Appendix for "Terrorism, Spoiling, and the Resolution of Civil Wars"

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Introduction

This appendix includes materials to accompany the manuscript. "Terrorism, Spoiling, and the Resolution of Civil Wars". Section A provides descriptive statistics, explanations, and the source for the key measures used in the study. Section B displays the baseline hazards for each model of recurrence and duration. Section C reports models that include measures of state violence. In Section D, we discuss and display several matching and selection models to deal with potential challenges to identifying the effects of terrorism on civil war duration and recurrence. None are completely conclusive. Taken together, however, they support the main results in the paper. Finally, we briefly discuss some additional modeling choices in Section E.

A Control Variables, Descriptive Statistics

Terrorism: measures the number of attacks against non-military targets as measured by the Global Terrorism Database (LaFree & Dugan 2007). Note that I include only the terrorist events located in civil war zones during ongoing civil wars.
Number of actors: measures the number of combatants as measured by the Uppsala Conflict Database (Uppsala 2006).
Population logged: measures the size of the population as reported in Cunningham (2006).
Ethno-linguistic fractionalization index: is a measure of the ethnic heterogeneity of a country as reported in Cunningham (2006).
Battle deaths logged: measures the total number of battle deaths over the course of a conflict as reported in Cunningham (2006).
GDP / capita: measures the wealth of a country by its population as reported in Fearon & Laitin (2003).
Mountains: is a measure of the terrain in a country as reported in Cunningham (2006).
Security guarantee: is a measure based on Walter (2002) and captures whether a third-party has guaranteed to uphold the peace process (from Cunningham 2006).
Instability: is a measure of whether the Polity IV regime index changed by more than three or more units in the three years prior to the year in question as reported in Hegre & Sambanis (2006).
Democracy in region: captures the median Polity IV score of contiguous neighbors as reported in Hegre & Sambanis (2006).
Third-party peacekeepers: is a measure of whether peacekeepers were present in the post-war period as reported in Collier, Hoeffler & Soderbom (2008).

Table A.1: Summary Statistics–Civil War Duration

Variable	**Mean**	**Std. Dev.**	**N**
Terrorism (log/lag)	0.825	1.136	6704
Terrorism (log/smooth)	0.805	1.095	6897
Population	9.954	1.249	6704
Ethno-linguistic Fractionalization	0.533	0.269	6704
GDP (log)	7.690	1.113	6704
Number of Actors	3.066	1.623	6704
Battle Deaths (log)	6.518	1.781	6704
Mountains	30.196	26.042	6704
Security Guarantee	0.024	0.154	6704

Table A.2: Summary Statistics–Civil War Recurrence

Variable	**Mean**	**Std. Dev.**	**N**
Terrorism (log/lag)	1.240	1.584	606
Terrorism (log/smooth)	1.202	1.505	616
Population	16.856	1.476	606
Ethno-linguistic Fractionalization	0.498	0.315	606
GDP per capita (log)	0.348	0.689	606
Instability	0.208	0.406	606
Democracy in Region	-2.154	5.619	606
Third-Party Peacekeepers	0.330	0.471	606

