Bread and Riots: Assessing the Effect of Food Security on Political Stability

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Abstract

Policymakers routinely argue that food security undergirds political stability. While some researchers have demonstrated that the two may be linked, the broader literature suggests that most internal conflicts arise from narrow avarice rather than common grievances. This paper seeks to address this seeming conflict using novel data sources. The results suggest, in contradiction to expectations, that increases in absolute levels of food security significantly increase the frequency of political protests. However, the research also finds that increases in the relative levels of food security significantly reduce political instability. If true, these findings suggest that the US government should consider alleviating both relative and absolute declines in food availability.

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I. INTRODUCTION

History suggests that, like the proverbial army, the state marches on its stomach. Roman emperors famously subsidized bread prices to keep the hoi polloi content in the twilight years of the empire. In Paris in 1789 and Saint Petersburg in 1917, poor harvests led to bread riots that culminated in uprisings that toppled monarchs. In modern times, observers connect food insecurity and political instability more explicitly, holding that rising food prices and empty stomachs rob states of output legitimacy. During such periods, the political leadership appears helpless as the public starves, abetting political opposition to the government. Indeed, the Arab Spring uprisings that spread across the Middle East and North Africa in 2011 (and continue in Syria to this day) appear to stem in part from diminished food security and its subsequent political effects.[1]

Volatile food prices appear weakly correlated with political instability; however, this correlation might be purely coincidental. For instance, during the immense spike in food prices in 2008, equivalently large as the one that precipitated the 2011 Arab uprisings, UN Secretary General Ban Ki-moon warned of mass unrest and instability. The 2008 price increase was indeed followed by numerous food riots across the developing world but did not produce political consequences as significant as those seen during the recent Arab uprisings (Topping 2008). Likewise, observers have connected the so-called "color revolutions" that spread across the post-Soviet world during the first decade of the twenty-first century to a wide variety of causes, but few argue that food insecurity triggered such upheavals. Indeed, the relevant literature on civil wars and unrest suggests that such conflicts are more likely the result of abundant profitable resources like oil and diamonds rather than the dearth of necessary resources such as basic foodstuffs.

Despite the apparent connection between the abundance of profitable resources and political instability, policymakers nonetheless invoke the importance of food security for political stability. In the wake of the 2008 price spike, the leaders of the world's largest economies committed billions of dollars to food aid in a statement that explicitly linked food insecurity with political unrest (G8 2009). Similarly, US officials have defended "Feed the Future," President Obama's $3.8 billion interagency food security initiative along similar lines, arguing that food assistance quells instability abroad and thus improves American national security.[2]

[1] See for instance, Ariana Eunjung Cha, "Spike in global food prices contributes to Tunisian violence." *Washington Post.* January 14, 2011; Zoe Flood, "At Least 20 Killed in Economic Protests in Tunisia and Algeria." *The Daily Telegraph*. January 10, 2011; and Caroline Henshaw, "The Food Politics of Egypt." *The Wall Street Journal*. February 1, 2011.

[2] See for instance, this post by Jonathan Shrier, the then acting Special Representative for Global Food Security for the State Department: Jonathan Shrier, "Food Security Contributes to National Security." US Department of State. October 28, 2011. Accessed April 4, 2013. http://blogs.state.gov/index.php/site/entry/food_national_security

Understanding the true relationship between food security and political instability is therefore a relevant policy problem because the Administration links political insecurity abroad with American national security worldwide. This paper tests the proposition that food insecurity causes political instability using food security data from the Food and Agriculture Organization (FAO) and a database of individual instances of political unrest maintained by the Cline Center for Democracy at the University of Illinois.[3] I find, contrary to US policy but in line with the prevailing literature, that increases in absolute levels of food security, i.e. the total amount of foodstuffs available, are associated with an increase overall political instability. However, I find increases in relative levels of food security, i.e. year-on-year change in the amount of foodstuffs available, are associated with a decrease in political instability.

