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Predicting atrocities
Statistically modeling violence against civilians during civil war

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Abstract: *In recent years, conflict research has seen a turn towards micro-level event data which often include casualty counts. This kind of data presents a challenge for statistical analysis, as it most often consists of long periods of no observations interrupted by extreme events with many victims. The present study uses such data and explores whether it is possible to predict the timing and the extent of violent acts perpetrated against civilians. Based on event data of one-sided violence during the war in Bosnia and Herzegovina, it is argued that predicting these events is feasible. Yet, the analysis of such difficult conflict event data requires a more coherent theoretical framework of the data generating process. Based on the assumption that this violence is used strategically, the paper maintains that the violence is unleashed in some situations and halted in others. Furthermore, as planning and execution of orders take place on lower levels of the hierarchy, leadership decisions might determine the occurrence of violent acts, but less so the exact number of victims. Hence, the decision to use violence should be influenced by different factors than the extent of violence. The paper models the violence as a result of two processes, occurrence and extent, and captures the abstract pattern of the data accurately.*

Predicting atrocities

Statistically modeling violence against civilians during civil war

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In recent years, conflict research has seen a turn towards micro-level event data which often include casualty counts. This kind of data presents a challenge for statistical analysis, as it most often consists of long periods of no observations interrupted by extreme events with many victims. The present study uses such data and explores whether it is possible to predict the timing and the extent of violent acts perpetrated against civilians. Based on event data of one-sided violence during the war in Bosnia and Herzegovina, it is argued that predicting these events is feasible. Yet, the analysis of such difficult conflict event data requires a more coherent theoretical framework of the data generating process. Based on the assumption that this violence is used strategically, the paper maintains that the violence is unleashed in some situations and halted in others. Furthermore, as planning and execution of orders take place on lower levels of the hierarchy, leadership decisions might determine the occurrence of violent acts, but less so the exact number of victims. Hence, the decision to use violence should be influenced

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by different factors than the extent of violence. The paper models the violence as a result of two processes, occurrence and extent, and captures the abstract pattern of the data accurately.

1. Introduction

Is violence against civilians during war predictable? Does it display regularities which may be exploited to this end? In recent years, the phenomenon of attacks against the unarmed has received increasing scholarly attention. In this literature, most publications maintain that attacks on civilians are based on strategic considerations (Schneider et al., 2010). If violence followed this logic, then it should display regularities that render prediction feasible. However, good p-values do not necessarily result in accurate predictions (Ward, et al., 2010). This paper probes this question through attempting to predict the timing and extent of violence against civilians during the war in Bosnia and Herzegovina. It builds on existing theories and proposes theoretical assumptions about the production of violence. Based on these assumptions, it demonstrates that both the occurrence and the extent of violence against civilians may be predicted accurately. Moreover, the explanations from theory and the narrative drive the predictions.

So far, only a few publications quantitatively looked into the micro-level pattern of one-sided violence in a small number of cases (cf. Balcells, 2011, Humphreys and Weinstein, 2006, Kalyvas and Kocher, 2009, Kalyvas, 2006, Schneider et al., 2012, Weidmann, 2011). However, a growing number of fine-grained conflict event datasets will now provide ample opportunities to fill this lacuna and present detailed records of acts of violence in a large number of countries, often even including casualty counts (Bussmann and Schneider, 2011, Raleigh et al., 2010, Sundberg et al., 2010). While the availability of data no longer presents an obstacle, standard statistical models often do not fit these time-series data well, as many data-series of one-sided violence consist of long periods of no events, interrupted by extreme spikes in the death toll.

In order to model and predict the abstract pattern of one-sided violence, this paper demonstrates and tests fairly simple statistical models of violent acts in Bosnia. Based on theoretical assumptions about the potential data generating process, it suggests simple

statistical procedures for otherwise difficult data. The ultimate goal is to generate precise predictions of *when* and *how much* one-sided violence occurred.

As the strategic use of one-sided violence by armed groups is a dominant theme in the literature (Schneider, et al., 2010), this paper conceptualizes violence as the output of an armed organization. Thereby, it assumes that violence is only observed in particular situations, whereby the extent of violence is determined by further factors, given that violence occurs. An armed group in which the leadership initiates violence and lower ranks plan and enact atrocities corresponds to this conceptualization. This assumption of two processes is even more plausible, if violence is delegated to partially independent sub-groups (cf. Mitchell, 2009). Furthermore, as many event datasets are coded from media sources, some violence might not be reported. Based on this logic, the occurrence of violence and the extent of violence are likely governed by separate processes, which might be related to distinct predictors. As a result, the combination of these separate processes should account for the pattern of the data-series.

These processes are tested with data of violence against civilians during the war in Bosnia and Herzegovina. The Bosnian War is interesting since it is a highly documented civil war, which gives a solid foundation of literature and allows extracting descriptions of potential strategies used by fighting factions. Moreover, the war saw the involvement of three main actors, Serbs, Croats and Bosnian Muslims, each with a distinct agenda (Gow, 2007, Kaser, 2007)[2]. Hence, the setting enables to test models using alternative cases.

The paper is organized as follows. After a brief discussion of the aim of this paper, the subsequent section discusses the diverse theoretical explanations of one-sided-violence, contrasts these with the narrative of the Bosnian War and presents the assumptions about the data generating process. Thereafter, the empirical section provides the analysis and assesses the predictive accuracy of the models.

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2 In this paper, only Serb and Bosnian Muslim violence is examined as the Croat strategy was less constant.

2. Why predict violence?

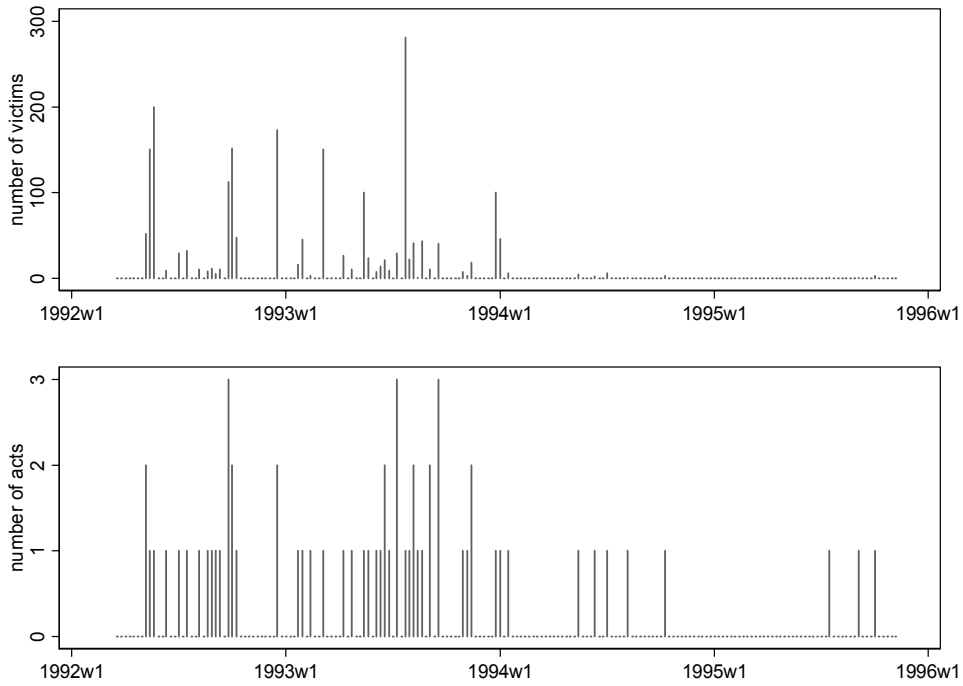
In the past decade, quantitative studies of conflict have blossomed. The study of civil war onset, for example, has produced many statistical models, which intend to capture the conditions under which civil conflicts escalate. Nevertheless, only a handful of common regularities were found (Hegre and Sambanis, 2006). Furthermore, the most cited publications from this research fail to predict civil war onset, despite impressively significant results from regression analysis (Ward, et al., 2010). As the quantitative analysis of conflict increasingly employs disaggregated data of conflicts, these lessons should provide a basis for more rigorous model assessment by analyzing the predictive accuracy of statistical models.

