, the existing literature makes crucial contributions to our understanding of the factors that motivate civil war and peace. And yet the binary conceptualization and measurement of war and peace hinders our ability to account for the complexity of these attempted war-to-peace transitions in many ways.[1] Most importantly, it weighs violent conflict far more heavily than cooperative events, such as the signature of peace agreements or the implementation of policies that benefit the different conflict parties. Perhaps due to challenges of conceptualizing and measuring cooperative actions, the cooperative aspect of these war-to-peace transitions has been largely neglected conceptually and empirically. An examination of peace processes in almost any country demonstrates that amid violence, the government, combatants, and populations frequently engage in cooperative behavior such as refugee repatriation, land rights agreements, ceasefires, or the implementation of key provisions of peace agreements. This article aims to address this gap in the literature by conceptualizing the coexistence and coevolution of violent conflict and peaceful cooperation and empirically demonstrating their sub-national relationship.

Following a review of the literature, we develop the concept of peace and discuss its most essential attributes. In doing so, we pursue a minimalist definition of peace that conceptualizes the relationship between conflict and cooperation at the sub-national level. Peace, we argue, is manifest through sub-national actions by state, societal, and international actors within an institutional environment that mitigates violence (or not) and incentivizes cooperation (or not). These cooperative and violent activities, moreover, coexist and coevolve in countries and over time such that peace is a heterogeneous and fluid concept. By emphasizing coexistence and coevolution, we underscore a crucial point: the absence of cooperation is not conflict, and the absence of conflict is not cooperation. As such, peace is not synonymous

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[1]We use the term "war-to-peace" transition to describe contexts in which countries are undergoing possible changes that could result in achieving or implementing peace agreements. These countries may successfully or unsuccessfully emerge from civil war or other large-scale violent conflict, a process that may take decades and whose end is not clearly defined.

with the presence of cooperation; nor is it synonymous with the lack of conflict. Instead, we must examine both jointly to understand the variation in peace.

After our conceptual discussion, we then operationalize peace through a latent variable analysis using data from Colombia for the period 1993–2012. We incorporate data from the Integrated Crisis Early Warning System (ICEWS; Boschee et al. 2015) on cooperation and conflict, and then aggregate the data using a Bayesian latent variable model to generate a multidimensional landscape of the heterogeneous state of peace across the country and over time. This approach enables us to identify the coexistence of both cooperation and conflict at the sub-national level and understand how they jointly constitute a broader notion of peace.

In analyzing the results of our conceptual and measurement models, we pay close attention to cooperation dynamics during conflict. Because Colombia was viewed as an active civil war for much of the 1993–2012 period, we illustrate our overall conceptualization of peace by showing that cooperation exists in the midst of war. Our analysis demonstrates that substantial cooperative behavior occurred during all years of the 1993–2012 period across much of Colombia. Within this context, however, it shows that the areas with the highest levels of violent conflict have lower levels of cooperation as compared to areas with lower levels of violent conflict, supporting the conventional wisdom that cooperation will occur less frequently during very high levels of violent conflict. Nonetheless, across all areas that experience hostility, we see variation in the extent to which cooperative behavior coexists and coevolves with violent conflict, demonstrating that substantial cooperation can occur even in the midst of high levels of violent conflict.

Latent variables allow us to measure concepts that do not have objective measures. A latent variable is created from objective measurements, but is "more than" these objective measurements. Latent variables have been used to measure many seemingly unmeasurable concepts, such as democracy (Treier and Jackman 2008) and human rights (Fariss 2014; Schnakenberg and Fariss 2014). We contend that peace represents a similarly ambiguous concept that defies objective measurement.

We hasten to add that we do not engage in any causal theorizing or testing about the causes or consequences of peace and, therefore, do not articulate or test a set of formal hypotheses. Instead, we theorize in a descriptive, conceptual sense. We identify the most essential attributes of the concept of peace and discuss how those attributes contribute to its conceptualization and measurement. The measures we produce should prove useful in future work that seeks to theorize and test relationships between peace and other variables. We now turn to our conceptualization and measurement approach.

Literature

The debate about positive and negative peace that emerged in the 1960s pointed to the importance of understanding peace as more than just the absence of violence, which was termed negative peace (Galtung 1969). Instead, some scholars argued for a focus on positive peace, defined as the presence of individual behaviors and structural conditions that enable all individuals within a society to "cooperate for mutual and equal benefit" (Galtung 2012). Despite the recognition that peace is more than just the absence of violence, few scholars of civil war or peace have attempted to measure the existence of peaceful cooperation or its coexistence with violence. To the extent that international relations research considers cooperation, it focuses on the national level, including broader studies of the evolution of cooperation (Axelrod 1984), mediation processes (Bercovitch and Rubin 1992), and trade (Pevehouse 2004), for example. The scholarship on intrastate conflict and peace, however, largely conceptualizes war and peace in a binary fashion, with death thresholds occupying a preeminent role.

Peace and War in Phases

In the political science and economics literatures, peace is typically identified in relation to war, and in our case, civil war.[2] Scholars typically disaggregate wars into multiple phases—war onset, war intensity and outcome, and war termination and recurrence—and consider the causes and consequences of war in each of these distinct phases with a focus on national-level, as opposed to sub-national-level, measures (Walter 2002; Diehl 2006; Findley 2013). Even the scholarship on peacebuilding and peacekeeping uses national-level death threshold measures, defining peace largely as the absence of battle deaths and, in some cases, the presence of a minimum degree of democracy (Doyle and Sambanis 2000, 2006; Fortna 2004, 2008; Autesserre 2009, 2010).

Prewar and War Onset: By conventional thinking, peace breaks down and war occurs as violence between a government and one or more opposition groups reaches a sufficiently high level in their fight to control the government or territory. Scholars differ in how they define civil war (Sambanis 2004), but violent escalation due to contention between government and opposition groups is reflected in most accounts. Despite arguments highlighting the complexity and ambiguity of violence and civil war (Kalyvas 2003), war is generally conceptualized and operationalized as a temporally bounded shift out of peace and into war.

Most scholarship attempts to capture the variation in civil war onsets by employing varying death thresholds, rather than by examining cooperation dynamics. The process by which wars escalate, however, may be considerably more fluid, with substantial conflict and cooperation ebbing, flowing, and coexisting for long periods of time. Although scholars often point to prominent examples of large-scale phase transitions from peace to war, such as the onset of the Rwandan genocide, even these cases are manifestations of conflict and cooperation dynamics that develop over time (Young 2013) and the result of deeply entrenched social and governance institutions that enable the ultimate escalation of violence (Uvin 1998; Findley and Edwards 2007).

War Intensity and Outcome: Once war is ongoing, most quantitative scholarship examines the levels of violence above an onset threshold (Lacina 2006), how long the war stays above that threshold (Collier, Hoeffler, and Soderbom 2004), the different types of violence, including terrorism, that occur while civil war is ongoing (Findley and Young 2012), and how precisely the war drops back below the violence threshold (Mason, Weingarten, and Fett 1999; DeRouen and Sobek 2004).

Absent from this conceptualization of war intensity and outcome is a consideration of cooperative behavior during the period in which violence remains above the chosen threshold. Apart from the negotiations that aim to reach a peace agreement, which have received some attention (e.g., Hoglund 2008), broader cooperation dynamics are not considered in most accounts of civil war. This approach prevents scholars from identifying the role that ongoing cooperation may play in the eventual termination of the war, or how cooperative dynamics may mitigate or even spur escalating violence. During the long civil war in Northern Uganda, for example, most of the country was relatively unaffected by the violence. Even during the height of the conflict in Northern Uganda, there were important periods of cooperation between combatants and among civilians associated with opposing groups.

