Web Appendix of

Public Health in the Aftermath of Civil War:

A Spatial Time-Series Cross-Sectional Analysis

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A Variables

Table A1: List of Variables

Variable	Database	Original Source	Variable Name in Database	Calculation Method
HALE	QoG	World Health Organization	who_halet	
Wartime	UCDP-BRDD		bd_best	binary (1 if Intensity>0)
Intensity	UCDP-BRDD		bd_best	sum
Population	QoG	World Development Indicators	wdi_pop	arithmetic mean, log
Urban Population Growth	QoG	World Development Indicators	wdi_popurbagr	geometric mean
Secondary School Enrollment	QoG	World Development Indicators	wdi_gers	arithmetic mean
GDP per capita	QoG	World Development Indicators	wdi_gdpcappppcon2011	arithmetic mean, log
GDP Growth	QoG	World Development Indicators	wdi_gdpgr	geometric mean
Polity Score	QoG	Polity IV	p_polity2	arithmetic mean

Note: The abbreviations in this table are as follows. QoG: *Quality of Government Dataset* (Teorell et al. 2019); UCDP-BRDD: *UCDP Battle-Related Deaths Dataset* (Pettersson, Högbladh and Öberg 2019). In the replication materials, I also utilize the *UCDP Onset Dataset Ver. 19.1* (Gleditsch et al. 2002, Pettersson, Högbladh and Öberg 2019) when checking whether disagreements of observations between this dataset and UCDP-BRDD exist. For the detailed information of original sources of the above variables collected in the QoG, see Teorell et al. (2019). When calculating the 5-year geometric mean values of *Urban Population Growth* and *GDP Growth*, these mean values are expediently calculated, using the following formula: $\{\prod[x_i + |\min(x)| + 1]\}^{\frac{1}{5}} - [|\min(x)| + 1]$, where x_i represents either *Urban Population Growth* or *GDP Growth* in each half decade, and $\min(x)$ is the minimum value of each variable of *Growth* in the sample period.

B Spatial Terms in Matrix Notation

$\gamma \sum_{j \neq i} w_{ij,t} G_{j,t-1}$ and $\lambda \sum_{j \neq i} w_{ij,t} u_{j,t}$ in Eq. (1) are written as:

$$\gamma \sum_{j \neq i} w_{ij,t} G_{j,t-1}$$

$$= \gamma \begin{bmatrix} \begin{bmatrix} 0 & w_{1,2} & w_{1,3} & \cdots & w_{1,N} \\ w_{2,1} & 0 & w_{2,3} & \cdots & w_{2,N} \\ w_{3,1} & w_{3,2} & 0 & \vdots & \\ \vdots & \vdots & & \ddots & w_{N-1,N} \\ w_{N,1} & w_{N,2} & \cdots & w_{N,N-1} & 0 \end{bmatrix}_{2000} & O_{2000} & O_{2000} & & & O_{2000} & & \\ O_{2005} & & & \ddots & O_{2005} & & O_{2005} & \\ O_{2010} & & & O_{2010} & \ddots & & O_{2010} & \\ O_{2015} & & & O_{2015} & O_{2015} & \begin{bmatrix} 0 & w_{1,2} & w_{1,3} & \cdots & w_{1,N} \\ w_{2,1} & 0 & w_{2,3} & \cdots & w_{2,N} \\ w_{3,1} & w_{3,2} & 0 & \vdots & \\ \vdots & \vdots & & \ddots & w_{N-1,N} \\ w_{N,1} & w_{N,2} & \cdots & w_{N,N-1} & 0 \end{bmatrix}_{2015} \end{bmatrix} \begin{bmatrix} G_{1,1995} \\ \vdots \\ G_{N,1995} \\ G_{1,2000} \\ \vdots \\ G_{N,2000} \\ G_{1,2005} \\ \vdots \\ G_{N,2005} \\ G_{1,2010} \\ \vdots \\ G_{N,2010} \end{bmatrix}$$

