Food Fight:

The Effect of Food Availability on the Probability of Violent Conflict Onset

by

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In the past decade, scholars have increasingly turned to quantitative analysis to understand the complex interplay of factors driving intrastate conflict. International agencies, nonprofits and governments have maintained that food insecurity is a significant driver of violent conflict. This paper tests this popular assumption with a model drawn from Azar's Theory of Protracted Social Conflict and a fixed effects logistic regression and finds that food availability has no significant effect on the probability of violent civil conflict onset. However, other factors such as a country's level of integration into the international system of states and economic growth are likely to be more effective at maintaining global stability. The policy implications are that efforts to promote peace can be more effective by focusing on integration into the world community and economic growth than by focusing exclusively on food availability.

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INTRODUCTION AND STATEMENT OF THE PROBLEM

Since the beginning of recorded history, people have associated periods of hunger with violent conflict. Cicero reported an attack on his home by an angry, hungry mob as early as the first century BC. Charles Tilly (1971) considers the "bread riot" to be the quintessential form of popular resistance in the late middle ages. More recently, the grey literature and press frequently link food insecurity and conflict, reporting many case studies of conflict driven by food insecurity, including the downfall of the Haitian government in 2008 (BBC Report, 2008). Agencies dedicated to food aid such as the International Food Policy Research Institute (IFPRI) have directly attributed violence to a lack of food security, particularly in its analysis of the Arab Spring (IFPRI, 2013). Additionally, in the United States, this assumption has been built into foreign policy as noted by the State Department in 2012 during World Hunger Day in its Twitter feed: "Food security is linked to global security. Chronic hunger creates conditions ripe for conflict" (2012).

The food security and conflict nexus provides a compelling rationale for foreign aid, especially in the context of future climate change, where some academics have argued that climate change will yield changes in food production patterns (IPCC, 2007; CNA Corporation, 2007). However, the empirical evidence showing that decreased food security leads to violent civil conflict is limited. Violent conflict unambiguously reduces individual levels of food security (Cohen, 1999), but the converse relationship is less clearly understood. Quantitative, causal research has been limited and in the few cases it has been tried, the findings are in disagreement, possibly due to methodological and data concerns common to the study of

conflict, including missing data and atheoretical, kitchen-sink regression models that lead to omitted variable bias.

Throughout the pact century, the study of conflict has evolved from simple mono-causal explanations of violent conflict, to complex multi-causal models of war attributing violence to a complex set of interactions between structural and individual motivational factors (Demmers, 2012). In the late 1990s, datasets and computing power enabled researchers to employ large-n econometric analysis to study the causal effects of violent conflict. However, the proliferation of studies has not led to general theory convergence, potentially because the models employed a "kitchen-sink" approach, where any potential relationship was included in the quantitative models (Dixon, 2009). This lack of convergence suggests that any analysis of violent conflict should be explicitly theoretically driven and should employ a complex, multi-causal theory of violent conflict.

This essay employs the theory of Protracted Social Conflict (PSC) (Azar, 1990) to guide the development of a quantitative model to answer the unresolved question of whether food availability affects the probability of civil conflict onset. PSC is consistent with theoretical work on food conflict from Messer (2009) and Patel and McMichael (2009) who argue that conflict follows from a combination of poorly functioning states and deprivation of human needs. This work also helps to identify potential omitted variables in the existing conflict literature. Using a fixed effects logistic regression and a dataset from 1965-2006, I test whether food availability, a key human need, reduces the probability of civil conflict onset as PSC suggests that it should. This study refines knowledge on the theory of Protracted Social Conflict. The results show that food availability has no effect on the probability of violent civil conflict onset, but that GDP per

capita, which is closely related to food access, and a country's integration into the international community have a significant effect. This study also informs policy about the generalizable effect of food availability on violent conflict, permitting improved efficiency of peacekeeping efforts and risk analysis for countries exposed to changing food availability due to climate change.

LITERATURE REVIEW

There are four key trends in the study of violent conflict. First, the study of violent conflict has evolved considerably in the last two decades as it reorients away from the Cold War paradigm of superpower conflict toward what Edward Azar (1990) has called the "new wars." These new wars are characterized by ambiguous start and end dates, protractedness, a lack of formally declared armies, a change in foreign support (away from superpower support), de-territorialization and the rise of identity groups. This shift in studies coincides with a precipitous drop in international conflicts and an increase in intra-national conflict (Figure 1). These "new wars" have driven scholars to focus more on state building and individual motivation for violent intra-national conflict (within states) as opposed to international violent conflict (between states). Second, increasing awareness of the risks posed by climate change have pushed theory and research to address natural resource conflict and has inspired a limited literature that focuses on hypothesized impacts of climate change on violent conflict in order to help policymakers prepare for climate change impacts (Nordas and Gleditsch, 2007). Third, increasing computational abilities and more widely available data has led to an explosion of quantitative studies looking to predict violent conflict using econometric methods. These results have varied widely and the increase in studies has not led to a convergence in theory. Dixon (2009) has shown that these studies typically did not employ robust theoretical specifications and may be

prone to omitted variable biases that reduce the reliability of their findings. His critique suggests that any future studies should clearly identify a theory for testing and specify an empirical model based on that theory. Developments in classic conflict theory, natural resource conflict theory and quantitative research have not been closely connected and development in one branch has often not contributed to the development of the other three. As a result, both classical theory development and the quantitative empirical literature have stalled.

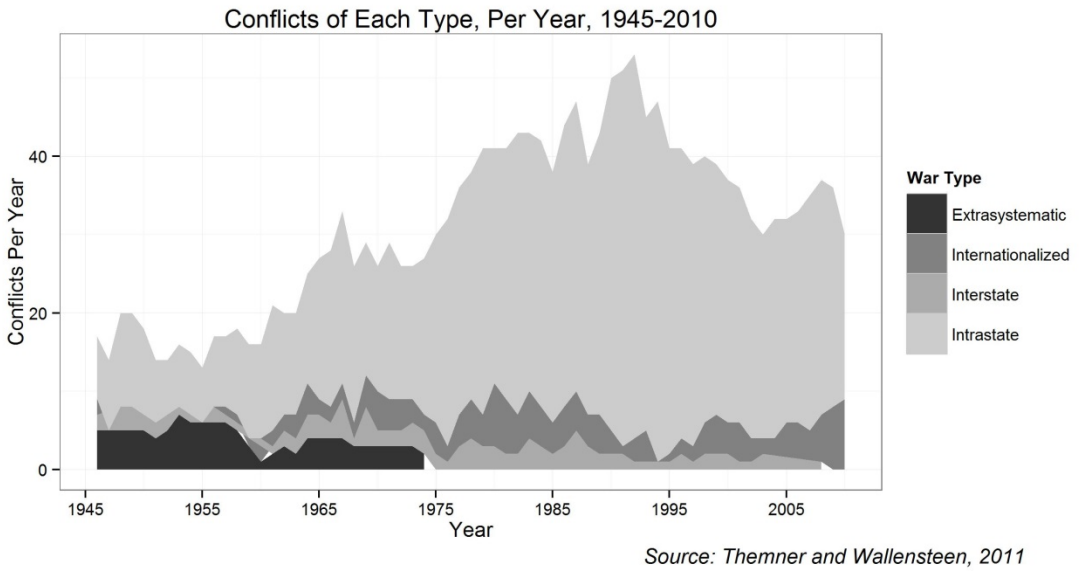

Figure 1 – Conflicts of Each Type, Per Year, 1945-2010

Theorists approach human agency differently and it is a useful way of categorizing conflict theories. Individualist theories of conflict argue that people's motivations are the key to explaining violent conflict. Many authors in this tradition have attributed violent conflict to rational utility maximizing actors (Hirshleifer, 1995; Collier and Hoeffler, 2004; Demmers, 2012). The "greed hypothesis," known as the "Honey-Pot Hypothesis" in the natural resource conflict literature, has been a dominant force in the quantitative conflict research. It suggests that wars

break out primarily due to the desire to possess an indivisible good such as oil resources that can be easily captured and that grievance factors like inequality or bad governance are unimportant (Collier and Hoeffler, 2004). In 2008, Collier, Hoeffler and Roehner stepped back from this paper and suggested that a structural feasibility interpretation might be more relevant (discussed in the next section). Other critiques suggest that the variables supporting the greed hypothesis, like GDP per capita, could easily be interpreted as grievances and that the distinction is purely theoretical (Cramer, 2002). Individualist theories share a common theme by assuming that individuals make decisions unconstrained by structural features, which has led to criticism as noted above.

