Supporting Information For

"Hunger Games: Food Security and Strategic Preemptive Conflict"

Contents

This Appendix proceeds in five parts. In the first part, the utility of the defense forces, and the derivations of the formal model's equilibrium results and comparative statics are discussed in detail. In the second part, a list of cases where it could be established that localities with some levels of food production were targeted *preemptively* to reduce the other side's levels of food support is reported (Table A.1). The third part includes summary statistics of all the variables used in the main analysis, prediction, and robustness models (Tables A.2 and A.3) as well as figures showing the geospatial distribution of the dependent and explanatory variables; and the frequency of conflict by grid cell and grid cell-year. Fourth, a set of sensitivity analyses designed to show the robustness of the model presented in the primary analysis to a variety of alternative specifications and the inclusion of different potential confounders are reported in Tables A.4–A.9. Finally, the receiver-operator characteristics (ROC) curves of the model when predicting raider attacks and defender responses for the years 2009-2010 are reported, as well as a comparison between the area under the curve of the LQRM model and regular logit models for both in and out-of-sample data.

Defense Forces Utility Function

Although the defense forces are not a strategic actor in this model and their behavior is assumed to reflect the civilians' actions, it is still worthwhile to briefly explain their utility function to understand the model's setting. To this end, let ν be the cost the defense forces d incur from violent conflict M, for example, due to the loss of lives or equipment, such that $\nu > 0$. In addition, if they defeat the raiders with probability ρ, the defense forces get to keep their rents R, e.g., through taxation, controlling natural resources production, etc., such that $\rho \times R$. If they lose, then they forfeit access to these rents, such that $(1-\rho) \times 0$. The defense forces' d utility function is thus:

$$U_d(M) = \rho R - \nu \tag{1}$$

Proofs

Proof of Lemma 1

- To derive the first part, begin by comparing the utilities of the civilian producers from providing food support in case the raiders attack, i.e., when $M = 1$ to their utility from not doing so. The utility in the first case is $U_b(M|\theta) = \rho s - \frac{1}{2}\theta^2 - \kappa$. In the second case, the utility of the civilians from conflict is identical, only $\theta = 0$, and so the probability of defender victory ρ collapses to the baseline probability of the defense forces' victory p. The civilians' utility in this case is now $U_b(M|\neg\theta) = ps - \kappa$. Setting the equation such that providing food support is at least as good an option as not providing it gives $U_b(M|\theta) \geq U_b(M|\neg\theta)$, then $p[1+(1-\delta)\theta\omega]s - \frac{1}{2}\theta^2 - \kappa \geq ps - \kappa$. This can be solved for p such that $p \geq \frac{2\theta}{(1-\delta)\omega s}$. Naturally, from this equation if $\theta = 0$ then it must be true that $p = 0$. Hence, in any case, as long as the raiders are not guaranteed to defeat the defense forces—i.e., $p \leq 1$—the civilian producers will *always* allocate some level of food support θ to their defense forces.

- To derive the second part, assign $\rho = p[1+(1-\delta)\theta\omega]$ into the civilian producers' utility: $U_b(M) = p[1+(1-\delta)\theta\omega]s - \frac{1}{2}\theta^2 - \kappa$. Taking the derivative of this utility function in respect to θ gives $\frac{\partial U(b)}{\partial \theta} = (1-\delta)\omega ps - \theta = 0$. Isolating θ gives $\theta^* = (1-\delta)\omega ps$.

- To derive the third part, compare the raiders' utility function for attacking a food producing region, i.e., when $M = 1$ and $\delta > 0$ to their utility from not focusing on food producing areas. The utility function in the first case is $U_r(\delta > 0|\theta^*) = [1 - p(1+(1-\delta)^2\omega^2 ps)](R+s) - \eta$, and in the second case it is $U_r(\delta = 0|\theta^*) = [1 - p(1+\omega^2 ps)](R+s) - \eta$. Clearly, as long as $\delta \geq 0$, attacking regions with more food production is a preferred strategy for the raiders.

- Now compare the costs of conflict to the utility from not initiating conflict, i.e., when $M = 0$: $U_r(\delta > 0|\theta^*) = [1 - p(1+(1-\delta)^2\omega^2 ps)](R+s) - \eta \geq 0$, and so $M = 0$: $U_r(M\theta^*) = [1 - p(1+(1-\delta)^2\omega^2 ps)](R+s) \geq \eta$.

Proof of Proposition 1

To obtain these results take the partial derivative of θ^* in respect to p, ω, and s when $M = 1$.

- In respect to p: $\frac{\partial \theta^*}{\partial p} = s(1-\delta)\omega \geq 0$ because $\delta < 1$; and so θ^* increases with higher probabilities of the defense forces d's victory.

- In respect to ω: $\frac{\partial \theta^*}{\partial \omega} = s(1-\delta)p \geq 0$ because $\delta < 1$; and so θ^* increases when food support is more important for improving the defense forces' overall probability of victory.

- In respect to s, $\frac{\partial \theta^*}{\partial s} = (1-\delta)\omega p \geq 0$ because $\delta < 1$; and so θ^* increases with higher value of land s.

Proof of Proposition 2

- To obtain these results, first take the partial derivative of the raiders' utility when $M = 1$ in respect to δ and compare it to 0 (the utility of the raiders when $M = 0$). Clearly, $\frac{\partial U(r)}{\partial \delta} = 2\omega^2 p^2 s(s+R)(1-\delta) > 0$ because $\delta < 1$; and so the raiders' utility from *initiating* conflict increases the stronger the effect of violence is on reducing food support.