Recently, several studies have shown that predicting violence within a conflict and on a micro-level is feasible. While Weidmann (2011) as well as Kalyvas and Kocher (2009) incorporate the spatial dimension, Weidmann and Ward (2010) predict "conflict in time and space". Like Weidmann (2011) and Weidmann and Ward (2010), this paper focuses on Bosnia, but does so by examining specifically violence against civilians and on a much finer level of temporal aggregation. It thus adds to the small but growing quantitative literature of attacks against non-combatants, known as one-sided violence, and introduces the effort prediction.

However, the prediction of event data is challenging, as its characteristics as a categorical time series may prove difficult for standard statistical analysis (Schrodt, 2012). Even when the data is aggregated on a temporal basis, it may be difficult to model. Casualty data of one-sided violence frequently displays longer periods within a conflict without reported violence, interrupted by extreme spikes, caused by gruesome single events. Figure 1 shows the observed number of casualties which was attributed to Bosnian Muslims during the war in Bosnia (based on the Konstanz One-sided Violence Event Dataset, KOSVED (see Bussmann and Schneider, 2011)). This pattern of single, extreme spikes would be even more pronounced in the case of Serb violence, due to events like the massacre of Srebrenica. Yet, the lower graph indicates, that the information contained in the data may be less difficult, depending on the information that is used.

While the number of victims displays the extreme spikes, the number of events in these series follows a Poisson or negative binomial distribution.

Figure 1: Reported one-sided violence by Bosnian Muslims: minimum number of reported victims and number of events documented by KOSVED (Bussmann and Schneider, 2011)



Whereas studying the number of events instead of the number of casualties may be a choice of convenience, there is also a theoretical reason for this procedure. The literature on atrocities has employed arguments based on a principal-agent relationship between leaders who initiate violence and followers who enact these acts (Mitchell, 2009). Based on this logic, this paper argues that the data is better characterized by two processes. The occurrence of violence is the initial process, most likely initiated by leading figures, while the extent of violence is determined, given that violence occurs. The analysis in this paper distinguishes these processes and generates an accurate fit between model and data.

3. Theories of Strategy, Tactic, and Structure

The literature on one-sided violence presents multiple explanations for these violent acts. The different theoretical arguments broadly follow three causal assumptions: One-sided violence may stem from military goals, could be due to organizational characteristics of the perpetrating group, or might well be linked to actors' assumptions regarding the international reaction to these acts (Schneider, et al., 2010). The subsequent discussion of the literature keeps to these categories.

3.1. Military strategy and tactics

As claimed by military explanations, one-sided violence may be attributed to strategic or tactical military decisions. In essence, many of these arguments describe violence as functions of control, or lack thereof. Valentino et al. (2004) state that mass killings of civilians stem from the attempt to deprive an adversary of its support base. According to their analysis, killings of civilians by governments appear more frequently in guerrilla wars, in which a guerrilla receives extensive support by the local population. A similar logic might apply to the level of violence by rebel groups. Hultmann (2007) finds that violence against civilians is on average employed more extensively by weaker rebel groups. In line with this reasoning, control of territory is the essential variable according to Kalyvas (2006): Depending on the command a group has over an area, it may rely on different types of violence. When control is absolute, then no violence is necessary. If, however, a group dominates but is challenged by another group, then it is expected to target non-collaborators selectively, in order to coerce them into compliance. Contrary to this, in areas where minor influence exists, indiscriminate violence may be used, since it destabilizes and demonstrates the opponent's inability to establish security. A number of studies have observed similar patterns in civil wars, both across cases (Wood, 2010) or in the analysis of single cases (Balcells, 2011, Hultman, 2009, Kalyvas and Kocher, 2009).

Yet, civilian victimization is not only found in civil wars. In an examination of interstate wars, Downes (2008) maintains that states resort to violence against noncombatants when desperation and the perceived need to improve their chances of victory drives them to target civilians. A second mechanism is the intention to conquer territory inhabited by a potentially hostile population. In order to avoid a guerilla war behind the frontline, the population is driven out of the annexed areas or detained. Although the case of Bosnia is often categorized as a civil war, the influence of both Belgrade and Zagreb on Serb and Croat fighting factions could justify the analysis according to this logic.

At first sight, it appears that the extensive “ethnic cleansings” in Bosnia fit the theory of territorial aspirations better than the logic of selective violence. Melander (2007) conducts a detailed study of “ethnic cleansing” during the Bosnian War. Thereby, he classifies “ethnic cleansing” as *forward cleansing* when it is used to establish control over a (newly gained) territory. *Rearguard cleansing*, on the other hand, is used to tactically secure communication and supply lines behind the front line. While *forward cleansing* appears closely related to the argument forwarded by Downes (2008), *rearguard cleansing* seems to pick up the logic of selective violence by Kalyvas (2006). In his analysis, Melander (2007) finds evidence for *forward* or *rearguard cleansing* for both Serb and Croat forces, as well as to a limited extent by Bosnian Muslims. Hence, the general theory of a military use of one-sided violence in Bosnia by all groups appears plausible and gives rise to the following hypotheses.

H1: One-sided violence was used more frequently by a group, when territory was conquered from an opponent (*forward cleansing*).

H2: One-sided violence was used more frequently by a group, when the opponent was gaining territory (*rearguard cleansing*).

3.2. Influence of third parties

The second category, relates violent acts against civilians to anticipated or realized reactions of the international community. Overall, the effect of international engagement remains disputed in the literature. In a prominent study, Krain (2005) compares the effects of overt military interventions on the severity of mass killings and concludes that only robust interventions are able to reduce the level of violence. With a focus on Bosnia, he even suggests that insufficient intervention might facilitate violence against civilians (Krain, 2005:368). Contrary to this, Melander (2009) demonstrates that the deployment of peacekeepers is correlated with the likelihood of genocidal mass killings of civilians in the first place. The inclusion of a function that explains the deployment of peacekeeping missions reverses this result and reveals a strong decrease in the probability of atrocities if peacekeepers are on the ground.

Both analyses center their arguments around the idea that interventions impose costs on the perpetrator of mass atrocities. Kathman and Wood (2011) maintain that third party military interventions in cases of genocidal violence affect not only the costs the perpetrator faces when continuing the violence, but also the threat which a perpetrator perceives and which induces him to engage in the killing. Following Valentino (2004), they state that perpetrators decide to commit genocides or politicides only after dismissing alternative, less extreme measures. From

this perspective, mass killings occur if a group is perceived as such an imminent threat to the perpetrators goals, that all other options are seen as inadequate. According to their logic, interventions are able to decrease violence over the long-term if they are resolute and, more importantly, impartial. By being resolute, i.e. determined to remain actively engaged in the conflict, interventions raise the costs of continuing the mass killing. On the other hand, impartiality guarantees that the perpetrator does not view an intervention as an increased threat.

