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PEACE AGREEMENTS: WHAT HAPPENS NEXT?

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Abstract

We examine the immediate effects of peace agreements on violence using the data of the Uppsala Conflict Data Program. The sample contains 52 peace agreements that took place over 1989 – 2018. We exploit the discontinuity that peace deals generate when concluded and the variation coming from peace treaties happening in different countries at different time. Applying the event study analysis and the regression discontinuity design we find that peace agreements bring a reduction in the number of fatalities already one month after the conclusion. Further, we study the heterogeneous effects that ceasefire and non-ceasefire agreements have on violence. This paper expands the existing literature by quantitatively analyzing the immediate effects of peace treaties and by providing evidence of heterogeneity in the impact of peace agreements.

Keywords: Conflict, Peace Agreements, Civil War, Ceasefire.

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1 Introduction

Conflict has been an urgent topic since the dawn of human history. Wars have many disastrous consequences, first and foremost in terms of human fatalities and damage to the social structures of countries involved in a conflict (e.g. reduced inter-ethnic trust, lower educational attainment): according to the Uppsala Conflict Data Program (UCDP), over the period of 1989 – 2018 state-based, non-state and one-sided conflicts caused nearly 3 million deaths, not accounting for deaths occurred due to the reasons related to wars indirectly (spread of diseases, psychological damage). At the same time, wars have economic costs for participant countries. For instance, civil wars reduce GDP growth of a country on average by 2.3% per year (Collier, 2007). Nevertheless, wars still happen, which draws attention of many researchers and practitioners to the ways in which wars can be ended and prevented from reoccurring.

Peace agreements are seen by the international community as a preferred tool to curb violence and end wars: many United Nations peacemaking initiatives center around “preventing, managing and resolving international disputes and internal conflicts” by assisting in peace processes (UN Peacemaker, 2019). However, there is still little quantitative evidence on the impact of peace agreements on violence, which emphasizes the relevance of the topic in question. Thus, the paper aims to examine what happens to violence right after a peace agreement is concluded.

To answer the question, we apply two methodologies – event study analysis and regression discontinuity design – combining two datasets of the Uppsala Conflict Data Program: the Georeferenced Event Dataset and Peace Agreement Dataset. The first contains data on all violent events with at least one death that happened between 1989 and 2018 around the world. The second provides information on agreements signed during the period of 1975 – 2018 and comprises only agreements, of which at least one side is a state (see Appendix A for

definitions). Thus, the study focuses on the monthly data on fatalities for 52 countries that experienced a peace agreement over 1989 – 2018.

In the paper we find that peace agreements have immediate and persistent effects on violence: there is a reduction in the number of fatalities that persists over at least two years after a peace agreement. With the objective of going beyond the average immediate effects of peace agreements, we use both event study and regression discontinuity design approaches to estimate the impact of peace agreements that have a ceasefire provision and those that do not have it. According to our results, the average effects mentioned above are driven by ceasefire agreements.

The paper is organized as follows: the next section provides the review of the existing literature on conflict, its determinants and, more specifically, on peace agreements. Section 3 focuses on the dataset used in the paper as well as on the descriptive statistics of the data. Section 4 highlights the methodology that was applied. Section 5 discusses the results obtained and, finally, section 6 concludes and highlights potential paths for further research.

2 Literature review

The existing body of literature on the topic focuses, firstly, on conflict theory and determinants of conflict. Possible reasons for which peaceful bargaining fails and a war starts were first formalized by Fearon (1995): asymmetric information about an opponent's military capabilities and commitment problems play an important role in explaining "war inefficiency puzzle". Another reason of bargaining failure found in the literature is political bias that occurs when incentives of a decision maker (a leader or authorities of a country) to maintain a war are different from those of the society as a whole (Jackson and Morelli, 2007).

The classical contribution to the conflict theory by Collier and Hoeffler (2004) examines the causes of civil war with the help of a framework that can be called "greed versus grievance": the authors divide all possible motives of rebellion into two groups – greed motives, that are

related to the maximization of profits grabbed during a war, and grievance motives, that represent objective reasons to fight, such as political repression or exclusion, economic inequality. Later Collier *et al.* (2009) complement the theory by focusing on the feasibility of conflict rather than on often interrelated greed and grievance motives: if there is a feasibility for a conflict to occur in terms of supply of rebel leaders and rebels, existence of possible causes for a rebellion and material feasibility, it will occur.

Another approach that is present in the literature on conflict is the rent-seeking approach that concentrates mostly on explaining the intensity of fighting. The theory relies on the fact that exerting a higher fighting effort to increase one's winning probability, thus, probability of getting some "prize", would mean a higher loss in terms of opportunity costs, thereby creating a dilemma for potential fighters (Skaperdas, 1992; Esteban and Ray, 2008, 2011; Ploeg and Rohner, 2012).

While reviewing the literature on the theory of conflict, attention should be drawn on several context-specific factors that make it harder to end wars. Among these factors, availability of natural resources, control of armed groups over a country's specific territories and presence of multiple participants are notably present in the literature (Collier *et al.*, 2004; Cunningham *et al.*, 2009; Cunningham, 2013; Berman *et al.*, 2017).

Turning to the literature on peace agreements, it centers around what dictates the success of peace deals. There are three broadly used approaches to measure the success of peace treaties: reduction in fatalities, duration of peace and pace of economic recovery following a peace agreement. In one of the first studies on peace treaties Licklider (1995) uses the first approach and finds that decisive military victories are more prone to bring long-lasting peace than a peaceful settlement of incompatibilities; however, the chances that military victories will be followed by genocides are higher, which can be seen as a failure to curb violence. Joshi *et al.*

(2015) use as well survival analysis to study whether provisions related to the security sector incorporated into a peace agreement have an impact on its long-term success.

With regard to the second approach to measure how successful a peace treaty is – peace duration – it is widely applied in many studies, for instance, in Licklider (1995), Harzell and Hoodie (2003), DeRouen *et al.* (2009).

The third criterion to assess the impact of a peace treaty – speed and degree of economic reconstruction – has been rarely used in the literature due to many confounding factors that could drive the results when estimating an effect of peace deals on economic growth (Collier *et al.*, 2008).

Linking success of peace agreements to their content forms an important part of the research on ending conflicts. According to Badran (2014), clauses and provisions contained in a peace agreement matter for its success in terms of reduction in fatalities or peace duration. Some authors define main dimensions around which the analysis of the content of peace agreements can be built: “security provision and ethnic balancing within the army”, “power sharing in politics”, “resource and surplus sharing”, “identity construction” and “legal arrangements” (Rohner, 2018). The literature on the impact of these dimensions on the success of peace agreements will be studied below.

We firstly start analyzing the above-mentioned dimensions of the content of peace treaties with provisions related to security, such as demobilization, ceasefire, disarmament. Those causes were found to be crucial for keeping peace after a peace agreement is concluded (Walter, 1997; Berman *et al.*, 2011). In addition to that, Joshi *et al.* (2015) find that a peace agreement that contains security sector reforms provisions result not only in a settlement of incompatibilities between the signing parties, but also in a reduction of fighting from non-signatory parties. In the context of high ethnic tensions, security provisions may incorporate

provisions related to reintegration of conflicting troops into a united army, which proved to work in some contexts (Samii, 2013).