B Baseline Hazards

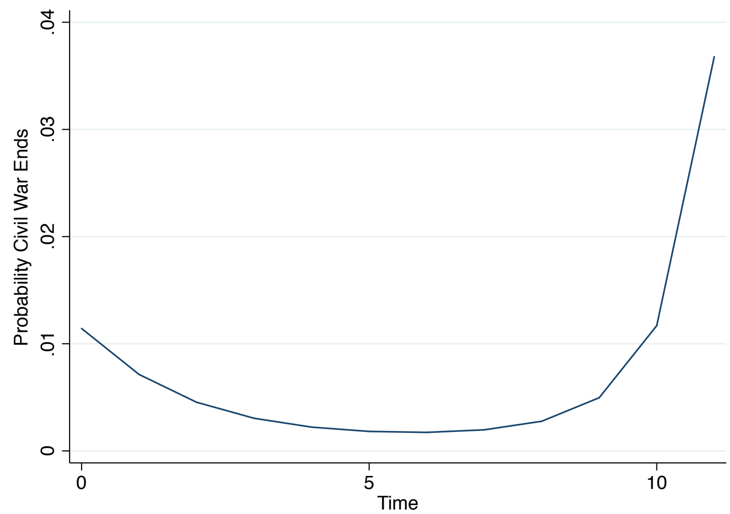

Figure B.1: Hazard of Civil War Duration Over Time

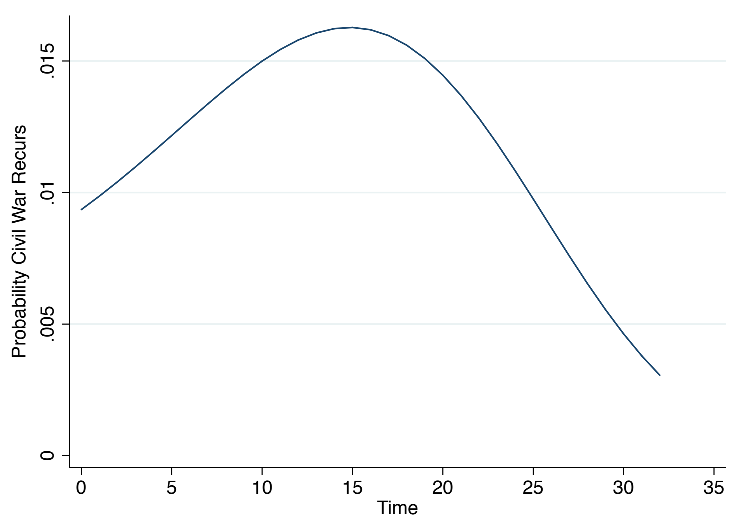

Figure B.2: Hazard of Civil War Recurrence Over Time

C Models with State Violence Variables

In the main text of "Terrorism, Spoiling, and the Resolution of Civil Wars," we report results including only information about opposition violence. Of course, the state could also use violence to spoil a peace process. We did not include a measure for state violence in Models 1–4 in the main paper because state violence is measured in quite different ways relative to opposition violence. Whereas measures of opposition violence are highly disaggregated — typically at the event level — measures of state violence are highly aggregated — typically recording only a rough scale of likely levels of violence not systematically aggregated from large numbers of events. Thus, the unit of analysis and aggregation levels are not directly comparable. We nonetheless want to report the results when including two established measures: the Political Terror Scale (PTS) and Violations of Physical Integrity Rights (CIRI) scale (Gibney, Cornett & Wood 2008, Cingranelli & Richards 1999). The results of these analyses are reported in Appendix Tables C.1–C.4. The consistency of the findings for war ending weaken. The results are weakest for the lagged/logged measure of terrorism but are still relatively strong for the logged/smoothed measure of terrorism. The results for war recurrence are not qualitatively different from those reported in the main paper providing robust support for the implementation models.

Table C.1: Lognormal Survival Model of War *Ending* with Political Terror Scale

Covariate	Model 5			Model 6		
Hazard (Lognormal)	$\hat{\beta}$	S.E.	P	$\hat{\beta}$	S.E.	P
War Related Terror (log/lag)	0.194	0.185	0.293	—	—	—
War Related Terror (log/smooth)	—	—	—	0.449	0.222	0.043
Political Terror Scale (lag)	0.306	0.194	0.115	0.424	0.197	0.031
Population (log)	0.342	0.123	0.005	0.322	0.126	0.010
Ethnic Fractionalization	−1.214	0.847	0.152	−0.882	0.844	0.296
GDP (log)	−0.243	0.192	0.204	−0.294	0.195	0.132
Number of Actors	0.821	0.257	0.001	0.905	0.270	0.001
Battle Deaths (log)	0.179	0.114	0.118	0.140	0.115	0.226
Mountainous Terrain	0.002	0.007	0.705	0.001	0.007	0.926
Security Guarantee	−4.831	2.580	0.061	−4.736	2.508	0.059
Constant	−0.917	2.005	0.648	−0.957	2.031	0.638