- To obtain the second part of this proposition and show that the raiders will be more likely to initiate conflict if it has a stronger effect on diminishing the defense forces' probability of victory, take the derivative of the raiders' utility from conflict in respect to p to isolate p^*, and then take the derivative of p^* in respect δ. Taking the derivative of $U_r(M|\theta^*)$ in respect to p and isolating p gives $p^* = -\frac{1}{2(d-1)^2 s\omega^2}$, which shows that—unsurprisingly—the utility of the raiders from conflict decreases with higher probability of the defense forces' victory. The derivative in respect to p^* should thus show how the utility from raiding in respect to the probability of the defense forces' victory changes with higher levels of δ: $\frac{\partial p^*}{\partial \delta} = s\omega^2(1-\delta) \geq 0$ because $\delta \leq 1$, and so the raiders will *initiate* conflict even with higher probability of the defense forces' victory if conflict has a strong effect on reducing the food support available to the defense forces.

Systematic Evaluation of Anecdotal Evidence

Table A.1 provides a list of cases where preemptive conflict over food resources has occurred. Distinguishing possessive conflict—i.e. conflict designed to increase one's own food security levels—from preemptive conflict—i.e., conflict designed to decrease one's rivals' food security levels—is complicated, because most conflict events over food resources is likely to involve elements of both. I thus only included in Table A.1 cases where it was explicitly stated that the aim of using violence was to weaken or hurt the other side by appropriating or destroying locally produced food resources.

Table A.1: A Partial List of Preemptive Conflicts over Food Security

Country	Target	Raiders	Resource	Source
Angola	civilian farmers, gov. troops	UNITA rebels	crops	Macrae and Zwi (1992)
East Timor	local civilians	rebel militias	livestock	The New Zealand Herald (2002)
El Salvador	local civilians	gov. troops	crops	Messer and Cohen (2006)
Ethiopia (Tigre and Eritrea)	civilians, EPLF and TPLF troops	the *Derg*	crops, livestock	Keller (1992)
Ghana	Fulani herders	Farmers	crops, livestock	Tonah (2006)
India (Bastar)	farmers, civil defense forces	Naxalite rebels	crops	Sundar (2007) Planning Commission of India (2008)
Italy (Sicily)	Mafia families	Mafia families	livestock	Blok (1969)
Kenya	Pokot/Turkana militias	Pokot/Turkana militias	livestock	Clemens (2013)
Mozambique	local civilians, gov. troops	RENAMO	crops	Hultman (2009)
Nigeria (Biafra)	Biafra civilians	Nigerian military	crops, stockpiles	Jacobs (1987)
Nigeria	Fulani herders	Farmers	crops, livestock	Ofuoku (2009)
Peru (Tacuna and Arequipa)	farmers, civil defense forces	Túpac Amaru rebels	crops, livestock	Masterson (1991); Walker (1999)
Sierra Leone	SLA/CDF	RUF	crops	Mkandawire (2002); Keen (2005)
Somalia (Somaliland)	local civilians	pro-Barre militias	crops, livestock	Ahmed and Green (1999)
Sudan (Darfur)	local civilians, JEM, SLA	Sudanese gov./ethnic militias	crops, livestock	de Waal (2005)
Sudan	ethnic Dinka	militias/Sudanese gov.	livestock	Barrow (1996)
Sudan/S. Sudan	S. Sudan	Sudanese pastoralists	livestock	Leff (2009)
Thailand (Songkhla)	farmers, civil defense forces	BRN-C rebels	crops	The Nation (2004) Montesano and Jory (2008)
Uganda	local civilians, LRA	Ugandan military	crops, stockpiles	Doom and Vlassenroot (1999)
Vietnam	local civilians, Viet Cong	U.S. military	crops	Leebaw (2014)

Summary Statistics

Table A.2: Summary Statistics of All Variables Used in Analysis, 1998-2008

	Minimum	Median	Mean	Max	SD
Raider Attacks	0	0	0.033	1	0.179
Defender Responses	0	0	0.016	1	0.127
Cropland	0	0.021	0.085	1	0.154
Wheat Yield	0	2.63E-5	0.009	0.930	0.047
Population[1]	0	9.721	9.369	16.268	2.263
GCP_t[1]	0	0.076	0.270	4.455	0.490
Terr. Change	0	0	0.007	1	0.081
Travel Time[1]	0	6.127	6.187	8.722	0.855
Border Distance[1]	0	4.913	4.682	7.574	1.137
Temperature	3.625	24.675	24.382	32.617	3.774
Precipitation[1]	4.220	6.155	5.981	8.417	1.016
$Conflict_{t-1}$	0	0	0.316	506	3.890
GDP Per $Capita_{t-1}$[1]	5.338	7.317	7.523	10.268	1.094
$Polity2_{t-1}$	-9	-1	-0.025	10	5.129
Urban	0	0	0.099	51.549	0.901
Capital Distance[1]	1.609	6.319	6.228	7.818	0.795
Mountains	0	0	0.123	1	0.243
Military $Expenditure_{t-1}$[1]	0	12.612	12.525	15.350	1.649
Attack Spl. Lag	0	0	0.060	1	0.237

[1] Natural log

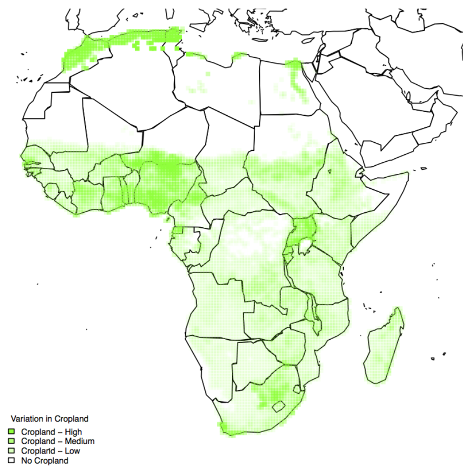
Table A.3: Summary Statistics of All Variables Used in Analysis, 2009-2010