The argument by Kathman and Wood (2011) implies that in order to hypothesize a potential effect of international intervention, both the type of intervention and the intervener have to be distinguished. In the case of Bosnia this requires to differentiate between a large number of diverse international actions (see Burg and Shoup, 1999). Although the range of international interventions during the course of the conflict proves to be very diverse, a general set of hypotheses may be deduced to explain an effect of interventions on one-sided violence. Rather than emphasizing how military interventions may increase the costs of engaging in one-sided violence, it appears more adequate to state that interventions affect the *relative* costs of victimizing noncombatants vis-à-vis other means. The emphasis on relative costs is related to the argument of Kathman and Wood (2011), but it is significantly broader since, for example, a mediation attempt does not necessarily have an impact on the level of threat or the particular costs of violence. Rather, mediation may facilitate a peaceful solution. In this sense, mediation does not affect the costs of violence, but its relative costs, i.e. the choice of violence vis-à-vis an alternative.

H3: External interventions alter the relative costs of violence. The higher the relative costs, the less violent acts occur, and vice versa.

How actors perceive the costs of engaging in one-sided violence has not been a central focus of literature (Hultman, 2008:32). The influence of international variables may be a way to operationalize these costs. However, given the different goals and strategies of actors, a unique pattern is not plausible. Rather, the expected effect should depend on the actor. An obvious cost associated with violence is the loss in reputation and the negative influence on the legitimacy of a conflict party's claims. Yet, if an actor has already damaged his reputation through extensive violence beforehand, additional violence should be less costly. Hence, the costs of a single act will strongly decline the more violence has been used beforehand. As a consequence, actors, who used less violence, should be swayed more easily by external intervention, while actors,

who have used one-sided violence extensively, should be only influenced by drastic, cost-imposing interventions. Additionally, drastic violence by opponents might lower the self-restraint of a group, since its reputation will remain better than that of its opponents, as long as it does not commit as many atrocities.

H4: The more that violent acts are committed by a group or its opponents, the more violent acts are subsequently committed by this group.

The theoretical discussion fits the narrative of the war in Bosnia. Throughout the early diplomatic initiatives, the Serbian side continuously gained territorial concessions. Compared to the Vance Owen Plan, the later Owen-Stoltenberg Proposal granted much more territory to Serbs (Burg and Shoup, 1999:277). Hence, the proposals served not as an incentive to end its confrontational approach. Potentially, the lack of consequences even led Serbs to continue their brutal strategy of "ethnic cleansing". To put it into more conceptual terms, the weak response to Serb atrocities by the international community might have even lowered the relative costs of one-sided violence, as the strategy of cleansing paid off. Empirically, this interpretation is sustained by the finding that periods after UN mediation actually correlated with increased conflict intensity (Schrodt and Gerner, 2004).

The relevance of international actions should bear even more weight, if the narrative of Bosnian Muslim goals is correct. If it was the Bosnians' main goal to gain the attention and support of the international community (Gow, 2007, Kuperman, 2008), then international interventions should strongly affect Bosnian Muslim decision making. Given the importance of international support to the Bosnian Muslims' cause, alienating the international community by victimizing civilians should be seen as extremely costly. Hence, it appears plausible, that the one-sided violence by Bosnian Muslims, which was reported, occurred as the Bosnian Muslim fighters were drawn into a malicious culture of violence. Thus, if the Bosnian Muslims had adequate control over their fighters, then one-sided violence should be less frequently observed when the Bosnian leadership tried to convince external actors to support its fight. Gow (2007:374) goes one step further and states the allegation that Bosnian Muslims actually attacked their own people and blamed Serb forces for the atrocities. Burg and Shoup (1999:165ff.) carefully weigh ambiguous accounts of such claims and find evidence for incidences of deliberate attacks by Bosnian Muslims on their own people. They conclude that while Serbs seemed to have initiated attacks "'out of spite' (iz inata)", Bosnian Muslims' actions were most concerned with the goal of increasing the sympathy of the West and affect meetings or decisions by Western policymakers

(Burg and Shoup, 1999:168). Thus, their account strongly underscores the relevance of international influence on the level of violence.

3.3. Organizational characteristics

The third explanation of one-sided violence, organizational characteristics, has not been addressed so far. Schneider et al. (2010) distinguish three categories of organizational reasons for one-sided violence. The three potential factors, which render a group more prone to one-sided violence, may be: recruitment tactics, the commitment of members to the group, as well as the hierarchy within the group (cf. Weinstein 2007). However, as different fighting factions within the three ethnic groups are not easy to distinguish in the dataset on Bosnia, the potential consequences of recruitment and commitment, as well as their empirical implications, are difficult to assess. Furthermore, these organizational arguments may be irrelevant in the task of predicting the timing of violence, as they explain the overall inclination to use violence not temporal variation. Hence, the remaining, testable organizational logic are potential consequences of lack of hierarchy and oversight, which in turn may vary during the conflict.

The narrative of one-sided violence during the Bosnia War indicates that violence was used strategically. Nevertheless, all actors in the war relied on paramilitary organizations, which committed a large part of the atrocities (Burg and Shoup, 1999:137f.). Bosnian Muslims were for example supported by Mujahedeen fighters, which joined the struggle to assist their religious brethren, although the impact of the Mujahedeen remains disputed (Zunec and Kulenovic, 2007:397). Whether these groups were entirely controllable appears questionable. Nevertheless, despite the inability to compare different fighting factions, some regularity due to lack of organizational control may be traceable. Since heavy fighting may reduce the oversight of the leadership over these groups, lack of control could increase, as the conflict becomes more severe. Hence, the occurrence of atrocities should be correlated with the conflict intensity itself:

H5: The more fighting takes place, the more violent acts occur.

3.4. Sketching the data generating process

So far, one-sided violence has been discussed as if it resulted from a single decision process by unitary actors. However, this conceptualization may be a stark simplification of the data generating process. The origins of civilian victimization may result from several sources and most likely involves several actors. A more nuanced theory, distinguishes the influence of elites and local level processes which fuel violence in civil wars (Kalyvas, 2006, Kalyvas, 2003). On the one hand, the ideological, political or military necessities from the top-level may instigate hostilities.

On the other hand, local level civil rivalries turn violent under the cover of civil war. Through denunciation of rivals over resources or other desired benefits, local actors "may effectively turn political actors into their own private 'contract killers'" (Kalyvas, 2006:14).[3]

However, even if one focuses solely on violence from above, there are most likely several processes at work. A theory that depicts violence as the output of an ideally hierarchical, Weberian organization would yield that decisions are turned into actions by a rational bureaucratic apparatus, where individual bureaucrats plan and enact measures based on political decisions (Weber, 1976). In terms of one-sided violence, this would imply the following predictions for patterns of one-sided violence: A top-level generates decisions of when and under which circumstances violence may be used. Midlevel echelons are planning more specifically how violence is used, whereas the lower echelons eventually conduct the one-sided violence or, alternatively, refrain from it as ordered. Hence, various levels in the hierarchy contribute to the outcome and violence is not produced by a single decision process. In the case of militias acting as agents under some lose control by a (political) principal, this pattern should be even more distinct, if the principal merely unchains or contains his "agents of atrocities" at strategically important times (Mitchell 2009). As such, both perspectives state that the decision to use violence may be a different process than the determinants of the extent of violence, as leaders initiate violent acts while followers execute them.