Years: 1970–2002; Num Subjects = 105; total war endings = 50 (Model 5)
Years: 1970–2002; Num Subjects = 103; total war endings = 49 (Model 6)
Results in Accelerated-Failure Time Form

Table C.2: Lognormal Survival Model of War *Ending* with Physical Integrity Rights Index

Covariate	Model 7			Model 8		
Hazard (Lognormal)	$\hat{\beta}$	S.E.	P	$\hat{\beta}$	S.E.	P
War Related Terror (log/lag)	0.150	0.219	0.495	—	—	—
War Related Terror (log/smooth)	—	—	—	0.385	0.250	0.124
Physical Integrity Index (lag)	0.016	0.115	0.887	0.030	0.114	0.791
Population (log)	0.484	0.171	0.005	0.484	0.176	0.006
Ethnic Fractionalization	−2.468	1.124	0.028	−2.278	1.130	0.044
GDP (log)	−0.433	0.227	0.056	−0.511	0.233	0.029
Number of Actors	0.988	0.354	0.005	1.140	0.384	0.003
Battle Deaths (log)	0.337	0.139	0.015	0.316	0.141	0.025
Mountainous Terrain	0.002	0.008	0.835	−0.005	0.008	0.944
Security Guarantee	−5.170	2.846	0.069	−5.210	2.827	0.065
Constant	−0.336	2.399	0.889	−0.145	2.443	0.953

Years: 1970–2002; Num Subjects = 98; total war endings = 41 (Model 7)
Years: 1970–2002; Num Subjects = 96; total war endings = 40 (Model 8)
Results in Accelerated-Failure Time Form

Table C.3: Lognormal Survival Model of War *Recurrence* with Political Terror Scale

Covariate	Model 9			Model 10		
Hazard (Lognormal)	$\hat{\beta}$	S.E.	P	$\hat{\beta}$	S.E.	P
War Related Terror (log/lag)	−0.417	0.142	0.003	—	—	—
War Related Terror (log/smooth)	—	—	—	−0.535	0.140	0.000
Political Terror Scale (lag)	−0.271	0.212	0.203	−0.225	0.199	0.259
Population (log)	0.000	0.164	0.999	0.026	0.151	0.862
Ethnic Fractionalization	0.767	0.636	0.228	0.697	0.594	0.240
GDP / capita (log/lag)	0.499	0.268	0.063	0.578	0.253	0.023
Instability	−0.616	0.390	0.114	−0.572	0.369	0.121
Democracy in Region	0.133	0.053	0.012	0.137	0.049	0.006
No Third Party Peacekeepers	−0.740	0.489	0.130	−0.776	0.458	0.090
Constant	10.266	2.744	0.000	9.901	2.539	0.000

Years: 1970–1999; Num Subjects = 59; total recurrences = 29
Results in Accelerated-Failure Time Form

Table C.4: Lognormal Survival Model of War *Recurrence* with Physical Integrity Rights Index

Covariate	Model 11			Model 12		
Hazard (Lognormal)	$\hat{\beta}$	S.E.	P	$\hat{\beta}$	S.E.	P
War Related Terror (log/lag)	−0.384	0.168	0.022	—	—	—
War Related Terror (log/smooth)	—	—	—	−0.559	0.167	0.001
Physical Integrity Index (lag)	−0.187	0.134	0.162	−0.132	0.128	0.301
Population (log)	−0.113	0.210	0.591	−0.090	0.194	0.643
Ethnic Fractionalization	1.636	0.737	0.026	1.568	0.694	0.024
GDP / capita (log/lag)	0.661	0.351	0.060	0.797	0.342	0.020
Instability	−0.227	0.483	0.639	−0.240	0.465	0.606
Democracy in Region	0.138	0.580	0.017	0.151	0.056	0.008
No Third Party Peacekeepers	−0.914	0.509	0.072	−1.036	0.490	0.035
Constant	11.644	3.284	0.000	11.395	3.035	0.000

