

## Supplementary Materials for:

### From Global to Local, Food Insecurity is Associated with Contemporary Armed Conflicts

These supplemental materials proceed in three parts. First, a selection of alternative robustness specifications, sequentially addressing concerns over (i) the global sample used in the primary analysis, (ii) the effects of food and agricultural imports, and (iii) excessive control variables and their effects on missing data are presented and discussed below. This is followed by a table of summary statistics for all independent, dependent, and control variables (Table S6). Finally, a map of the global PRIO-Grid structure, which is described in the main paper and which underpins our analysis, is presented in Figure S1. Note that due to the specificity of the data and the small size of the cells analyzed here (0.5 decimal degree x 0.5 decimal degree), this map appears opaque with latitude and longitude lines crossing it. To see the specificity of the cells one must therefore substantially increase focus when viewing this map.

Turning to the robustness specifications, one can first note that many of cell-years within the global grid sample analyzed in the primary paper correspond to advanced developed democracies such as the United States, Sweden, and Japan. These countries generally exhibit a mix of political and economic traits that preclude them from experiencing most forms of large-scale political violence such as civil war. Though some advanced industrialized democracies might nevertheless occasionally experience civil or international conflict on their soil, it is reasonable to view these countries, and cropland areas therein, as being nearly “immune” to the food security-conflict dynamics discussed above. The primary logit models control for several sources of this immunity through the inclusion of variables such as democracy, and cell-level economic output per capita. Furthermore, the presence of conflict-immune grid cells, if anything, should bias any findings for the aforementioned food security measures towards zero, rather than increase any potential for false positives.

Even so, Table S1 seeks to more fully account for these potential conflict-immune grid-cells within the analysis through the use of a split population (i.e., zero-inflated) logit model. Using a single system of two estimating equations, this model accounts for “inflated” (i.e., conflict-immune) cells by explicitly estimating each cell’s propensity for conflict immunity within an “inflation stage” that includes a collection of the most intuitive predictors thereof (polity, log gross cell product per capita, and log population), and then probabilistically down-weighting the leverage of conflict-immune cases within the full (i.e., outcome stage) logistic analysis. This approach is consistent with related conflict studies in the literature (Bagozzi et al. 2015), and reveals that in this case, even after taking these cell-specific inflation propensities into account and down-weighting these cells accordingly, the positive and significant findings for *cropland* and negative and significant findings for *ln cropland pc* remain.

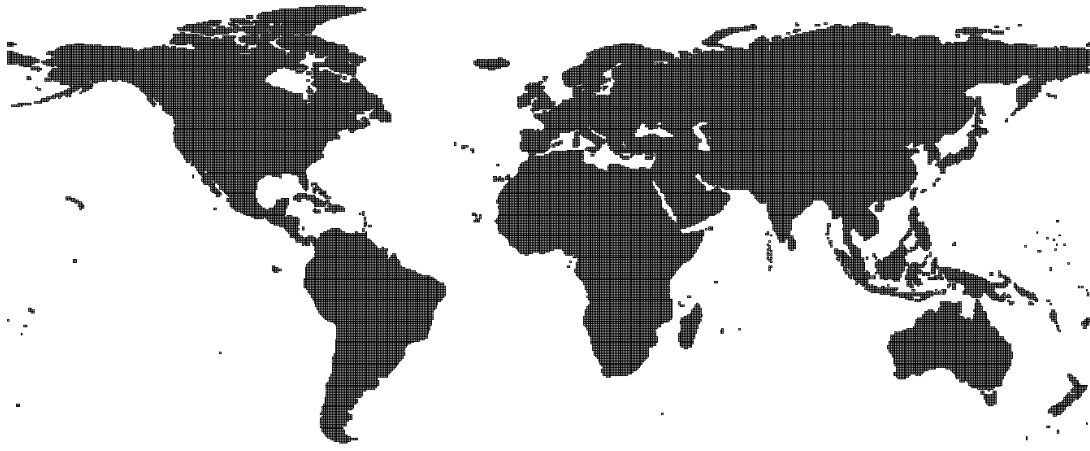
An alternate approach to addressing concerns over the inclusion of theoretically irrelevant country cells within the primary analysis is to drop those cells entirely. Building on the evidence that climatic variation is more likely to affect warmer regions

(e.g. Miguel et al. 2004; Burke et al. 2009; Hsiang and Meng 2014; FAO 2008), as well as the concentration of conflict presented in Figure 1, Table S2 re-estimates the four logistic regression models presented in Table 1 for a subsample consisting of only tropical regions, i.e., regions above 25<sup>th</sup> latitude south and below 25<sup>th</sup> latitude north. These models reveal that the positive and significant findings for *cropland* and negative and significant findings for *ln cropland pc* remain even when colder regions, which might have biased the sample, are removed from analysis. A list of the countries that are partly or wholly located in the Tropics is provided in Table S7.