War Termination and Recurrence: The termination of a war has been conceptualized as the point at which violence drops below a threshold, and the parties reach (Zartman 1985) and implement that agreement (Walter 2002). In practice, scholars designate an agreement as "implemented" if fighting does not recur within some time frame, say two or five years (Fortna 2004; Doyle and Sambanis 2006; Collier, Hoeffler, and Soderbom 2008; Mattes and Savun 2009; Autesserre 2010). Given

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[2]An examination of peace in the interstate conflict literature is beyond the scope of this article.

that many peace agreements are "comprehensive"—containing provisions to trans-form the country's political, security, judicial, and social service institutions—this battle death threshold fails to capture the multidimensional nature of many peace agreements and their implementation.[3] It also neglects the possibility that some aspects of the agreement may be implemented while violence continues. In Burundi, for example, the main provisions of the Arusha Peace Agreement, signed in 2000, were implemented between 2001 and 2009, a period during which the Burundian army engaged in intense periodic battles with two separate rebel groups.

Some work rightly points to the need to identify other aspects of cooperation, such as abiding by terms of an agreement, yet does not capture the multidimensional nature of these terms (Walter 2002). On the flip side, attention is given to addressing the violence that often punctuates ongoing peace agreement negotiation processes (Hoglund 2008; Stedman 1997). And yet, little attention is paid to the spatial variation or the continued ebb and flow of cooperation and conflict dynamics during the postwar period.

Peace Not Directly Defined in Relation to War: Other scholars conceptualize peace outside war. They situate peace in relation to lower-level group mobilization and extremism (Tilly 2003), state formation (Tilly 1993; Leander 2004), state collapse (Reno 2005), criminal violence (Moodie 2010), terrorism (Hoffman 2006), and nonviolent resistance (Stephan and Chenoweth 2008). Yet even these approaches focus on relatively binary measures of violence (or non-violence), without conceptualizing or measuring the existence of cooperative behaviors alongside the violence or examining how violent conflict and peaceful cooperation may coevolve, contributing to violent, non-violent, and cooperative outcomes.

Challenges with Existing Conceptualizations

The focus of the civil war, peacekeeping, and peacebuilding scholarship on binary, national-level measures of "war" and "peace" has limited our understanding in several ways. First, the focus of much of the literature on national-level measures of war or peace hinders a full accounting of local variation. Daily reporting on political violence reveals the often-unequal distribution over time; sub-national mapping of conflict-related events reveals the same. While studies of political violence increasingly focus on micro-level instances and causes of violence, they too fail to account for the variation in both violence *and cooperation* across the territory (Kalyvas 2003; Salehyan et al. 2012; Croicu and Sundberg 2015). But all sub-national activities may not be equal. Violence and cooperation that occur in the state capital may have a much greater effect on political stability, for example, than violence or cooperation in the distant periphery. By focusing on national-level measures or micro-level instances of violence or cooperation, scholarship on intrastate conflict has largely overlooked crucial sub-national variation across space.

Second, by using a measure of battle deaths as the indicator for both war and peace, the literature has largely identified peace as a non-event rather than as the presence of conflict-mitigating actions or institutions. Theoretically, conflict-mitigating events can occur in contexts in which there are more than 25 (or 100 or 1,000) battle deaths as well as contexts in which there are less. By failing to consider conflict-mitigating events, existing scholarship may erroneously attribute "peace" to contexts in which there may be no conflict mitigation but "war" to contexts in which significant conflict mitigation may exist. This is true even for literature that seeks to identify the effect of international peacekeeping, peacemaking,

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[3]Encouragingly, recent work has begun to address more comprehensively the variation in implementation of peace accords at the country-year level (Joshi, Quinn, and Regan 2015), which is an important step toward capturing variability in peace.

or armed group behavior on conflict mitigation (Walter 2002; Doyle and Sambanis 2000, 2006; Fortna 2004, 2008; Autesserre 2009, 2010). A multidimensional measure of conflict and cooperation would enable scholars to focus on a more proximate effect of international interventions or armed group behavior, be they cooperative or conflictual.

Third, the use of a battle-death threshold as the primary measure of civil war (below the threshold) and peace (above the threshold) leads the scholarship to code the escalation or de-escalation of violence that occurs within a single, protracted war as separate civil wars. While efforts have been made to better identify distinct war beginnings and endings (Doyle and Sambanis 2006; Kreutz 2010), the common use of battle-death thresholds prevents scholars from examining the effects of peacekeeping, peacebuilding, terrorism, or other factors on the coevolution of "war" and "peace" over time. Rather than separate processes, violent conflict and peaceful cooperation are often highly related, with both occurring simultaneously during peace processes in ways that may undermine or advance peace (Kydd and Walter 2002; Hoglund 2008).

By identifying the sub-national variation in violent conflict and peaceful cooperation, this article takes a first step toward a fuller understanding of the coexistence and coevolution of war and peace, and its implications for current scholarship on civil war, peacekeeping, and peacebuilding. The coexistence and coevolution of war and peace characterizes a wide array of conflicts, including Burundi, Nepal, the Democratic Republic of the Congo, Syria, Sudan, South Sudan, Colombia, Mali, Senegal, Sierra Leone, Liberia, Uganda, and Palestine. The prevalence of these contexts underscores the need to conceptualize and operationalize the relationship between conflict and cooperation more precisely.

Heterogeneity in Sub-National Peace and War

To characterize the degree of peace at the sub-national level, we contend that two primary attributes need to be identified: (1) cooperative activity and (2) violent activity, both of which we argue coexist and coevolve. Peace is not merely the absence of violence; peace also includes the active pursuit of cooperative behavior within and between opposing sides. A casual perusal of the empirical reality in war-affected countries shows that cooperation and violence often coexist, coevolve, and are even carried out by the same actors during the same period.

Coexistence of Cooperation and Violence

Cooperative and violent behavior coexist in the same country and even in the same small towns or areas. A general analysis of Sudan, for example, presents a picture of violence and cooperation occurring at the same time but in different geographic locations. The areas along the eastern border with Eritrea are mostly free of violence, and all parties seem to be engaged in active, if fragile, cooperation. In other parts of the country, such as some parts of Darfur, South Kordofan, and the Blue Nile states, however, violence dominates the landscape and few cooperative interactions are visible among warring parties, despite several prior peace agreements.

A more detailed sub-national analysis reveals, however, that conflict and cooperation also coexist in the very same places at the same time. In the South Kordofan region of Sudan, for example, some communities regularly cooperate to resolve land and livestock conflicts while other, adjacent, communities battle over these same resources. In Burundi's capital, Bujumbura, during the initial stages of the implementation of the Arusha Agreement (2002–2003), intense combat on its outskirts took place in the same year and same general location as crucial cooperative agreements between the same warring parties.

Violent conflict and cooperation may also coexist because some actors prioritize the use of violence whereas others focus on cooperation. For example, in Northern Uganda during the long war between the Lord's Resistance Army (LRA) and the Ugandan government, local civilians desired cooperation and continually pushed for cooperative relations among all groups (Author Interviews 2013). The LRA and Ugandan government, however, pursued violence against each other, and even against the civilian population, at the very same time. The use of violent and cooperative actions by civilians, the LRA, and the Ugandan government demonstrates the coexistence of violence and cooperation in the same country and same sub-national geographic location. They also point to ways in which coexisting events may, in fact, coevolve.

Coevolution of Cooperation and Violence

Not only do violence and cooperation coexist in any given country and a given sub-national location, but they also coevolve over time. Coevolution is a biological concept that describes the influence of two closely associated species on each other's evolution. It offers a good analogy for the relationship between conflict and cooperation at the sub-national level, in which both conflictual and cooperative actions are taken by different parties to influence the trajectory of a war-to-peace transition. The coevolution of conflict and cooperation are particularly visible in protracted intrastate wars that last many years and survive multiple peace agreements and bouts of intense violence (Azar 1990). The ongoing wars in Sudan, South Sudan, Israel and Palestine, Burundi, and the DRC provide just a few of the many examples, described below, of the coevolution of conflict and cooperation during protracted intrastate wars.