In contrast, structural theories of conflict attribute the cause of violent conflict to factors outside the control of individuals, instead attributing it to environment, political setting, economic structure and other relatively stable, institutional factors (Demmers, 2012). Prominent quantitative work on structuralism has focused on factors such as pragmatism or feasibility (See: Fearon and Laitin, 2003; Horowitz, 1981; Collier, Hoeffler and Rohner, 2008). This theoretical perspective suggests that violent conflict can best be predicted by looking at the places where it is most feasible. Mountainous terrain, easily fragmented societies (through high levels of ethnic fragmentation), weak states and places with sufficient resources to purchase weapons (or an abundance of weapons in storage) affect whether or not rebels will fight. Two other popular structural theories, drawing from the natural resource conflict literature are the “Political Ecology Conflict Hypothesis” and the “Resource Curse Hypothesis.” The Political Ecology Conflict Hypothesis draws heavily on Marx and suggests that unequal distributions, based on class or other social differentiators, will lead to violent conflict (Kahl, 2006, pg. 21). In the “Resource

Curse Hypothesis," key structures are poorly formed due to the presence of high value natural resources, which may allow governments to forgo important structural developments and turn into poorly managed, rentier states that are incapable of providing basic services to the public (Kahl, 2006). Yet, structural theories tend to share a weakness when explaining human behavior because they fail to explain sudden triggers of conflict (Gleditsch and Ward, 2013; Collier, 2008).

Finally, a third category of theories mix structural and individualist elements by considering a "situated agent," who makes decisions but is constrained or enabled by structural forces (Demmers, 2012, 83). The mixed approach to conflict theory developed largely as scholars realized that the extreme forms of classical theory were insufficient to explain much of conflict behavior. Ted Gurr (1970) was a major contributor to the hybridization of conflict theory with the theory of Relative Deprivation (RD) by incorporating key structural features of conflict like persistent poverty and inequality within communities of individuals who have personal interests and fight when they experience a perceived deprivation. A more balanced version of these hybrid approaches, Azar's theory of Protracted Social Conflict is a descriptive framework that draws broadly from both Maslow's hierarchy of needs and builds on Gurr. The theory argues that when key human needs are not met (or access is reduced) and a state is unable to meet those needs, conflict is inevitable. The hybrid approach is also seen in the natural resource conflict literature, where Kahl (2006) noted that weak "institutional inclusivity," mixes with high levels of ethnic "groupness," and deprivation of natural resources like water, land and timber occurs. Similarly, Messer (2009) and Patel and McMichael (2009) note that food conflict develops because of deprivation of food resources, worsened by the presence of states that are too weak or corrupt to address the concerns.

Multicausal models are sometimes criticized for their limited success in actually explaining conflict and are often purely descriptive. Both structuralists and individualists have rejected (perhaps prematurely) hypotheses about relative deprivation (grievance) in quantitative empirical models, primarily by taking an individual (e.g. Collier, et al., 2004) or a structural interpretation (e.g. Fearon and Laitin, 2003) and avoiding interpretations that blend the two. Additionally, quantitative multi-causal models have not typically considered the interactions between structural and individualist variables as suggested by multi-causal theories. The needs based theories are clearly designed to understand the interaction between structural (e.g. inequality) and individualist (e.g. a desire for wealth) to understand how these features affect conflict together.

Methodologically, the development of high powered personal computing and greater access to data has enabled researchers to more easily apply quantitative research methods. However, this explosion in quantitative studies has failed to yield the expected improvements in our understanding of conflict because the results are more frequently contradictory than confirming. Dixon (2009) studied all of the published findings on the cause of conflict from 1998 to 2007 and argues that the contradictory findings are partially a function of the limited application of theory to quantitative research. Additionally, data limitations mean that testing hypotheses about theories employing similar proxies risks providing evidence that fails to distinguish between theories (Cramer, 2002).

Consensus has not been achieved since Dixon finished his detailed literature review in 2007 as illustrated in Table 1. Since 1998, 21 variables have been tested in 10 or more models. Table 1 reports their average effect and the number of models in which they appeared. Many of

the factors build on either Fearon and Laitin (2003), or Collier and Hoeffler (2004). Only 11 of these 21 factors have found consistent effects more than 50% of the time, likely due to two key methodological reasons. First, omitted variable bias caused by atheoretical model specification and random effects modeling is a likely problem. Atheoretical models may be blind to key missing variables and random effects modeling misses potentially important country or time fixed effects. Second, several authors have noted that different factors have different effects on different specifications of conflict. Specifications of conflict include size of conflict (the cutoff threshold for defining a conflict may be 25 or 1000) and rules about proportion of battle-deaths by each side. For example, the Correlates of War requires that both sides suffer at least 5% of total conflict deaths (Cotet and Tsui, 2010; Bazzi and Blattman, 2011; Dahl, 2012). Additionally, the lack of explicit theoretical specifications in the literature means that interpretations of findings differ based on theoretical predisposition of the author. For example, GDP per capita is shown to have a significantly negative effect approximately 61% of the time (in 67 studies). However, GDP per capita is interpreted theoretically differently in these articles, including as a measure of state strength (for example: Fearon and Latin, 2003) and as an indicator of reduced opportunity cost for conflict (for example: Collier and Hoeffler, 2004). Cramer (2002) notes that GDP per capita could be construed as an amount of deprivation in line with Gurr's theory of Relative Deprivation. This consistent finding, due to ambiguities in its interpretation, has done little to advance theory.

Table 1 – Top 21 Variables Tested in Quantitative Literature

Variable	Sum Of Effects	N Models	Avg. Effect
Per-capita GDP	-41	67	-0.612
Ethno-linguistic fractionalization	11	60	0.183
Democracy	-3	49	-0.061
Population	24	36	0.667
Mountains	18	35	0.514
Recent Regime Change	21	34	0.618
Oil Exporter	21	33	0.636
Peace Years	-13	33	-0.394
Polity Score	3	33	0.091
Religious Fragmentation	-1	27	-0.037
Primary Commodity Exports	1	25	0.04
Anocracy or Semi-Democracy	12	21	0.571
New State	12	19	0.632
GDP Growth	-8	16	-0.5
Previous War Since 1945	-4	16	-0.25
Noncontiguous State	8	15	0.533
Per-Capita GDP Growth	-8	14	-0.571
Population Density	6	11	0.545
Ethnic Heterogeneity	7	10	0.7
Rainfall Deviation	2	10	0.2

(1) Variables studied more 10 times or more in the literature.
(2) "Sum of Effects" assigns a value of -1 for negative significant findings, +1 for positive significant findings and 0 for insignificant findings.
(3) "Avg. Effect" is the Sum of Effect divided by Count
Sources: Dixon, 2007; Authors own review of literature from 2007-2012

The quantitative study of food as a cause of conflict has had limited success. Pinstrup-Anderson and Shimokowa (2008) found that malnutrition and general poverty exacerbated the risk of violent conflict, but due to missing data with regard to malnutrition, their sample shrunk to only 38 total cases (from approximately 3,000 country years to start). They found a significant relationship, but the finding was tempered by the small sample. Bazzi and Blattman (2010) studied the effect of agricultural commodity prices on conflict, suggesting that higher prices will lead to higher risk of conflict due to deprivation of food access but they found no significant effect, attributing the non-finding to inconsistencies in translation of international market prices

to local market prices. Both approaches incorporated an analysis of human needs deprivation with regard to food, but came to differing conclusions.