$$\lambda \sum_{j \neq i} w_{ij,t} u_{j,t}$$

$$= \lambda \begin{bmatrix} \begin{bmatrix} 0 & w_{1,2} & w_{1,3} & \cdots & w_{1,N} \\ w_{2,1} & 0 & w_{2,3} & \cdots & w_{2,N} \\ w_{3,1} & w_{3,2} & 0 & \vdots & \\ \vdots & \vdots & & \ddots & w_{N-1,N} \\ w_{N,1} & w_{N,2} & \cdots & w_{N,N-1} & 0 \end{bmatrix}_{2000} & O_{2000} & O_{2000} & & & O_{2000} & & \\ O_{2005} & & & \ddots & O_{2005} & & O_{2005} & \\ O_{2010} & & & O_{2010} & \ddots & & O_{2010} & \\ O_{2015} & & & O_{2015} & O_{2015} & \begin{bmatrix} 0 & w_{1,2} & w_{1,3} & \cdots & w_{1,N} \\ w_{2,1} & 0 & w_{2,3} & \cdots & w_{2,N} \\ w_{3,1} & w_{3,2} & 0 & \vdots & \\ \vdots & \vdots & & \ddots & w_{N-1,N} \\ w_{N,1} & w_{N,2} & \cdots & w_{N,N-1} & 0 \end{bmatrix}_{2015} \end{bmatrix} \begin{bmatrix} u_{1,2000} \\ \vdots \\ u_{N,2000} \\ u_{1,2005} \\ \vdots \\ u_{N,2005} \\ u_{1,2010} \\ \vdots \\ u_{N,2010} \\ u_{1,2015} \\ \vdots \\ u_{N,2015} \end{bmatrix},$$

where O_t is the zero matrix at t. O_t is an $N \times N$ matrix when $\forall N_t = N$, where N_t represents the number of observations at t. My data set is unbalanced. Thus, the number of observations, N_t, is different in each period as follows: 125 in the sample using HALE_{2000}, 133 in the sample using HALE_{2005}, and 135 in the samples using HALE_{2010} and HALE_{2015} (i.e., $\forall N_t \neq N$). In the above equations, for simplicity, N_t is denoted by N. Moreover, the borders are not stable. Therefore, $w_{ij,t}$ may differ every half decade t.

C Descriptive Statistics

The variables are defined as in Section A. *GDP per capita* and *Population* are log-transformed in the analysis because their distributions are skewed.