Table S3 re-estimates the four logistic regression models presented in Table 1 while controlling for (lagged) country-year measures of agricultural imports and food imports, each measured as a share of a given country's total merchandise imports. As mentioned in the main paper, food imports have been widely shown to have political instability-inducing effects (Bellemare 2014; Hendrix and Haggard 2015; Weinberg and Bakker 2015). Additionally, the increase in "land grabbing" for the purpose of non-crop (e.g., ethanol) or exports production since 2008 (De Schutter 2011) has potential implications for this study's findings, although 2008 is the final year in the sample. While the theory and analyses discussed earlier focus on local food availability and access, ensuring that these findings are robust to varying levels of food and agricultural resources available from imports is critical. Table S3 evaluates these concerns, and demonstrates that the findings for *cropland* and *ln cropland pc* are robust to models that control for food and agricultural imports.

The specifications presented in the main paper also include a large number of control variables. While these controls allow for the most comprehensive assessment of food security possible, they also increase missingness levels due to listwise deletion, in addition to potentially introducing biases of their own (Achen 2005). To further ensure the robustness of the findings reported in the main paper, two smaller ("Baseline" and "Medium") model specifications are estimated for Models 1-4. The Baseline specifications (Table S4) include only basic socioeconomic controls in addition to cropland measures to show that the effect of the latter is independent of cell level socioeconomic conditions. In the Medium specification models (Table S5), climate related factors are added to show that the effect of cropland and cropland per capita is independent of both socioeconomic conditions and the effect of climatic variation. As Tables S4 and S5 clearly illustrate, the findings presented in the main paper hold in every case.

**Figure S1: The PRIO-Grid**



**Table S1: Split Population (i.e., Zero-Inflated) Logit Coefficient Estimates of the Likelihood of Conflict by Cell-Year, 1991-2008**

	<b>Model 1: Any Conflict</b>	<b>Model 2: Civil Conflict</b>	<b>Model 3: Any Conflict</b>	<b>Model 4: Civil Conflict</b>
<b>Outcome Stage</b>				
<i>Cropland</i>	0.001* (0.001)	0.001** (0.0003)	.	.
<i>Ln Cropland Pc</i>	.	.	-18.604** (3.263)	-18.377** (3.237)
<i>Lag Conflict</i>	5.807** (0.044)	.	5.828** (0.045)	.
<i>Lag Civil Conflict</i>	.	5.771** (0.042)	.	5.791** (0.043)
<i>Ln Travel Time</i>	0.253** (0.013)	0.241** (0.013)	0.232** (0.013)	0.219** (0.013)
<i>Ln Cell Area</i>	1.469** (0.072)	1.457** (0.071)	1.498** (0.072)	1.487** (0.072)
<i>Ln GCP</i>	-0.084** (0.017)	-0.082** (0.016)	-0.084** (0.017)	-0.083** (0.016)
<i>Ln Precipitation</i>	-0.341** (0.011)	-0.328** (0.011)	-0.331** (0.011)	-0.318** (0.011)
<i>Drought</i>	-0.054** (0.011)	-0.055** (0.011)	-0.055** (0.011)	-0.055** (0.011)
<i>Temperature</i>	0.068** (0.001)	0.069** (0.001)	0.068** (0.001)	0.069** (0.001)
<i>Ln Border Distance</i>	-0.007 (0.007)	-0.001 (0.007)	-0.006 (0.007)	-0.0002 (0.007)
<i>Ethnic Diversity</i>	0.101** (0.005)	0.103** (0.005)	0.104** (0.005)	0.106** (0.005)
<i>Polity</i>	-0.013** (0.002)	-0.014** (0.002)	-0.013** (0.002)	-0.013** (0.002)
<i>Ln Military Expenditure</i>	-0.079** (0.005)	-0.079** (0.005)	-0.078** (0.005)	-0.078** (0.005)
<i>Ln Population</i>	0.247** (0.008)	0.237** (0.008)	0.242** (0.008)	0.233** (0.008)
<i>Constant</i>	-16.526** (0.557)	-16.415** (0.552)	-16.591** (0.558)	-16.501** (0.553)
<b>Inflation Stage</b>				
<i>Polity</i>	0.016** (0.005)	0.011* (0.005)	0.016** (0.004)	0.011* (0.005)
<i>Ln GCP</i>	0.582** (0.080)	0.709** (0.085)	0.565** (0.080)	0.694** (0.084)
<i>Ln Population</i>	0.274** (0.011)	0.275** (0.011)	0.274** (0.011)	0.273** (0.011)
<i>Constant</i>	-1.246** (0.100)	-1.254** (0.101)	-1.253** (0.099)	-1.253** (0.100)
Observations	867,272	867,272	537,593	537,593
AIC	174,066.8	173,057.8	174,025.7	173,020.0
BIC	174,475.4	173,466.4	174,434.3	173,428.5