Three key lessons regarding both theory and methodology can be drawn from this literature review. First, theory has moved away from the first generation mono-causal explanations of either individual motivation or structural explanations of violent conflict and towards multi-causal, interactive models. Second, the sensitivity to multiple codings of the dependent variable is crucial to understanding the generalizability of the results. This analysis follows Bazzi and Blattman (2011), Cotet and Tsui (2010) and Dahl (2012) in testing model specification on four different versions of violent civil conflict. If a variable is significant in only one out of four possible specifications, the generalizability of the findings should be questioned. Third, the quantitative literature has developed rapidly, but not incorporated the wealth of theoretical development, instead focusing on kitchen-sink regression analyses that do not contribute to theory development leading to stasis in both. Addressing the problem requires a paradigm shift in the quantitative conflict literature away from adding a single variable to the standard set of controls and instead towards focusing on theory-specified models of conflict that reflect the state of the art in the theory of violent conflict.

Drawing from these lessons, this paper employs Azar's theory of Protracted Social Conflict as a guide for building a quantitative model of violent conflict. PSC has synergies with Gurr's work, but expands it by explicitly defining the causal mechanisms for translating needs deprivations into violence. PSC suggests that deprivation turns into violence when a state has high communal diversity, low state competency and limited international connections. It also explicitly outlines security needs and acceptance needs as the key needs of the masses that may

lead to deprivation. Furthermore, the probability of conflict or cooperation is strongly affected by the competing groups' histories of conflict or cooperation. Finally, PSC has synergies with Kahl (2006) and food conflict theorists like Patel and McMichael (2009) and Messer (2009). Like Relative Deprivation, they also fail to address key factors like a history of violence within a culture, suggesting that they may be prone to omitted variable bias. PSC more adequately addresses these missing factors and serves as a useful theory to guide model specification in order to test the effect of food security on violent conflict, analyzing deprivation of the need for food. Figure 2 and Figure 3 illustrate both Azar's (1990) theoretical model of Protracted Social Conflict and this paper's empirical model based on Azar. Factors in the model that examine mechanisms of violent transition, such as communal or state actions and strategies are assumed to be random or captured by country fixed effects, although this may be a faulty assumption and contribute to omitted variable bias. More complete data is not available to test those components.

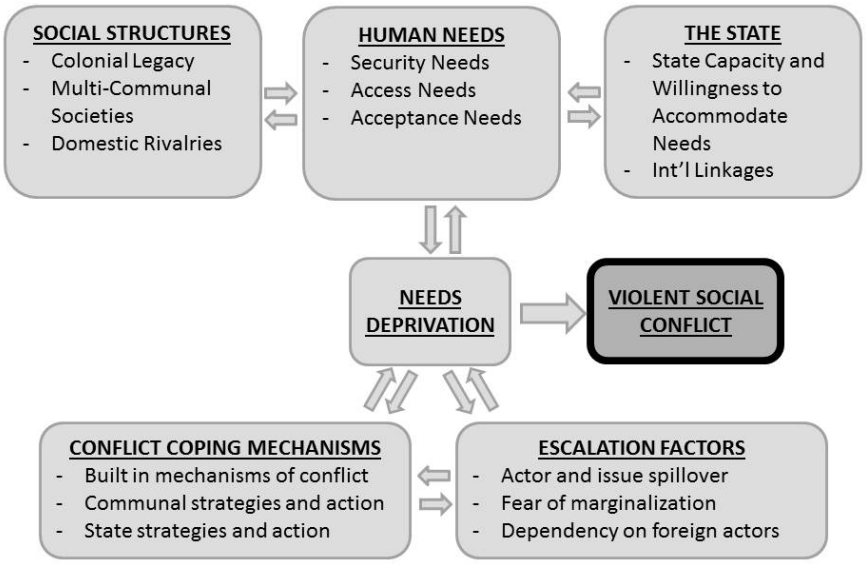

Figure 2 – The Theory of Protracted Social Conflict (Azar, 1990)

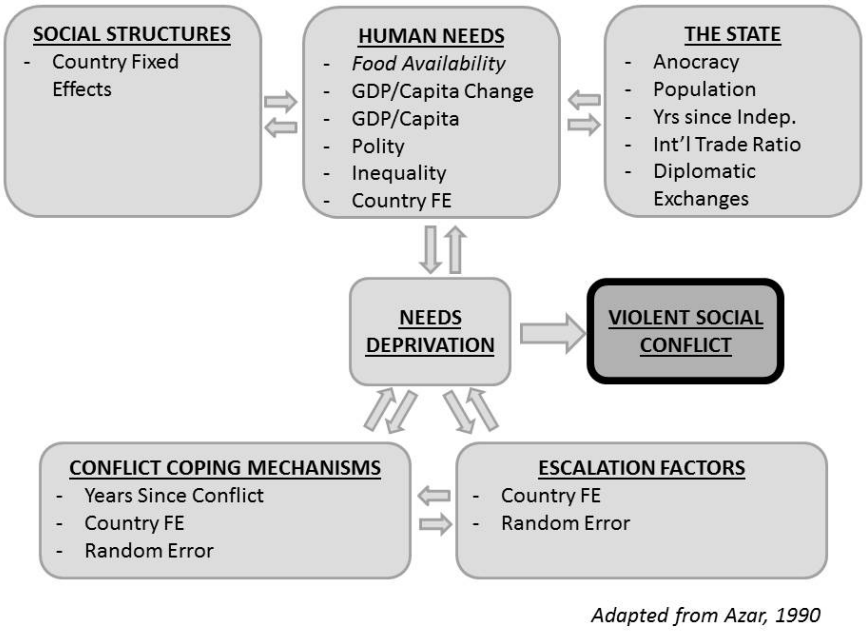

Figure 3 – Empirical Model Derived from Azar (1990)

METHODS

This model employs logistic regression for hypothesis testing. Logistic regression offers two key benefits. First, it constrains estimates between 0 and 1, maximizing the probability of onset as 100%, which a linear regression does not do. Second, it automatically accounts for interactions between variables in the estimation of parameter values (Norton, Wang and Ai, 2004), which is a key theoretical need for the highly complex, interactive conflict models described in the theoretical literature. The addition of fixed effects represents a departure from most of the existing literature. Country fixed effects control for time invariant factors in a state that may affect their probability of conflict, thus reducing the risk of omitted variable bias. This effectively makes each country an experimental group. Time fixed effects control for location invariant factors in a time period. They are more frequently employed in the literature than country fixed effects. All time varying independent and control variables are lagged by one year. Finally, the analysis drops all observations of consecutive conflict to avoid endogeneity, where conflict affects the explanatory variables and biases the predictors. Data sources are discussed in detail below.

$$\begin{aligned} Conflict_{ct} = \lambda(&\beta 1 GDPCapChange_{c(t-1)} + \beta 2 LN(GDPCap)_{c(t-1)} \\ &+ \beta 3 Ln(Pop)_{c(t-1)} + \beta 4 IntlTrade_{c(t-1)} + \beta 5 Consolidation_{c(t-1)} \\ &+ \beta 6 YrsSinceIndep_{c(t-1)} + \beta 7 Inequality_{c(t-1)} \\ &+ \beta 8 InequalityMissing_{c(t-1)} + \beta 9 DipExch_{c(t-1)} \\ &+ \beta 10 YrsSinceConflict_{c(t-1)} + \beta 11 FoodAvailability_{c(t-1)} \\ &+ \beta 12 CountryDummy_c + \beta 13 YearDummy_t + e_{ct}) \end{aligned}$$

HYPOTHESIS

I hypothesize that there will be a negative and significant relationship between food availability and the probability of conflict initiation. Given the theories of Relative Deprivation

and Protracted Social Conflict, decreased food availability should increase the probability of violent conflict, *ceteris paribus*. A null finding for this independent variable will undermine the notion that food availability is a driver of conflict.