Table A2: Descriptive Statistics

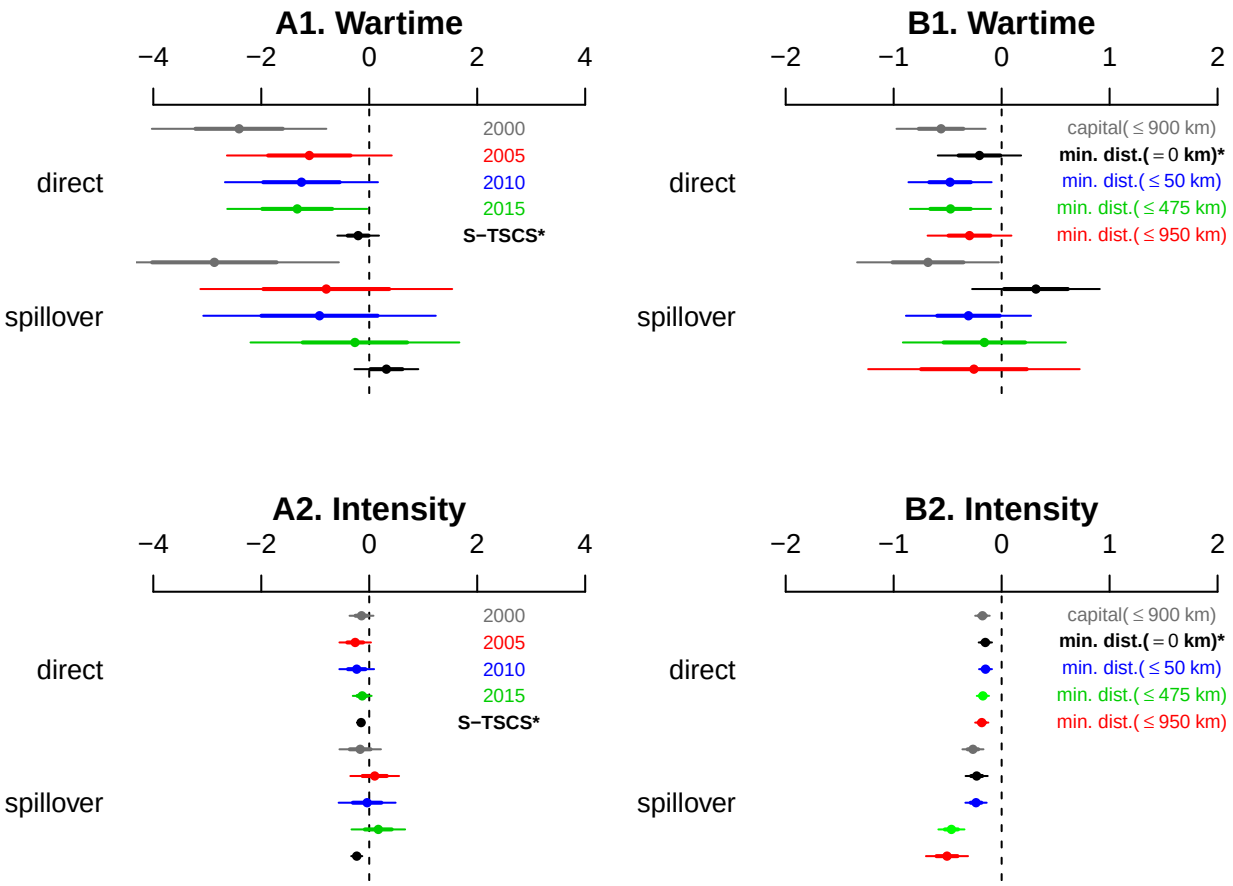
Variable	N	Mean	SD	Min	Max
HALE	528	60.940	8.585	35.6	74.7
Wartime$_{t-1}$	528	0.258	0.438	0	1
spillover (Wartime$_{t-1}$)	528	0.280	0.323	0	1
Intensity$_{t-1}$	528	0.674	2.400	0.000	22.891
spillover (Intensity$_{t-1}$)	528	0.794	1.427	0.000	12.528
unweighted spillover (Intensity$_{t-1}$)	528	2.641	4.727	0.000	27.970
Population$_{t-1}$	528	42316198.449	145781874.753	339722	1324505000
Urban Population Growtht-1	528	2.342	2.008	−3.079	14.649
Secondary School Enrollment$_{t-1}$ (%)	528	68.142	32.504	5.338	158.555
GDP per capita$_{t-1}$	528	14562.197	17609.488	372.694	119869.122
GDP Growth$_{t-1}$	528	3.677	5.116	−31.407	48.634
Polity Score$_{t-1}$	528	3.766	6.276	−10	10

Note: Wartime is a binary variable. Intensity is battle-related deaths divided by 1000.

D Detailed Results for All Models

Figure A1 displays a full-color version of Figure 2.

Figure A1: Direct and Spillover Effects of Civil War on HALE (Full-Color Version)



Note: For additional detail, see *Notes* to Figure 2.

The following tables show the detailed results of the regression analyses. All TSCS models include country FEs and a variable for either trend or 5-year FEs. Coefficients of the direct and spillover effects of civil war in all models are presented in A1 and A2 of Figure 2.