Secondly, it is necessary to consider another category of provisions of peace treaties that the research has been focused on, which is power sharing provisions that imply different parties benefitting from at least a share of power. The net impact of these provisions is somewhat ambiguous: some studies show that power-sharing brings more peace (Wright, 2008), others show the opposite as with democracy come better opportunities to revolt (Esteban *et al.*, 2015). However, the characteristics of a democracy are crucial: Hegre *et al.* (2001), Collier and Rohner (2008) highlight that the success of power-sharing provisions depends on the level of democracy as well as on a country's income. A country's potential to implement numerous reforms in different policy aspects and its more democratic values facilitate success of a peace agreement (DeRouen *et al.*, 2010; Joshi and Quinn, 2015).

Concerning power sharing provisions and following them political reforms, the risk of renewed fighting will be mitigated subject to the process of democratization being gentle and steady. Evidence shows that after a peace deal elections should be delayed by some years to build first solid domestic institutions (Diamond, 2006; Flores and Nooruddin, 2012; Brancati and Snyder, 2013; Walter, 2014).

Summing up the research that has been done on power-sharing provisions, most papers find that they are a key to success of peace deals (Walter, 1997; Hartzell and Hoodie, 2003; Cederman *et al.*, 2015). Nevertheless, DeRouen *et al.* (2009) do not find any statistically significant impact of power sharing provisions on the peace length after a peace treaty is concluded, which signals that further research is needed.

Third important aspect of peace treaties that is seen to affect the success of them and that is widely studied in the literature is represented by provisions related to natural resources. The existing literature shows that peace settlements that provide sharing of economic and territorial

resources lead to a more stable peace (Hartzell and Hoodie, 2003; DeRouen *et al.*, 2009; Cederman *et al.*, 2015).

Another important dimension of the content of peace deals is identity construction and reconciliation provisions: peace agreements that provide bottom-up initiatives, departing from community level, proved to be able to solve the problem of low trust in the society, which results in a longer peace duration (Fortna, 2003). Joshi *et al.* (2017) find that vertical mechanisms incorporating local, national and external members' meetings have as well peace-fostering effects. Cilliers *et al.* (2016) conduct a randomized control trial in Sierra Leone in order to examine the effect of community-level reconciliation initiatives, such as reconciliation forums with village members, and find that these events result in a better social capital, higher trust, but, at the same time, they might have some negative non-cognitive consequences at the individual level, such as increased depression and anxieties of participants.

Final aspect of peace agreements' content to be analyzed would be provisions concerning amnesties. When it comes to the debate around peace agreements, amnesties become a subject to a trade-off that can be called "peace versus justice", meaning that sometimes, in order to conclude a peace agreement more rapidly, parties to an agreement are forced to include these provisions, even if they are not considered fair (Rohner, 2018). Some evidence suggests that including amnesty provisions in peace agreements brings lower chances of peace to break down (Joshi *et al.*, 2017) and contributes to civil-war resolution (Dancy, 2017).

Regardless the fact that the literature on conflict and peace agreements is extensive, there are some lacunas, which allows this paper to expand, firstly, the existing literature on peace agreements in general by quantitatively examining the immediate effects of peace agreements on violence measured by the number of fatalities. Secondly, this study contributes to the existing research on the determinants of the success of peace agreements by analyzing some heterogeneity in peace treaties, namely by quantitatively analyzing heterogeneous effects of

ceasefire peace agreements and non-ceasefire peace agreement (see Appendix A for definitions).

3 Data

3.1 Fatalities and peace agreements data

Data used in the study is derived from the Uppsala Conflict Data Program's Georeferenced Event Dataset and Peace Agreement Dataset of the Uppsala University. The former dataset contains data on all violent events with at least one death that happened between 1989 and 2018 around the world with further information on type of violence, date of an event, conflict that an event refers to, conflicting sides, number of fatalities and other characteristics. The usage of the disaggregated data allows to consider different time horizons and, consequently, various levels of precision, as the UCDP disaggregated data contains information about exact location and exact timing of violence. Another advantage of the UCDP dataset would be the fact that it contains data on violent events happening all around the world, which enables to account for heterogeneity among multiple countries and regions (see Appendix B).

The UCDP Peace Agreement Dataset represents a dataset of formal agreements concluded between conflicting parties to resolve incompatibilities. The dataset in question contains information on agreements signed during the period of 1975 – 2018 and comprises only agreements, of which at least one side is a state, meaning an internationally recognized government (see Appendix A for definitions). Information that can be derived from the dataset is conflict that a peace agreement refers to, date of an agreement¹, signing parties, presence of ceasefire or other provisions and other characteristics of the agreement.

The paper follows an approach that is widely used in the literature, when the success of peace agreements is measured in terms of fatalities dynamics (Licklider, 1995; Joshi *et al.*, 2015). The data on fatalities used in the main specification of the event study is monthly data

¹ Hereinafter, the date of a peace agreement refers to “the date of the last signature of the peace agreement” (Högbladh, 2019).

resulting in 18,720 observations (52 countries, 30 years). The analysis addresses only state-based violence due to the above-mentioned feature of the UCDP Peace Agreement Dataset.

Another important point concerning the data used in the study deals with the analysis being restricted to the first peace agreement that was concluded for every country, which means that, in case other complementary or follow-up agreements ensue the first peace agreement, the study takes into account only the first treaty signed resulting in 52 peace agreements being analyzed. This decision is motivated by the following intuition: when thinking about a case of a country with multiple peace agreements signed over a short time horizon, the first treaty is perceived to make a difference if compared to the status quo, while the subsequent ones are seen to contain minor changes and advances.

3.2 Descriptive statistics

Conflicts and peace agreements are, unquestionably, very heterogeneous in many different aspects. As it was already mentioned above, in the paper we focus on conflicts that ended up with a peace treaty being concluded. However, to understand better the nature of peace deals and conflicts that we are analyzing, it is important to compare conflicts that have peace agreements and conflicts that do not have any.

As we can see from Table 1, conflicts that have peace deals are on average different from conflicts that do not have peace deals: the former have higher average numbers of violent events and fatalities and longer conflict duration, while slower growth of fatalities compared to the conflicts without peace agreements, which suggests that the question of whether the conclusions of this study are valid for active conflicts that are still without peace agreements is subject to further research.

We will further compare conflicts with and without ceasefire peace agreements. The term “ceasefire peace agreements” refers to the peace deals that “included provisions for a ceasefire

or the cessation of hostilities” (UCDP, 2019). Consequently, by “non-ceasefire peace agreements” we mean those deals that do not have the above-mentioned provisions.