H0: Food Availability Impact = 0

H1: Food Availability Impact != 0

DATA

The dataset for this study has been constructed from several sources, including the World Bank's Global Development Finance Database (WB-GDF) (2011), the Polity IV Project (Marshall and Gurr, 2010), the Occupational Wages of the World (OWW) dataset (Oostendorp, 2012), the Correlates of War project and the Upsalla-Conflict Data Project (UCDP) (Gleditsch, Wallensteen, Eriksson, Sollenberg and Strand, 2002 [Note: 2011 version used for analysis]). The analysis is in panels of country years ranging from 1965 to 2006, although due to the creation of lags, data used in the analysis will range from 1966-2006. Missing data is handled using list-wise deletion in most cases, although inequality is imputed with zeros where missing and an indicator for missingness is included in the regression to check for systematic bias. List-wise deletion does increase the risk of a biased sample because many countries where data are not collected are less stable or relatively more poor. In the case of inequality, the number of missing observations is severe and requires imputation in order to allow a model to be estimated. Significant results for the missingness indicator in some model specifications suggest that results are systematically biased (if the dummy is omitted) and this is corrected by keeping the indicator in the model (Dardanoni et al., 2011). The results section details the impact of list-wise deletion

more completely. This section details the variables drawn from each of these datasets. The summary statistics are presented in Table 2.

Table 2 – Descriptive Statistics

Variable	Median	Mean	SD	Nas	Expectation	N
Security Needs						
Availability Per Capita (kg)	987.6	1062	542.1058	3933	(−)	1915
GDP/Cap Growth	6.124	6.865	15.57094	885	(−)	4963
Ln(GDP/Cap)	7.001	7.251	1.654845	801	(−)	5047
Access Needs						
Polity 2	0	0.5272	7.594825	121	(−)	5727
Gini	0.243	0.25	0.10957	4818	(+)	1030
State Capacity and Willingness						
Consolidation	7	7.141	2.636343	121	(−)	5727
Ln(Population)	29.56	29.6	1.5178	250	(+)	5598
Yrs Since Indep	43	116.8	190.0771	42	(−)	5806
International Linkages						
Allies Percent	29.52	34.03	21.50142	768	(−)	5080
Trade Ratio	51.03	66.29	154.1281	817	(−)	5031
Mechanisms of Conflict						
Peace	19	20.45	17.66143	714	(−)	5134

(1) Dropping years of consecutive conflict
(2) Availability Per Capita includes Cereals, Vegetables, Meats, Starches, Sugarcrops and Pulses

CONFLICT

In this analysis, conflict is coded three different ways in order to model differently sized conflicts separately. Conflict datasets vary significantly in their definition of a conflict, and the literature suggests that any findings on the correlates of conflict should test across multiple datasets to account for uncertainty of results. A methodological concern is that authors tend to focus on a narrow subset of civil conflicts, but then generalize that finding across all types of violent civil conflict. This analysis follows Cotet and Tsui (2010), who showed that grievances have a more significant effect on lower violence than in larger violent conflicts, suggesting that

the different levels of conflict should be considered discretely in any analysis. Conflict is analyzed at discrete levels of violence across multiple datasets.

This study recodes UCDP's 2011 version 4 conflict dyads dataset into country time-series where 1 equals the presence of at least one civil conflict with more than 25 deaths in a country in a given year. It includes only conflicts involving a state actor against a non-state actor. Consecutive years of conflict have been dropped to avoid endogeneity and focus exclusively on conflict onset. Consistent with Bazzi and Blattman (2011), Cotet and Tsui (2010) and Dahl (2012), two alternative specifications address only conflicts with fewer than 1000 deaths and only conflicts with more than 1000 deaths. Due to missing data and the small number of conflicts coded over 1000 deaths, the model failed to converge for the sample of conflicts in this category, so that model is dropped from the results. One other alternative specification employs the dataset of conflicts from the Correlates of War (COW) "Intrastate Wars" dataset, which requires that a conflict achieve a 1000 death toll threshold and that 5% of fatalities be inflicted by the opponent to distinguish between riots, wars and massacres (Sarkees and Wayman, 2010). This alternative dataset addresses Bazzi and Blattman's (2011) concern about the resilience of findings when tested against only a single dataset.

Table 3 – Dependent Variable Descriptive Statistics

Data Specification	N Obs	N States	N Onset	N States Onset
UCDP All	5848	163	170	82
UCDP Small	5848	163	103	65
UCDP Large	5848	163	67	39
COW	2609	81	61	39

(1) UCDP All - More than 25 battle deaths
(2) UCDP Small - More than 25 battle deaths, fewer than 1000
(3) UCDP Large - More than 1000 battle deaths
(4) COW - Correlates of War, More than 1000 battle deaths, 5% inflicted by opposition

SECURITY NEEDS

Food availability is the sum (in kg) of food produced and traded in a country derived from FAO (2012) food balance data and includes the categories of cereal grains, meat, vegetables, pulses and sugars, averaged across the population. These are the main categories of food production and exchange.

Food availability is an incomplete measure of food security; however, it is frequently employed in analyses of food security because it is both easily measurable and the first component of a three part model of food security that includes food availability, food access and food utilization. Other measures of food security posed difficulties for this analysis. Measures of food access are broadly unavailable for a cross-country study because they depend on measuring individual level incomes, safety net access to food and specific markets. Measures of food utilization, which are preferred in the food security literature because they represent the impacts of food security or insecurity, are broadly unavailable for a cross-country study. Data on under-nutrition is collected by the World Health Organization, but due to its costly and

time-consuming collection, the data is collected infrequently and incompletely for a world sample, reducing sample size to unusable levels.

PSC considers food security a key human security need, so increasing food availability, *ceteris paribus,* should reduce individual deprivation and reduce the risk of civil conflict.

GDP per capita growth is drawn from the WB-GDF (2012) dataset variable indicating a country's GDP in 2011 US dollars and measures the percentage difference in GDP from time = -2 to time = -1. It is one of the most consistent predictors of violent conflict in the quantitative literature and in this model represents a key human security need as a source of income for housing, food, healthcare and other key life-sustaining needs. As GDP per capita increases, the risk of civil conflict declines.

The natural logarithm of GDP per capita is the logarithmically transformed value from the WB-GDF (2012) dataset indicating a country's GDP in 2011 US dollars. The transformation normalizes the data, which is highly and positively skewed towards wealthier states (Hill et al., 2008, 93). This measure represents the *level* as opposed to growth of GDP per capita. It is included here because it represents the ability of a state to accommodate individual and group needs. Wealthy countries are more capable (not necessarily willing) of making larger investments in addressing the public's unmet needs and it should reduce the risk of violent conflict.

ACCESS NEEDS

Polity, or government type, is measured by the frequently used Polity 2 measure from the Polity IV dataset. It codes countries from -10 (fully consistent with an autocratic state) to

+10 (fully consistent with a democratic state) (Marshall and Gurr, 2010). The literature is mixed with regards to its handling as either a dummy, ordinal or continuous variable, but will be included here as a linear, continuous variable. Past literature has shown inconsistent results for this variable, but this may be due to omission of a variable representing a state's level of consolidation, which this model includes. According to PSC, as countries democratize, access should increase for the public and decrease deprivation and the risk of civil conflict.