Note: \* p<0.05; \*\*p<0.01. Cell values are logistic regression coefficient estimates with standard errors in parentheses. Year fixed effects included in each regression though not reported here. All time varying covariates are lagged by one year.

**Table S2: Logit Coefficient Estimates of the Likelihood of Conflict by Cell-Year, 1991-2008 For the Tropics**

	<b>Model 1: Any Conflict</b>	<b>Model 2: Civil Conflict</b>	<b>Model 3: Any Conflict</b>	<b>Model 4: Civil Conflict</b>
<i>Cropland</i>	0.001** (0.0004)	0.001** (0.0004)	.	.
<i>Ln Cropland Pc</i>	.	.	-39.952** (4.857)	- 39.970** (4.851)
<i>Lag Conflict</i>	4.597** (0.019)	.	4.799** (0.021)	.
<i>Lag Civil Conflict</i>	.	4.610** (0.019)	.	4.812** (0.021)
<i>Ln Travel Time</i>	0.259** (0.015)	0.259** (0.030)	0.316** (0.017)	0.318** (0.017)
<i>Ln Cell Area</i>	1.016** (0.090)	1.018** (0.091)	0.965** (0.093)	0.966** (0.093)
<i>Ln GCP</i>	-0.181** (0.019)	-0.178** (0.019)	-0.114** (0.020)	-0.116** (0.020)
<i>Ln Precipitation</i>	-0.066** (0.012)	-0.063** (0.012)	-0.132** (0.015)	-0.135** (0.015)
<i>Drought</i>	-0.081** (0.011)	-0.080** (0.011)	-0.103** (0.012)	-0.105** (0.012)
<i>Temperature</i>	0.029** (0.002)	0.029** (0.002)	0.031** (0.002)	0.031** (0.002)
<i>Ln Border Distance</i>	0.088** (0.007)	0.090** (0.007)	0.076** (0.008)	0.074** (0.008)
<i>Ethnic Diversity</i>	0.297** (0.008)	0.298** (0.008)	0.307** (0.009)	0.306** (0.009)
<i>Polity</i>	-0.010** (0.002)	-0.010** (0.002)	-0.013** (0.002)	-0.013** (0.002)
<i>Ln Military Expenditure</i>	-0.007 (0.005)	-0.008 (0.005)	0.025** (0.006)	0.026** (0.006)
<i>Ln Population</i>	0.276** (0.008)	0.274** (0.009)	0.265** (0.010)	0.266** (0.010)
<i>Constant</i>	-16.658** (0.745)	-16.687** (0.747)	-16.691** (0.778)	-16.694 ** (0.778)
Observations	272,969	272,969	233,226	233,226
AIC	108,142.8	107,752.4	90,413.8	90,714.7
BIC	108,468.8	108,078.5	90,734.9	91035.9

Note: \* p<0.05; \*\*p<0.01. Cell values are logistic regression coefficient estimates with standard errors in parentheses. Year fixed effects included in each regression though not reported here. All time varying covariates are lagged by one year.

**Table S3: Logit Coefficient Estimates of the Likelihood of Conflict by Cell-Year, 1991-2008, Additional Food and Agricultural Import Controls**