Table 1. Descriptive statistics

	Mean (1)	Std. Dev. (2)	Min (3)	Max (4)	Obs. (5)
CONFLICTS WITH AND WITHOUT PEACE TREATIES					
Conflicts with PAs					63
Number of violent events	76.15	166.61	1	865	
Number of fatalities	830.79	2 148.24	16	24 554	
Fatalities growth	2.13	2.9	-1	23.13	
Duration of conflicts (years)	23.03	8.17	0	29	
Years before the first peace deal	9.68	8.04	0	29	
Conflicts without PAs					1033
Number of violent events	20.02	38.54	1	322	
Number of fatalities	309.88	2 073.61	5	34 105	
Fatalities growth	4.86	19.35	-1	500.04	
Duration of conflicts (years)	14.94	10.64	0	29	
CONFLICTS WITH CEASEFIRE AND NON-CEASEFIRE PEACE TREATIES					
Conflicts with ceasefire PAs					21
Number of violent events	77.75	83.42	5	308	
Number of fatalities	1 064.72	3 231.35	26	24 554	
Fatalities growth	2.17	3.94	-0.96	23.13	
Duration of conflicts (years)	20.08	7.99	0	29	
Years before the first peace deal	10.86	9.12	0	29	
Conflicts with non-ceasefire PAs					33
Number of violent events	85.26	201.65	4	865	
Number of fatalities	833.66	1 564.23	16	6 702	
Fatalities growth	2.09	2.37	-1	8.30	
Duration of conflicts (years)	24.43	8.08	0	29	
Years before the first peace deal	7.56	6.13	1	23	

Notes. This table represents the descriptive statistics for all conflicts with and without peace agreements from the UCDP Georeferenced Event Dataset with the event data being aggregated to the yearly level as well as the descriptive statistics for all ceasefire and non-ceasefire agreements (excluding 9 agreements without information on ceasefire provisions). *Violent events* refer to incidents "where armed force was used by an organized actor against another organized actor, or against civilians, resulting in at least 1 direct death at a specific location and a specific date" (UCDP, 2019). *Fatalities growth* is computed year to year as follows: $\frac{fatalities_t - fatalities_{t-1}}{fatalities_{t-1}}$.

According to the descriptive statistics (Table 1), ceasefire and non-ceasefire agreements seem to occur for, on average, similar conflicts in terms of number of violent events, number of fatalities, growth of fatalities and duration of conflicts, which to some extent allows us to attribute differences in their impact on fatalities to the presence of a ceasefire provision (see Section 5).

4 Methodology

The lack of quantitative analysis on the topic can be partially explained by presence and timing of peace agreements being endogenous, meaning the content of peace treaties is not random, which thereby raises an endogeneity problem. To identify the impact of peace agreements on violence, this study exploits discontinuity that a peace deal generates when concluded (having other characteristics continuous). Moreover, we rely on the fact that different peace treaties happen in different countries at different time, which represents a source of variation for the paper.

The study uses two methodologies in order to analyze the relationship between violence and peace agreements: event study analysis and temporal regression discontinuity design. The first methodology considered is the event study approach as in Greenstone and Hanna (2014), Hoynes *et al.* (2016), which allows to analyze the setting of interest in which treatment timing – in our case timing of peace agreements – varies across countries. The event study analysis enables to look at possible pre-trends in violence dynamics before the date of a peace treaty as well as to look at immediate and lagged effects after the signature. The initial data is aggregated to the monthly level. In the context of event-based dataset, using monthly data presents the drawback of having a larger level of noise in the information since violent events can be rare. The use of logarithm of the number of fatalities instead of levels allows to avoid cases when extreme events drive the results. The following equation represents the benchmark specification:

$$\log(y_{it}) = \alpha + \sum_T \gamma d_{T,t} + \lambda_t + a_m + \delta_i + \mathbf{X}'_{it} + \varepsilon_{it} \quad (1)$$

where i and t indices refer to a specific country and month accordingly, $\log(y_{it})$ denotes the logarithm of the number of fatalities for a country i in month t and α denotes a constant. $d_{T,t}$ represents a vector with separate indicators for the periods before and after a peace agreement is concluded. Because violence reported at monthly level is noisy (due to the exact reporting of

events), we aggregate period indicators into groups of two consecutive months (bi-months). For instance, the dummy of bi-month₁ contains dummies of month₁ and month₂ after a peace agreement, the dummy of bi-month₋₁ contains dummies of month₋₁ and month₋₂ before a peace treaty, etc. Terms λ_t and a_m capture correspondingly year and month fixed-effects to account for unobservable year- and month- characteristics that could influence the outcome of interest. δ_i refers to the country fixed-effects, which allows controlling for time-invariant factors that affect violence in the country, such as its geography, culture. \mathbf{X}'_{it} denotes the set of controls, which are demeaned average rainfall and temperature levels. Finally, the error term ε_{it} includes all other factors affecting violence that are not captured by the model and is assumed to be serially correlated within each country.

The second methodology used in the paper is the temporal regression discontinuity design (RDD). The approach provides a way to compare the dynamics of violence right before and right after the cutoff, which in our setting is the first month after the month of a peace agreement, while month₀, when a peace deal is concluded, belongs to the time period preceding the signature of a peace agreement. The choice can be explained as follows: as some peace treaties were concluded at the beginning of a month₀, and some – at the end, the cutoff is set at the month₁. The main assumption of the RDD approach is that, while at the cutoff there is a discontinuity of the outcome variable and the treatment variable, all other relevant variables must remain continuous (Angrist, 2008). This assumption will be tested below using the control variables. To measure the effect of a peace deal being concluded on the number of fatalities, we estimate the following equation:

$$\log(y_i) = \alpha + \sum_p \gamma n_i^p + \mathbf{X}'_i + \varepsilon_i \quad (2)$$

where i index refers to a specific country, $\log(y_i)$ denotes the logarithm of the number of fatalities for a country i , term α represents a constant and p corresponds to an order of the polynomial fit. Term n_i refers to the variable of time, which represents the time distances in

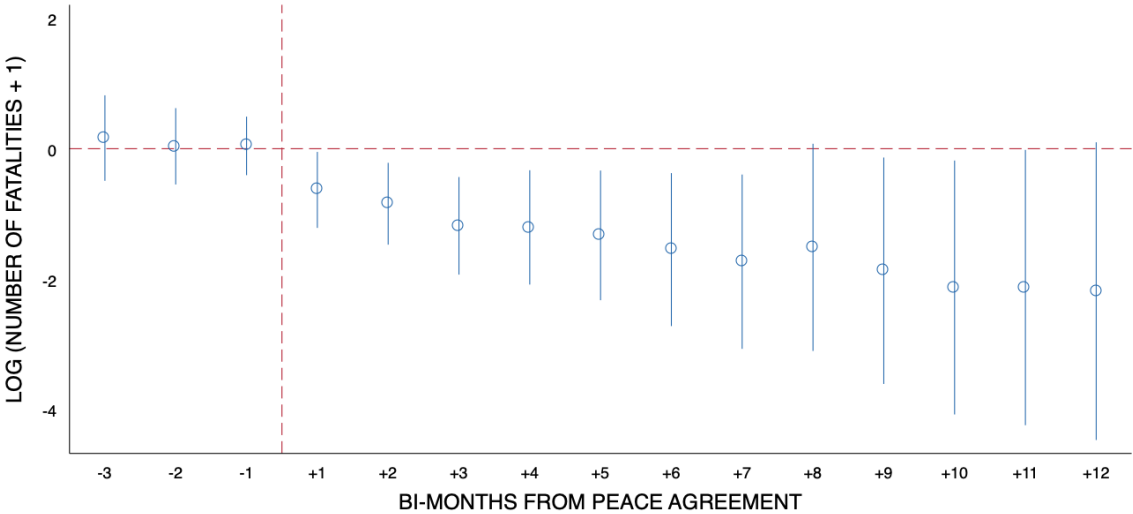
months from the month of a peace treaty for every country and which takes values (-36; 36), meaning 3 years before and after a peace deal was concluded. X'_i denotes the set of controls, which are demeaned average rainfall and temperature levels. Finally, the error term ε_i includes all other determinants of violence that are not captured by the model.