In protracted conflicts, a sidelined party may use violence to attain a seat at the negotiation table. By using violence, an armed group identifies itself as an actor with the potential to "spoil" the peace process, often leading to its inclusion in the negotiation process (Stedman 1997). In Colombia in the first half of 2016, the National Liberation Army (ELN) simultaneously declared that it was joining the peace process while also ramping up violence in numerous regions, all of which occurred ahead of the signing of the peace agreement between the Colombian government and the Revolutionary Armed Forces of Colombia (FARC) in September 2016. Because the government is hoping to sign a subsequent peace agreement with ELN, the ELN appears to be using violence to strengthen its bargaining position in the forthcoming negotiations. While the ELN is likely to agree to peace, the strategic use of violence during the negotiation process increases its potential share of a future settlement. Violence becomes this group's path to political cooperation and, thus, increased power and influence.

Alternatively, sidelined parties may use violence to undermine ongoing peace processes, "spoiling" ongoing peace negotiations, with the possible aim of inclusion in future negotiations or of ending the negotiations altogether (Stedman 1997; Greenhill and Major 2006; Findley and Young 2015). At times, the exact strategy underlying a violent or cooperative action may be ambiguous, potentially caused by fragmentation within a rebel group or political party (Cunningham 2013). For example, Yasser Arafat, the former president of the Palestinian National Authority, often claimed to be pursuing cooperative relations with Israel, while Hamas, a closely related militant organization, would simultaneously carry out violent attacks against Israelis. The Israeli government, for its part, has frequently pressed for cooperation with Palestinians while at the same time expanding settlements and continuing secret raids against Palestinians in the West Bank and Gaza. In these instances, violence and cooperation coevolve as part of a single, if protracted, war-to-peace transition.

Scholarship on state formation accepts the coevolution of violent conflict and political cooperation as part of violent state formation processes (Wagner 2007). Tilly's (1993) chronicle of historical state formation processes in Europe describes a gradual change from violent conflict to cooperation based, in part, on the need to respond to citizen demands for peace and security. Accounts of contemporary state formation processes, however, show that the same push by citizens or leaders for the consolidation of peace and security does not exist in many of today's violent state formation processes (Ayoob 2007). Porous borders and regional conflict systems, on the one hand, and international intervention, on the other, contribute to the protraction of contemporary state formation processes, punctuated by intense episodes of conflict and cooperation (Luttwak 1999; Rubin 2002; Reno 2005; Ayoob 2007; Mukhopadhyay 2014).

Synthesis

Each of these explanations of the dynamics of contemporary intrastate wars points to the coexistence and coevolution of violent conflict and peaceful cooperation. The heterogeneity of cooperation and violence across a country underscores a key point about our understanding of peace. Rather than conceptualizing peace and war as a dichotomy, a better conceptualization would seek to explicitly capture the heterogeneity of cooperation and conflict in the same sub-national locations within a country as well as across a country. By more accurately capturing both violence and cooperation, scholars can more precisely identify the dynamics of ongoing state formation processes and how "peace" is situated within them. If this conceptualization is accurate, then we should observe the following in attempts to operationalize peace:

1. At a given point in time in a country, we should observe not only that conflict and cooperation dynamics occur in different areas, but that conflict and cooperation occur substantially in the same locations.
2. In each country over time, we should observe not only that conflict and cooperation fluctuate in different areas, but that conflict and cooperation substantially fluctuate in the same locations.

Operationalization of peace should thus adequately capture the variation inherent in the attributes of conflict and cooperation that constitute a conceptualization of peace, which we now consider.

Research Design and Measurement

In this section, we present a model of the coexistence and coevolution of cooperative and conflictual events, expanding on the conceptual discussion in the sections and above. Conflict and cooperation result from various dynamics, including international peacemaking and peacekeeping efforts, strategies of armed groups, state policies, the presence or absence of certain political institutions, and individual perceptions. We thus develop *latent* variables for conflict and for cooperation, generating observable measurements of the degree and evolution of peace in each sub-national location. Latent variables, as opposed to observable variables, capture concepts that can be inferred from the presence of multiple observable variables but which, absent these variables, cannot be directly observed or measured. To capture the relationship between the latent variables and observed data, we apply Bayesian Item Response Theory to the case of Colombia from 1993 to 2012.

The case of Colombia provides unique analytical opportunities to investigate the coexistence and coevolution of conflict and cooperation. The Colombian civil war has been ongoing for over half a century, with episodes of conflict and cooperation that range from participation of all the parties in high-profile peace processes to

intense episodes of armed violence among several warring parties. Colombia also has a high availability of quality sub-national data. As a middle-income country that has made significant investment in its own statistics infrastructure and national research institutions, Colombia has significantly better sub-national data than most countries affected by ongoing civil war. Colombia also has a relatively strong media that covers its full territory.[4] Our analysis uses data generated from media reports, which means a relatively free, established media presence is important to lessen reporting bias, even if it is impossible to completely avoid.

Data

For observed measurements of conflict (labeled the "hostility" latent variable) and cooperation, we draw on the Integrated Crisis Early Warning System (ICEWS) Dataset (Boschee et al. 2015). The ICEWS dataset is a product of automated text analysis of more than 30 million news stories over the past 13 years, with global coverage. The news stories are classified into event categories based on the CAMEO (Conflict and Mediation Event Observations) taxonomy, which provides information about the type of event and its characteristics relative to other events. Each event category in the CAMEO classification has a numerical value describing its intensity, ranging from negative 10 to positive 10, using Goldstein's (1992) Conflict-Cooperation Scale. The negative values signify the hostility of an event, with –10 capturing higher hostility and –1 lower hostility.[5] The positive values represent the cooperative nature of the event, with 10 capturing higher cooperation and 1 capturing lower cooperation.

Our use of events data builds on a long tradition in international relations (e.g., Schrodt 1995; Pevehouse 2004; Polachek, Seiglie, and Xiang 2005). Our application follows the insight in Pevehouse (2004) to disaggregate conflict and cooperation rather than considering them as mutually exclusive measures on the same scale. In contrast to much previous work in international relations, our implementation is at the sub-national level. In contrast to other sub-national events data analysis, we do not restrict ourselves to a study of conflict, but instead extend the logic of Pevehouse (2004) and incorporate cooperation alongside conflict.

Because we are interested in the distribution of peace across space and over time, we aggregate the ICEWS dataset to a municipality-year format. The municipality level is the second level administrative district in Colombia, providing us with the highest available degree of spatial resolution with which to construct a latent measure of peace. Following guidelines for ICEWS aggregation, we create seven count variables for conflict and cooperation among various parties: counts of high-hostility events (intensity: –10 to –8); moderate-hostility events (intensity: –7 to –4); low-hostility events (intensity: –3 to –1); neutral events (intensity: 0); low-cooperation events (intensity: 1 to 4); moderate-cooperation events (intensity: 5 to 6), and high-cooperation events (intensity: 7 to 10).[6] We use data from all 1,122 municipalities for 20 years from 1993 to 2012.

Despite its broad coverage of the information sources, the ICEWS dataset is generated with machine learning and thus still subject to measurement concerns. Although at least one study confirms the precision of ICEWS dataset relative to a comparable dataset—the Global Dataset of Events, Language, and Tone (GDELT) dataset (Ward et al. 2013)—ICEWS still lacks systematic reliability and validity

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[4]Recently, there have been reports of media bias due to self-censorship. See Reporters Without Borders, Colombia, https://rsf.org/en/colombia (accessed March 13, 2016).