Before detailing these results I briefly outline the competing literature on the effect of food and other resource abundance on political unrest. From these, I build a complementary conceptual framework for how food security can influence political unrest, which will be the bedrock of the analytical model I will test. After summarizing the results of these tests, I explore their implications and offer a few tentative suggestions to future researchers and policymakers.

[3] Accessible from http://faostat3.fao.org/home/index.html and http://www.clinecenter.illinois.edu/research/speed.html, respectively

II. LITERATURE REVIEW

The prevailing view in the policy world holds that food insecurity precipitates political instability. Vice President Joe Biden articulated this view in a 2011 speech on global hunger:

> *As Pope Paul VI once said, "development is the new word for peace." And the reality is that, in many countries, food security and political stability are closely linked.*
>
> *Investments made to ward off food insecurity and prevent its recurrence can prevent the vicious cycles of rising extremism, armed conflict and state failure than can require far larger commitments of resources down the road.*
>
> *When food prices spiked three years ago, riots or demonstrations broke out in dozens of countries because people could no longer feed their children. Many of these protests turned violent.*
>
> *In Sudan, the Darfur crisis, which seized the world's attention for much of the past decade, was sparked, in part, by a competition for arable land—a competition later used to justify unspeakable atrocities by the Janjaweed militia. The crisis in Darfur is man-made. But it is also true that with dwindling supplies of water and arable land, often exacerbated by climate change, the conditions were ripe for conflict—because people were forced to compete for resources they once shared* (Biden 2011).

Unfortunately, the predominant literature does not corroborate the vice president's interpretation. Researchers investigating the influence of natural resources on political instability explain the linkage through two competing motivations: greed and grievance.[4] Proponents of the former argue that the abundance of valuable and portable resources, such as minerals, oil, or cash crops, allows self-interested groups to exploit internal conflict by harvesting and selling these goods and using their profits to fuel further conflict (Ross 1999). Grievance-based explanations, on the other hand, cite a dearth of vital resources, such as water, livestock, and staple crops, as instigating conflicts between groups or against the government (Diamond 2005). Comparative studies have traditionally found greed-centric explanations more persuasive for explaining civil war (Collier and Hoeffler 2000; Fearon and Laitin 2003). Wars require significant financial and organizational investments and are especially risky endeavors. These high costs therefore require a reward large enough to incentivize armed revolt. While political grievances can aid opportunistic actors in fomenting conflicts, a more potent motive is often necessary. Greed is one example of such a motive. However, the literature's emphasis on greed runs contrary to current US policy regarding food security, which holds that resource deprivation, rather than greed, leads to political instability.

Civil war represents only one extreme along the spectrum of political instability. In contrast to the above consensus, a number of scholars have proposed that resource scarcities, specifically regarding food or water, can precipitate a range of disorders that do not rise to the level of outright war. Homer-Dixon (1991), for instance, argues that environmental constraints lead to diminished agricultural yields, which in turn disrupt the social order within states. Conversely, both Rotberg (2005) and Bates (2008) attribute food insecurity, and associated ecological problems, to greed and dysfunction at the highest levels, while Cohen and Pinstrup-Anderson (1999) paint a more nuanced picture in which unrest appears to precipitate hunger as well as the reverse.

Unfortunately, quantitative investigations of this issue are sparse and unpersuasive. Hendrix and Salehyan (2010), for instance, link extreme hydrological events with instances of political unrest but do not link their findings on hydrology to food shocks specifically. This is especially notable as Lagi et al. (2011b) find no correlation between the instance of extreme weather conditions and international food prices. In a separate but related paper, Lagi et al. (2011a) instead correlate the international food price index calculated by the FAO with instances of food riots globally. However, doing so limits the explanatory power of their findings. It therefore does not seem likely that

[4] This dichotomy stems primarily from Paul Collier and Anke Hoeffler, "Greed and Grievance in Civil War," World Bank Policy Research Working Paper No. 2355, May 2000

one can extrapolate this relationship to political unrest more generally, for which food riots serve as a biased proxy. Additionally, the researchers fail to distinguish between qualitatively different types of events, making no distinction between a minor protest in Bangladesh and the Syrian civil war. The researchers consider both of these as examples of food riots despite the difference in their severity. Finally, the researchers do not control for the possibility that food prices may have been independently increased by global instability. Bellemare (2011) uses instrumental variables to avoid the problems with causality but otherwise suffers similar problems and further fails to capture variation at the national level, looking solely at international time-series data.