For this model, inequality is drawn from Oostendorp (2012), who developed a dataset identifying inequality in worker's wages by occupational industry. It is measured as the Gini coefficient calculated from the OWW data by country-year. Consistent with Milanovich and Squire (2005), each Gini score required that at least fifteen occupations report data; otherwise it is counted as missing data. This necessarily limits the sample, but reduces the risk that single occupations will skew results significantly. This data has been normalized to account for differences in reporting between countries and provides data normalized for consistent time periods and to account for differences in reporting (for example, does the country report male or female wages separately or combined).

Inequality is a data-intensive, complex variable to measure across countries, so data are very sparse. Gallup (2012) notes that considerable measurement error is introduced to most inequality datasets due to differences in survey instruments, including the popular Deninger and Squire (1996) dataset. Unfortunately, the Oostendorp (2012) data is also recorded inconsistently, with some countries reporting regularly, some not reporting at all and a range that report inconsistently. There are 7,853 possible country year observations and only 16% come with measures of the OWW Gini coefficient. The missing data significantly biases the

results in some models when missing data is imputed as 0 and a dummy is included for imputed variables. This bias is corrected for by the inclusion of the dummy and imputed data in the final model (Dardononi et al., 2011).

Inequality is a highly relevant variable in most of the literature, but it is rarely included in empirical models because of the data acquisition challenges. In PSC, it represents an access need and increased inequality adds to an individual's level of deprivation, making civil conflict more likely.

STATE CAPACITY AND WILLINGNESS TO ACCOMMODATE NEEDS

Consolidation of government authority is the absolute value of Polity IV's scale of democracy and measures from 0-10 the level of anocracy in a state (where 0=fully anocratic). A complete autocracy is equal to a complete democracy with a score of 10. Vreeland (2008) notes that scale construction for the Polity IV variable includes a competition variable that draws down the measure of consolidation in cases of violent conflict and could lead to endogeneity. Time lags eliminate this endogeneity problem. Theoretically, as a state consolidates power more completely towards either democracy or autocracy, the institution of the state will grow stronger and reduce the risk of civil conflict.

The natural logarithm of population is the logarithmically transformed value of total population from the WB-GDF (2012) dataset at time t-1. The logarithmic transformation normalizes the highly skewed distribution (Hill et al, 2008 pg. 93). Population represents a threat to human security needs across the board through increased competition for all scarce resources and as it increases, the probability of conflict should also increase.

Years since independence is coded as the lagged difference between the country year in the dataset and the year of independence according to Hensel (2009). It represents a potential structural factor underlying violent civil conflict where states who recently achieved independence may be vulnerable to competing claims for power, weak government, low levels of legitimacy and other factors that may increase the risk of violent conflict.

PATTERNS OF INTERNATIONAL LINKAGES

The international trade ratio is the total trade (imports + exports) as a percentage of the total economy (GDP), indexed to 2009 for inflation and lagged by one year. The economic trade data comes from the Correlates of War project (Barbieri, Keshk and Pollins, 2009) and the GDP data comes from the WB-GDF dataset (2012). It is frequently used to measure states' economic integration into the international community and may provide incentives for states to avoid destabilizing actions.

A diplomatic exchange is simply the percentage of diplomatic missions in a given country out of the total possible missions. This data is drawn from the Correlates of War project and recoded from a country-year dyad format to count the percentage of available diplomatic exchanges that a country participates in (Resat, 2007). It is lagged by one year. The data is available in 5-year increments from 1920-2005 and interpolated in missing years assuming a linear progression from period 1 to period 2. Diplomatic exchanges are a direct mechanism for the international system to pressure states to avoid conflict and also a means of sharing information about state violence against citizens, so a higher score should reduce conflict risk.

BUILT IN MECHANISMS OF CONFLICT

Peace years is the number of years since the last conflict, either international or intranational, lagged by one year and drawn from the UCDP dataset. This approach is consistent with more than 20 other models in the literature. This represents the built in mechanisms of conflict and suggests that proximity (in time) to war has a strong effect on conflict. Other authors support this notion and find that it normalizes the experience of war (Apter, 1998; Norris, 2000) and reduces the costs of mobilization (Hirschleifer, 1995).

DATA CHALLENGES

While this model more clearly approximates the theory of Protracted Social Conflict, and reduces the risk of omitted variable bias, there is a greater risk of multi-collinearity and reduced efficiency of the estimator. Variance Inflation Factors (VIF) provide a measure of multicollinearity and Allison (1999, pg. 50) recommends a cutoff of VIF=2.5. Food availability does not meet this threshold, but diplomatic exchange and the logarithm of population both do. This may underestimate the significance of their effects.

Additionally, in Macedonia and Swaziland, the independent variables of interest include values that are implausibly high and the countries are dropped from the analysis to avoid measurement bias.

RESULTS

Table 2 shows the results of the fixed effects logistic regressions in odds ratios. The values represent the percentage change in the probability of conflict onset for a one unit change in the independent variable. Accordingly, a parameter estimate of one represents no effect,

while a value under one is a negative relationship and a value over one is a positive relationship. The table shows results for three different specifications of violent conflict, each with an unconditional regression of the food availability variable and with a full model based on Azar's PSC. This section walks through the findings variable by variable and then discusses the potential issues introduced by missing data.

Table 4 – Results of Fixed Effects Logistic Regression

	All Conflicts		Small Conflicts		COW Conflicts	
	Food Only	Full Model	Food Only	Full Model	Food Only	Full Model
Security Needs						
Avail/Cap (kg)	1.00*	1.00	1.00	1.00	1.00	1.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
GDP/Cap Growth		0.96**		0.96		1.03
		(0.02)		(0.02)		(0.03)
Ln(GDP/Cap)		1.15		0.68		0.34
		(0.92)		(1.24)		(1.98)
Access Needs						
Polity 2		1.08		1.29**		1.02
		(0.06)		(0.10)		(0.14)
Gini		0.15		0.01		1.14
		(2.11)		(3.10)		(6.78)
Gini Impute Flag		1.80		4.19		0.17
		(1.25)		(1.80)		(3.43)
State Capacity and Willingness						
Consolidation		0.95		0.99		1.54
		(0.14)		(0.20)		(0.31)
Ln(Population)		385.08		1325.70		0.00
		(4.29)		(5.63)		(12.85)
Yrs Since Ind		1.38		1.30		0.65
		(0.32)		(0.32)		(2.50)
International Linkages						
Allies Percent		0.82***		0.86**		0.66**
		(0.06)		(0.07)		(0.17)
Trade Ratio		1.03		1.03		1.17**
		(0.03)		(0.03)		(0.06)
Mechanisms of Conflict						
Peace Yrs		1.10***		1.15***		0.95
		(0.03)		(0.04)		(0.06)
AIC	338.60	319.33	236.80	221.00	163.67	151.40
BIC	537.38	562.74	377.71	401.65	258.41	279.76
Log Likelihood	-120.30	-99.66	-79.40	-60.50	-50.84	-33.70
Deviance	240.60	199.33	158.80	121.00	101.67	67.40
Num. obs.	427	427	274	274	157	157
Num. States	23	23	20	20	13	13
Num Wars	43	43	27	27	21	21

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

(1) Results in odds-ratio

(2) Country and Time FE suppressed

(3) "All Conflicts": UCDP, more than 25 battle deaths; "Small Conflicts": UCDP, More than 25 and fewer than 1000 battle deaths. "COW Conflicts": COW, More than 1000 battle deaths and at least 5 percent casualties inflicted by rebels.