When applying this conceptualization to the problem of violence against civilians, it is worth questioning whether superiors actually have any incentives to initiate atrocities through clearly formulated and therefore documented orders. Osiel (2009:16) describes how ever since the Nuremberg trials, high level perpetrators have been careful to conceal their involvement in the atrocities and tried to issue orders very implicitly. Thus, even if violence is ordered, the top-level will certainly initiate these acts fairly generally, leaving the planning of specifics to lower levels. To shroud the involvement of superiors, orders may be enforced and controlled through informal networks (Osiel, 2009:45f.). The formation or support of non-institutionalized actors, such as militias, is a further way to obscure the responsibility for certain acts, which could be observed throughout history (Thomson, 1994). This description further sustains the notion that initiation

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3 Weidmann (2011) finds that both violence from above and below were present in the Bosnian conflict in different localities.

and extent might be separate processes, as leaders are not willing to order specific violence and leave the specific outcomes for their followers to decide.

Furthermore, given that violence occurred, leaders are likely to suppress reports of violence against unarmed civilians. If violent acts are indeed covered up, then we cannot be certain that the observed violence represents a correct sample of cases. Similarly, lack of news coverage may be a further source of no observed events. Consequently, whether violence is observed is further determined by factors which are distinct, but empirically indeterminable from the decision process to use violence.

Summing up, the argument introduced above would state that an organized perpetration would have distinct empirical features. The occurrence of violence would originate from top-level decisions, the extent of violence, once it is employed, depends on decision on lower levels of the hierarchy or subgroups. Moreover, some events might remain unobserved. The empirical analysis below uses the theoretical discussion outlined above and assumes that leadership decisions affect the occurrence of violence. The extent of violence is determined by a separate process, given that violence occurs.

4. Data and Models

4.1. Dependent variable

The dependent variable is coded from the Konstanz One-Sided Violence Events Dataset (KOSVED) on Bosnia. KOSVED documents, among other information and when available, the number of victims, ethnicity, and nationality of actors, the location as well perpetrator characteristics (Bussmann and Schneider, 2011). Although KOSVED includes information on injured victims, for the purpose of this study, only events which document the killing of people are used. The analysis distinguishes between the perpetrators of one-sided violence to enable separate models for each conflict party.

Based on the theoretical assumptions outlined above, the analysis uses two different operationalizations of the dependent variable. For the model of *when* a group resorts to violence a count of violent acts or a dichotomous variable (one-sided violence: yes/no) appears to be most adequate. On the other hand, in the model of the *extent* of violence, the number of victims is of interest. Theoretically, a dependent variable that consists of an event count is an interesting

operationalization for the question of when violence occurs, since it contains the relevant information for this question, i.e. the number of reported acts of one-sided violence.

Count data consists of a count of events in a time period (Long, 2005). Therefore, the analysis below uses an aggregation on a weekly level. This decision is due to several considerations. First, compared to most previous studies of civil wars, weekly data is extremely fine grained. At the same time, events which happen within several days and are potentially correlated are most likely coded in the same time interval or lagged by one period. Hence, the coding on a weekly level captures timely proximity. Furthermore, even though some fighting continued over more than one day, it is usually coded as one event at the time of its onset. If this is the case, then there is a good chance that the week captures not only the coded onset of the violence, but includes also the second or third day of atrocities.[4] The operationalization as a count has also nice statistical properties, since it very closely follows a negative binomial distribution. Hence, the resulting event count variable fits statistical models for count data very accurately. The operationalization as an event count therefore does not display the same problems as the data series of the casualty count.

The dependent variable for the models of the extent of violence is operationalized as the number of victims per week.[5] However, the data of one-sided violence is characterized by several extremely violent events. In order to reduce the height of the spikes in the data series, the natural log of the data is taken. As a result, weeks without observed violence are coded as missing. According to the theoretical discussion, it is assumed that the extent of violence is determined by a separate process, given that violence occurs. Hence, the dependent variable for the models of the victim toll reflects this assumption about the data generating process, in which violence is only observed, if a decision was made to use violence in the first place. Furthermore, coding weeks with no events as missings addresses the uncertainty regarding unreported violence. In the case that some events were not reported, it would be inaccurate to state that no

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4 Additionally, due to the make-up of the KOSVED data, the weekly level is a handy choice, since the exact date is not known for all events. Some events are only assigned to a specific month. However, if possible, the week is coded.

5 Since reports of casualties vary considerably in some instances, the most conservative estimate is used. All models were replicated with maximum casualty reports and yielded virtually identical results.

violence occurred. Rather, we have no information about violence at this time of the conflict, whereby the conclusion that no events took place is highly plausible, but not necessarily correct.

4.2. Independent variables

The independent variables for the study are mainly drawn from three sources and with the exception of UN and NATO variables correspond to the analysis of Schneider et al. (2012). KOSVED provides the database for all one-sided violence-related data (Bussmann and Schneider, 2011). Involvement of external actors is coded from the Kansas Events Data System (KEDS), which provides the WEIS coded Balkan dataset (Schrodt, 2006).[6] The Armed Conflict Events Dataset (ACLED) is probed for data on military events, such as battles, changes in territory etc. (Raleigh, et al., 2010). Furthermore, variables on UN and NATO actions are coded from official online resources published by these organizations.

The independent variables coded from KOSVED are coded and aggregated along with the dependent variable. In order to account for violent acts by adversaries, the respective dependent variables for the other conflict parties are used. Additionally, the weekly number of killings perpetrated by each group is coded, but for the purpose of independent variables weeks with no observed violence are coded as zero. These numbers are based on the lowest estimates documented in KOSVED.

The military variables comprise the number of battles which took place in a week, as well as the number of territorial gains in a directed dyad. Hence, for each actor, two variables document territorial gains vis-à-vis the two other actors. The complex issue of international interventions is coded with two main methodologies. The interaction between the conflict parties and international actors are coded from the KEDS project based on a selection of WEIS codes. The international actors comprise the U.S., the UN, the EU, and Russia. A distinction is drawn between the category meeting and agreement. The former is coded based on the keywords “consult”, “meet” and “talk”, whereas the latter used “agree” or “make agreement”. If any of the categories was documented between any actor combination in a given week, the corresponding variable takes on the value one.

In contrast to this procedure, UN or NATO actions are coded from online documentation by these organizations. NATO actions are published in a web description of all operations conducted

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6 available under http://web.ku.edu/~keds/data.dir/balk.html

during the conflict. A day is assigned the value 1, if any military action was taken on that day. In the aggregation, the respective week takes on the value 1. Each UN resolution is coded as a separate variable which takes on the value 1 for the period during which the resolution was in effect. This coding decision is rooted in the consideration that these resolutions should have a long-term effect on the propensity of violence.

4.3. Choosing a statistical model

As described above, the dependent variable is coded as a count of the violent acts which where perpetrated per week. The observed frequency of counts per week may be accurately described by a Negative Binomial distribution. In the regression analysis, the heterogeneity displayed in the Negative Binomial distribution is completely accounted for by the independent variables. Hence, a Poisson distribution is adequate for the stochastic component of the model.

The model of the number of victims per week consists of two separate models. As described above, it is theoretically perceivable that the extent of one-sided violence results from two processes: one governing the onset, the other determining the extent of violent acts. Modeling these two processes explicitly is fairly simple. If both processes are independent, two separate regression models can be estimated. First, a binary (or count) regression model captures the process of occurrence and non-occurrence, while a linear regression model is used to depict the process governing the extent of violence, given that violence is used in this time period. Whether estimating independent models is adequate, is determined through a Heckman Selection Model, which picks up and corrects for eventual correlation of the error term of the binary and the linear model. None of the models display significantly covarying errors.