Table A3: Results of Spatial Cross-Sectional Analysis

	Wartime			
	2000	2005	2010	2015
Wartime_{t-1}	-2.411^{**}	-1.109	$-1.255^{\dagger}$	-1.334^{*}
	(0.808)	(0.763)	(0.709)	(0.648)
spillover(Wartime_{t-1})	-2.869^{*}	-0.796	-0.921	-0.265
	(1.153)	(1.166)	(1.077)	(0.967)
$\log(\text{Population}_{t-1})$	0.608^{**}	$0.288^{\dagger}$	$0.240^{\dagger}$	0.359^{**}
	(0.175)	(0.153)	(0.138)	(0.125)
$\text{Urban Population Growth}_{t-1}$	0.418^{*}	-0.279	-0.171	0.064
	(0.181)	(0.197)	(0.183)	(0.155)
$\text{Secondary School Enrolment}_{t-1}$	0.078^{**}	0.055^{**}	0.039^{*}	0.068^{**}
	(0.020)	(0.018)	(0.019)	(0.016)
$\log(\text{GDP per capita}_{t-1})$	1.887^{**}	2.811^{**}	3.108^{**}	2.592^{**}
	(0.464)	(0.436)	(0.432)	(0.368)
GDP growth_{t-1}	0.036	0.105^{*}	-0.067	0.017
	(0.040)	(0.047)	(0.061)	(0.092)
$\text{Polity Score}_{t-1}$	0.193^{**}	0.151^{**}	0.141^{*}	0.125^{**}
	(0.058)	(0.053)	(0.055)	(0.047)
λ	0.819^{**}	0.778^{**}	0.744^{**}	0.719^{**}
	(0.038)	(0.043)	(0.050)	(0.054)
Constant	29.086^{**}	28.655^{**}	28.874^{**}	29.656^{**}
	(4.286)	(3.923)	(3.643)	(3.286)
Obs.	125	133	135	135
Log Likelihood	-330.272	-347.124	-334.390	-320.323
LR test statistic	85.108^{**}	96.521^{**}	75.011^{**}	58.775^{**}

$^{**}p < 0.01, ^{*}p < 0.05, ^{\dagger}p < 0.1$

	Intensity			
	2000	2005	2010	2015
Intensity_{t-1}	-0.143	$-0.260^{\dagger}$	-0.232	-0.130
	(0.111)	(0.146)	(0.161)	(0.087)
spillover(Intensity_{t-1})	-0.168	0.101	-0.039	0.168
	(0.192)	(0.226)	(0.264)	(0.248)
$\log(\text{Population}_{t-1})$	0.526^{**}	0.345^{*}	0.215	0.282^{*}
	(0.180)	(0.148)	(0.132)	(0.119)
$\text{Urban Population Growth}_{t-1}$	0.464^{*}	-0.232	-0.216	0.022
	(0.189)	(0.191)	(0.185)	(0.157)
$\text{Secondary School Enrolment}_{t-1}$	0.090^{**}	0.062^{**}	0.037^{*}	0.070^{**}
	(0.020)	(0.018)	(0.019)	(0.015)
$\log(\text{GDP per capita}_{t-1})$	1.878^{**}	2.878^{**}	3.173^{**}	2.626^{**}
	(0.481)	(0.420)	(0.422)	(0.368)
GDP growth_{t-1}	0.048	0.106^{*}	-0.070	0.011
	(0.040)	(0.046)	(0.060)	(0.092)
$\text{Polity Score}_{t-1}$	0.203^{**}	0.165^{**}	0.142^{*}	0.132^{**}
	(0.060)	(0.052)	(0.055)	(0.049)
λ	0.808^{**}	0.783^{**}	0.750^{**}	0.728^{**}
	(0.039)	(0.043)	(0.049)	(0.053)
Constant	28.973^{**}	26.200^{**}	28.682^{**}	30.382^{**}
	(4.487)	(3.809)	(3.508)	(3.219)
Obs.	125	133	135	135
Log Likelihood	-333.896	-343.772	-334.497	-320.947
LR test statistic	79.832^{**}	103.920^{**}	72.836^{**}	57.673^{**}