	Minimum	Median	Mean	Max	SD
Raider attacks	0	0	0.044	1	0.205
Defender responses	0	0	0.020	1	0.140
Cropland	0	0.028	0.091	1	0.155
Wheat yield	0	7.29E-5	0.008	0.791	0.037
Population[1]	0	9.854	9.489	16.268	2.281
GCP_t[1]	0	0.110	0.358	4.455	0.597
Terr. Change	0	0	0.003	1	0.056
Travel time[1]	0	6.040	6.113	8.722	0.846
Border distance[1]	0	4.941	4.729	7.587	1.114
Temperature	5.114	24.508	24.188	39.525	4.526
Precipitation[1]	0.349	6.332	5.840	7.838	1.456
$Conflict_{t-1}$	0	0	0.402	432	4.955
GDP per $capita_{t-1}$[1]	5.369	7.254	7.340	9.912	1.046
$Polity2_{t-1}$	-9	2	1.945	10	5.292

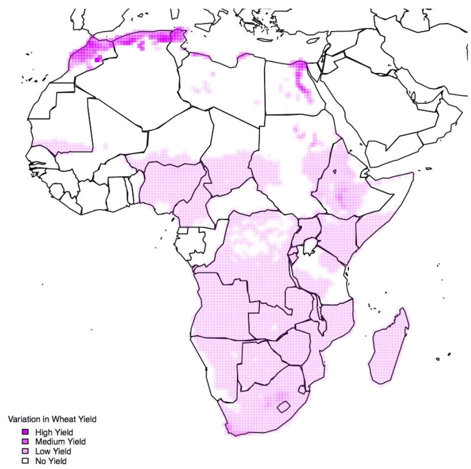
[1] Natural log

Summary Figures

Figure A.1: The Regional Distribution of Staple Cropland and Wheat Yields, 1998-2008

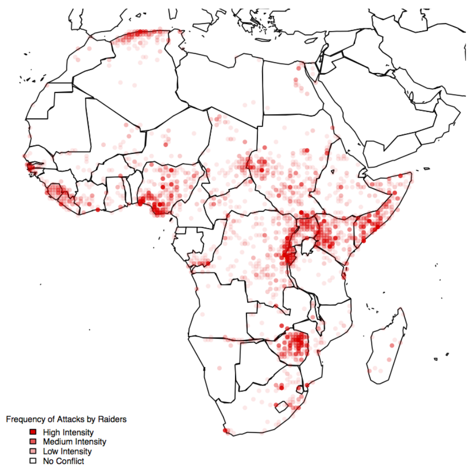


Cropland, 1998-2008

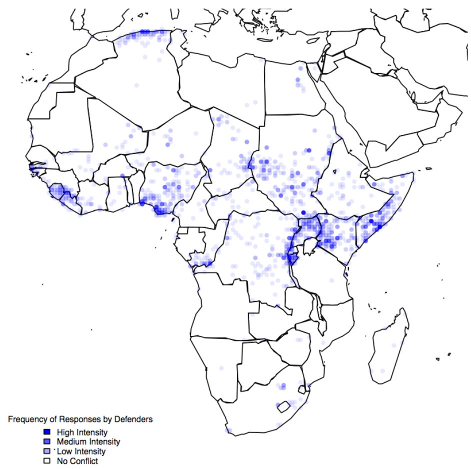


Wheat Yields, 1998-2008

Figure A.2: The Regional Distribution of Attacks by Raiders and Responses by Defense Forces, 1998-2008