5. Results

The initial model selection used the significance level and the in-sample fit as a means to choose the best model. Since assessing the validity of a model only based on significance levels and in-sample fit does not guaranty out-of-sample validity (Ward, et al., 2010), the prediction subsection further checked the best models by assessing their capability to generate correct out-of sample predictions. It therefore randomly excluded 25 percent of the observations in the sample and estimated the model again, using the remaining 75 percent of the sample. Based on this model, predictions of the expected number of violent acts or victims were generated. The

accuracy of the model is assessed by comparing the prediction error of the model to the error of a naive prediction which is based on the number of violent acts in the previous period. To do so, the study calculated Theil's U which may be denoted as:

Where is the observed data at time and is the prediction of the model for time . Hence, the numerator is the sum of squared prediction errors, whereas the denominator is the sum of squared prediction error from a naive model, which expects no change from one observation to the other (Farnum and Stanton, 1989:26). Consequently, values below 1 indicate a better performance of the statistical model vis-à-vis the naive prediction.

5.1 Serbs

The violence committed by Serbs is by far the most frequent type of one-sided violence. Table 1 presents the results of count regressions which test the effects of military and international variables on the expected number of Serb violent acts. The first model examines the effect of military gains or losses vis-à-vis the other conflict parties as well as the impact of conflict intensity on the level of one-sided violence. It thus tests both the (military) hypotheses 1 and 2 of forward and rearguard cleansing. In addition, hypotheses 5 is assessed, which predicts more violence during intense fighting, when discipline could become more difficult to uphold. The second model focuses on the effect of the opponent's violence on the level of violence by Serbs (H4). It includes the level of civilian victimization inflicted by Muslims and Croats and controls for potential reciprocity by including the number of attacks against Serbs in the previous period. The results lend no support to either hypothesis 1 or 4, as none of these variables reach significance. The support for hypothesis 2 is ambiguous, as territorial gains by Croats are only found to increase the level of violence if all variables are included in the model. Contrary to this, a small, yet robust relationship is found between the number of battles in a week and the level of violence. Ceteris paribus, one additional battle increases the expected number of violent acts by a factor of 1.05.

The variables on international interventions were included due to their robust significance. With two exceptions, they remain significant, even when all variables are included in the model. The hypotheses tested with these variables are focused on the relative costs of one-sided violence. The general hypothesis 3 that the magnitude of the impact of interventions depends on the

degree to which they affect the relative costs of violence seems to hold. Both resolutions, which called for a dramatic increase of peacekeepers (914) and drastic sanctions against Bosnian Serbs (942), have a far larger effect than the mediation and agreement variables. The strong positive effect of resolution 942 is puzzling at first sight. Given the immense costs imposed by the sanctions, the relative costs of violence should have become extraordinarily high. However, the resolution marked a turning point and might be seen as a point of no return, when the alliance between Bosnian Serbs and Yugoslavia broke apart. Parallel to resolution 942, resolution 943 eased the sanctions on Yugoslavia which in the previous weeks had closed the borders to Bosnia and accepted a proposal for the territorial settlement of the conflict. Hence, Bosnian Serbs were isolated from this point on, which should indicate that the relative costs of violence decreased drastically, as they had no ally left, who could have abandoned them due to their appalling atrocities.

Table 1: Predictors of Serb on-sided violence (dep. var. is count of violent acts by Serbs)

	(1) Count of Serb OSV	(2) Count of Serb OSV	(3) Count of Serb OSV	(4) Count of Serb OSV
Serb terr. gains from Muslims $_{t-1}$	-0.025			-0.021
	(0.055)			(0.050)
Muslim terr. gains from Serbs $_{t-1}$	0.016			-0.039
	(0.102)			(0.087)
Serb terr. gains from Croats $_{t-1}$	-0.019			-0.150
	(0.127)			(0.112)
Croat terr. gains from Serbs $_{t-1}$	0.078			0.109**
	(0.063)			(0.050)
total no. of battles	0.059**			0.049**
	(0.026)			(0.023)
Muslim OSV $_{t-1}$		0.065		0.018
		(0.154)		(0.136)
Croat OSV $_{t-1}$		0.112		0.189
		(0.144)		(0.123)
OSV against Serbs $_{t-1}$		0.140		0.057
		(0.165)		(0.148)
rus meet w/ bos			-0.633*	-0.600*
			(0.332)	(0.321)
uno agree w/ bos			-0.477**	-0.546**
			(0.239)	(0.233)
eec meet w/ ser $_{t-1}$			0.446**	0.310
			(0.190)	(0.189)
uno agree w/ bos $_{t-1}$			-0.379*	-0.310
			(0.227)	(0.237)
eec agree w/ cro $_{t-1}$			0.743**	0.731**
			(0.350)	(0.314)
UN SC res942			1.814***	1.600***
			(0.602)	(0.598)
UN SC res914			-1.844***	-1.552***
			(0.595)	(0.597)
Serb OSV $_{t-1}$				0.167***
				(0.056)
Constant	-0.078	-0.050	0.211*	-0.162
	(0.099)	(0.107)	(0.120)	(0.170)
ln(alpha)	-1.078**	-0.888**	-1.941**	
	(0.456)	(0.398)	(0.828)	
Observations	189	189	189	189
Log likelihood	-260.084	-263.329	-243.227	-233.004
Theil's U	0.817	0.837	0.767	0.706

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; models 1-3 are Negative Binomial

regressions, model 4 is a Poisson regression.

Hypotheses 3 can be further specified, in the sense that the importance of the actor for the conflict party should determine the impact of the intervention. Reviewing the list of significant variables, it becomes apparent that only mediations and agreements by the UN and Russia are correlated with a decrease in violence. The only significant European interventions variables correlate with an increase in violence. Russian influence on Serb actions comes as no surprise, as Russia was an ally for its smaller Slavic relative. Consequently, it is safe to argue that, through its support of Serbia, Russia was certainly the most important actor for the Serbs (Burg and Shoup, 1999:301ff.). Jeopardizing this support would have meant becoming more vulnerable to UN resolutions of any kind, since an alienated Russia could be more inclined to accept Security Council action against the Serbs. From this point of view, it is not surprising that UN agreements with Bosnian Muslims served as a warning sign and were followed by decreases in violence. Compared to an average week without agreement between the UN and Muslims, the predicted probability of no violent acts increases by 18.8 percentage points during an average week with such an agreement and increased by 10.9 percentage points in an average week after an agreement. However, the coefficient for the latter calculation narrowly misses the 10% significant level in the full model. The same logic should apply to meetings between Russian officials and Bosnian Muslims. Atrocities that coincided with such meetings would have presented Bosnian Muslims with an opportunity to lobby the Serbs' most important ally for support. Ceteris paribus, in weeks with Russian-Bosnian Muslim contacts, the expected number of violent acts by Serbs decreases by 45.1 percent. The findings underscore the more general observations of triangular effects published by Goldstein and Pevehouse (1997).

The seemingly positive influence of European diplomatic activity on violence levels seems puzzling, at first sight. However, a look at the analysis of Muslim and Croat violence suggests that all EU actions are correlated with increases in violence. A plausible explanation would yield that the European Community got involved early and at times of conflict escalation. In this sense, the causal mechanism would be reversed. Alternatively, more events might have been reported as the international engagement rendered them more newsworthy. In any case, the effect of lagged intervention variables is a regularity which bolsters the ability to predict violence levels.

Turning to predictions, table 1 also indicates the Theil's U statistic for each model, which compares the prediction error of the model to the error of a naïve prediction which expects that a week should display the same level of violence as the previous week. As discussed above,

Theil's U values smaller than 1 indicate that the model outperforms the naïve model. Models 1 and 2 outperform only somewhat the naïve model. Unsurprisingly, given the better fit, international variables account for most of the full models performance.