5 Results

5.1 Event study analysis

We start by examining the effect of peace agreements on the number of fatalities using the event study approach. The dependent variable is the number of fatalities transformed into a logarithm adding 1. As it was already discussed in Section 4, event study analysis using dummies for months produces noisy estimates. Thus, the main specification uses dummies for bi-months.

Figure 1. Event study analysis: effect of peace agreements on fatalities



Notes. This figure plots the coefficients of the benchmark equation (1) against the time distances from the date of peace agreements (bi-months from peace agreements) for the sample of 52 peace agreements. Bi-months from a peace agreement are represented by 16 dummy variables denoting time distances from a peace agreement from 3 bi-months before a peace agreement and till 12 bi-months after a peace agreement. Dummy "0" for the month of a peace agreement is excluded. The vertical line indicates the month of the peace agreement. Every bi-month dummy contains two corresponding months in accordance with their time distance from the month of a peace agreement: e.g. bi-month₁ contains month₁ and month₂ after a peace agreement. The dependent variable is the logarithm of the number of fatalities adding 1. Confidence intervals are computed at 95%. Year, month and country fixed-effects as well as rainfall and temperature controls are included in the specification. The time horizon is restricted to 6 months (3 bi-month) before and 24 months (12 bi-months) after the month of a peace agreement.

Table 2. Event study analysis: effect of peace agreements on fatalities

	Dependent variable: Specification:		
	(1)	(2)	(3)
A. Points in time before a peace treaty			
3 bi-months before	0.163 (0.391)	0.163 (0.391)	0.156 (0.390)
2 bi-months before	0.036 (0.349)	0.036 (0.349)	0.050 (0.352)
1 bi-month before	0.043 (0.268)	0.043 (0.268)	0.050 (0.269)
B. Points in time after a peace treaty			
1 bi-month after	-0.632* (0.348)	-0.632* (0.348)	-0.645* (0.349)
2 bi-months after	-0.844** (0.374)	-0.844** (0.374)	-0.866** (0.374)
3 bi-months after	-1.182** (0.446)	-1.182** (0.446)	-1.186*** (0.442)
4 bi-months after	-1.207** (0.523)	-1.207** (0.523)	-1.208** (0.518)
5 bi-months after	-1.329** (0.593)	-1.329** (0.593)	-1.325** (0.590)
6 bi-months after	-1.547** (0.700)	-1.547** (0.700)	-1.546** (0.698)
7 bi-months after	-1.733** (0.797)	-1.733** (0.797)	-1.725** (0.796)
8 bi-months after	-1.513 (0.948)	-1.513 (0.948)	-1.518 (0.947)
9 bi-months after	-1.872* (1.036)	-1.872* (1.036)	-1.857* (1.032)
10 bi-months after	-2.128* (1.162)	-2.128* (1.162)	-2.120* (1.160)
11 bi-months after	-2.129* (1.260)	-2.129* (1.260)	-2.120* (1.260)
12 bi-months after	-2.184 (1.362)	-2.184 (1.362)	-2.168 (1.365)
Year, month, country fixed effects	yes	yes	yes
Controls	no	yes	yes
Continent-specific seasonality	no	no	yes
Observations	1 560	1 560	1 560
Number of peace agreements	52	52	52

Notes. The table reports the effects of peace agreements on fatalities estimated using the event study analysis. Standard errors in parentheses are assumed to be correlated within each country. Specification (1) refers to the equation (1) without controls and without additional trends, specification (2) constitutes the benchmark specification, while specification (3) accounts for controls as well as for quadratic trends in continent-specific seasonality, which is represented by interaction terms of a continent and year, a continent and year². The dependent variable is the logarithm of the number of fatalities adding 1. Independent variables represent time distances from the date of peace agreements (bi-months from peace agreements) for 52 countries. Bi-months from a peace agreement are represented by 16 dummy variables denoting time distances from a peace agreement from 3 bi-months before a peace agreement and till 12 bi-months after a peace agreement. Dummy "0" for the month of a peace agreement is excluded. Every bi-month dummy contains two months in accordance with their time distance from the month of a peace agreement: e.g. bi-month₁ contains month₁ and month₂ after a peace agreement. Confidence intervals are computed at 95%. Controls are demeaned rainfall and temperature levels. The time horizon is restricted to 6 months (3 bi-month) before and 24 months (12 bi-months) after the month of a peace agreement. *** is significant at the 1% level, ** is significant at the 5% level, * is significant at the 10% level.

Figure 1 shows that two months after a peace agreement is concluded (+1 bi-month) there is a significant reduction in the number of fatalities that persists over following months till more than 2 years after the conclusion of a peace deal (+7 bi-months). Table 2 presents estimates of the effect of interest for three specifications: in the first column we can see estimates of the equation (1) without control variables; the second column provides estimates of the benchmark specification; finally, the third column presents the estimates of the benchmark equation with quadratic trends in continent-specific seasonality (introducing continent*year and continent*year² interactions). Panels A and B provide estimates for different time moments before and after a peace agreement is concluded correspondingly.

According to the column (2) of Table 2, two months after a peace agreement (+1 bi-month) the immediate effect can already be seen: the logarithm of the number of fatalities reduces by 0.63 percentage points, which corresponds to a reduction of 47% in the number of fatalities². Four months after (+2 bi-months) the logarithm of the number of fatalities decreases by 0.84 percentage points, meaning the number of fatalities decreases by 53%. The effect of the conclusion of peace agreements remains significant at 5% level over following months and reaches its highest value of an 82%-decrease 14 months after (+7 bi-months). The usage of different specifications shows that the results are robust.

The results of the event study analysis show that the main dynamics in the number of fatalities happens right after a peace agreement is concluded, which suggests that a deeper analysis of the effect around the threshold, i.e. right before and right after the signature, would benefit the study.