Arezki and Bruckner (2011), with the International Monetary Fund, address many of these issues. For instance, they use a fixed effects model to demonstrate that a country-specific food price index correlates with various measures of political instability within that country beyond just food riots. However, their estimation method for the within-country food price index excludes a number of factors that dictate prices in a particular country, most notably government interventions such as tariffs, export taxes, and subsidies. Arezki and Bruckner also fail to account for issues of endogeneity in their model and, unlike Bellemare, cannot persuasively demonstrate that food prices precipitate instability rather than the reverse (as Rotberg and Bates theorize). Indeed, this relationship disappeared when Arezki and Bruckner looked specifically at the effect of the previous year's food prices on political instability, suggesting that the linkage was not causal. Finally, Arezki and Bruckner, like the remainder of the above papers, only consider international food prices rather than measures of the food situation within each country. An examination of country-specific food security would be able to better measure the true effect on political instability within that country and thus perhaps reconcile the differing theoretical arguments about the linkage between food shortages and political unrest.

III. CONCEPTUAL FRAMEWORK

This paper seeks to build on these previous works. In accordance with current US development policy, I hypothesize the existence of a positive relationship between food security and political stability, with greater food security enhancing political stability. As with previous empirical studies, I anticipate that deficiencies in food security worsen the well-being of the average citizen, which in turn rob states of output legitimacy. This decline in legitimacy could induce the members of the public to seek extra-political measures to influence the government or even to turn to rival sub-state actors to replace the government. Diminished food security could reduce political stability through less direct channels such as inducing governments to seek other forms of legitimation independent of the public

well-being or increasing food prices to increase inflation and further rob the government of its legitimacy.

However, causality need not flow solely from food security to political stability. Indeed, as Cohen and Pinstrup-Anderson (1999) outlined, political unrest frequently precipitates food crises within countries. Growing political unrest disrupts trade internationally and internally, limiting both the availability and access elements of food security, due in part to the capricious actions of repressive regimes or the realities of intrastate conflict. Political unrest also frequently displaces whole groups of people, uprooting them from their homes and traditional food sources. This apparent effect of political unrest on food security requires me to consider the potential for reverse causality in my models, a consideration that previous quantitative studies have undertaken only sparingly.

One must consider other confounding variables as well. For instance, the type of regime may influence the relationship between food security and political unrest in a particular country. If food insecurity acts primarily by robbing governments of output legitimacy, then one would expect the resultant political unrest to be more likely in authoritarian regimes, where the governing legitimacy rests more exclusively on outputs and where no peaceful means of expressing discontent exist (Acemoglu and Robinson 2001). Additionally, as Amartya Sen and others have argued, authoritarian states are themselves more likely to experience famines due to unequal distributions of food within states and the insularity of the governing regimes (Sen 1981). Therefore, it will be incumbent to consider the effects of regime type, as more autocratic regimes would be presumed to experience more food insecurity and greater upheaval across equivalent levels of food insecurity. Likewise, an increase in inflation rates independent of food shocks would be expected to worsen both food security (through diminished food access due to heightened food prices) and political stability (through decreased output legitimacy also due to heightened prices more generally). Finally, states with insufficient capacity for agriculture will face problems producing and distributing sufficient food in a crisis, which can also amplify the effect of food shortages. My model will need to control for these country-specific factors.