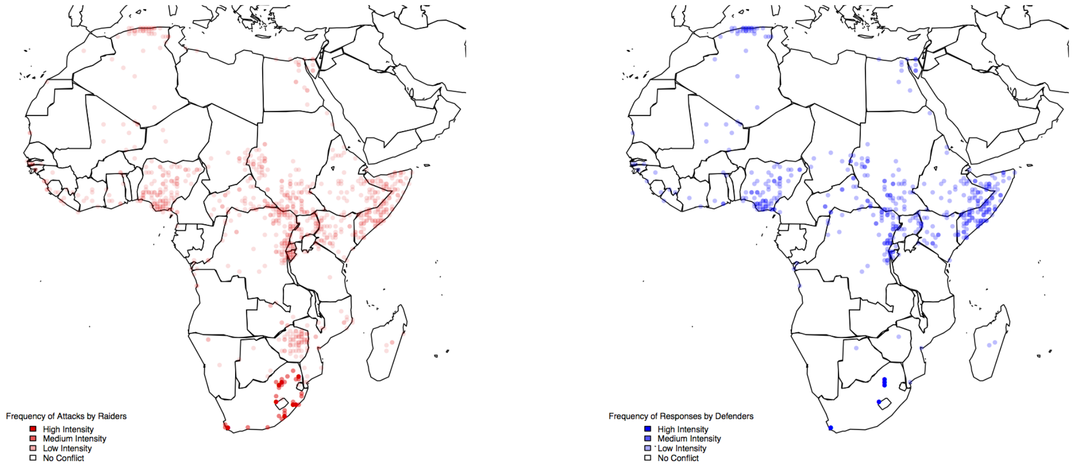


Raider Attacks, 1998-2008



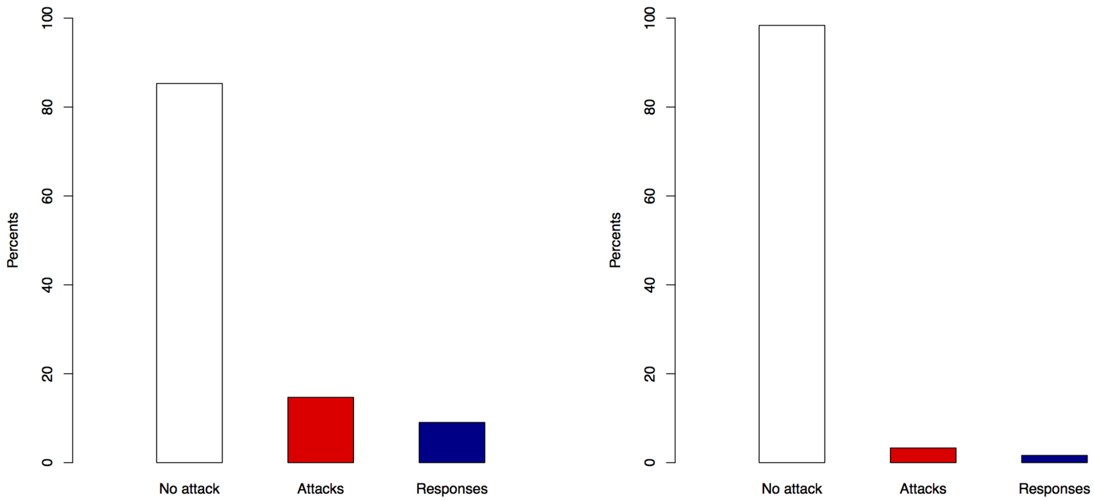
Defender Responses, 1998-2008

Figure A.3: The Regional Distribution of Attacks by Raiders and Responses by Defense Forces, 2009-2010



Raider Attacks, 2009-2010 | Defender Responses, 2009-2010

Figure A.4: The Distribution of Raider Attacks and Defense Forces Response by Grid Cell and Cell-Year, 1998-2008

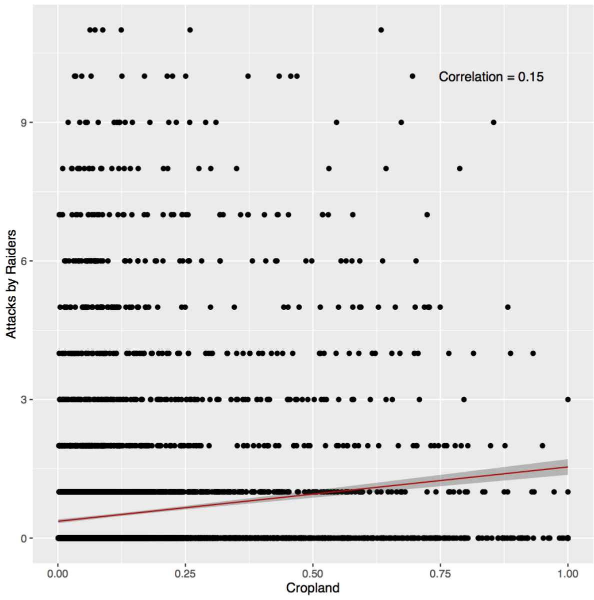


Distribution by Grid Cell | Distribution by Cell-Year

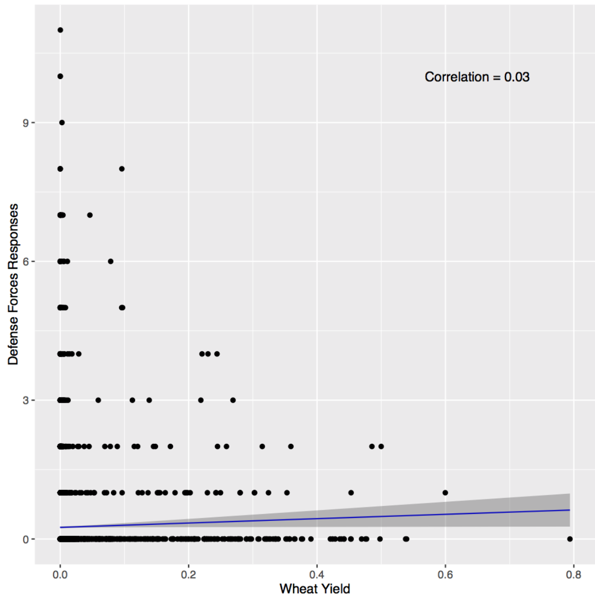
Correlation Plots

To provide illustrative evidence regarding the effect of the local food indicators discussed above on the different categories of the dependent variable, the correlations between (i) cropland levels and attacks by raiders, and (ii) between wheat yield levels and responses by defense forces, collapsed by year for the 1998-2008 period are presented in Figure A.5 (with 95% confidence intervals). As the figure shows, both localized food indicators are associated with the dependent variables categories as assigned by their respective utility functions. This provides evidence in favor of the validity of argument that more conflict is likely in regions with more food production, adjusting for the different conceptualizations and strategic relationships derived by the model. As illustrated below, these correlations are not driven by the rural-urban divide, which higher levels of agricultural output might characterize.