	<b>Model 1: Any Conflict</b>	<b>Model 2: Civil Conflict</b>	<b>Model 3: Any Conflict</b>	<b>Model 4: Civil Conflict</b>
<i>Cropland</i>	0.004** (0.0003)	0.004** (0.0003)	.	.
<i>Ln Cropland Pc</i>	.	.	-7.544* (3.211)	-7.363* (3.168)
<i>Lag Conflict</i>	5.195** (0.199)	.	5.371** (0.022)	.
<i>Lag Civil Conflict</i>	.	5.217** (0.021)	.	5.399** (0.017)
<i>Ln Travel Time</i>	0.273** (0.137)	0.255** (0.014)	0.415** (0.016)	0.398** (0.017)
<i>Ln Cell Area</i>	2.112** (0.082)	2.076** (0.082)	1.560** (0.084)	1.540** (0.084)
<i>Ln GCP</i>	-0.075** (0.030)	-0.070** (0.015)	-0.040* (0.016)	-0.035* (0.017)
<i>Ln Precipitation</i>	-0.308* (0.012)	-0.300** (0.011)	-0.343** (0.014)	-0.336** (0.014)
<i>Drought</i>	-0.027** (0.012)	-0.027** (0.015)	-0.092** (0.013)	-0.093** (0.013)
<i>Temperature</i>	0.049** (0.001)	0.051** (0.002)	0.050** (0.002)	0.051** (0.002)
<i>Ln Border Distance</i>	0.005 (0.007)	0.009 (0.007)	-0.004 (0.008)	0.007 (0.008)
<i>Ethnic Diversity</i>	0.106** (0.006)	0.108** (0.006)	0.149** (0.006)	0.150** (0.006)
<i>Polity</i>	0.021** (0.002)	0.020** (0.002)	0.025** (0.002)	0.023** (0.002)
<i>Ln Military Expenditure</i>	-0.002 (0.006)	-0.003 (0.006)	-0.010 (0.007)	-0.011 (0.007)
<i>Ln Population</i>	0.350** (0.008)	0.342** (0.007)	0.395** (0.009)	0.387** (0.009)
<i>Agricultural Imports (%)</i>	0.027** (0.004)	0.025** (0.004)	0.013** (0.005)	0.012* (0.005)
<i>Food Imports (%)</i>	0.027** (0.002)	0.027** (0.002)	0.022** (0.002)	0.022** (0.002)
<i>Constant</i>	-25.140** (0.637)	-24.770** (0.638)	-22.060** (0.659)	-21.804** (0.659)
Observations	735,264	735,264	456,722	456,722
AIC	120,393.5	119,437.7	98,670.7	97,806.3
BIC	120,773.3	119,817.5	99,034.8	98,170.3

Note: \* p<0.05; \*\*p<0.01. Cell values are logistic regression coefficient estimates with standard errors in parentheses. Year fixed effects included in each regression though not reported here. All time varying covariates are lagged by one year.

**Table S4: Logit Coefficient Estimates of the Likelihood of Conflict by Cell-Year, 1991-2008, Baseline Specification**

	<b>Model 1: Any Conflict</b>	<b>Model 2: Civil Conflict</b>	<b>Model 3: Any Conflict</b>	<b>Model 4: Civil Conflict</b>
<i>Cropland</i>	0.009** (0.0002)	0.009** (0.0002)	.	.
<i>Ln Cropland Pc</i>	.	.	-115.596** (3.440)	-114.679** (3.439)
<i>Lag Conflict</i>	5.581** (0.014)	.	5.340** (0.015)	.
<i>Lag Civil Conflict</i>	.	5.597** (0.014)	.	5.359** (0.015)
<i>Ln Travel Time</i>	-0.216** (0.007)	-0.219** (0.007)	-0.045** (0.009)	-0.049** (0.009)
<i>Ln GCP</i>	-0.044* (0.009)	-0.044* (0.009)	-0.007 (0.009)	-0.007 (0.009)
<i>Constant</i>	-2.758** (0.055)	-2.748** (0.055)	-3.276** (0.064)	-3.264** (0.065)
Observations	1,137,361	1,137,361	671,615	671,615
AIC	229,665.9	228,012.4	186,482.8	185,222.3
BIC	229,928.7	228,275.2	186,734.0	185,473.4

Note: \* p<0.05; \*\*p<0.01. Cell values are logistic regression coefficient estimates with standard errors in parentheses. Year fixed effects included in each regression though not reported here. All time varying covariates are lagged by one year.

**S5: Logit Coefficient Estimates of the Likelihood of Conflict by Cell-Year, 1991-2008, Medium Specification**

	<b>Model 1: Any Conflict</b>	<b>Model 2: Civil Conflict</b>	<b>Model 3: Any Conflict</b>	<b>Model 4: Civil Conflict</b>
<i>Cropland</i>	0.001** (0.0003)	0.002** (0.0003)	.	.
<i>Ln Cropland Pc</i>	.	.	-14.134** (2.506)	-13.887** (2.494)
<i>Lag Conflict</i>	4.826** (0.015)	.	4.938** (0.016)	.
<i>Lag Civil Conflict</i>	.	4.844** (0.015)	.	4.958** (0.016)
<i>Ln Travel Time</i>	0.276** (0.011)	0.266** (0.011)	0.360** (0.012)	0.351** (0.012)
<i>Ln Cell Area</i>	0.881** (0.044)	0.867** (0.044)	0.576** (0.044)	0.570** (0.044)
<i>Ln GCP</i>	-0.195** (0.011)	-0.191** (0.011)	-0.155** (0.012)	-0.153** (0.012)
<i>Ln Precipitation</i>	-0.225** (0.008)	-0.221** (0.008)	-0.234** (0.010)	-0.230** (0.010)
<i>Temperature</i>	0.057** (0.001)	0.058** (0.001)	0.053** (0.001)	0.053** (0.001)
<i>Ln Population</i>	0.391** (0.005)	0.386** (0.005)	0.397** (0.006)	0.393** (0.006)
<i>Constant</i>	-15.596** (0.333)	-15.430** (0.333)	-13.758** (0.337)	-13.668** (0.337)
Observations	1,030,029	1,030,029	612,740	612,740
AIC	193,495.6	192,172.9	163,010.2	161,917.8
BIC	193,803.5	192,480.9	163,304.7	162,212.2