[5]"Hostility" is the term used in the CAMEO classification for Goldstein's (1992) conflict side of his conflict-cooperation scale, which ranges from extreme physical hostility, or violent conflict, to less extreme verbal hostility.

[6]The aggregation process can also be incorporated to the empirical model. In this study, nonetheless, we follow the standard guidelines to contain the computational time within a reasonable amount.

assessments, which may be a reason for caution in use and interpretation. It is also important to note that because the data are generated from media reports, they do not necessarily represent the state of cooperation and conflict dynamics, but rather what is publicly reported in the media *about cooperation and conflict dynamics*. This is less of a concern for the present study, however, which seeks to demonstrate the plausibility and usefulness of a new approach to conceptualizing peace.

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The Estimation Strategy

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To measure the concept of conflict and cooperation, which are not directly observable, we apply the Bayesian Item-Response Theory (IRT) approach (Armstrong et al. 2014). Although it appears complex, our approach to creating latent variables for conflict and cooperation is relatively simple. We take the Goldstein scale and break it up into seven count variables that represent the number of events that have a range of values on the Goldstein scale. For the cooperation latent variable, we regress the counts of cooperative and neutral events—neutral events (intensity: 0); low-cooperation events (intensity: 1 to 4); moderate-cooperation events (intensity: 5 to 6), and high-cooperation events (intensity: 7 to 10)—on the cooperation latent variable. For the conflict latent variable, we regress the counts of hostile and neutral events—high-hostility events (intensity: –10 to –8); moderate-hostility events (intensity: –7 to –4); low-hostility events (intensity: –3 to –1); neutral events (intensity: 0)—separately on the conflict latent variable. In effect, our model is comprised of seven regressions.

The key differences between the Bayesian IRT and conventional regression analyses are that 1) the "regressors" are unobservable; and 2) we are interested in measuring the latent variables instead of testing specific relationships among variables. Thus, unlike regression analyses or correlational methods such as the multivariate spatial correlation analysis (Wartenberg 1985), the Bayesian IRT allows us to go beyond correlations among observed indicators to create more direct measures of the latent variables.

Instead of calculating the simple average of the indicators, which assumes that low-hostility and high-hostility events possess the same weights, the Bayesian IRT assigns weights to indicators based on data. It allows us to show how conflict and cooperation positively or negatively correlate with one another. The Bayesian IRT can also easily incorporate temporal dependency and discrete indicators. As Fariss demonstrated (Fariss 2014; Schnakenberg and Fariss 2014), Bayesian IRT can account for how a latent variable depends on its past values. Unlike factor analysis, the Bayesian IRT allows us to use not only continuous indicators but also discrete indicators in estimating latent variables. Note that the way we use Bayesian IRT to develop a latent variable is not new and is very like the method used in prior studies of human rights and democracy (Fariss 2014; Schnakenberg and Fariss 2014; Armstrong et al. 2014; Treier and Jackman 2008). Our contribution is the *application of* this method to the measurement of peace.

Because the observed measures are counts of events, and because the distributions of cooperative and hostile events are over-dispersed, we use negative binomial regression models. The model is then expressed as

$$Pr\left(hostileH_{i,t}|\boldsymbol{\theta}\right) = NB\left(\frac{r_{hH}}{r_{hH} + \exp\left(\beta_{0,hH} + \beta_{1,hH}\ hostility_{i,t}\right)},\ r_{hH}\right);$$

$$\vdots$$

$$Pr\left(hostileL_{i,t}|\boldsymbol{\theta}\right) = NB\left(\frac{r_{hL}}{r_{hL} + \exp\left(\beta_{0,hL} + \beta_{1,hL}\ hostility_{i,t}\right)},\ r_{hL}\right);$$

$$Pr\left(neutral_{i,t}|\boldsymbol{\theta}\right) = NB\left(\frac{r_n}{r_n + \exp\left(\beta_{0,n} + \beta_{1,n}\ hostility + \beta_{2,n}\ cooperation_{i,t}\right)},\ r_n\right);$$

$$Pr\left(cooperativeL_{i,t}|\boldsymbol{\theta}\right) = NB\left(\frac{r_{cL}}{r_{cL} + \exp\left(\beta_{0,cL} + \beta_{1,cL}\ cooperation_{i,t}\right)},\ r_{cL}\right);$$

$$\vdots$$

$$Pr\left(cooperativeH_{i,t}|\boldsymbol{\theta}\right) = NB\left(\frac{r_{cH}}{r_{cH} + \exp\left(\beta_{0,cH} + \beta_{1,cH}\ cooperation_{i,t}\right)},\ r_{cH}\right).$$

The left side of each equation is the probability of observing realizations of one of the seven ICEWS count variables listed in the previous paragraph. The right-hand side denotes the negative binomial regression on the latent variables. In these equations, i is a given municipality (sub-national administrative unit), t is a given year, $\boldsymbol{\theta}$ is a vector of all parameters, r is an auxiliary parameter,[7] and β is a coefficient for a latent variable, known as an item discrimination parameter.[8] The coefficient represents the extent to which a latent variable can explain the variation of an observed variable. This parameter is like factor loading in factor analysis (Treier and Jackman 2008, 205). To make the model identifiable, we put constraints of $\beta_{0,n} = 0$, and $\beta_{1,n} = \beta_{2,n} = 1$. These constraints define values of the other coefficients relative to those of neutral events. For example, $\beta_{1,hH}$ represents the response of the latent hostility variable to the high-hostility events as compared to the response of the same variable to the neutral event. Without this constraint, the coefficients are not unique and the model is not estimable.

Because the latent variables are unobservable, we also need to make assumptions about their prior probability distributions. The "priors" are our beliefs about the distributions of latent variables. In this analysis, we use normal prior distributions for the latent variables. Because each latent variable ought to be dependent over time, we consider normal random walk (normal distribution with temporal dependency) priors (Schnakenberg and Fariss 2014):

$$hostility_{i,t} \sim \begin{cases} Normal\left(hostility_{i,t-1}, \tau^2\right) & if\ t \geq 2 \\ Normal\left(0, \tau_1^2\right) & if\ t = 1 \end{cases};$$

$$cooperation_{i,t} \sim \begin{cases} Normal\left(cooperation_{i,t-1}, \vartheta^2\right) & if\ t \geq 2 \\ Normal\left(0, \vartheta_1^2\right) & if\ t = 1 \end{cases},$$

where τ^2, τ_1^2, ϑ^2, and ϑ_1^2 are precision parameters.[9] The random walk prior assumes that a current value of a latent variable is centered on a previous value with a random disturbance. The normal random walk prior only considers the temporal dependency but not the spatial dependency precisely because we aim to

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[7]r is assumed to have an uninformative gamma prior.

[8]In the above equations, an *H or L* after *hostile* or *cooperative* connotes high or low, respectively. The equations for moderate hostile and cooperative events are not pictured above, but are indicated by $\vdots$.

[9]The parameters are assumed to have uninformative gamma priors.

understand the two latent variables' overall distribution across the country and coevolution within each municipality.

The model is estimated by the stochastic simulation method (Markov Chain Monte Carlo; MCMC) with the Just Another Gibbs Sampler (JAGS).[10] Once estimated, we can examine the two latent variables of cooperation and hostility together to characterize better the multidimensional aspects of peace.