Figure A.5: Correlation Between The Explanatory and Dependent Variables, 1998-2008



Correlations Between Raider Attacks and Cropland



Correlations Between Defense Forces Responses and Wheat Yields

Robustness Analysis

This robustness section includes six alternative replications of the primary analysis to test its sensitivity to alternative mechanisms and specification choices. First, the effect of urbanization on the utilities of the raiders and the civilians is more throughly taken into account by including an indicator measuring the level of urbanization in each grid cell in the equations capture the raiders' and defense forces' utilities in Table A.4. Second, numerous studies have equated a higher likelihood of conflict with lower state capacity levels (e.g., Fearon and Laitin, 2003). To account for this possibility, Table A.5 estimates the primary model with the inclusion of distance to capital and the percentage of a given cell that is mountainous, in a manner used in past studies (Fearon and Laitin, 2003; Fjelde and Hultman, 2014). Third, attacks in certain grid cells might be caused because attacks nearby push raiders to attack these cells due to their vicinity, i.e., conflict can simply spill over from a neighboring cell. To account for this possibility, Table A.6 includes spatial lags of raider attacks in the raiders' utility function.

Fourth, recall that non of the independent variables (excluding the lag of the dependent variable) were lagged due to the potential misspecification issues and inferential biases that might result (Bellemare, Masaki and Pepinsky, Forthcoming). Nevertheless, to show that my results are robust to this decision, a model where all time varying indicators are lagged by one year is reported in Table A.7. Fifth, the size of the state's military might influence the raiders' decision whether to initiate conflict or pursue more peaceful solutions under the status quo. To account for this possibility, a model that includes lagged military expenditure in the raiders' utility from the status quo (obtained from the Correlated of War dataset Singer, Bremer and Stucky, 1972) is reported in Table A.8 to account for the potential effects of military (i.e., defense force) size on the raiders' decision to attack. Finally, to show that the results are not driven by my choice of controls or the number of indicators included in the model, a baseline specification of the primary analysis using only a small number of variables in the utility functions of the both the raiders and the civilians. Crucially, the significance and sign of *cropland* and *wheat yields* is consistent across these different specifications, which additionally confirms the argument developed in the main paper.

Table A.4: **Player Utilities for Raids and Defenses, 1998-2008 – With Urbanization**

	$U_r(AF)$	$U_b(AF)$	$U_r(SQ)$
Cropland	1.802*	–	–
	(0.331)		
Wheat Yield	–	0.318*	–
		(0.072)	
Population[1]	-1.224*	-0.134*	–
	(0.558)	(0.015)	
GCP[1]	-7.051*	-0.256*	–
	(1.644)	(0.027)	
Terr. Change	19.633*	0.808*	–
	(2.934)	(0.195)	
Travel Time[1]	-1.636	-0.062*	–
	(0.845)	(0.023)	
Border Distance[1]	-0.863*	-0.025*	–
	(0.328)	(0.008)	
Temperature	0.416*	0.020*	–
	(0.128)	(0.003)	
Precipitation[1]	-3.010*	-0.162*	–
	(1.003)	(0.020)	
Urbanization	1.023*	0.033*	–
	(0.359)	(0.006)	
Conflict$_{t-1}$	–	–	-0.143*
			(0.022)
GDP per capita$_{t-1}$[1]	–	–	0.081
			(0.057)
Polity2$_{t-1}$	–	–	0.066*
			(0.008)
t	-2.195	0.096	-2.230
	(8.132)	(0.153)	(8.088)
t^2	1.064	-0.043	1.088
	(1.097)	(0.023)	(1.077)
t^3	-0.073	0.003*	-0.075
	(0.050)	(0.001)	(0.048)
Constant	-35.796	3.157*	-39.785
	(34.374)	(0.378)	(30.389)

Number of observations: 63,218
Akaike Information Criterion: 20,796.49
* indicates $p < 0.05$.
Values in parentheses are standard errors clustered by player and bootstrapped using 1000 iterations.
$U_b(A\neg F)$ is the reference node and was normalized to zero.
[1] Natural log

Table A.5: **Player Utilities for Raids and Defenses, 1998-2008 – With State Capacity Indicators**

	$U_r(AF)$	$U_b(AF)$	$U_r(SQ)$
Cropland	1.563*	–	–
	(0.377)		
Wheat Yield	–	0.168*	–
		(0.072)	
Population[1]	-2.107*	-0.098*	–
	(0.904)	(0.018)	
GCP[1]	-1.858	-0.058	–
	(3.022)	(0.067)	
Terr. Change	24.296*	0.583*	–
	(3.329)	(0.284)	
Travel Time[1]	-1.624	-0.033	–
	(1.229)	(0.034)	
Border Distance[1]	-0.862	-0.016	–
	(0.498)	(0.013)	
Temperature	0.950*	0.021*	–
	(0.170)	(0.008)	
Precipitation[1]	-3.465	-0.111*	–
	(1.896)	(0.045)	
Mountains	2.379	-0.010	–
	(1.282)	(0.036)	
Capital Distance[1]	3.592*	0.077*	–
	(1.037)	(0.037)	
Conflict_{t-1}	–	–	-0.146*
			(0.023)
$\text{GDP per capita}_{t-1}$[1]	–	–	0.099
			(0.056)
Polity2_{t-1}	–	–	0.050*
			(0.008)
t	3.806	0.080	4.237
	(5.098)	(0.100)	(5.085)
t^2	0.443	-0.009	0.337
	(0.704)	(0.017)	(0.672)
t^3	-0.051	0.001	-0.045
	(0.034)	(0.001)	(0.031)
Constant	-121.80*	1.830*	-80.356
	(32.164)	(0.904)	(27.183)

Number of observations: 62,567
Akaike Information Criterion: 20,419.50
* indicates $p < 0.05$.
Values in parentheses are standard errors clustered by player and bootstrapped using 1000 iterations.
$U_b(A\neg F)$ is the reference node and was normalized to zero.
[1] Natural log