Note: \* p<0.05; \*\*p<0.01. Cell values are logistic regression coefficient estimates with standard errors in parentheses. Year fixed effects included in each regression though not reported here. All time varying covariates are lagged by one year.



### S6: Summary Statistics of All Variables

	Mean	Median	Standard Deviation	Range
<i>Conflict</i>	0.066	0	0.247	0 – 1
<i>Civil Conflict</i>	0.065	0	0.246	0 – 1
<i>Cropland</i>	16.920	0.419	27.554	0 – 99.990
<i>Ln Cropland Pc</i>	0.004	0.0004	0.036	0 – 2.080
<i>Lag Conflict</i>	0.062	0	0.242	0 – 1
<i>Lag Civil Conflict</i>	0.062	0	0.241	0 – 1
<i>Ln Travel Time</i>	6.339	6.231	1.250	0 – 10.310
<i>Ln Cell Area</i>	7.399	7.697	0.969	0 – 8.039
<i>Ln GCP</i>	0.506	0.087	0.845	0 – 6.970
<i>Ln Precipitation</i>	6.146	6.122	0.805	4.220 – 9.620
<i>Drought</i>	0.320	0	0.768	0 – 2.500
<i>Temperature</i>	9.853	10.417	13.874	-32.280 – 35.930
<i>Ln Border Distance</i>	5.615	5.753	1.462	0 – 9.300
<i>Ethnic Diversity</i>	2.814	1	3.090	0 – 15
<i>Polity</i>	4.170	6	6.451	-10 – 10
<i>Ln Military Exp.</i>	15.687	15.994	2.656	0 – 20.130
<i>Ln Population</i>	7.799	8.291	3.689	0 – 16.690
<i>Ag. Imports</i>	2.004	1.491	1.553	0.01 – 42.32
<i>Food Imports</i>	10.281	6.905	6.640	0.47 – 62.42

**Table S7: List of Countries Partly or Wholly Located Within The Tropics (The Sample Analyzed in Table S2)**

United States	Chile	Somalia	Pakistan
Bahamas	Argentina	Djibouti	Bangladesh
Cuba	Cabo Verde	Ethiopia	Myanmar
Haiti	Sao Tome and Principe	Eritrea	Sri Lanka
Dominican Republic	Guinea-Bissau	Angola	Maldives
Jamaica	Equatorial Guinea	Mozambique	Thailand
Trinidad and Tobago	Gambia	Zambia	Cambodia
Barbados	Mali	Zimbabwe	Laos
Dominica	Senegal	Malawi	Viet Nam
Grenada	Benin	South Africa	Malaysia
Saint Lucia	Mauritania	Namibia	Singapore
Saint Vincent and the Grenadines	Niger	Botswana	Brunei
Antigua and Barbuda	Cote d'Ivoire	Madagascar	Philippines
Saint Kitts and Nevis	Guinea	Comoros	Indonesia
Mexico	Burkina Faso	Mauritius	Timor-Leste
Belize	Liberia	Seychelles	Australia
Guatemala	Sierra Leone	Morocco	Papua New Guinea
Honduras	Ghana	Algeria	Vanuatu
El Salvador	Togo	Libya	Solomon Islands
Nicaragua	Cameroon	Sudan	Kiribati
Costa Rica	Nigeria	Egypt	Tuvalu
Panama	Gabon	Saudi Arabia	Fiji
Colombia	Cent. African Republic	Yemen Arab Republic	Tonga
Venezuela	Chad	Yemen	Nauru
Guyana	Congo	Qatar	Marshall Islands
Suriname	Dem. Rep. of Congo	United Arab Emirates	Palau
Ecuador	Uganda	Oman	Micronesia
Peru	Kenya	China	Samoa
Brazil	Tanzania	Taiwan	Paraguay
Bolivia	Burundi	Japan	
	Rwanda	India	