Years: 1970–1999; Num Subjects = 53; total recurrences = 22
Results in Accelerated-Failure Time Form

D Robustness and Causal Identification

Another concern is that the influence of terrorism on civil duration or recurrence is difficult to identify in this kind of observational study. Since these relationships are not definitive, we can not eliminate this possibility. We can, however, utilize several approaches (explained in greater detail below) to better identify the potential causal influence of terrorism. In short, we use several ways to isolate the impact of terrorism through propensity score matching and use a duration model with selection. First, we match data on the likelihood of experiencing terrorism. Second, we match on different levels of terrorism in a generalized propensity score framework. In a standard matching approach, where the data are pre-processed and the distributions of control variables are balanced, the effect of terrorism is similar to what we find with the unmatched data again suggesting the same inference. When we use a more generalized approach where data are matched within low, medium, and high levels of expected amounts of terrorism, the results are a bit more nuanced. At low levels of terrorism on duration and recurrence, the result is indeterminate. When terrorism is high, duration of the war is likely to increase. When it is at a medium level, recurrence is the most likely and substantively important. The results suggest that higher levels of terrorism likely have a stronger influence on duration and recurrence, a finding that could lead to refinement of this more general claim and worthy of further investigation. Additionally, we estimate duration models with selection to examine whether the kinds of civil wars with terrorism are more likely to last longer than the type without using this kind of violence (Boehmke, Morey & Shannon 2006). The results are consistent with what we report in the main paper.[1]

D.1 Propensity Score Matching

As a robustness check, we use a propensity score matching approach where we match on terrorism and then compare the effects relative to civil war zones with different levels of terrorism. Matching is a nonparametric method for pre-processing data for subsequent estimation of causal effects. In short, matching tries to fix a broken experiment. If terrorism is not randomly assigned to civil wars, we should try to create a situation where the treatment group (exposed to terrorism) is nearly identical to the control group (not exposed to terrorism).

Matching in this context is complicated by a number of factors. We need to match using time-series cross-sectional data. Also, to match on terrorism, we need to dichotomize the "treatment" or think about a more generalized treatment approach. We do both. First, like in the selection models, we estimate a probability of treatment, then keep matched pairs that did or did not receive treatment, but that have similar propensity scores. Comparing the unmatched sample to the matched sample, we reduce the bias (or difference in average values for independent variables between the treatment and control groups) from about 15% to around 5%. We tried several ways to match using *psmatch2* in Stata and use nearest neighbor matching while trimming 2% of the treatment observations where the match is lowest as it led to the largest reduction in absolute bias between treatment and control

[1] We attempted to identify appropriate instrumental variables and, while we could identify relevant variables (correlated with terrorism), we could not find any that plausibly satisfied the exclusion restriction.