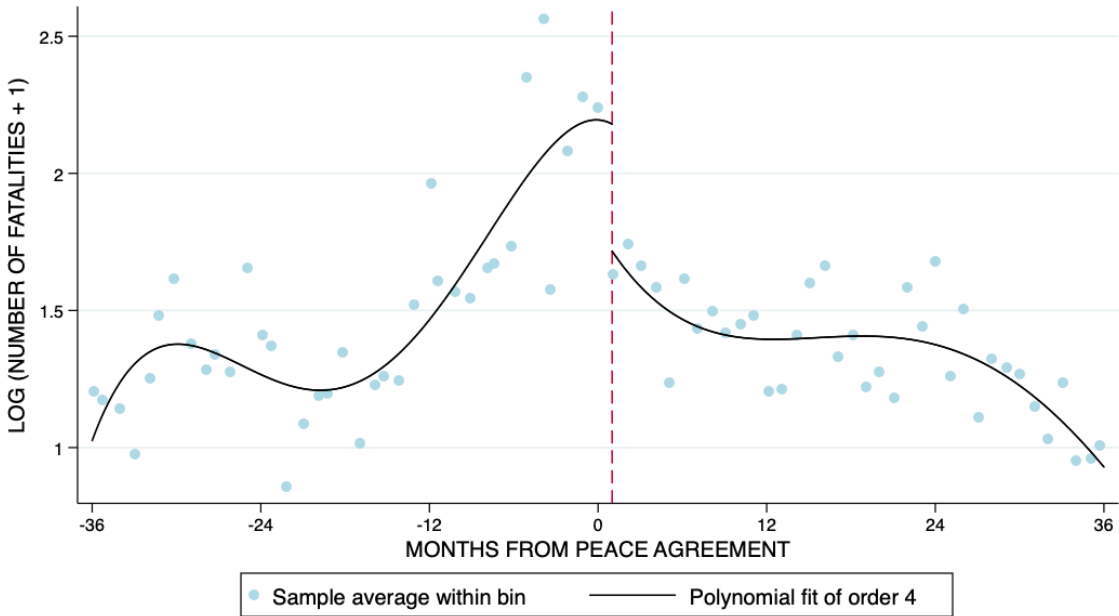
² As the estimates of the event study are large in magnitude, the interpretation of the coefficients in our log-linear model will be as follows: being period_t after a peace agreement multiplies the expected value of the number of fatalities by $e^{\beta t}$. For instance, one bi-month after a peace agreement the number of fatalities is equal to the number of fatalities before a peace treaty multiplied by $e^{(-0.632)}$, which correspond to a reduction of 47%.

5.2 Regression discontinuity design

In order to look at the immediate effects of peace agreements, the temporal regression discontinuity design is used. As already mentioned in Section 4, the time threshold of the RDD is set at month₁ after a peace agreement to account for cases when a peace agreement takes place at the end of the month₀.

Figure 2 presents the regression discontinuity plot for the relationship between the number of fatalities and the time variable, which incorporates time distances in months from month₀, which is the month of a peace agreement. The time horizon of the RDD analysis is between 3 years before a peace deal (-36 months) and 3 years after it (36 months).

Figure 2. Regression discontinuity design: effect of peace agreements on fatalities



Notes. This figure represents the regression discontinuity plot for the relationship between the logarithm of the number of fatalities adding 1 and the time variable, which contains the time distances in months from the signature of peace agreements for 52 peace agreements. The time variable takes values from -36 till 36, referring to 36 months before a peace agreement and 36 months after a peace agreement. The cutoff is set at the end of the month in which a peace treaty is signed in order to account for cases when a peace agreement takes place at the end of month₀. The vertical line indicates the cutoff. Dots correspond to the sample averages within bins, polynomial fit of order 4 is used to approximate the conditional expectation functions for the points in time before and after the cutoff.

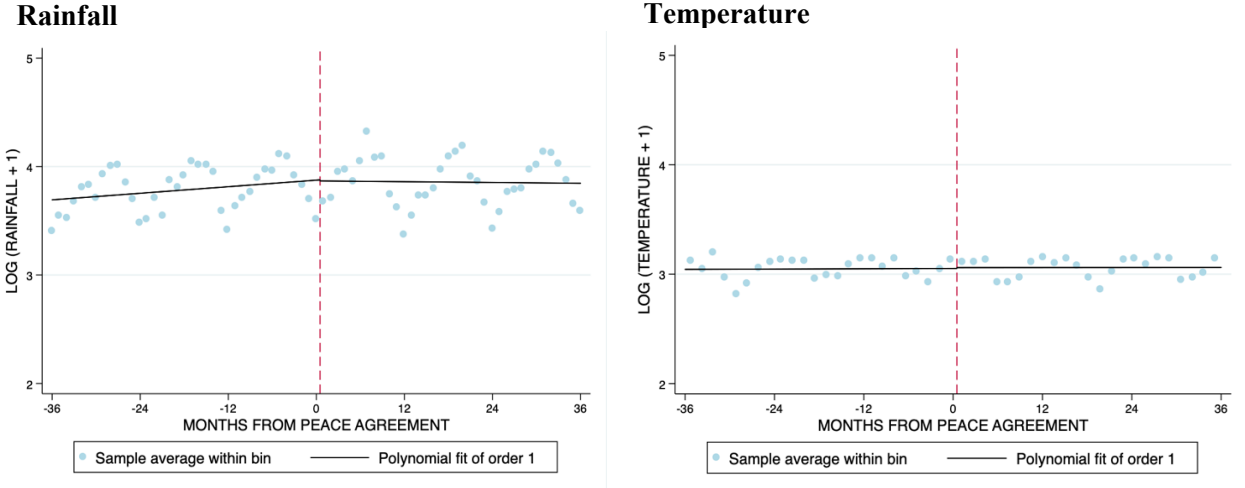
As we can see from Figure 2, there is a significant discontinuity in the number of fatalities happening one month after the conclusion of a peace agreement (the cutoff is set at month₁). According to Panel A of Table 3, the estimate of the average effect of peace agreements on

fatalities is similar to the estimate obtained using the event study analysis for the first bi-month after the conclusion. One month after a peace treaty there is a reduction in the logarithm of the number of fatalities of 0.62 percentage points, meaning there is a decrease in the number of fatalities of 46%.

Following the main assumption of the RDD approach that was discussed in Section 4, it is important to test that the discontinuity we have found previously is driven by the treatment – in our case, by the conclusion of a peace agreement – rather than by other unaccounted non-linearities. Thus, the analysis of the relationship between the control variables and the time variable is performed.

Figure 3 plots the relationship in question and clearly shows that both control variables remain continuous around the threshold, which satisfies the assumption for using the regression discontinuity design. According to Panel B of Table 3, the RD estimates of the relationship between the controls variables and the time variables are not significant.