IV. DATA AND METHODS

Compared to previous studies, this paper uses novel and hopefully more accurate data sources to measure both food security and political instability within a particular country.

I use the aggregate food supply measures collected by the FAO as a direct measure of in-country food supply, rather than inferring such data from international food prices. These data are collated from self-reported yield figures and then modified using similar data on agricultural imports and exports to calculate the

total foodstuffs available within each country in a particular year. FAOStats (2012) reports this information in kilocalories per capita per day. I multiplied these data by the FAO's country-year population estimates to approximate the daily food supply in the country. This paper will also pair this measure with an estimate of food quality, calculated as the percentage of calories of a country's daily food supply that comes from either fats or proteins, which suggest a higher quality and more varied diet.[5] I use 1979 as the starting point for all panel data since the FAO only began tracking such information in that year (FAOStats 2012).

Predicating my measure of food security on country-level food supply data, rather than international food prices, offers several distinct advantages relative to previous studies. Most notably, doing so allows me to use country-year panel data for all variables rather than time series data using international averages, in contrast to Bellemare or Lagi et al. (2011b). Additionally, unlike Arezki and Bruckner, my data captures more detailed levels of food availability, rather than relying on imputed measures. However, this points to a significant potential disadvantage in using FAO's food supply data rather than international food prices. While the latter are predicated on prices on the international market, the former relies solely on official government sources (FAOStats 2012). This leads to reliability issues as individual governments may have an incentive to misrepresent their food supply. Additionally, some countries do not respond to these surveys at all, either out of dysfunction or pique, which could potentially further bias my results. FAO does correct for instances where the data are unavailable or unreliable, but these corrections just shift the locus of the problem from the countries to the FAO itself (FAOStats 2012). Indeed, some countries with a history of instability (such as Somalia and Afghanistan) or with negligible internal food production (such as Qatar and Bahrain) do not report food supply data to the FAO at all and have therefore been removed from the sample (FAOStats 2012).

I likewise rely on a novel data source to approximate political stability within a particular country. Arezki and Bruckner, for instance, proxy a country's political stability through its degree of democratic governance combined with the intensity of intra-state wars within its borders. But this metric is both too broad and too narrow: it misses instances of political violence that do not rise to the level of civil war and at the same time characterizes stable autocratic states as unstable. Instead, this paper will use event data to proxy political stability, but, unlike previous studies, the data are not restricted solely to instances of food riots and are linked specifically to the country of origin.

Specifically, the data come from the Social, Political, and Economic Event

[5] Calculated using the approximation that 1 gram of fat = 10 calories and 1 gram of protein = 4 calories.

Database (SPEED), collated by Dr. Peter Nardulli and others at the Cline Center for Democracy at the University of Illinois.[6] Using automated search protocols, Nardulli and his colleagues combed through the complete archives of the *New York Times* and the *Wall Street Journal* from 1946 to 2009 for instances of instability such as coups, group violence, and anti-regime protests. Finding these sources lacking in international coverage, the researchers also included reports from the Foreign Broadcast Information Service and the Summary of World Broadcasts because the former sources lacked broad international coverage. The latter sources contain English language summaries of tens of thousands of newspapers from most countries globally, collated by the CIA and BBC, respectively. I collapsed the data from SPEED into simple counts of events per country-year to be used as my primary dependent variable. As with the independent variable, this data begins in 1979 and extends to 2009. On the personal advice of Dr. Nardulli, I removed the United States from my sample, as the *New York Times* and *Wall Street Journal* are heavily weighted towards domestic coverage, complicating comparisons between the United States and other countries.

V. ANALYSIS PLAN

I use regression analysis to predict events of political unrest in a country given different levels of food security in order to test my hypothesis that food security is positively associated with political stability. As Gould (2011) argues, the Poisson regression model is most appropriate for attempting to predict count data.[7] This is especially necessary in this instance as most country-years did not have a recorded event, leading to a high concentration of null observations relative to positive ones (see Figure 1). Poisson regressions rely on the Poisson distribution, which is used to predict the likelihood of a certain number of discrete events, given a set small mean. Unlike with the normal distribution, a Poisson distribution can only vary across one parameter, the conditional mean, while the variance is assumed to be a simple function of the conditional mean (Wooldridge 2009).