Results

Below, we discuss our results first in relation to the convergence validity of our measurements: whether the latent measurements of hostility and cooperation indeed capture the underlying concepts of conflict and cooperation. The coefficients help us do this by gauging the relationship between the observed ICEWS measures and our latent variables of *hostility* and *cooperation*. If our measurements are valid, the latent variables should respond to the measurement similarly. For instance, if the latent measurements of hostility indeed capture observed hostility, the coefficients of the hostility latent variable should converge for all hostility measurements. Second, we discuss our results in relation to the temporal and spatial distributions of the latent variables and their association with each other. This enables us to examine our expectations that conflict and cooperation coexist and coevolve at the sub-national level.

If our expectation is correct that conflict and cooperation coexist within all Colombian municipalities in the sample, the latent variables of hostility and cooperation should positively correlate, although the proportional relationship between hostility and cooperation should vary across municipalities. In other words, if conflict and cooperation events occur within the same year in the same municipality, then we should see them represented in the graphs below as on-diagonal cases. If conflict and cooperation dynamics are unrelated—not occurring within the same year in the same municipality—then they will be visualized as off-diagonal cases.

In addition, our above discussion of coevolution implies that cooperation and hostility are part of a single protracted localized dynamic, with higher levels of hostility some years and higher levels of cooperation other years. We therefore expect to see some municipalities where, over time, there is change between two conflict/cooperation contexts: *primarily* hostility or cooperation, and *relatively balanced relationship between* hostility and cooperation. This would show that, over time, conflict and cooperation ebb and flow as part of a single localized dynamic where conflict can lead to cooperation, and cooperation can lead to conflict.

In sum, our assessment of the *coexistence* of conflict and cooperation focuses on the spatial component of the data without examining the temporal component. Afterward, we assess the *coevolution* of conflict and cooperation, examining the temporal component of the same data. The expectations about the coexistence and coevolution are, thus, not mutually exclusive; in fact, we expect them to occur within the same municipality. We nonetheless examine the coexistence and coevolution of conflict and cooperation separately to test these distinct assumptions about the relationship between these two types of events.

Relationship between Observed Measures and the Latent Scales

To assess the convergence validity of the measurements, or whether the latent measurements of hostility and cooperation indeed capture the underlying concepts of conflict and cooperation, Figure 1 shows the 95% credible intervals of the coefficients.

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[10]For details of the MCMC, refer to standard textbooks of Bayesian statistics, such as Gill (2014).
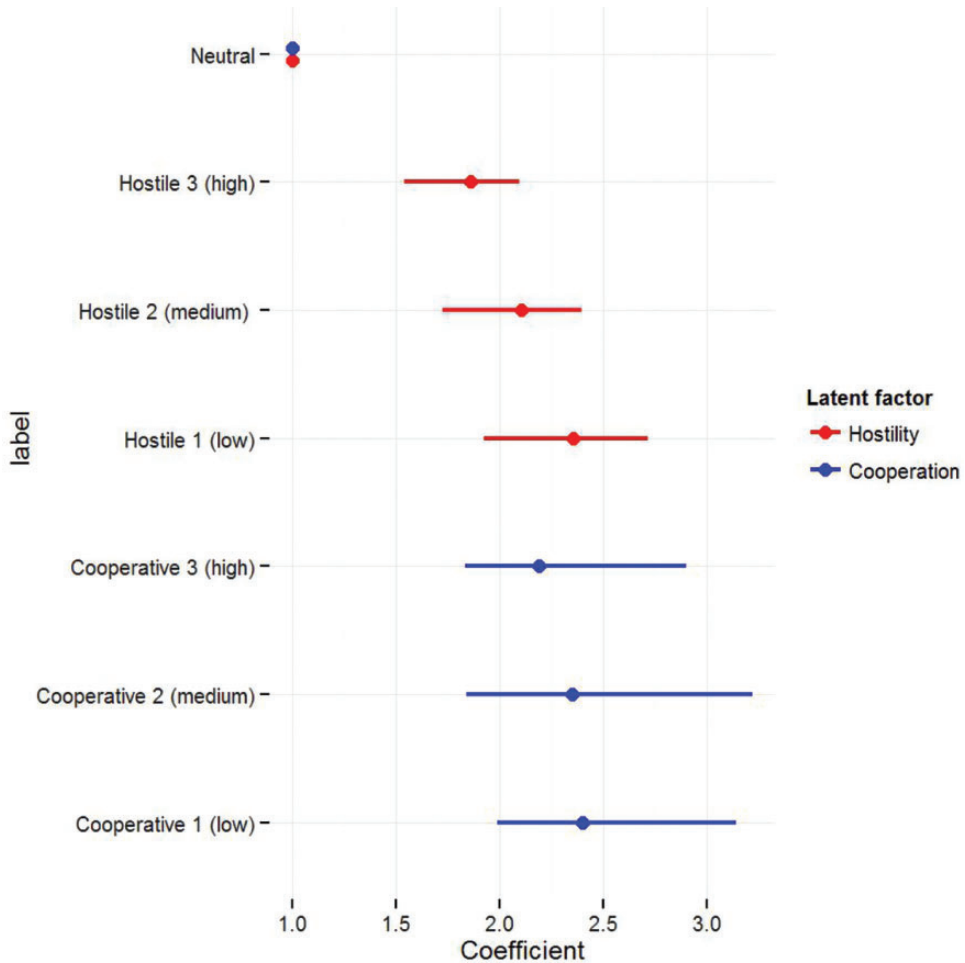
Figure 1. Estimates on the coefficient parameters. *Note:* The figure shows the 95% credible intervals of the coefficient parameters for the latent variables. The dot on each line represents the median of the posterior distribution for each parameter, and the lines represent the 0.025 and 0.975 quintiles of the posterior distributions. The figure shows positive relationships between the latent and observed measurements, with the strongest relationships indicated by higher correlation coefficients. It also shows that the latent variables for hostility and cooperation have similar coefficient values for the corresponding hostility and cooperation measurements.