Table A.6: **Player Utilities for Raids and Defenses, 1998-2008 – With Spatial Lag Attacks**

	$U_r(AF)$	$U_b(AF)$	$U_r(SQ)$
Cropland	1.330*	–	–
	(0.380)		
Wheat yield	–	0.259*	–
		(0.100)	
Population[1]	-1.186*	-0.113*	–
	(0.403)	(0.022)	
GCP[1]	-3.548*	-0.151*	–
	(1.340)	(0.037)	
Terr. Change	21.832*	1.095*	–
	(5.430)	(0.259)	
Travel Time[1]	-1.026	-0.042	–
	(0.890)	(0.032)	
Border Distance[1]	-0.376	-0.005	–
	(0.332)	(0.014)	
Temperature	0.406*	0.019*	–
	(0.111)	(0.005)	
Precipitation[1]	-2.109*	-0.108*	–
	(0.948)	(0.041)	
Attack Spl. Lag	5.867*	–	–
	(0.189)		
Conflict$_{t-1}$	–	–	-0.065*
			(0.012)
GDP Per Capita$_{t-1}$[1]	–	–	0.087
			(0.061)
Polity2$_{t-1}$	–	–	0.049*
			(0.009)
t	-11.822	0.360	-10.821
	(9.140)	(0.277)	(8.759)
t^2	2.209	-0.071	2.065
	(1.439)	(0.046)	(1.366)
t^3	-0.113	0.004	-0.107
	(0.070)	(0.002)	(0.066)
Constant	-26.354	1.691*	-18.649
	(25.927)	(0.662)	(20.321)

Number of observations: 63,163
Akaike Information Criterion: 19,119.33
* indicates $p < 0.05$.
Values in parentheses are standard errors clustered by player and bootstrapped using 1000 iterations.
$U_b(A\neg F)$ is the reference node and was normalized to zero.
[1] Natural log

Table A.7: **Player Utilities for Raids and Defenses, 1998-2008 – With Lagged Independent Variables**

	$U_r(AF)$	$U_b(AF)$	$U_r(SQ)$
Cropland	1.455*	–	–
	(0.322)		
Wheat Yield$_{t-1}$	–	0.113*	–
		(0.034)	
Population$_{t-1}$[1]	4.270*	0.051*	–
	(0.788)	(0.008)	
GCP$_{t-1}$[1]	7.198*	0.158*	–
	(1.655)	(0.022)	
Terr. Change$_{t-1}$	-9.589	-0.224*	–
	(5.647)	(0.056)	
Travel Time[1]	1.413	0.036*	–
	(1.185)	(0.016)	
Border Distance[1]	1.219*	0.029*	–
	(0.540)	(0.007)	
Temperature$_{t-1}$	-5.700*	-0.010*	–
	(0.179)	(0.002)	
Precipitation$_{t-1}$[1]	7.842*	0.132*	–
	(1.298)	(0.017)	
Conflict$_{t-1}$	–	–	-0.148*
			(0.024)
GDP per capita$_{t-1}$[1]	–	–	0.140*
			(0.055)
Polity2$_{t-1}$	–	–	0.080*
			(0.008)
t	17.486*	-0.110*	14.277
	(8.245)	(0.056)	(7.738)
t^2	-1.512	-0.007	-0.885
	(0.936)	(0.007)	(0.817)
t^3	0.043	0.001*	0.009
	(0.040)	(0.0004)	(0.031)
Constant	315.65*	-0.884*	-128.40*
	(86.084)	(0.217)	(45.501)

Number of observations: 63,163

Akaike Information Criterion: 21,693.97

* indicates $p < 0.05$.

Values in parentheses are standard errors clustered by player and bootstrapped using 1000 iterations.

$U_b(A\neg F)$ is the reference node and was normalized to zero.

[1] Natural log

Table A.8: **Player Utilities for Raids and Defenses, 1998-2008 – With Military Expenditure**

	$U_r(AF)$	$U_b(AF)$	$U_r(SQ)$
Cropland	1.376*	–	–
	(0.324)		
Wheat Yield	–	0.189*	–
		(0.074)	
Population[1]	-2.257*	-0.108*	–
	(0.556)	(0.017)	
GCP[1]	-5.856*	-0.139*	–
	(1.376)	(0.024)	
Terr. Change	23.231*	0.568*	–
	(3.224)	(0.174)	
Travel Time[1]	-2.066*	-0.045*	–
	(0.830)	(0.023)	
Border Distance[1]	-0.914*	-0.012	–
	(0.297)	(0.008)	
Temperature	0.729*	0.020*	–
	(0.131)	(0.004)	
Precipitation[1]	-3.871*	-0.126*	–
	(1.029)	(0.022)	
Conflict$_{t-1}$	–	–	-0.145*
			(0.021)
GDP Per Capita$_{t-1}$[1]	–	–	0.257*
			(0.055)
Polity2$_{t-1}$	–	–	0.056*
			(0.008)
Mil. Exp$_{t-1}$	–	–	-0.280*
			(0.029)
t	3.578	-0.092	4.578
	(6.560)	(0.125)	(6.453)
t^2	0.568	-0.009	0.361
	(0.938)	(0.021)	(0.901)
t^3	-0.062	0.001	-0.051
	(0.045)	(0.001)	(0.042)
Constant	-82.572*	2.713*	-78.229*
	(29.310)	(0.370)	(26.043)