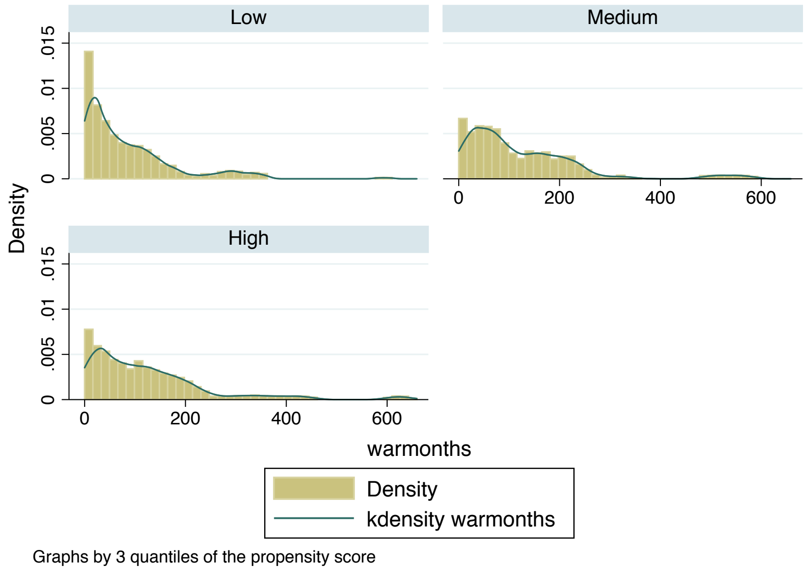

Figure D.1: Density of War Months by Level of Terrorism (Duration)

groups.

Again, this is not a randomized controlled trial, but this technique is an attempt to proxy an experiment as best as we can with observational data. After matching, we re-estimate the model for terrorism with the two duration models and the effect is similar (0.373, 0.568) and still statistically significant supporting our initial inferences.

The second way to estimate the matching models is to use a generalized propensity score. In short, rather than dichotomizing the treatment, create groups of observation that receive different levels of the probability of treatment. Within those groups or subclassifications, the expected amount of treatment is similar, and thus differences in outcome should be related to the actual level of treatment (see (Imai & Van Dyk 2004) for a formal discussion). In the duration models, we predict the expected number of terrorist attacks by first estimating a model using these attacks as the DV, then predicting yhat. We then create subclassifications within the predictions. It is unclear what the "right" number of subclassifications is. We divide the groupings into 3 categories, low, medium and high numbers of expected attacks. The results are similar to having 5 categories, but chopping the data in smaller pieces makes most statistical results insignificant when we use more categories.

Figure D.1 shows the kernel density of war months across the three groupings of generalized propensity score for terrorism in the duration models. Figure D.2 shows the same result in the recurrence models. Interestingly, the medium and high terrorist attacks groups have less short lived war months, while the medium and especially the high group have the highest number of longer lived war months.

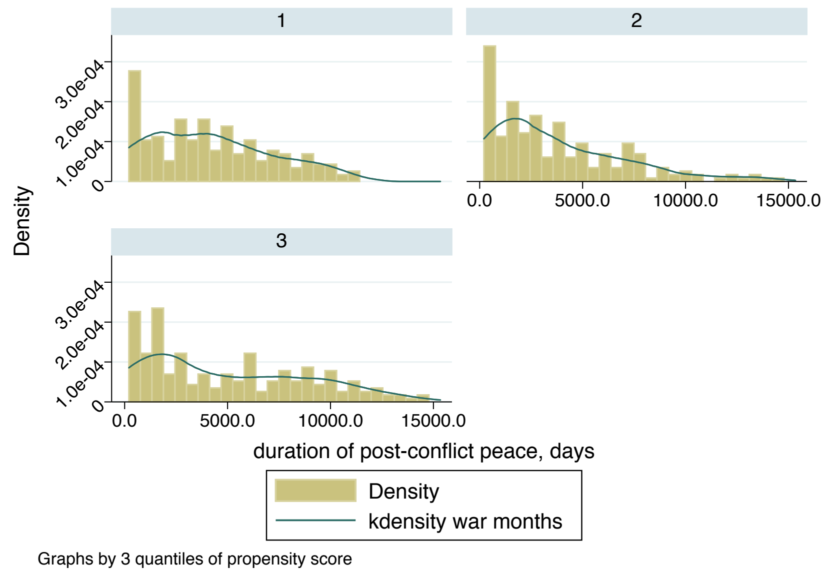

Figure D.2: Density of War Months by Level of Terrorism (Recurrence)