Figure 1 indicates that the latent variables of hostility and cooperation have positive relationships with all the respective ICEWS measurements. The fact that the latent variable of hostility responds more sharply to the low-hostility events, connoted by a higher correlation coefficient, than medium- and high-hostility events suggests that the latent variable captures more verbal than physical hostility, as conceptualized by the Goldstein scale (1992). Nonetheless, the positive relationship between the hostile and cooperative events and the corresponding latent variable shown in Figure 1 in relation to high and medium hostility demonstrate that the hostility variable also captures important amounts of physical hostility. The responses of the cooperation latent variable, however, do not vary as much with the levels of cooperation, meaning that the variable reflects cooperation in general.
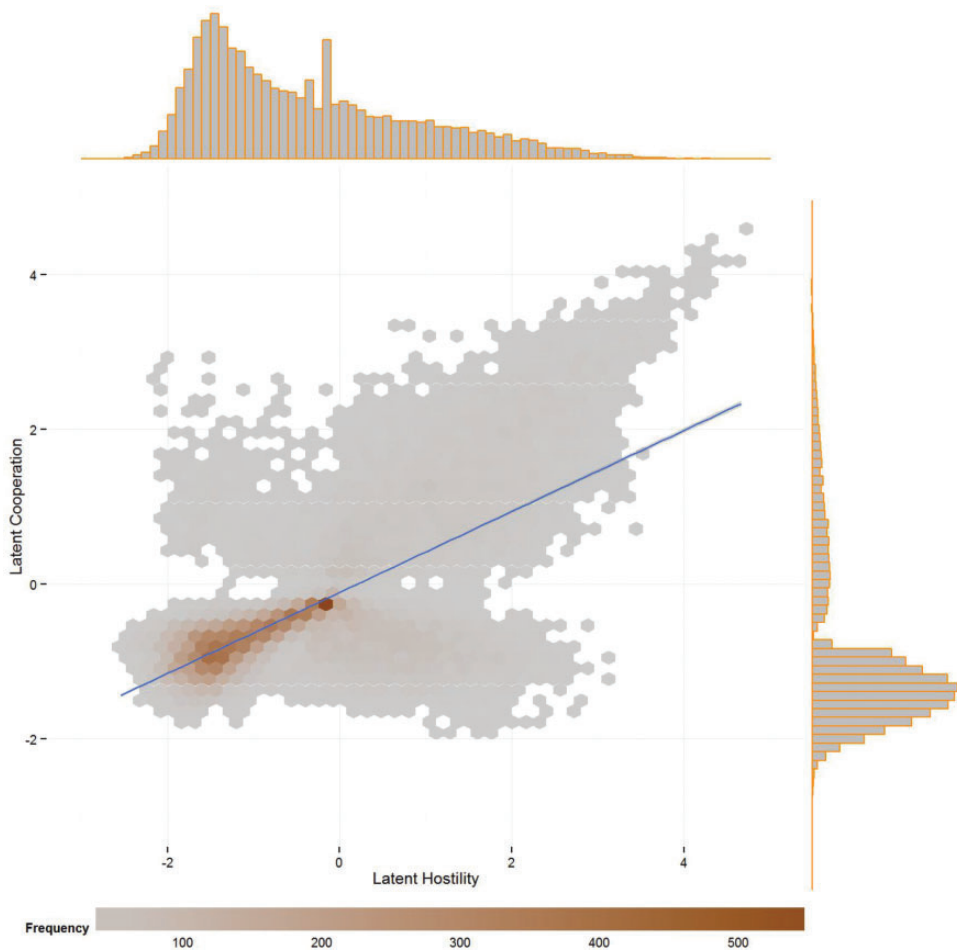
Figure 2. Hexagon and histograms of the latent variables. *Note*: The hexagon plot and histograms show the posterior joint and marginal distributions of the latent hostility and cooperation variables with a fitted line. As an estimate of the latent variables for each municipality-year, we use the median value of the posterior distribution. The hexagon plot shows the frequency of municipality-year observations in each hexagon cell, while the histograms along each axis show the density of municipality-year observations for each latent variable. As the color band at the bottom of the figure shows, dark orange indicates high frequency while light gray indicates low frequency. The fitted line is an estimate of the Generalized Additive Model (GAM), a flexible non-parametric line fitting. The figure shows a positive correlation of hostility and cooperation with a certain number of off-diagonal cases in relation to both no-cooperation and hostility (bottom-right portion of the figure) and in relation to no-hostility and cooperation (upper-left portion of the figure), with the former presenting more observations than the latter.

Relationship between Hostility and Cooperation Latent Scales

To gauge the relationship between the hostility and cooperation latent variables, the hexagon plot and histograms in Figures 2 and 3 show the distribution of the hostility and cooperation variables generated and updated through the Bayesian IRT analysis. We also fit a line.[11] The hexagon plot in the center of Figure 2 shows

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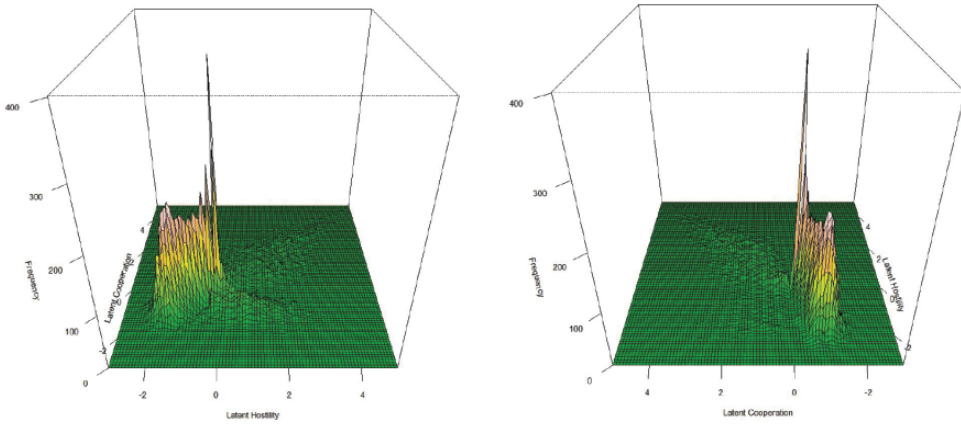[11]We use the Generalized Additive Model to fit the line.

Figure 3. 3D density plots of the latent variables. *Note:* The 3D density plots show the joint distribution of the *hostility* and *cooperation* variables. The figure on the left side has *hostility* in the horizontal axes and *cooperation* in the vertical axes, while the figure on the right side has *cooperation* in the horizontal axes and *hostility* in the vertical axes. The 3D plots show that there are many observations that had hostility but did not have cooperation, while there are fewer observations that had cooperation but did not have hostility.

the frequency of municipality-year observations in each hexagon cell. The histograms on the upper horizontal and right vertical axes of Figure 2 show the density of municipality-year observations for each latent variable.

The upper-right-hand portion of Figure 2 (above 0 on the *x*- and *y*-axes) shows that many observations take positive values on the latent variables for both hostility and cooperation. Combined with the positive slope of the fitted line, this suggests that hostility and cooperation indeed coexist in many municipality-year observations. Because of the rarity of both conflict and cooperative events, however, most of the observations are in the bottom-left quadrant, taking negative values on both of the latent values. This shows that most municipalities have neither hostile nor cooperative events in any given year.

Figures 2 and 3 also indicate that there are hundreds of off-diagonal municipality-year observations, where the events take positive values on the hostility latent variable but negative values on the cooperation latent variable. These municipalities, therefore, experienced hostility without cooperation. In addition, there are many observations showing that municipalities experienced cooperation but no hostility, although these occur less frequently than those with hostility but no cooperation.

In Figure 3, we create the 3D density plots to better visualize the low-frequency cases. It shows the frequency of *hostility* and *cooperation* variables from two angles: the left figure has *hostility* on the horizontal axis and *cooperation* on the vertical axis, while the right figure has *cooperation* on the horizontal axis and *hostility* on the vertical axis. Figure 3 shows that there are many observations that had hostility but did not have cooperation, while there are fewer observations that had cooperation but did not have hostility.

These off-diagonal cases thus imply that cooperation tracks closely to hostility, whereas hostility can emerge without cooperation. The off-diagonal municipality-year observations lend tentative support to our expectation that conflict and cooperation coexist, with some municipality-year observations being dominated by cooperation while others are dominated by conflict. A better representation of the coevolution—or relationship over time—of conflict and cooperation, however, is contained in Figure 4, discussed below.
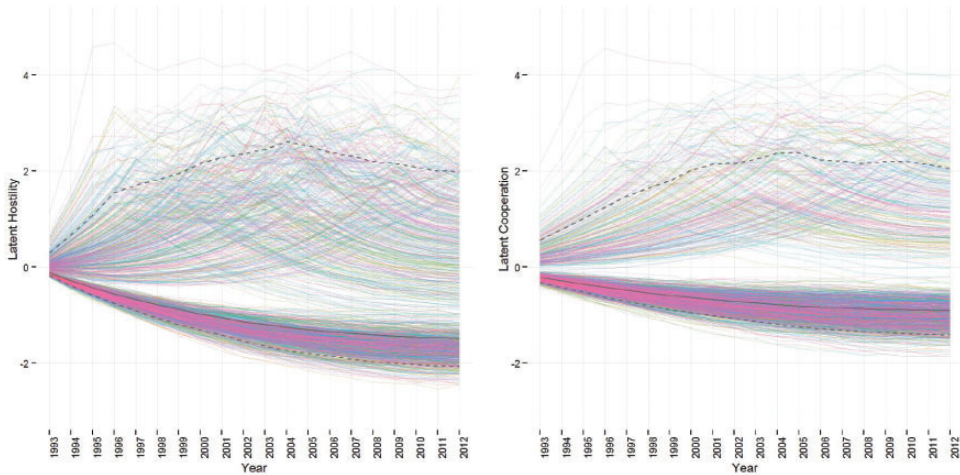
Figure 4. Temporal distributions of the latent variables. *Note*: The figures above are plots of hostility (left) and cooperation (right). The plot is made by (1) calculating the estimates (median) of hostility and cooperation variables for each municipality-year, and then (2) calculating the median of hostility and cooperation variables for each year among all municipalities. The colored lines are the values of hostility and cooperation variables for each municipality generated from the first procedure. The solid and dashed black lines are generated from the second procedure. The dashed lines are the 90% quantiles of the *hostility* and *cooperation* variables. The black solid line is the median of all values. The figures show that there are two groups, one that did not experience the events and thus took negative values, and another that did experience one or more events, taking a positive value. They also show the substantial variation within the municipalities that take positive values.