SECURITY NEEDS

Food availability was statistically significant in only the specification with no control variables and lumping together all sizes of conflict, although in the Correlates of War specification, it comes close (p-value=.107). The direction of the insignificant effects in the model runs is positive and the opposite of what Protracted Social Conflict theory would suggest. The results are consistent with a variety of alternative specifications, including a quadratic relationship, the use of categorical values, and an alternative specification using only cereals, vegetables and meats as food types (dropping pulses and sugar crops). These sensitivity test results are discussed in greater detail in Appendix 1. This finding is discussed in greater detail in the discussion section as a matter of policy.

GDP per capita growth is not consistently significant across all versions of the dependent variable, but does have a highly significant negative effect in the sample of all conflicts for UCDP, consistent with the literature. In the specification for all conflicts, one percent of economic growth makes conflict 96% as likely. This suggests a small effect. The implications of this finding are discussed in greater detail in the discussion section.

The natural logarithm of GDP per capita (level of wealth in a country), as opposed to its growth rate, has no significant effect in any of the models.

ACCESS NEEDS

Polity, which has found inconsistent results in the literature, shows an interesting effect in this model. It is significant only in the models that separate small conflicts (fewer than 1000 deaths) from large conflicts (greater than 1000 deaths). Increasing the Polity IV scale by one

point (towards democracy), increases the probability of a small-scale conflict by 29%. This may suggest that there are severe tradeoffs to democracy promotion. This effect remains consistent across a variety of specification sensitivity tests, detailed in Appendix 1. This finding is discussed in greater detail in the discussion section as both a theoretical implication and a policy implication.

The effect of inequality in this model is inconclusive because of the significant amount of missing data it introduced. It was included as a necessary control for theoretical reasons even though a significant portion of the data was missing. Any significant findings may be spurious, although it never achieved significance in any of the primary models. The limited data affects the validity of this finding.

STATE CAPACITY AND WILLINGNESS TO ACCOMMODATE NEEDS

Consolidation, measured as the absolute value of the Polity 2 score in the Polity IV dataset, had an insignificant effect across the board, although in small scale conflicts its sign was negative and in large scale conflicts (COW specification) its sign was positive. This suggests that in some cases, the consolidation of the government reduced the likelihood of small conflicts, but increased the risk that a conflict would escalate into a large scale civil war. Interestingly, this finding becomes significant when the full sample is tested and food availability per capita is dropped (due to missing data), suggesting that the sample may have affected the finding of no significance.

Population had no effect among smaller conflicts or the conflicts coded by the Correlates of War project. Due to multicollinearity and sample size, significance is understated in the models.

Years since independence was insignificant in all specifications, suggesting that either the sample size was too small for inference or that it has no effect.

PATTERNS OF INTERNATIONAL LINKAGES

A country's level of international trade significantly increases the risk of major civil wars (COW specification), but had no effect on smaller conflicts, suggesting that it enables larger scale violence. A one percent increase in trade makes a country approximately 17% more likely to engage in a civil war. This finding may be sensitive to the type of international trade. Many authors have linked primary commodity exports like oil to conflict (Rustad, et al. 2008; Collier and Hoeffler, 2002a; Collier and Hoeffler, 2002b; Elbadawi and Sambanis, 2002; Fearon and Laitin, 2003; Regan and Norton, 2005; Collier and Hoeffler, 2004; Collier, Hoeffler and Roehner, 2008). However, the finding is not necessarily contrary to existing conflict theories. It is broadly consistent with the feasibility and a utility maximizing rational choice interpretation because the international trade represents a lootable good for the rebel. This finding is addressed more in the theoretical implications section.

The percentage of diplomatic exchanges that a country participates in has a strong, statistically significant negative effect on the probability of conflict initiation. A one unit increase in diplomatic exchanges makes conflict about 82% as likely for all conflicts, 86% as likely for small conflicts and 66% as likely for civil wars. Increased access to international legitimacy reduces the risk of civil war to very small levels and may contribute significantly to global peace. This finding will be discussed in greater depth in the discussion section.

BUILT IN MECHANISMS OF CONFLICT

Finally, the number of years of peace significantly increases the risk of small-scale civil conflict, but has no significant effect in large-scale civil war. This finding is contrary to most of the literature. Each year of peace makes the probability of smaller conflict 10 percent more likely. This finding is consistent across a wide range of alternative model specifications in a fixed effects model and employing different samples. Additional investigation measured the effect with a quadratic term and indicates that a country's risk of conflict significantly declines initially, until approximately 10 years, and then risk increases for all UCDP conflicts. This suggests that the decline in conflict risk immediately following another conflict may reflect a war fatigue while groups rally or re-orient towards conflict. Once the critical point has passed by, the risk of conflict increases. This would be a major finding that deviates from *most*, but not all of the literature that has included it in quantitative models. Specification sensitivity tests show that the use of random effects switches the sign of this result to negative, but insignificant. Otherwise, it remains consistent across a wide range of specification sensitivity tests, including models that were subset by polity type, income level and geographic region as detailed in Appendix 1. More research is necessary to confirm this hypothesis, including unpacking the detailed components of post-war conflict re-initiation. To my knowledge this research has not been conducted and future steps are discussed in the theoretical implications section.

MISSING DATA

List-wise deletion of missing data for some independent variables is not random and reduces the generalizability of these findings. A random effects logistic regression with an indicator for missing food availability data found that small countries, with missing data for

inequality, a conflict in the coming year and an autocratic or anocratic government were significantly more likely to have missing data. The number of years since independence and number of years since conflict decreases the probability of having missing data. The percentage of alliances, GDP, GDP per capita growth, inequality, and trade ratios were randomly distributed between the missing and non-missing data. A random effects ordinary least squares regression estimating per capita food availability in a given country in a given year suggests that countries with larger populations, higher percentages of available allies and former French African colonies are negatively correlated with per capita food availability. GDP per capita and years of peace are correlated with increases in food availability. This suggests that the missing availability data may be lower (large countries tend to have lower levels of per capita availability and are significantly likely to be missing). Additionally, the fact that countries with impending conflict are more likely to be missing likely reduces the sample size and probably affects the significance levels in the model. If these same countries suffer from lower levels of availability, it could alter the finding of non-significance. Improved data on food availability would likely improve the reliability and generalizability of the results. However, the use of fixed effects and consistent availability of data for individual country panels allows for confidence in the results for this specific sample. Finally, a model with the full sample of data evaluating the PSC model without food availability per capita does not show any bias in the parameter estimates, but does highlight different significance levels for GDP per capita growth (not significant in full), population (significant in full), trade ratio (not significant in full) and consolidation (significant in full).

DISCUSSION AND IMPLICATIONS

These findings and the specification sensitivity tests suggest that food availability per capita has no significant effect on the probability of violent conflict onset. This does suggest that formal trade and production of food is unrelated to violent conflict, but data questions may affect the generalizability of these findings and suggest that the theoretical connection should not be fully discarded for two reasons. First, significant differences exist between countries with missing availability data and those with complete availability data. These differences might affect the findings, but sufficient data to test that hypothesis is not available. Second, food security theory suggests that many of the world's poorest people live almost exclusively on subsistence agriculture, whether from full-time farming or from supplemental vegetable gardens, which is not captured by this analysis (Flynn, 2005). A measure of food availability for subsistence farmers is crucial because the limitation imposed by not including subsistence agricultural entitlements may both overstate the food security effects of food availability and also fail to capture the serious ramifications of shocks to food systems by weather or even trade. New mechanisms may be necessary to account for this missing data including remote sensing techniques that analyze the agricultural content of areas through overhead detection capabilities. Another effort to measure subsistence agricultural effect might consider analyzing only countries or regions dependent on subsistence agriculture and testing the effect of rainfall as an instrumental variable against the probability of conflict onset. Both approaches could yield important insights. Nonetheless, the findings do suggest that formal availability of food has no significant effect on violent conflict onset.