Contrary to the models of Muslim, the full Serb model contains a lagged dependent variable. The decision to include such a variable is based on the moderate autocorrelation, which the Serb one-sided violence exhibits. Additionally, a further interesting finding is the lack of unobserved heterogeneity in the full model. The null hypothesis of equidispersion is safely rejected, even without including the lagged dependent variable. Hence, it appears that the variables in the model account for the heterogeneity.

Table 2: Predictors of Serb on-sided violence, given violence occurred (dep. var. is number of victims of Serb OSV)

	(1) actor5ratio
Muslim OSV $_{t-1}$	0.008**
	(0.003)
Serb terr. gains from Muslims $_{t-1}$	0.170***
	(0.053)
Croat terr. gains from Serbs $_{t-1}$	0.196**
	(0.087)
Operation Deliberate Force	1.828*
	(0.938)
NATO air strike	2.909**
	(1.168)
UN SC res757	-1.394**
	(0.541)
UN SC res908	1.891***
	(0.600)
UN SC res914	-2.034***
	(0.609)
usa meet w/ ser $_{t-1}$	-0.693**
	(0.265)
eec meet w/ ser $_{t-1}$	0.950***
	(0.297)
usa agree w/ bos $_{t-1}$	-0.789*
	(0.455)
Constant	3.798***
	(0.548)
Observations	108
R^2	0.434

OLS coefficient estimates; Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The analysis of the extent of civilian victimization by Serb forces, given that violence occurs, is explained by both military and international variables. Serb territorial gains and losses as well as

the extent of civilian victimization by Muslims thereby account for about half of the explained variance. As postulated by hypothesis 1, Serb atrocities became increasingly violent in weeks after Serb forces had captured territory from Bosnian Muslims. Increased Serb violence after Croat territorial gains from Serbs hints towards acts of rearguard cleansing (H2). The positive effect of Muslim violence on the expected level of Serb violence sustains hypothesis 4. As the dyadic analysis by Schneider et al. (2012) revealed no reciprocal one-sided violence from Serb forces, it is likely that finding stems from the fact that Serb forces attempted to profit from hostilities between Croat and Muslims. Burg and Shoup (1999:138) describe how Serbs entered in to diverse local alliances, as Croats and Muslims fought throughout 1993.

Several international actions are correlated with violence levels. The positive coefficients of NATO airstrikes and Operation Deliberate Force indicate that NATO intervened during especially brutal times. Three UN resolutions mark distinct periods within the conflict: Following UNSC resolution 757, which ordered an embargo against the remainder of Yugoslavia, violence drastically decreased on average. In early 1994 violence escalated once more. Resolution 908 presented a first step to contain this escalation by ordering more peacekeepers to the area. As fighting continued, resolution 914 drastically increased the number of peacekeepers once more. Thereafter, violence levels decreased drastically. Resolution 914 also coincided with the first NATO air strikes. Weeks with mediation attempts by the U.S. are followed by a reduction in Serb violence levels, so are weeks in which agreements between the U.S. and Bosnian Muslims were reached. As in the count models, EU initiatives had no appeasing effect and seem to have taken place during times of escalating violence. Overall, the model is capable of explaining around 40 percent of the variance of Serb violence.

5.2. Bosnian Muslims

The analysis of Bosnian Muslim actions proceeds in the same way as the analysis of Serb one-sided violence. Model 1 of table 3 includes the military variables of territorial change and number of battles. Only territorial gains by Muslims against Croats have a strong positive and significant, albeit not robust, influence on the level of violence perpetrated by Muslims. Similarly, model 2 suggests that violence by Muslims occurred more frequently at times when Croats engaged in violence. Yet, this finding is also not robust against the inclusion of international variables. If the variable of meetings between Croats and the UN are excluded from the analysis, the territorial gains variable retains its significance and approximate coefficient size, while the Croat violence variable does not. This finding underscores further that the positive

effect of the consultation variables appear to be rather proxies of conflict intensity. This finding is in line with the analysis of Schrodt and Gerner (2004), who found that mediation attempts were more likely during times of escalation. Overall, the finding of more violence during the confrontations with Croats in 1993, which is when most violence by Croats occurred, sustains the analysis of the pattern of violence by Muslims as well as the narrative of the conflict (cf. Malcolm, 1996:284, Melander, 2007:66). It appears that some forward cleansing against Croats occurred, while there are weak signs that violence by opponents promoted Bosnian Muslim tendencies to engage in atrocities on their own. In this sense, the result presents moderate support for hypotheses 1 and 6.

Table 3: Predictors of Muslim on-sided violence (dep. var. is count of violent acts by Muslims)

	(1) Count of Muslim OSV	(2) Count of Muslim OSV	(3) Count of Muslim OSV	(4) Count of Muslim OSV
Muslim terr. gains from Serbs $_{t-1}$	0.081			-0.130
	(0.134)			(0.146)
Serb terr. gains from Muslims $_{t-1}$	0.014			-0.036
	(0.066)			(0.116)
Muslim terr. gains from Croats $_{t-1}$	1.586***			0.846
	(0.464)			(0.549)
Croat terr. gains from Muslims $_{t-1}$	-0.526			-1.146
	(1.082)			(1.135)
total no. of battles	0.047			0.018
	(0.033)			(0.043)
Serb OSV $_{t-1}$		0.212		0.208
		(0.153)		(0.164)
Croat OSV $_{t-1}$		0.432**		0.135
		(0.196)		(0.251)
OSV against Muslims $_{t-1}$		-0.309		-0.307
		(0.200)		(0.228)
eec agree w/ ser			0.832*	0.729*
			(0.432)	(0.442)
uno agree w/ ser			0.950***	0.992***
			(0.269)	(0.301)
usa meet w/ bos			-0.806**	-0.803**
			(0.369)	(0.386)
uno meet w/ cro			0.743***	0.811***
			(0.275)	(0.308)
eec meet w/ ser $_{t-1}$			0.521*	0.528*
			(0.289)	(0.314)
Muslim-Croat			-1.396***	-1.332***

Federation			(0.392)	(0.416)
Constant	-1.314***	-1.243***	-1.289***	-1.381***
	(0.157)	(0.184)	(0.240)	(0.309)
Observations	189	189	189	189
Log likelihood	-135.099	-138.871	-114.471	-111.666
Theil's U	0.734	0.758	0.641	0.618

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; all models are Poisson regression models

The included international variables further confirm the finding that these factors capture the dynamics of violent acts at best. All international variables are robust to the inclusion of the remaining variables. As discussed above, meetings by international actors with Croats and Serbs are found to coincide with increases in violence. Similarly, agreements between the EU or the UN and Serbs are also correlated with an increase in violence. Potentially, reverse causation could be responsible for this finding as well, as rapprochement between Serbs and EU or UN became more likely as Muslims engaged in violence. Alternatively, the theory of relative costs would imply that these agreements could have led to desperation and reduced the reluctance to use one-sided violence, similar to the observed increase of Serb violence after resolution 942. The same argument of endogeneity applies to the talks between the U.S. and Bosnian Muslims. The results in the analysis suggest that Muslims engaged in less violence when they met with U.S. officials. As the United States were by far the most important actor for Bosnian Muslims and their leadership's strategy was to get the attention and support of the West (Gow, 2007, Kuperman, 2008), engaging in violence when trying to persuade the U.S. to intervene would be highly counterproductive. Thus, the finding of a drastic reduction in violence during these encounters powerfully underlines the prediction of hypothesis 3. Ceteris paribus, violent acts decreased by 55.2 percent when such meetings took place. However, an alternative explanation is also perceivable. As the U.S. could have been reluctant to become involved, it engaged only in mediation when less violence occurred.