Spatial Distribution of Hostility and Cooperation Latent Scales

To illustrate the spatial distribution of hostility and cooperation, Figure 5 presents the median values of the latent variables and their differences for each municipality.[12] The two sub-figures on the left side of Figure 5 again confirm the finding that hostility and cooperation coexist. Indeed, the municipalities with deep blue colors (high cooperation values) correspond to those of deep red colors (high hostility values). These observations are concentrated in the municipalities that are on the frontlines of the combat between the Colombian government and the FARC: the Sucre, Bolivar, and Norte de Santander departments (administrative level 1) in the north of Colombia, the Tolima and Huila departments in the south, and a few departments east of Bogota.

The right side of Figure 5, nonetheless, indicates the heterogeneity in the relative levels of hostility and cooperation. Although hostility and cooperation cancel each other out and thus the color on the right side of Figure 5 is white in several municipalities, the difference between the two latent variables varies substantially across the country. In some instances, moreover, the municipalities with high relative hostility are next to those with high relative cooperation. These results imply that hostility and cooperation indeed coexist spatially and that there is substantial variability in the relative degrees of hostility and cooperation across the country, and even between adjacent municipalities.

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[12]Due to the difference in the municipality names between the ICEWS dataset and the polygon dataset, about 20% of the municipalities have missing values.
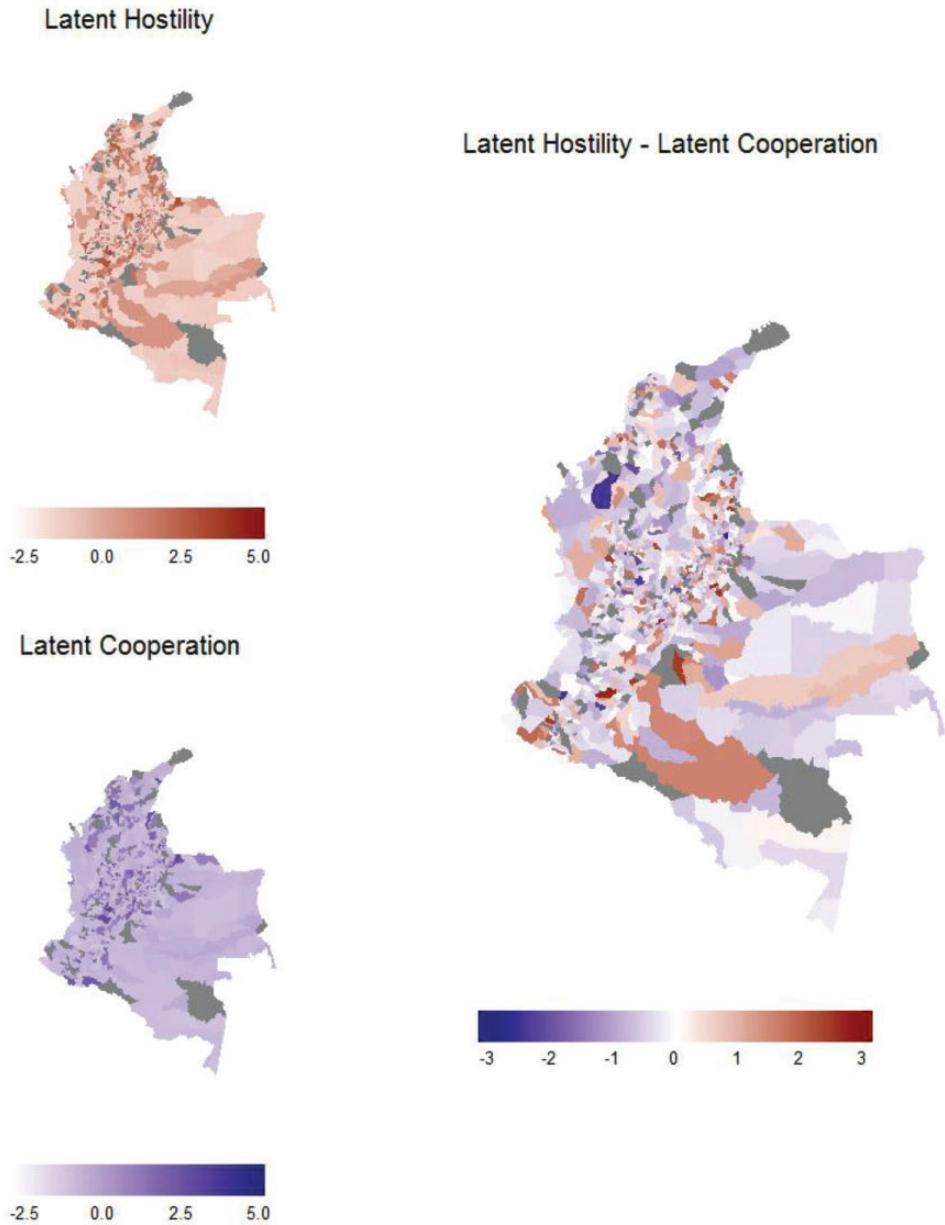
Figure 5. Geographical distributions of the latent variables. *Note*: The figures present the median and difference of the latent variables for each municipality. As an estimate of the latent variables for each municipality-year, we use the median value of the posterior distribution, and then calculate and map the median of the variables for each municipality. The two figures on the left side show the medians of the hostility (top-left) and cooperation (bottom-left) variables, respectively. The right figure shows the values of the hostility variable minus those of the cooperation variable. The deep blue (on the left) and the red (on the right) colors correspond to cooperation and hostility, respectively. The gray municipalities have missing values due to failures to merge the ICEWS dataset to the municipality polygons. The figures suggest that the municipalities of high cooperation correlate with those of high hostility, while the relative levels of these two variables substantially differ across the country.

Temporal Distribution of Hostility and Cooperation Latent Scales

Figure 4 presents the temporal distribution of hostility, on the left-hand side, and cooperation, on the right-hand side, in each year, depicting the median values of hostility (left) and cooperation (right) for each municipality over time. Each municipality is represented by one line in the hostility figure and one line in the cooperation figure. The dashed lines at the bottom and top of the figures represent the 90% quantile. The solid black line represents the median value of all observations. Because we assume a random-walk distribution for the latent variables, the values of the first years have less variation, centering on zero, with the values diverging in later years.

Both plots show that municipalities become segmented into two separate groups over time, with the two groups becoming visible as early as 1996. The municipalities that cluster toward the bottom of the figures (below 0) have largely negative values on the hostility latent variable (left figure) and cooperation latent variable (right figure), while those that cluster toward the top of the figures (above 0) tend to have positive values. At the bottom of each figure, there is a large cluster of municipalities whose values are below zero and slowly decrease over time. As seen in Figures 2 and 3, most these are municipalities that experience no hostile events (left figure) or no cooperative events (right figure), which is expected due to the rare nature of these events and the fact that our unit of analysis is the municipality-year. In contrast, there is another cluster of observations at the top of each figure, each of which experience high levels of hostility or cooperation over time.