Figure 3. Regression discontinuity design: control variables



Notes. This figure serves as part of the analysis on the validity of the RDD approach and represents the regression discontinuity plots for the relationship between the control variables and the time variable, which contains the time distances in months from the signature of peace agreements for 52 peace agreements. Left panel uses the logarithm of the demeaned rainfall level adding 1 as a dependent variable, right panel uses the logarithm of the demeaned temperature level adding 1 as a dependent variable. The time variable takes values from -36 till 36, referring to 36 months before a peace agreement and 36 months after a peace agreement. The cutoff is set at 0.5 month after a peace agreement is concluded. The vertical lines indicate the cutoff. Dots correspond to the sample averages within bins, polynomial fit of order 1 is used to approximate the conditional expectation functions for the points in time before and after the cutoff.

Table 3. Regression discontinuity design results

		(1)
A. Average effect of peace agreements on fatalities		
	Dependent variable:	Log (number of fatalities + 1)
Sharp RD estimate		-0.621** (0.311)
B. Testing continuity of the control variables		
	Dependent variable:	Log (rainfall + 1)
Sharp RD estimate		0.088 (0.233)
	Dependent variable:	Log (temperature + 1)
Sharp RD estimate		0.028 (0.055)

Notes. The table reports the results of the RDD estimation for various variables. Panel A shows the sharp RD estimate for the change in the number of fatalities after a peace agreement is concluded. The dependent variable is the logarithm of the number of fatalities adding 1. The cutoff is set at the end of the month in which a peace treaty is signed in order to account for cases when a peace agreement takes place at the end of month₀. The benchmark specification is used. Panel B serves as an analysis of the validity of the continuity assumption for the control variables. The dependent variables are the logarithm of the demeaned rainfall level adding 1 and the logarithm of the demeaned temperature level adding 1. The cutoff is set at 0.5 month after a peace agreement is concluded. Confidence intervals are computed at 95%. For all panels the running variable is the time variable that takes values from -36 till 36, referring to 36 months before a peace agreements and 36 months after a peace agreement. *** is significant at the 1% level, ** is significant at the 5% level, * is significant at the 10% level.

5.3 Ceasefire and non-ceasefire peace agreements

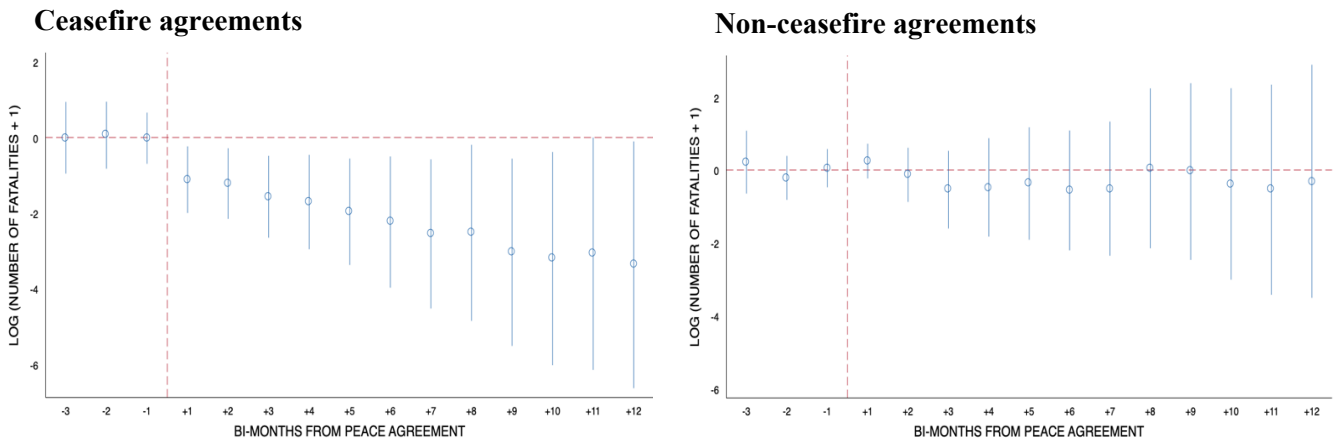
The effects of peace agreements discussed previously can be considered as the average effects. However, as we know from Section 3, there is some heterogeneity in peace agreements, which means that different types of peace agreements could have heterogeneous immediate effects on violence. In the context of this study, we focus on analyzing heterogeneous effects that ceasefire and non-ceasefire peace agreements have on the dynamics of fatalities. Figure 4 and Table 4 show the results of the event study analysis for ceasefire and non-ceasefire peace agreements: ceasefire agreements bring an immediate decrease of 67% in violence from the first bi-month after a peace agreement onwards, while non-ceasefire agreements do not have any significant effects after the signature.

Table 4. Event study analysis: ceasefire and non-ceasefire peace agreements

Dependent variable:	Log (number of fatalities + 1)	
	Ceasefire agreements (1)	Non-ceasefire agreements (2)
A. Points in time before a peace treaty		
3 bi-months before	-0.007 (0.559)	0.215 (0.498)
2 bi-months before	0.061 (0.523)	-0.216 (0.349)
1 bi-month before	-0.019 (0.399)	0.050 (0.303)
B. Points in time after a peace treaty		
1 bi-month after	-1.117** (0.520)	-0.243 (0.276)
2 bi-months after	-1.219** (0.551)	-0.134 (0.429)
3 bi-months after	-1.568** (0.640)	-0.539 (0.616)
4 bi-months after	-1.709** (0.737)	-0.478 (0.780)
5 bi-months after	-1.967** (0.830)	-0.372 (0.892)
6 bi-months after	-2.239** (1.024)	-0.560 (0.950)
7 bi-months after	-2.554** (1.164)	-0.512 (1.064)
8 bi-months after	-2.525* (1.374)	0.046 (1.268)
9 bi-months after	-3.040** (1.461)	0.043 (1.401)
10 bi-months after	-3.206* (1.664)	-0.383 (1.518)
11 bi-months after	-3.078 (1.814)	-0.542 (1.667)
12 bi-months after	-3.371* (1.926)	-0.311 (1.849)
Year, month, country fixed effects	yes	yes
Controls	yes	yes
Observations	960	600
Number of peace agreements	32	20

Notes. The table reports the effects of peace agreements on fatalities estimated using the event study analysis for ceasefire and non-ceasefire peace agreements. Standard errors in parentheses are assumed to be correlated within each country. Column (1) provides estimates of the benchmark specification for ceasefire agreements, while column (2) presents estimates of the benchmark specification for non-ceasefire agreements. The dependent variable is the logarithm of the number of fatalities adding 1. Independent variables represent time distances from the date of peace agreements (bi-months from peace agreements). Bi-months from a peace agreement are represented by 16 dummy variables denoting time distances from a peace agreement from 3 bi-months before a peace agreement and till 12 bi-months after a peace agreement. Dummy "0" for the month of a peace agreement is excluded. Every bi-month dummy contains two months in accordance with their time distance from the month of a peace agreement: e.g. bi-month₁ contains month₁ and month₂ after a peace agreement. Confidence intervals are computed at 95%. Controls are demeaned rainfall and temperature levels. The time horizon is restricted to 6 months (3 bi-month) before and 24 months (12 bi-months) after the month of a peace agreement. *** is significant at the 1% level, ** is significant at the 5% level, * is significant at the 10% level.