In order to illuminate this uncertain relationship and potential endogeneity, seemingly unrelated probit models were used to check whether the conflict influenced mediation and agreements and whether controlling these effects alters the estimation of violence onset. The seemingly unrelated probit models indicate that the equations are not related, while the coefficients for EU agreements and U.S. consultations remain significant.

The findings confirm that violence was much less frequently used after the Croat-Muslim federation was formed in early 1994. An average week before the federation has a predicted

probability of seeing at least one violent act of 29.8 percent. Thereafter, the predicted probability drops to 8.9 percent for an average week. Interestingly, this development coincides with the decision by the United States to clandestinely endorse the secret arms deliveries by Islamic nations to the Bosnian Muslims, who eased the military inferiority vis-à-vis the Serbs (Burg and Shoup, 1999:307f., Danner, 1998). Hence, the level of violence by Bosnian Muslims dropped drastically, once the Muslims were no longer as militarily weak, faced no longer two opponents and were more assured about the support by the United States. If violence against civilians is a tactic of the weak (cf. Hultman, 2007), than the drop in violence could be accounted to the gained strength. Based on the relative costs argument, a strategy of violence also became a lot more costly, as it may have cost the newly gained support. Consequently, the relevance of hypothesis 3 is emphasized by the empirical analysis. The predictive power of the models in relation to a naïve model is better than for Serb one-sided violence. Again, among models 1 to 3, the Theil's U values are the best for the models which include the international variables. The full model performs only slightly better.

Table 4: Predictors of Muslim on-sided violence, given violence occurred (dep. var. is number of victims of Muslim OSV)

	(1) actor6ratio
total no. of battles $_{t-1}$	0.129**
	(0.064)
usa agree w/ bos $_{t-1}$	-1.271**
	(0.606)
Muslim-Croat Federation	-2.029***
	(0.476)
Constant	2.930***
	(0.249)
Observations	49
R^2	0.453

OLS coefficient estimates; Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The analysis of the number of victims of Bosnian Muslim one-sided violence, given that violence occurred, gives a very simple picture. The extent of one-sided violence by Bosnian Muslims is largely predicted by the extent of fighting, which took place in the previous week. The more fighting occurred, the more victims were observed. While this finding strongly supports the analysis that Bosnian Muslims harmed civilians in the heat of battle (H5), the results also underscore the strong influence of the U.S., given that violence decreased drastically in weeks after an agreement was reported between the U.S. and the Bosnian Muslim leadership. As in the

count models, Bosnian Muslim violence practically ceases with the establishment of the Muslim-Croat Federation in 1994. Overall, these three predictors explain almost half of the variance in the data.

5.3. Predictions

Figure 2 graphically displays the predictions of the models for Serb one-sided violence. The lower graph contains the expected number of violent acts (orange line) contrasted against the observed number of violent acts by Serbs (spikes). These model predictions were generated using Model 4 in Table 1. It is apparent, that the model largely picks up the general pattern of violence over time, while missing some larger spikes or periods of no events. However, since the models assume that violence is inherently random and Poisson distributed, these deviations are still fairly probable, given the expected value . The upper figure depicts the observed number of victims (log) and the predictions. The predictions were generated by a Heckman selection model, whereby a prediction from a linear regression was replaced with zero, if the predicted probability from a Probit model was lower than 0.5. The linear model is equivalent to the model in Table 2, while the Probit model used a binary dependent variable (1=violence occurs) with the same predictors as Model 4 in Table 1. As in the lower graph, the expected value captures the overall dynamics of violence.

Figure 2: Actual one-sided violence by Serbs and model prediction

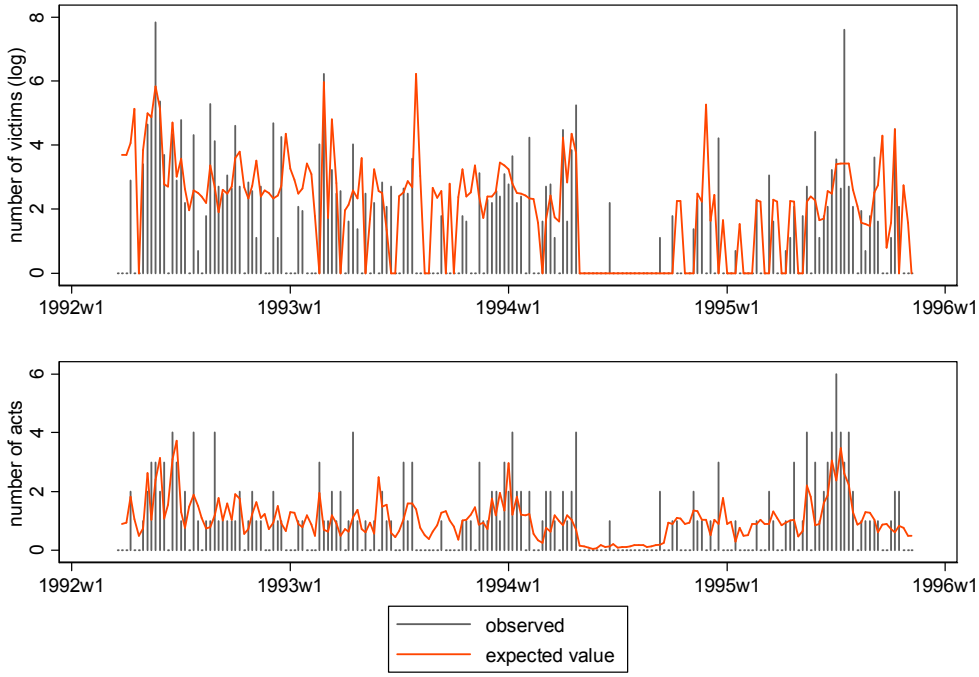
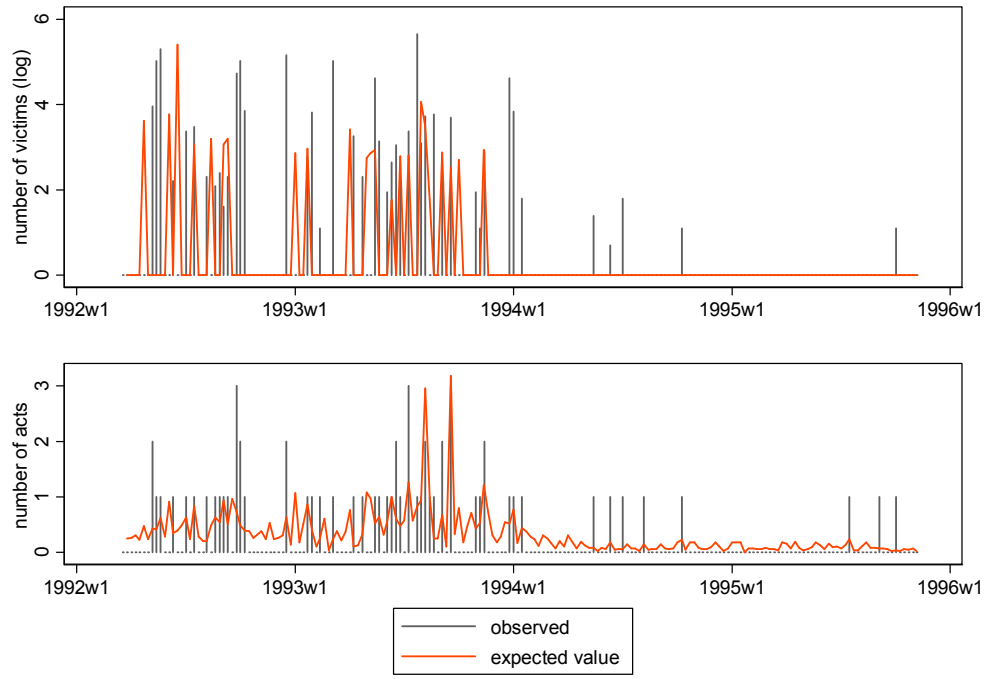


Figure 3 displays the same information for one-sided violence by Bosnian Muslims. Based on Model 4 in Table 3, the lower graph depicts the observed and expected number of violent acts. The upper graph contains the predicted number of victims. The procedure was the same as for Serb violence. The victim prediction fails to predict some weeks with violence. This deficiency is reduced, if a slightly lower threshold for the predicted probability is used, rather than arbitrarily setting the expected value to zero if the predicted probability of violence is lower than 0.5.