$^{**}p < 0.01, ^{*}p < 0.05, ^{\dagger}p < 0.1$

Table A4: Results for S-TSCS Using Different w_{ij}

	Wartime				
	Capital(≤900 km)	***min.dist.(=0 km)***	min.dist.(≤50 km)	min.dist.(≤475 km)	min.dist.(≤950 km)
Wartime_{t-1}	-0.561^{**}	-0.205	-0.478^{*}	-0.473^{*}	-0.297
	(0.206)	(0.193)	(0.193)	(0.188)	(0.194)
$spillover(\text{Wartime}_{t-1})$	-0.682^{*}	0.318	-0.307	-0.160	-0.257
	(0.328)	(0.296)	(0.290)	(0.377)	(0.490)
$\log(\text{Population}_{t-1})$	4.886^{**}	3.485^{**}	2.894^{**}	4.115^{**}	4.660^{**}
	(0.867)	(0.856)	(0.904)	(0.912)	(0.945)
$\text{Urban Population Growth}_{t-1}$	0.069	0.056	0.051	0.053	0.061
	(0.055)	(0.050)	(0.048)	(0.054)	(0.058)
$\text{Secondary School Enrolment}_{t-1}$	-0.005	-0.009	-0.014^{*}	-0.007	-0.004
	(0.008)	(0.007)	(0.007)	(0.007)	(0.008)
$\log(\text{GDP per capita}_{t-1})$	0.726^{**}	0.310	0.204	0.294	0.259
	(0.269)	(0.269)	(0.257)	(0.268)	(0.290)
GDP growth_{t-1}	-0.006	-0.027^{*}	-0.022^{*}	-0.013	-0.002
	(0.012)	(0.011)	(0.011)	(0.012)	(0.013)
$\text{Polity Score}_{t-1}$	0.010	0.017	0.030	0.007	-0.005
	(0.021)	(0.021)	(0.020)	(0.020)	(0.023)
λ	0.651^{**}	0.700^{**}	0.756^{**}	0.776^{**}	0.777^{**}
	(0.029)	(0.028)	(0.025)	(0.028)	(0.034)
Constant	-35.484^{*}	-3.803	9.415	-15.792	-26.302
	(17.226)	(17.024)	(17.868)	(17.948)	(18.844)
Two-way FEs	✓	✓	✓	✓	✓
Obs.	528	528	528	528	528
Log Likelihood	-725.239	-714.785	-695.338	-701.352	-731.178
LR test statistic	206.753^{**}	213.524^{**}	255.295^{**}	243.231^{**}	188.331^{**}

$^{**}p < 0.01, ^{*}p < 0.05, \dagger p < 0.1$

	Intensity				
	Capital(≤900 km)	***min.dist.(=0 km)***	min.dist.(≤50 km)	min.dist.(≤475 km)	min.dist.(≤950 km)
Intensity_{t-1}	-0.178^{**}	-0.151^{**}	-0.149^{**}	-0.174^{**}	-0.184^{**}
	(0.034)	(0.031)	(0.030)	(0.028)	(0.031)
spillover(Intensity_{t-1})	-0.266^{**}	-0.231^{**}	-0.237^{**}	-0.465^{**}	-0.506^{**}
	(0.049)	(0.051)	(0.049)	(0.060)	(0.097)
$\log(\text{Population}_{t-1})$	5.007^{**}	3.452^{**}	3.190^{**}	4.340^{**}	5.089^{**}
	(0.841)	(0.838)	(0.885)	(0.865)	(0.909)
$\text{Urban Population Growth}_{t-1}$	0.074	0.054	0.041	0.032	0.042
	(0.054)	(0.049)	(0.047)	(0.052)	(0.056)
$\text{Secondary School Enrolment}_{t-1}$	−0.005	−0.012	-0.015^{*}	−0.007	−0.006
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
$\log(\text{GDP per capita}_{t-1})$	0.655^{*}	0.200	0.143	0.204	0.101
	(0.269)	(0.265)	(0.254)	(0.258)	(0.283)
GDP growth_{t-1}	−0.007	-0.027^{*}	-0.024^{*}	−0.007	−0.004
	(0.012)	(0.011)	(0.011)	(0.011)	(0.012)
$\text{Polity Score}_{t-1}$	0.022	0.026	$0.036^{\dagger}$	0.025	0.002
	(0.021)	(0.020)	(0.019)	(0.019)	(0.022)
λ	0.608^{**}	0.692^{**}	0.734^{**}	0.740^{**}	0.744^{**}
	(0.032)	(0.028)	(0.027)	(0.031)	(0.038)
Constant	-37.260^{*}	−1.688	4.167	−18.629	$-32.122^{\dagger}$
	(16.576)	(16.628)	(17.494)	(17.024)	(18.119)
Two-way FEs	✓	✓	✓	✓	✓
Obs.	528	528	528	528	528
Log Likelihood	−712.576	−704.372	−684.732	−675.516	−712.551
LR test statistic	173.005^{**}	206.558^{**}	237.868^{**}	230.755^{**}	174.332^{**}

$^{**}p < 0.01, ^{*}p < 0.05, ^{\dagger}p < 0.1$

Note: ***min.dist.(=0 km)*** stands for main models when discussing the findings in the main text.