Figure 4. Event study analysis: ceasefire and non-ceasefire peace agreements



Notes. This figure plots the coefficients of equation (1) against the time distances from the signature of peace agreements (bi-months from peace agreements) for ceasefire and non-ceasefire peace agreements. Bi-months from a peace agreement are represented by 16 dummy variables denoting time distances from a peace agreement from 3 bi-months before a peace agreement and till 12 bi-months after a peace agreement. Dummy "0" for the month of a peace agreement is excluded. The vertical line indicates the month of the peace agreement. Every bi-month dummy contains two corresponding months in accordance with their time distance from the month when a peace agreement was signed: e.g. bimonth_1 contains month_1 and month_2 after a peace agreement. Left panel displays the effect of ceasefire agreements on the number of fatalities. Right panel displays the effect of non-ceasefire agreements on the number of fatalities. The dependent variable is the logarithm of the number of fatalities adding 1. Confidence intervals are computed at 95%. Year, month and country fixed-effects as well as rainfall and temperature controls are included in the specification. The time horizon is restricted to 6 months (3 bi-month) before and 24 months (12 bi-months) after the month of a peace agreement. See Appendix A for definitions of "ceasefire peace agreements" and "non-ceasefire peace agreements".

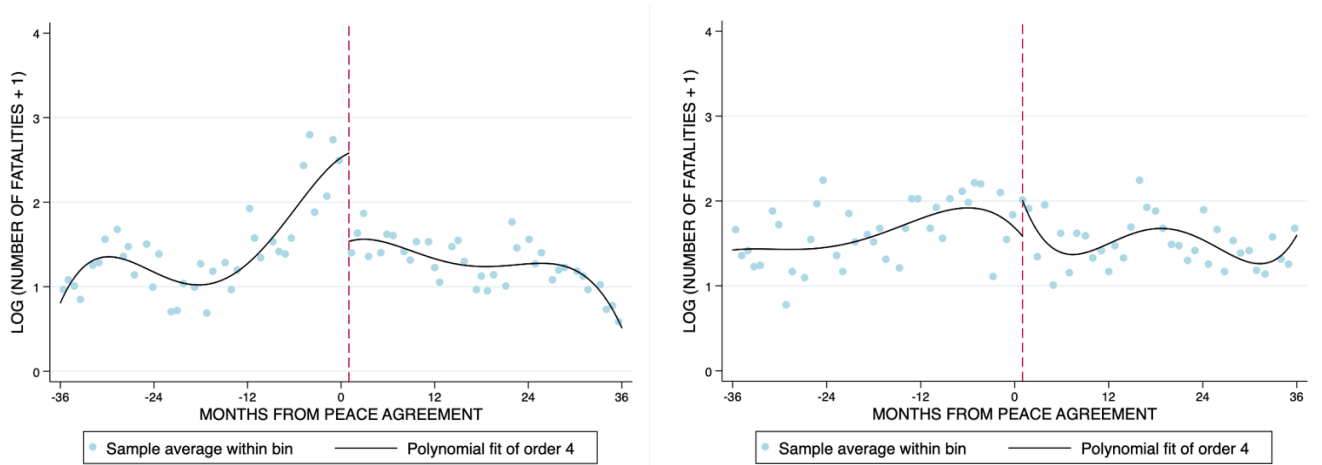
Figure 5 presents the regression discontinuity design plot for ceasefire and non-ceasefire agreements. In the figure as well as in Table 5 that contains the estimates for the discontinuity, we can clearly see the difference in the impact of the two types of peace deals on the fatalities' dynamics. Moreover, the RD estimate for the immediate effect of ceasefire peace treaties is similar to the estimate of the effect 2 months after the signature of a ceasefire peace deal obtained using the event study design.

If we compare now the event study estimates and the RDD estimates for the first months after a peace agreement for all peace agreements and for ceasefire peace agreements, we can easily conclude that the results obtained in sub-sections 5.1 and 5.2 are driven by ceasefire agreements. Suggestive evidence from sub-section 3.2 shows that conflicts that end up with ceasefire provisions and without ceasefire provisions are similar in some aspects such as number of violent events, number of fatalities, growth of fatalities and duration of conflicts.

Figure 5. Regression discontinuity design: ceasefire and non-ceasefire peace agreements

Ceasefire agreements

Non-ceasefire agreements



Notes. This figure represents the regression discontinuity plots for the relationship between the logarithm of the number of fatalities adding 1 and the time variable, which contains the time distances in months from the signature of peace agreements for ceasefire and non-ceasefire peace agreements. Left panel displays the effect of ceasefire agreements on the number of fatalities. Right panel displays the effect of non-ceasefire agreements on the number of fatalities. The time variable takes values from -36 till 36, referring to 36 months before a peace agreement and 36 months after a peace agreement. The cutoff is set at the end of the month in which a peace treaty is signed in order to account for cases when a peace agreement takes place at the end of month₀. The vertical lines indicate the cutoff. Dots correspond to the sample averages within bins, polynomial fit of order 4 is used to approximate the conditional expectation functions for the points in time before and after the cutoff. See Appendix A for definitions of "ceasefire peace agreements" and "non-ceasefire peace agreements".

Table 5. Regression discontinuity design: ceasefire and non-ceasefire peace agreements

(1)	
Dependent variable: Log (number of fatalities + 1)	
Effect of ceasefire and non-ceasefire agreements on fatalities	
Sharp RD estimate for ceasefire agreements	-1.122** (0.453)
Sharp RD estimate for non-ceasefire agreements	0.252 (0.439)

Notes. The table displays the results of the RDD estimation of the change in the number of fatalities after ceasefire peace agreements and non-ceasefire peace agreements. The dependent variable is the logarithm of the number of fatalities adding 1. The running variable is the time variable that takes values from -36 till 36, referring to 36 months before a peace agreements and 36 months after a peace agreement. The cutoff is set at the end of the month in which a peace treaty is signed in order to account for cases when a peace agreement takes place at the end of month₀. The benchmark specification is used for ceasefire and non-ceasefire deals separately. Confidence intervals are computed at 95%. *** is significant at the 1% level, ** is significant at the 5% level, * is significant at the 10% level.

However, the study focuses only on the first peace agreement for every conflict, meaning the question whether a conflict ends up with a ceasefire peace agreement or not is still open. Summarizing, further research is required to understand whether our findings mean that ceasefire provisions, unlike peace treaties without ceasefire provisions, reduce violence and bring a reduction in fatalities or there are other differences driving the results.

6 Conclusions

Peace agreements are considered as the main tool to curb violence and end wars. However, little quantitative evidence exists on what are the immediate effects of peace agreements on violence. This study provides novel insights on the relationship between peace treaties and dynamics of fatalities right after a peace agreement is concluded.

Estimating the above-mentioned relationship, we use the event study analysis and the regression discontinuity design approach and find similarly for both methods that already one month after the signature of a peace agreement there is a considerable reduction in the logarithm of the number of fatalities of 0.63 percentage points corresponding to a decrease of 47% in the number of fatalities. This effect remains persistent till at least 14 months after a peace agreement, growing in its magnitude.