Figure 3: Actual one-sided violence by Muslim and model prediction



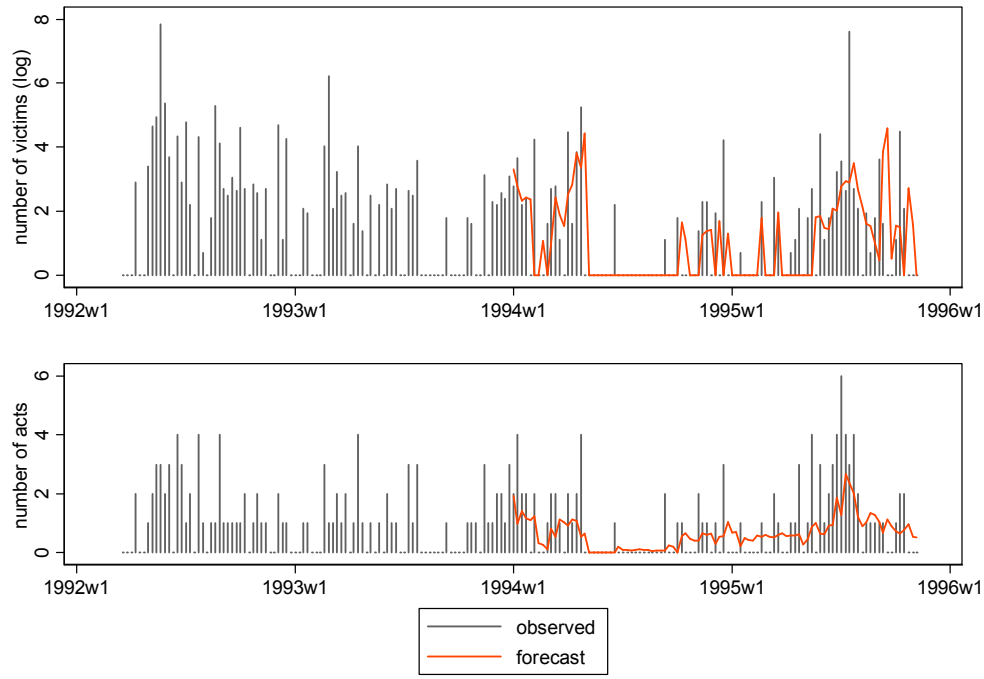
So far, only in-sample predictions were considered. In order to assess the model performance more rigorously, 25 percent of the observations were randomly excluded. The model was estimated with the remaining 75 percent. Thereafter, the ability of the model to predict the data used to estimate it (in-sample prediction) was compared against the out-of-sample accuracy, i.e. the ability to predict the excluded 25 percent of observations. The measure used to assess the accuracy was Theil's U (see above). As the accuracy might fluctuate somewhat depending on the random sample used to estimate it, this procedure was repeated 190 times with different random samples. Table 5 lists the median Theil's U value across models. As expected, the accuracy decreases somewhat when predictions are made out-of sample. Nevertheless, the models still outperform a naïve prediction which relies solely on a lagged dependent variable.

Table 5: *Median of Theils U values for predictions, calculated from 190 different random samples*

		Serbs	Muslims
OSV acts	In-sample	0.72	0.63
	Out-of-sample	0.79	0.72
Weekly victims	In-sample	0.67	0.86
	Out-of-sample	0.82	0.89

In the out-of-sample predictions summarized in Table 5, the prediction was generated for a randomly excluded part of the sample. Randomly excluding observation from the entire conflict period presents a test whether the model is able to predict observations from any period of the conflict. This stands in contrast to an ex-post forecast, which uses data up to a certain date and predicts events that happened after this date. Such a forecast is not interesting for the Bosnian Muslim data series, as the second half of the conflict saw virtually no violence. However, the Serb data displays quite a bit of variation for the second half of the conflict. Therefore, the ex-post forecast is only conducted for Serb one-sided violence.

Figure 4: *Actual one-sided violence by Serbs and one-week-ahead forecasts (starting for week 1 in 1994)*



The forecast starts based on the data up to December 1993. Based on the model, it issues a prediction for the first week of 1994. The next estimation includes the first week of 1994 and issues a forecast for the second week of 1994. This procedure is continued until the end of the conflict. The resulting forecasts therefore simulate what a hypothetical forecaster with all data at hand could have predicted in one-week-ahead forecasts during the conflict. The Theil's U values for the event count forecast is 0.83, the victim forecast even reaches a value of 0.7. Figure 4 displays the observed one-sided violence and the one-week-ahead forecasts.

6. Conclusion

This paper assessed to what extent violence against civilians might display regularities which render prediction feasible. It thereby added to recent efforts which attempted to predict conflict events. It extends this research to the subfield of one-sided violence. Based on event data of the war in Bosnia and Herzegovina, it demonstrated that accurate prediction is indeed feasible.

The analysis found that the best predictors correspond both to theories of one-sided violence as well as to the narrative of the war. The extent of Serb violence increased as Serbs captured territory, whereas Bosnian Muslim one-sided violence is best explained by the conflict intensity. The U.S. is the only external actor whose actions are consistently correlated with the level of violence, as U.S. involvement was followed by decreased violence. The overall level of violence significantly differed across periods during the conflict. The count of violent acts is largely predicted by international actions, a finding which amends the conclusion of Schneider et al. (2012) who found no such effects for victim counts in a dyadic analysis.

The paper further improves the anticipation of weeks without observed violence and thereby enhances the predictive accuracy. In order to achieve an adequate model fit, the analysis distinguished between an equation which explains the occurrence of violence against civilians and an equation which explains the extent of violence, given that violence occurs. This approach is rooted in the theoretical assumption that violence is initiated or contained by leaders, but enacted by subordinates. Furthermore, some events might simply be less likely reported. The operationalization of the dependent variables according to these assumptions enables to model the processes accurately, as the count of violent acts closely follows a negative binomial distribution while the victim count for weeks with violence can be approximated through a log-

normal distribution. The resulting models produce a good fit, capture the distinct characteristics of the data and link these patterns to the assumed data generating process.

Despite the better fit, the intensity of the most violent week, which saw the horrific events in Srebrenica, continues to be underestimated in the model. While the models described in this paper enable to predict small and medium sized events, the probability of gruesome outliers might require a more cautious look at the heavy-tailed characteristics of one-sided violence (e.g. Scharpf, 2012). Further research is needed to address this challenge. As suggested by Schrodt (2012), pure prediction models might also improve forecasts if they relied on more complex models, such as machine learning algorithms.

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