Number of observations: 62,527
Akaike Information Criterion: 20,303.92
* indicates $p < 0.05$.
Values in parentheses are standard errors clustered by player and bootstrapped using 1000 iterations.
$U_b(A\neg F)$ is the reference node and was normalized to zero.
[1] Natural log

Table A.9: **Player Utilities for Raids and Defenses, 1998-2008 – Baseline Model**

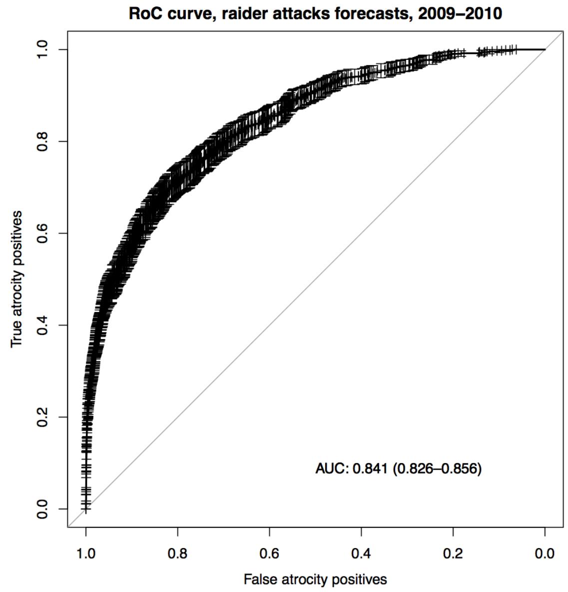
	$U_r(AF)$	$U_b(AF)$	$U_r(SQ)$
Cropland	1.529*	–	–
	(0.309)		
Wheat Yield	–	0.283*	–
		(0.071)	
Population[1]	-2.151*	-0.159*	–
	(0.615)	(0.020)	
Temperature	0.614	0.025*	–
	(0.161)	(0.004)	
Precipitation[1]	-1.831*	-0.108*	–
	(0.721)	(0.018)	
Conflict_{t-1}	–	–	-0.208*
			(0.027)
$\text{GDP Per Capita}_{t-1}$[1]	–	–	0.123*
			(0.042)
Polity2_{t-1}	–	–	0.075*
			(0.008)
t	6.767	0.008	-17.798
	(7.552)	(0.130)	(15.115)
t^2	-0.318	-0.044*	3.527*
	(0.921)	(0.021)	(2.101)
t^3	-0.005	0.003*	-0.189**
	(0.041)	(0.001)	(0.096)
Constant	-76.377	2.859*	61.260
	(45.476)	(0.337)	(36.381)

Number of observations: 62,527
Akaike Information Criterion: 20,307.26
* indicates $p < 0.05$.
Values in parentheses are standard errors clustered by player and bootstrapped using 1000 iterations.
$U_b(A\neg F)$ is the reference node and was normalized to zero.
[1] Natural log

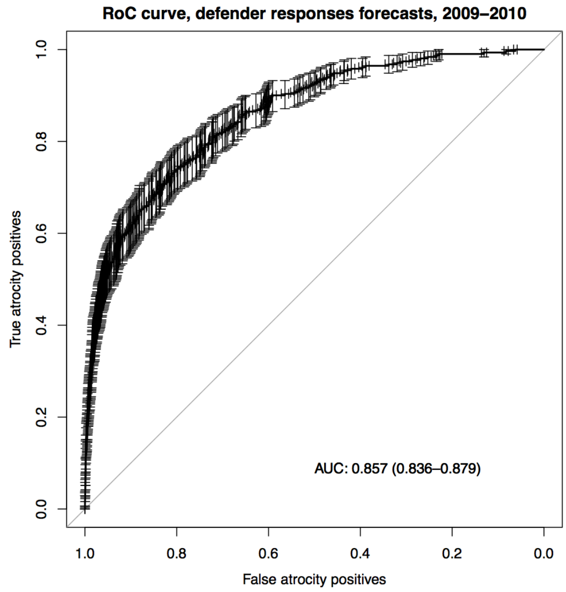
Predictive Analysis

As evidenced from the plots presented in the main paper as well as the graphs below, the strategic model does a reasonably good job of predicting conflict given that most of the events are clustered on the right-hand side of the graph. Indeed, the ROC curves reported in Figure A.6 for this model show that it correctly predicts approximately 84% of raider attacks (with a 95% confidence interval of 32% ⇔ 86%) and 86% of defender responses (with a 95% confidence interval of 84% ⇔ 88%) for the years 2009-2010. These quantities can be compared to the forecasting strength of a completely random "coin flip" model, which should correctly predict about 50% of all observations. Moreover, as additionally shown in Tables A.10 and A.11, this model provides a statistically significant better predictive fit to the data based on DeLong, DeLong and Clarke-Pearson (1988) test compared with standard logit models that do not account for the *strategic* nature of preemptive conflict fought over food security (i.e., models that include all the regressors in one equation), using both in and out-of-sample data.

Figure A.6: ROC Curves for Each Stage in The Statistical Strategic Model



Out-of-Sample ROC:
Raider Attacks, 2009-2010



Out-of-Sample ROC:
Defender Responses, 2009-2010

Note: The AUCs for each phase are ≈ 95% for raider attacks and ≈ 98% of responses by defense forces when the threshold is dichotomized at 0.5 instead of 1, as used by numerous studies that employ ROCs.

Table A.10: Comparison of Prediction Strength, LQRM and Logit Models, 1998-2008

	Raider Attacks		**Defender Responses**	
	LQRM	Logit	LQRM	Logit
AUC	0.83	0.82	0.86	0.85
DeLong et al. test	$z = 5.373$*		$z = 4.787$*	
Favors:	LQRM		LQRM	
N	63,218			

Note: * indicates $p < 0.05$.