Estimating the model then within each grouping, we get slightly nuanced results. We find that terrorism in the low and medium grouping is positive but insignificant. In the high group, terrorism is positive, has a bigger effect, and is significant. This effect is the same regardless of how we operationalize the terrorism variable. In short, terrorism at higher levels seems to be more prone to increase duration of the war than lower levels. While our expectation was not this fine-grained, we think the results are more consistent with some of the spoiler literature and (Cunningham 2006) work as veto players or higher levels of violence are more likely to increase duration of conflict than disparate or insignificant groups using violence. Of course, this result is provisional, but we think it is consistent with our claim and is worthy of more microlevel (maybe at the group-level) investigation. The results in the recurrence model are similar, but the medium level of terrorism category produces the strongest statistical and substantive results. Again, this could be the result of cutting the data into smaller pieces as we are only left with about 200 obs in each category. These results are more tentative.

D.2 Selection Models

Table D.1: Survival Model of War *Duration* with Selection

Covariate	Model 13			Model 14		
Hazard (Exp)	$\hat{\beta}$	S.E.	P	$\hat{\beta}$	S.E.	P
Selection Equation						
Population (log)	0.085	0.016	0.000	0.085	0.016	0.000
Mountainous Terrain	−0.001	0.001	0.390	−0.001	0.001	0.390
Ethnic Fractionalization	−0.105	0.073	0.149	−0.105	0.073	0.149
Outcome Equation						
War Related Terror (log/lag)	0.267	0.090	0.003	—	—	—
War Related Terror (log/smooth)	—	—	—	0.141	0.079	0.076
Population (log)	0.069	0.037	0.062	0.065	0.037	0.078
Ethnic Fractionalization	0.464	0.134	0.001	0.502	0.134	0.000
GDP / capita (log/lag)	−0.236	0.027	0.000	−0.239	0.028	0.000
Number of Actors	−0.066	0.016	0.000	−0.064	0.016	0.000
Battle Deaths (log)	−0.128	0.019	0.000	−0.122	0.020	0.000
Mountainous Terrain	0.002	0.001	0.125	0.002	0.001	0.129
Security Guarantee	0.542	0.112	0.000	−0.524	0.110	0.000
Constant	−2.815	0.504	0.000	−2.782	0.508	0.000

Years: 1970–2002; Number of Uncensored Observations: 821
Results in Accelerated-Failure Time Form

Table D.2: Survival Model of War *Recurrence* with Selection

Covariate	Model 15			Model 16		
Hazard (Exp)	$\hat{\beta}$	S.E.	P	$\hat{\beta}$	S.E.	P
Selection Equation						
Population (log)	0.009	0.055	0.816	0.007	0.055	0.891
No Third Party Peacekeepers	0.769	0.235	0.390	0.759	0.275	0.006
Outcome Equation						
War Related Terror (log/lag)	−0.497	0.295	0.092	—	—	—
War Related Terror (log/smooth)	—	—	—	−0.413	0.486	0.395
Population (log)	0.102	0.066	0.121	0.085	0.066	0.199
GDP / capita (log/lag)	0.346	0.125	0.006	0.395	0.127	0.002
Instability	−0.657	0.001	0.125	−0.579	0.440	0.188
Democracy in the Region	−0.009	0.017	0.620	−0.005	0.017	0.000
Constant	7.592	1.091	0.000	8.046	1.051	0.000

Years: 1970–1999; Number of Uncensored Observations: 50
Results in Accelerated-Failure Time Form