Table A5: Results for S-TSCS Using Different Operationalization of Temporal Effects and Spillover Effects

	Model A5.1 (Wartime)	Model A5.2 (Intensity)	Model A5.3 [either-or spillover (Wartime)]	Model A5.4 [unweighted spillover (Intensity)]
Civil War$_{t-1}$	-0.218	-0.151^{**}	-0.410^{*}	$-0.054^{\dagger}$
	(0.193)	(0.031)	(0.184)	(0.031)
spillover(Civil War$_{t-1}$)	0.297	-0.231^{**}	-0.144	0.005
	(0.296)	(0.051)	(0.184)	(0.017)
log(Population$_{t-1}$)	3.414^{**}	3.379^{**}	3.301^{**}	3.221^{**}
	(0.857)	(0.839)	(0.852)	(0.853)
Urban Population Growth$_{t-1}$	0.058	0.055	0.065	0.068
	(0.050)	(0.049)	(0.050)	(0.050)
Secondary School Enrolment$_{t-1}$	-0.010	$-0.012^{\dagger}$	-0.010	-0.010
	(0.007)	(0.007)	(0.007)	(0.007)
log(GDP per capita$_{t-1}$)	0.306	0.196	0.295	0.257
	(0.269)	(0.264)	(0.268)	(0.269)
GDP growth$_{t-1}$	-0.027^{*}	-0.027^{*}	-0.026^{*}	-0.026^{*}
	(0.011)	(0.011)	(0.011)	(0.011)
Polity Score$_{t-1}$	0.018	0.027	0.020	0.028
	(0.021)	(0.020)	(0.020)	(0.020)
trend	1.068^{**}	1.091^{**}		
	(0.113)	(0.111)		
λ	0.706^{**}	0.698^{**}	0.710^{**}	0.696^{**}
	(0.027)	(0.028)	(0.027)	(0.028)
Constant	-3.439	-1.354	0.195	1.858
	(16.966)	(16.574)	(16.907)	(16.934)
Country FEs	✓	✓	✓	✓
5-year FEs			✓	✓
Obs.	528	528	528	528
Log Likelihood	-715.412	-705.075	-715.049	-714.336
LR test statistic	223.678^{**}	215.446^{**}	222.047^{**}	200.320^{**}

$^{**}p < 0.01,^{*}\, p < 0.05,^{\dagger}\, p < 0.1$

Notes: Definition of *Civil War* is given in parentheses in each model name. Instead of using a variable for trend, Models A5.3 and A5.4 employ 5-year FEs.

As Figure 1 suggests, HALE shows an upward trend. Instead of using the unit-invariant half-decade FEs, Models A5.1 and A5.2 employ a variable for trend. Model A5.3 analyzes spillover effects by employing the binary variable for whether any contiguous country experiences civil wars that Ghobarah, Huth and Russett (2004) and Shikano and Eckert (2011) used. Model A5.4 estimates the spillover effects of civil wars by using the unweighted total sum of battle-related deaths in contiguous countries that Shikano and Eckert (2011) employed.

References

Ghobarah, Hazem Adam, Paul Huth and Bruce Russett. 2004. "Comparative Public Health: The Political Economy of Human Misery and Well-Being." *International Studies Quarterly* 48(1):73–94.

Gleditsch, Nils Petter, Peter Wallensteen, Mikael Eriksson, Margareta Sollenberg and Håvard Strand. 2002. "Armed Conflict 1946-2001: A New Dataset." *Journal of Peace Research* 39(5):615–637.

Pettersson, Therese, Stinaand Högbladh and Magnus Öberg. 2019. "Organized Violence, 1989-2018 and Peace Agreements." *Journal of Peace Research* 56(4):589–603.

Shikano, Susumu and Peter Eckert. 2011. The Medium- and Long-Term Consequences of Civil Wars on Citizens Health. In *Annual Conference of the Midwest Political Science Association*.

Teorell, Jan, Stefan Dahlberg, Sören Holmberg, Bo Rothstein, Pachon Natalia Alvarado and Richard Svensson. 2019. *The Quality of Government Standard Dataset, version Jan19*. University of Gothenburg: The Quality of Government Institute. Available at `http://www.qog.pol.gu.se`.