Aside from the finding that food availability has no significant effect on violent conflict onset, this study also yielded novel findings about the effect of diplomatic exchanges, the importance of accounting for anocracy and the importance of separating conflicts by size. The strongly significant effect of integration with the international community, proxied by the percentage of diplomatic exchanges a country participates in, is a new finding on a previously untested variable with potential foreign policy ramifications, which will be discussed in the policy implications section. Further research into this finding could have significant theoretical implications for understanding violent civil conflict in the context of multi-level structural influences, where states are constrained by the international system. Network analysis, which looks at descriptive features of relationships between entities, could more accurately and realistically measure a state's integration than the measure employed here. That development could also potentially allow for analysis of the types of networks that yield greater peace dividends and support policymakers interested in promoting peace.

The inclusion of a variable measuring a state's consolidation of authority helped to better understand the direct effect of polity type on civil conflict. Future research that incorporates this previously underused variable could better account for the strength of a state and allow the polity measure to more accurately reflect government type and not government consolidation. In this analysis, it helped to produce interesting insights and should be considered in future modeling efforts.

In keeping with Bazzi and Blattman (2011), Cotet and Tsui (2010) and Dahl (2012), this study found that factors affect large and small conflicts differently and illustrated the sensitivity of some findings to different coding of the dependent variable. The type of war matters,

changing the effects of polity and GDP per capita growth. This approach of separating conflict size allows one to test the sensitivity of findings and hopefully report less spurious results.

The study also yielded some curious results and potential areas of future research for investigation, partially as a result of separating conflicts by size. One spurious, or at least confusing, finding from the literature has to do with the effect of democracy. In this analysis, it was possible to separate the effect of democracy on large conflicts and small conflicts, and the effect on conflict changes. Higher levels of democracy may make a state more inclined to small-scale violence, but there is no effect on large-scale violence. This finding helps to explain conflicting findings in the literature that democracy both increases and decreases the risk of civil conflict. Future research that addresses this possibility could contribute significantly to our theoretical knowledge of the causes of war and our practical knowledge about the costs and benefits of a foreign policy of democracy promotion.

Another interesting finding driven by the use of separate models for different size conflicts is that a high trade ratio may increase the probability of large-scale violent civil conflict, but not small-scale civil conflict. This finding is interesting, but future research should work to understand this disjuncture from the theoretical literature. The significance level of this finding may be driven by the types of trade that lead to high trade ratios like oil exports. Previous literature (Rustad, et al. 2008; Collier and Hoeffler, 2002a; Collier and Hoeffler, 2002b; Elbadawi and Sambanis, 2002; Fearon and Laitin, 2003; Regan and Norton, 2005; Collier and Hoeffler, 2004; Collier, Hoeffler and Roehner, 2008) has suggested that a high level of trade in primary commodity exports (usually oil) has a strong positive effect on violence. Oil exports would also

likely increase the trade ratio and may be driving the finding on trade ratio significance. This would be an interesting topic for future research.

Finally, the model also found that the years since conflict had a consistent positive effect on conflict across UCDP specifications, which is a finding that is inconsistent with the majority of the literature but not all of it. Further investigation found a quadratic relationship was highly significant and u-shaped, suggesting that conflict risk decreases until about year 10 and then begins to increase, at least in this sample. This could have important theoretical ramifications and the effects of different post-conflict strategies should be considered to understand how this mechanism works. Research should also be conducted specifically on post-conflict states and the effect of different peace agreements and strategies at peacekeeping to understand how best to reduce the risk of conflict in the years following a war, when most states are at a greater risk than pre-conflict.

From a modeling perspective, the findings from this research show that a tight coupling of theoretical and empirical work can yield novel insights and avoid omitted variable bias. The finding on peace years, democracy and trade are counter intuitive, but by capturing a broader swath of theoretically relevant variables, this model has hopefully helped to reduce the risk of biased results due to omitted variables by including country and time fixed effects. Moreover, it yielded a novel insight with regards to international integration, which could prove to be a useful tool for governments around the world to prevent the next civil war. This previously untested variable had been ignored by an empirical literature which has focused on incremental improvements to Collier and Hoeffler (2004) or Fearon and Laitin (2003). Definite drawbacks arise in the implementation of theoretically driven models, including the risk of missing data for

key variables of interest. In the case of this analysis, this happened with the data for inequality, but econometric methods were employed to control for missing data (Dardanoni, 2011).

Another key methodological finding is that the underdeveloped nature of existing models requires the use of time and country fixed effects to avoid omitted variable bias. This approach helps control for unknown factors that have not yet been identified in the still developing, incomplete empirical conflict literature. A Hausman test comparing the outcome models with random effects equivalents confirms that a fixed effects approach is necessary (Hill, Griffiths and Lim, 2008 pg. 404) and suggests that earlier state of the art models like Collier et al. (2008) and Fearon and Laitin (2003) may have suffered from omitted country variables that affected their results. Future research could work to reduce reliance on these effects by finding the factors that make both time and country fixed effects so important, so as to explicitly model their effects.

These findings also have practical, applied implications for agencies implementing U.S. foreign policy. U.S. foreign policy is primarily executed by the U.S. Department of State. The Department of State's mission statement includes support for a "more democratic, secure and prosperous world composed of well-governed states… [that] reduce widespread poverty and act responsibly…" (Department of State, 2012b). The findings from this analysis suggest that the security component of the mission is most effectively achieved by promoting economic growth and helping states integrate into the international system. These are the highest payoff activities for reducing political violence at both the small and the large scale. Increased food availability per capita does not appear to directly reduce conflict risk. However, increased food availability through the provision of aid may contribute to the other aspects of the mission statement such

as a “prosperous world” and helping to “reduce widespread poverty.” Food aid may also support economic growth and enable the U.S. to integrate states into the international system more effectively by building goodwill with states. These side effects have not been analyzed, but could significantly add to peacekeeping efforts. Regardless, this would be a secondary effect used only to enable more efficient mechanisms to reduce the risk of violent civil conflict. Additionally, these findings support the notion that building a more democratic world is not always supportive of the peacekeeping components of the mission because it may increase the risk of smaller-scale violence.

The findings from this research suggest that efforts by some in civil society to tie food security to national security may be misplaced. Even without a national security justification, there is still support in U.S. foreign policy for helping to reduce poverty and suffering. This report’s findings suggest that if civil society is aiming to defend funding for food aid, other mechanisms such as increasing human capacity, supporting commitments to the Millennium Development Goals and moral concerns to help the starving make a more accurate case than preventing conflict.

This analysis also has implications for the intelligence community, which is responsible for identifying, understanding and forecasting national security risks, including violent civil conflict around the world. The CIA for example, lists one component of its mission as, “Producing timely analysis that provides insight, warning and opportunity to the President and decisionmakers charged with protecting and advancing America’s interests” (CIA, 2013). In this context, this analysis primarily has methodological implications for forecasting and suggests that the current state of the art in open source conflict modeling may have serious shortcomings that

are not sufficiently developed to deploy as an intelligence asset. This finding is due to the inconsistency of findings and the methodological problems noted previously that may lead to spurious forecasts. Additional research could develop existing capabilities to the point of usefulness and support the qualitative expert analysis already conducted.