Table D.3: Lognormal Survival Model of War *Duration* with All Terrorist Attacks

Covariate	Model 17			Model 18		
Hazard (Lognormal)	$\hat{\beta}$	S.E.	P	$\hat{\beta}$	S.E.	P
All Terror (log/lag)	0.294	0.162	0.072	—	—	—
All Terror (log/smooth)	—	—	—	0.494	0.186	0.008
Population (log)	0.324	0.107	0.003	0.311	0.111	0.005
Ethnic Fractionalization	−0.338	0.656	0.606	−0.218	0.661	0.742
GDP (log)	−0.219	0.156	0.161	−0.295	0.161	0.067
Number of Actors	0.603	0.147	0.000	0.619	0.149	0.000
Battle Deaths (log)	0.162	0.087	0.061	0.152	0.087	0.080
Mountainous Terrain	0.004	0.005	0.461	0.003	0.006	0.586
Security Guarantee	−6.126	1.881	0.001	−6.259	1.891	0.001
Constant	0.069	1.713	0.968	0.646	1.767	0.715

Years: 1970–2002; Num Subjects = 122; total war endings = 79 (Model 17)
Years: 1970–2002; Num Subjects = 121; total war endings = 77 (Model 18)
Results in Accelerated-Failure Time Form

Table D.4: Lognormal Survival Model of War *Recurrence* with All Terrorist Attacks

Covariate	Model 19			Model 20		
Hazard (Lognormal)	$\hat{\beta}$	S.E.	P	$\hat{\beta}$	S.E.	P
All Terror (log/lag)	−0.495	0.121	0.000	—	—	—
All Terror (log/smooth)	—	—	—	−0.612	0.119	0.000
Population (log)	−0.063	0.159	0.692	−0.033	0.146	0.824
Ethnic Fractionalization	0.744	0.658	0.258	0.682	0.606	0.260
GDP / capita (log/lag)	0.662	0.281	0.018	0.722	0.266	0.007
Instability	−0.918	0.391	0.019	−1.009	0.368	0.006
Democracy in Region	0.114	0.051	0.027	0.118	0.049	0.015
No Third Party Peacekeepers	−0.611	0.485	0.208	−0.610	0.453	0.178
Constant	10.726	2.587	0.000	10.543	2.392	0.000

Years: 1970–1999; Num Subjects = 60; total recurrences = 30
Results in Accelerated-Failure Time Form

One problem with our estimates from the models reported in the main paper is that they could be biased by nonrandom selection. If we can develop a two-stage process where first we predict conflict months where there is no terrorism and months where these is some (at least one event), and then duration of the conflict, this might provide evidence that the duration is uncorrelated with the decision to use terrorism. In a survival modeling set-up, this is a complicated task. Fortunately, (Boehmke, Morey & Shannon 2006) developed the *dursel* program to estimate duration models with selection in Stata.

Of our conflict months in the duration models, 1082 are zeroes while the remaining 5419 are 1s (some terror). We don't have strong theoretical priors for what to include in the selection equation. To best account for variables that would predict a longer conflict, we include ethnic fractionalization, mountainous terrain, and population. We tried other combinations of variables in the selection equation, and the results are quite similar. Population is the strongest predictor and most robust. Even when estimating this selection model, our inferences remain the same: as terrorism increases, the time to ending civil war increases. As terrorism increases, the time to beginning a new war also decreases. We estimated the results in all four models (two survival models, two ways to measure terrorism). The results are generally robust across these (except the smoothed terrorism measure in the recurrence model). There are, however, a couple of caveats. First, the results are using an exponential model as the lognormal would not converge. Like other selection models, this is a full-information likelihood model and is somewhat sensitive to convergence depending on the specification. Second, as mentioned above the results become insignificant in the recurrence model when using the smoothed measure. This is due to a huge reduction in N to 291. The sign remains negative (suggesting a decrease in time to recurrence), but it was not statistically significant p=.395.

E Additional Modeling Choices

To further ensure the results are robust to different modeling choices, we also estimated discrete time survival models, other parametric survival models (exponential and weibull), and Cox semi-parametric models. The results for models of civil war recurrence are all robust to any way that we adjust the survival model. The results for the war duration models were mostly robust as well. In the discrete time framework, however, terrorism was not significant in four of the eight models. Across the other parametric models and semi-parametric models, the results were always significant but sometimes at a 90% level in several models.

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