Null hypothesis for Delong et al.'s Test for two correlated ROC curves: true difference in AUC's is equal to zero.

Table A.11: Comparison of Prediction Strength, LQRM and Logit Models, Out-of-Sample Data for 2009-2010

	Raider Attacks		**Defender Responses**	
	LQRM	Logit	LQRM	Logit
AUC	0.84	0.83	0.86	0.83
DeLong et al. test	$z = 2.234$*		$z = 3.602$*	
Favors:	LQRM		LQRM	
N	14,420			

Note: * indicates $p < 0.05$.

Null hypothesis for Delong et al.'s Test for two correlated ROC curves: true difference in AUC's is equal to zero.

References

Ahmed, Ismail I and Reginald Herbold Green. 1999. "The heritage of war and state collapse in Somalia and Somaliland: local-level effects, external interventions and reconstruction." Third World Quarterly 20(1):113–127.

Barrow, Greg. 1996. "ANCIENT CATTLE CULTURE UNDER THREAT FROM WAR." The Guardian, April 4, 1996.

Bellemare, Marc F., Takaaki Masaki and Thomas B. Pepinsky. Forthcoming. "Lagged Explanatory Variables and the Estimation of Causal Effects." Journal of Politics .

Blok, Anton. 1969. "Peasants, Patrons, and Brokers in Western Sicily." Anthropological Quarterly 42(3):155–170.

Clemens. 2013. "GUNS, LAND, AND VOTES: CATTLE RUSTLING AND THE POLITICS OF BOUNDARY (RE)MAKING IN NORTHERN KENYA." African Affairs (112):216–237.

de Waal, Alex. 2005. Famine that Kills: Darfur, Sudan. Oxford: Oxford University Press.

DeLong, Elisabeth R., David M. DeLong and Daniel L. Clarke-Pearson. 1988. "Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach." Biometrics 44:837–845.

Doom, Ruddy and Koen Vlassenroot. 1999. "Konny's Message: A New Koine? The Lord's Resistance Army in Northern Uganda." African Affairs 98:5–36.

Fearon, James D. and David D. Laitin. 2003. "Ethnicity, Insurgency, and Civil War." American Political Science Review 97(1):75–90.

Fjelde, Hanne and Lisa Hultman. 2014. "Weakening the Enemy: A Disaggregated Study of Violence against Civilians in Africa." Journal of Conflict Research 58(7):1230–1257.

Hultman, Lisa. 2009. "The Power to Hurt in Civil War: The Strategic Aim of RENAMO Violence." Journal of Southern African Studies 35(4):821–834.

Jacobs, Dan. 1987. The Brutality of Nations. New York: Alfred Knopf.

Keen, David. 2005. Conflict and Collusion in Sierra Leone. Suffolk: James Currey.

Keller, Edmond J. 1992. "Drought, War, and the Politics of Famine in Ethiopia and Eritrea." The Journal of Modern African Studies 30(4):609–624.

Leebaw, Bronwyn. 2014. "Scorched Earth: Environmental War Crimes and International Justice." Perspectives on Politics 12(4):770–788.

Leff, Jonah. 2009. "Pastoralists at War: Violence and Security in the Kenya-Sudan-Uganda Border Region." International Journal of Conflict and Violence 3(2):188–203.

Macrae, Joanna and Anthony B. Zwi. 1992. "Food as an Instrument of War in Contemporary African Famines: A Review of the Evidence." Disasters 16(4):299–321.

Masterson, Daniel M. 1991. Militarism and Politics in Latin America: Peru from Sánchez Cerro to Sendero Luminoso. New York: Greenwood Press.

Messer, Ellen and Marc. J. Cohen. 2006. "Conflict, Food Insecurity, and Globalization." FCND Discussion Paper 206, International Food Policy Research Institute.

Mkandawire, Thandika. 2002. "The terrible toll of post-colonial ?rebel movements? in Africa: towards an explanation of the violence against the peasantry." The Journal of Modern African Studies 40(2):181–215.

Montesano, M. and Patrick Jory. 2008. Thai South and Malay North: Ethnic Interactions on a Plural Peninsular. Singapore: NUS Press.

Ofuoku, A.U. 2009. "The Role of Community Development Committees in Farmer-Herder Conflicts in Central Agricultural Zone of Delta State, Nigeria." International Journal of Rural Studies 16(1):1–10.

Planning Commission of India. 2008. "Development Challenges in Extremist Affected Areas: Report of an Expert Group." Official Report.

Singer, J. David, Stuart Bremer and John Stucky. 1972. Capability Distribution, Uncertainty, and Major Power War, 1820-1965. In Peace, War, and Numbers, ed. Bruce Russett. Beverly Hills: Sage.

Sundar, Nandini. 2007. Subalterns and Sovereigns: An Anthropological History of Bastar (1854-2006), 2nd Edition. Delhi: Oxford University Press.

The Nation. 2004. "Food fights between BRN-C and Farmers in Songkhla." The Nation 19 November 2004, pp.A-2.

The New Zealand Herald. 2002. "Timor peacekeepers farewelled as 'epitome of modern force'." November 15, 2002.

Tonah, Steve. 2006. "Migration and Farmer-Herder Conflicts in Ghana's Volta Basin." Canadian Journal of African Studies 40(1):152–178.

Walker, C.F. 1999. Smoldering Ashes: Cuzco and the Creation of Republican Peru. Durham: Duke University Press.