The division of the observations into these two general groups suggests that hostility and cooperation are not uniformly distributed, but that municipalities that experience cooperation tend to continue to experience cooperation while municipalities that experience hostility tend to continue to experience hostility.

Despite the division of municipalities into two separate groups, Figure 4 shows that there is substantial variation within the clusters, especially within the municipalities that fall within the upper half of each figure, depicting high hostility (left) and high cooperation (right). Within these two groups, there are multiple single-peaked lines with different heights, meaning that these municipalities experienced a hostile (left figure) or cooperative (right figure) event, leading to an increase in the corresponding latent variable. Although the municipalities that peak tend to return to negative, the return rate is not rapid, due to the temporal dependency of latent variables. The substantial variation of the timing of the peaks, especially for the hostility variable, implies that conflict and cooperation vary to a substantial degree within one municipality over time. The existence of both conflict and cooperation within one municipality (see Figures 2 and 3) and the variation in the levels of both conflict and cooperation over time illustrates their coevolution not only within one country, but also within one locality.

In summary, this empirical analysis of the Colombian context shows the coexistence and coevolution of the hostility and cooperation latent variables, both spatially and temporally. The estimates of the Bayesian Item Response Theory show that the latent variables of hostility and cooperation have a positive correlation, demonstrating that they coexist within the same municipalities in the same year. There are also hundreds of off-diagonal cases that show that some municipalities have conflict but not cooperation, while others have cooperation but not conflict. The empirical analysis also shows that there is significant variation in the levels of hostility and cooperation, relative to one another and relative to the municipality at another point in time. Of course, the above analysis shows that some municipalities tend to experience neither conflict nor cooperation while others experience both conflict and cooperation, lending support to the general expectation that
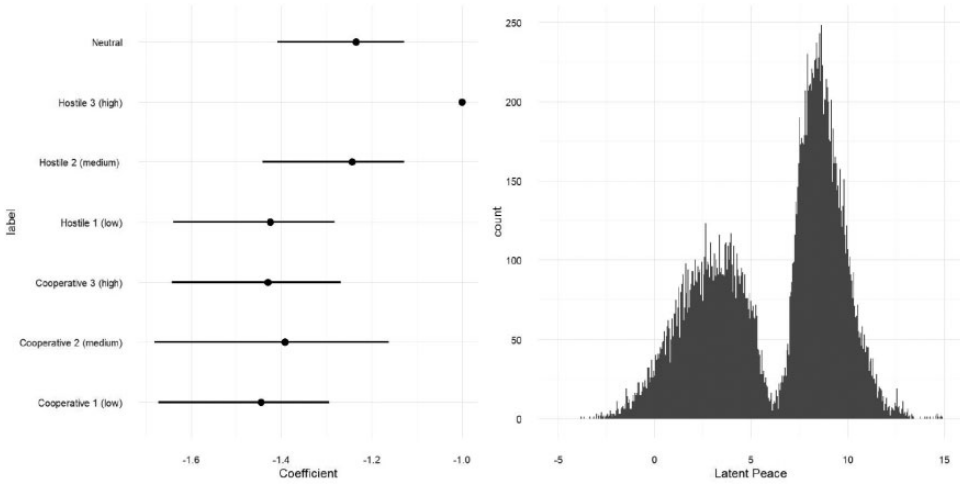
Figure 6. Latent peace scale. *Note*: The left figure shows the 95% credible intervals of the coefficient parameters for the latent variable. The dot on each line represents the median of the posterior distribution for each parameter, and the lines represent the 0.025 and 0.975 quintiles of the posterior distributions. The right figure is the histogram of the latent peace variable for all municipality-year observations.

conflict and cooperation are more intense in some locations than others precisely because of their dependence on one another, or coevolution.

Measuring Peace

In the above analysis, we provided empirical evidence of the coexistence and co-evolution of conflict and cooperation, emphasizing the necessity of conceptualizing in terms of both conflict and cooperation. Nonetheless, this does not leave us with a single latent variable for peace. To create a measurement of peace that incorporates the coexistence and coevolution of conflict and cooperation, we replicate our Bayesian IRT approach to create a single peace latent variable. We replace the conflict and cooperation latent variables in the above model with a single peace latent variable. This gives us seven negative binomial regressions of the observed events on the peace latent variable. Because peace should negatively relate to the highest hostile events (events that involve physical violence), we assume a −1 coefficient for the latent peace variable in the regression of the highest hostile events (in the above model of the hostility and cooperation latent variables, we assumed 1 for the coefficients of the latent hostility and cooperation variables in the regression of the neutral events). This constraint is necessary to identify the model. The rest of the model and the estimation are kept the same.

Figure 6 shows the results of the latent peace variable, supporting the above findings about the latent conflict and cooperation variables. First, as shown on the left side of Figure 6, all events, regardless of whether they are hostile or cooperative events, negatively relate to the latent peace variable. This means that positive peace at its extreme may be understood and measured as the absence of reporting on violent conflict or peaceful cooperation among former adversaries, indicating that cooperation has reached such a degree of normalcy that it is no longer a noteworthy event. Of course, this requires that events are reported by a relatively open and independent media, as discussed above. Second, the histogram on the right of Figure 6 shows that the observations on the latent peace variable are polarized into two groups. The municipalities that did not experience any events have much

higher peace values than those that had either hostile or cooperative events. Again, this result confirms the above observation. Although not presented in this paper, the temporal and spatial distributions of the latent peace variable also correspond to the above findings; peace varies over time, and the level of peace is low in municipalities that experienced either hostile or cooperative events.

Conclusion

In this article, we have argued that conceptualizations of peace in most prominent civil war, peacekeeping, and peacebuilding literatures devote disproportionate attention to conceptualizing and operationalizing peace as the absence of violence, or negative peace. In conflicts worldwide, however, violent events often occur alongside cooperation. Periods of cooperation are similarly punctuated by violent events. While this observation is not in itself novel, few studies consider conflict and cooperation jointly. The dearth of such studies is hardly due to academic neglect; instead, the analytical task is challenging.

In this article, we offer a conceptualization and measurement strategy that combines conflict and cooperation dynamics. Our measurement strategy—Bayesian Item Response Theory—produces latent measures of conflict and cooperation as well as a latent measure of peace that combines the two. In other words, the resulting measure we produce does not simply capture the absence of conflict; nor does it simply measure the presence of cooperation. Instead, it considers the full variation of the presence and absence of both conflict and cooperation.

Taken together, and examined jointly, the latent variable approach thus allows us to characterize the multidimensional aspects of peace more robustly. We have further interpreted the results and made a plausible case that conflict and cooperation dynamics coexist within one country, Colombia, and coevolve in certain locations in Colombia. This probe into the dynamics of conflict and cooperation suggests optimism about the possibility for creating more robust measures of peace that can be used more widely in studies of civil war conflict resolution.

Future research should use these more nuanced measures of peace to investigate the multiple potential causes and consequences of different degrees of peace. For example, future research could investigate the relationship between political, social, and economic institutions and outcomes on the hostility and cooperation latent variables. Research could also examine the organization, leadership, and strategies of rebel groups and their effect on these measures of conflict and cooperation. Or, future research could examine the effect of international mediation, peacekeeping, or peacebuilding efforts on these more nuanced measures of both conflict and cooperation. By employing measures of both conflict and cooperation in some of these ways, or perhaps others, the latent variable approach presented here should help researchers capture more accurately the trajectories of war-torn countries.

Acknowledgments

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