To understand better what is behind our main findings we analyze as well some existing heterogeneity in peace agreements, i.e. we compare the effects of ceasefire and non-ceasefire peace agreements following the same estimation strategy. The main findings seem to be driven by ceasefire agreements, while non-ceasefire agreements in the sample do not have any significant impact on the number of fatalities. Suggestive evidence based on comparing the conflicts that ended up with ceasefire treaties and those without ceasefire treaties shows that the two groups of conflicts are similar in various aspects such as number of violent events, number of fatalities, growth of fatalities and duration of conflicts.

However, further research is necessary to answer whether the found difference in the immediate effects of ceasefire and non-ceasefire peace agreements is coming from the provision itself or from other factors. Another avenue for future research would be to examine further heterogeneity across peace agreements that leads to heterogeneous effects of peace deals on violence.

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Appendix

A Definitions (UCDP)

Term	Definition
<i>Ceasefire peace agreement</i>	Peace agreements that included provisions for a ceasefire or the cessation of hostilities.
<i>Civil conflicts</i>	Conflicts that count at least 25 battle deaths per annum.
<i>Civil wars</i>	Internal conflicts that count more than 1000 battle deaths in a single year.
<i>Date of a peace agreement</i>	Date of the last signature of a peace agreement.
<i>Fatalities</i>	Deaths resulting from the use of armed force between warring parties in a conflict.
<i>Non-ceasefire peace agreement</i>	Peace agreements that did not include provisions for a ceasefire or the cessation of hostilities.
<i>Non-state conflicts</i>	Use of armed force between two organized armed groups, neither of which is the government of a state, which results in at least 25 battle-related deaths in a year.
<i>One-sided violence</i>	Use of armed force by the government of a state or by a formally organized group against civilians which results in at least 25 deaths. Extrajudicial killings in custody are excluded.
<i>Peace agreement</i>	Formal agreement between at least two opposing primary warring parties, which addresses the disputed incompatibility, either by settling all or part of it, or by clearly outlining a process for how the warring parties plan to regulate the incompatibility.
<i>State</i>	Internationally recognized sovereign government controlling a specified territory or an internationally non-recognized government controlling a specified territory which is not disputed by an internationally recognized sovereign government, which previously controlled the same territory.
<i>State-based conflicts</i>	Contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths in a calendar year.
<i>Violent event</i>	Incident where armed force was used by an organized actor against another organized actor, or against civilians, resulting in at least 1 direct death at a specific location and a specific date.

Note. All definitions are derived from the UCDP Georeferenced Event Dataset Codebook or Peace Agreement Dataset Codebook, versions 19.1.

B List of countries and peace agreements

Country	Peace agreement
Afghanistan	Peshawar Accord, 1992
Angola	The Gbadolite Declaration, 1989

Bangladesh	Chittagong Hill Tracts Peace Accord, 1997
Bosnia-Herzegovina	Medjugorje Agreement, 1993
Burundi	Declaration by the participants to the peace negotiations on Burundi, involving all the parties to the Burundi conflict (1998)
Cambodia (Kampuchea)	The Paris Agreement, 1991
Cameroon	The Greentree agreement, 2006
Central African Republic	Syrte Agreement, 2007
Chad	El Geneina agreement, 1992
Colombia	Political Agreement between the National Government, the Political Parties, M-19 and the Catholic Church as Moral and Spiritual Guardian of the Process (1990)
Comoros	Addis Ababa Agreement, 1997
Congo	Agreement on Ending Hostilities in the Republic of Congo, 1999
Croatia	Medjugorje Agreement, 1993
DR Congo (Zaire)	Lusaka Accord, 1999
Djibouti	Accord de paix et de la réconciliation nationale, 1994
Ecuador	Acta Presidencial de Brasilia, 1998
El Salvador	Geneva Agreement, 1990
Eritrea	Agreement on cessation of hostilities between the Government of the Federal Democratic Republic of Ethiopia and the Government of the State of Eritrea (2000)
Ethiopia	Agreement on cessation of hostilities between the Government of the Federal Democratic Republic of Ethiopia and the Government of the State of Eritrea (2000)
Georgia	Final Document of the Moscow Meeting (Moscow Ceasefire), 1992
Guatemala	The Oslo Accord, 1990
Guinea-Bissau	Abuja Peace Agreement, 1998
Haiti	The Governors Island agreement, 1993
India	Memorandum of settlement and Bodoland Autonomous Council Act, 1993
Indonesia	Points for Further Consultation, 2002
Israel	Declaration of Principles on Interim Self-Government Arrangements/ Oslo Agreement, 1993
Ivory Coast	Linas-Marcoussis Peace Accords, 2003
Liberia	Banjul III Agreement, 1990
Macedonia, FYR	The Ohrid Agreement, 2001
Mali	Tamanrasset Accord, 1991
Mexico	Protocol on the negotiating principles for the peace agreement concluded between the Government and the Zapatista National Liberation Army (Ejército zapatista de liberación nacional, EZLN) (1995)
Moldova	Memorandum on the Basis for Normalization of Relations between the Republic of Moldova and Transdnistria, 1997
Mozambique	The Protocol on the Agreed Agenda, 1991
Myanmar (Burma)	Kalo Htoo Baw (DKBA-5) Government Union Level peace agreement, 2011
Nepal	Ceasefire Code of Conduct, 2006
Nicaragua	Managua Protocol on Disarmament, 1990
Niger	Paris Accord, 1993
Pakistan	Memorandum of Understanding between the Governments of India and Pakistan, 1999

Papua New Guinea	Endeavour accord on dialogue and return of services to Bougainville, 1990
Peru	Acta Presidencial de Brasilia, 1998
Philippines	Statement of Understanding (Cipanas Understanding), 1993
Rwanda	N'sele Cease-fire Agreement, 1991
Senegal	Accord général de paix entre le gouvernement de la république du Sénégal et le Mouvement des forces démocratique de la Casamace (MFDC), 2004
Serbia (Yugoslavia)	Brioni Agreement, 1991
Sierra Leone	Abidjan Peace Agreement, 1996
Somalia	Addis Ababa Agreement, 1993
South Sudan	Agreement between the Government of the Republic of South Sudan (GRSS) and the South Sudan Democratic Movement/Army (SSDM/A) (2012)
Sudan	Machakos Protocol, 2002
Tajikistan	Protocol on the Fundamental Principles of Establishing Peace and National Accord in Tajikistan, 1995
Uganda	Yumbe Peace Agreement, 2002
Ukraine	Protocol on the results of consultations of the Trilateral Contact Group with respect to the joint steps aimed at the implementation of the Peace Plan (2014)
Yemen (North Yemen)	The Peace and National Partnership Agreement, 2014

Note. This list of countries and peace agreements represents the sample of peace agreements used for the analysis as per the UCDP Peace Agreement Dataset.