CONCLUSION

The conflict literature has been unable to translate increasing availability of data and a large quantity of studies into sustained improvements in our understanding of the causes of conflict. This is partially the result of limited application of theory to violent conflict models. This study demonstrates the potential for theoretically driven models to yield novel insights and avoid omitted variable bias. Moreover, this study finds no significant evidence to support the popular conception that food insecurity increases the risk of civil war onset. Instead, increased integration into the world community and GDP per capita growth reduce that risk. Democratization brings tradeoffs, by increasing the probability of small-scale conflict. Finally, the number of years of peace may have a positive effect on the probability of conflict. Each of these findings requires more research to make conclusive findings, but hold the potential for a more complete and more nuanced set of conflict models that can be used by the policy community to pursue its objectives of building a safer, more stable world.

While food availability is not a predictor of violent civil conflict, this does not suggest that policy interventions with food security do not contribute to peacekeeping. It is possible that food availability contributes to stability through secondary mechanisms by enabling

peacekeeping interventions like increased integration into the world community. These relationships require additional research.

Finally, this paper indicates that pundits and policymakers who predict widespread instability due to climate change induced food scarcities may be overconfident in their predictions. Specifically, it notes that in-country food availability is unlikely to drive civil conflict. This finding is limited to experience in the past 50 years, and climate change could induce changes at a more rapid pace than human history has experienced to date. In that case, these findings may be irrelevant. Nonetheless, given the state of conflict modeling and conflict theory today, it is unlikely that climate change induced cropping changes will drive civil conflict in the future.

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APPENDIX

APPENDIX 1 – ROBUSTNESS TESTS

Given the inability of the key independent variable to yield a significant finding, several robustness checks were performed to rule out the possibility of a statistical problem driving the null finding. This section describes those tests. Out of the following 164 models, only 11 yielded a significant finding with regard to food security, and most of those came in the COW specification and were positively significant. Finding only 11 significant results with a cut-off threshold of 90% raises serious questions about the reliability of those findings because one would expect 16.4 statistically significant findings based on blind luck. This suggests that the null findings are not spurious.

First, alternative modeling approaches were taken, including country fixed effects logit with a time trend, random effects and linear fixed effects with a time trend. Each of these approaches provides a different strength and is susceptible to alternative weaknesses. The baseline model using country and time fixed effects may underestimate the effect of institutional variables that change very slowly over time and also must drop all countries with non-variation. This yields very small sample sizes. Additionally, time fixed effects could be reducing degrees of freedom enough to understate the effect of some variables. Running a country fixed effects model with a time trend suggests that it is an issue, but not for the key independent variable. Polity gained significance. Unfortunately, the use of a time trend increases the risk of omitted time specific variables. Regardless, it yields no change in the availability finding. The linear fixed effects model and the random effects model incorporate countries with no history of conflict. Random effects runs the risk of omitting key variables that are correlated with both the outcome variable and some independent variables, which violates

the exogeneity assumption for regression by making the error term correlate with the independent variables and yielding potential bias. This may be an issue as random effects changes the sign of the Years of Peace variable from positive to negative, even when fixed effects like percentage of mountainous terrain, ethnic fractionalization and a cold war dummy are included. This negative finding is consistent with the random effects literature. Again, availability is not significant. Finally, the use of a linear country fixed effects model, which allows observations with no dependent variable variation but also allows for the incorporation of fixed effects, showed no change in the availability variable, but did increase the significance of consolidation and the level of economic development. Similar impacts were found with different conflict sizes, suggesting that model selection had no impact on the results when fixed effects are used, but supporting the results of the Hausman test which find significant differences between the random and fixed effects models. Further, it supports the use of linear fixed effects with heteroskedasticity robust standard error for additional specification tests.

Next, alternative specifications of the key independent variable were tested in the standard time and country fixed-effects logistic regression. The only change in results was in the logistic regression that evaluated the quadratic term of food availability. However, normal t-tests are unreliable with non-linear terms in logistic regression because a factor may be significant in one direction over a certain range of the independent variable and significant in the other direction over another range (Norton, Wang and Ai, 2004). Alternative means of assessing this effect are unavailable in fixed effects due to the use of a large number of country specific dummies, so a linear fixed effects regression was used to evaluate this significant finding. The linear fixed effects model found no significant quadratic effect in either the

constrained sample (countries with DV variation) or the full sample (all countries, including those without DV variation). This suggests that there was a spurious correlation problem. Additionally, dummies separating low levels of food availability and high levels were insignificant. Another specification that employed only the cereal grains, meats and vegetables in the calculation of total available food also failed to find significance and had the same issue as the standard specification when included as a quadratic term. The results suggest that the main findings are consistent and unbiased.

Next, some suggested omitted variables were included to test their effect on the findings. This included a dummy for political instability, which is defined as a change in the polity index in the previous year. The instability dummy was not significant and had no effect on the other parameter estimates in any of the dependent variable specifications. Next, a dummy indicating ethnic minority leadership, drawn from Fearon, Kasura and Laitin (2007) was included and tested. This dummy only covers the years up to 2000, so six years of data are dropped. The dummy is significant and draws down the significance of economic growth. This is likely a sample size issue as the two factors are only marginally correlated (4% with p=.0079). Food availability was not affected and neither were the variables for allies or polity.

To test for structural differences between types of government, subsamples were taken of autocracies (polity < -5), anocracies (5<=polity <=-5) and democracies (polity>5) and run as separate linear fixed effects models dropping the polity and the consolidation dummies to avoid multicollinearity problems. An F-test of the model variance for the UCDP-defined conflict mostly rejects the null hypothesis of no significant variation between the model variances suggesting that there are structural differences between the variances. However, the key independent

variable is insignificant in all specifications except the COW, where it is positively significant. Moreover, the results for peace years and allies holds steady. The finding on COW model is that food is significantly and positively linked with increased conflict risk, suggesting that larger amounts of food availability are necessary to sustain an army and an opposition force at an intensity that yields a large number of battle deaths.

To test for structural differences between geographic areas, subsamples were taken of the World Bank's geographic regions (World Bank, 2013) and run as separate linear fixed effects models. An F-test of the model variance fails to reject the null of no significant variation in only 6 out of 16 combinations. Nonetheless, geography does not change the finding of non-significance for food availability in any case except for Sub-Saharan Africa in the Correlates of War specification, where it is positively significant. Again, this suggests potential, but inconclusive, support for a feasibility interpretation where food is necessary to care for troops.

After ruling political structural differences and geographic structural differences as causes of the null finding, the results were subset by the World Bank's income groups in 2013 (World Bank, 2013). This would allow for the parsing of structural modeling differences between different income categories, which Collier (2007) noted in "The Bottom Billion," where the poorest category of people is more likely to fight. While the results definitely support the notion of structural differences due to income (70% of the model combinations are significantly different), the finding of no significance for food availability is mostly unchanged. In the small wars, lower-middle income model it is positively significant at the 90% level. Additionally, it is positively significant in the Correlates of War specifications for low income countries at confidence greater than 99%. It is negatively significant for high income and high income OECD

countries with 90% confidence, once again supporting the hypothesis that troops must be fed in the COW specification. This is the only instance out of all the models where there are significant findings supporting the hypothesis, suggesting that they may be spurious.

Finally, to test the validity of the positive peace effect, a lagged dependent variable approach was taken. It was included in a linear country fixed effects regression with indicators for the first year following war through the 9th year, with the reference category as years greater than 9 years post conflict. Unfortunately, the estimates are highly unstable showing a significantly increased risk in one year, a significant decreased risk the next and then a significant increased risk the next. This is a common problem in distributed lag models (Woolridge, 2009). This problem is typically overcome with a dynamic model, but heteroskedasticity biases the model and makes it inefficient. Given that this model is linear, there is little reason to believe that a dynamic model of this type would be appropriate. The result of these tests is inconclusive.

While there is evidence that structural differences exist between certain types of countries, there is little evidence that the null finding regarding food availability's effect on violent conflict onset is spurious. In fact, the few occasions that it gains significance in the robustness checks, it is positively significant. This is the opposite of the expected effect of negative significance.