However, this is often an unrealistic assumption for a given set of data: many real-life datasets have greater variability than assumed by a simple Poisson distribution, leading to a problem of overdispersion. Some methodologists, like Wooldridge and Gould, assert that this overdispersion can be easily corrected for, but the majority of researchers have instead moved towards correcting for

[6] Many thanks to Dr. Nardulli for graciously providing the data and offering helpful tips on its coding and uses.

[7] The Poisson regression assumes that the expected value of the dependent variable is a function of *e* raised to the combination of the independent variables and their beta coefficients and is thus, in that respect, similar to but not identical to taking the natural log of the dependent variable. It is the difference between E(ln(y)) and ln(E(y)), but in situations with strong skew and large numbers of zeroes, as observed with most count variables including my own, the latter is more appropriate (Wooldridge 2009).

Figure 1: Distribution of Event Data

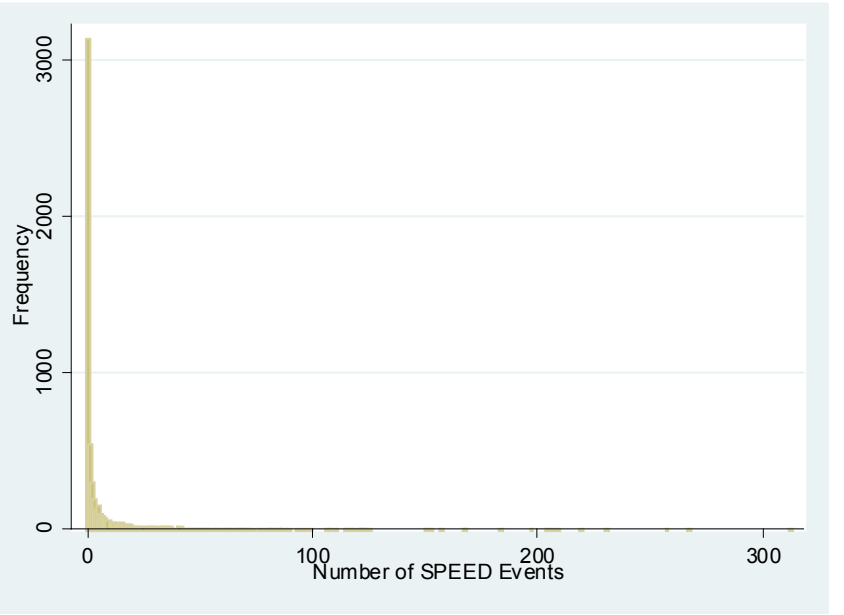

Figure 1: Frequency graph of the number of events recorded for each observation. Over 70 percent of the observations have zero events and, of those that have at least one event, roughly 60 percent had only one event recorded.

overdispersion by using a negative binomial regression (G. Krause 1994; Simmons and Elkins 2004; V. Krause, Suzuki, and Witmer 2006). A negative binomial regression relies on the negative binomial distribution instead of the Poisson distribution and thus allows the estimated conditional variance to vary independent of the conditional mean.[8] The negative binomial regression in effect introduces an additional source of randomness to the Poisson model, multiplying the Poisson-determined conditional mean by a gamma distributed random variable with an expected value of one (Krause 1994).[9] I primarily use negative binomial regression models to predict the event count variable, since the greater variance enabled by the negative binomial regression better approximates my data.[10]

My initial specification will use event counts per country-year as the dependent variable and food supply measured in both quantity (kilocalories of food per day) and quality (as

[8] The negative binomial distribution refers to the number of successes one is expected to receive in a series of Bernoulli trials before a set number of failures are obtained. For instance, one could use the negative binomial distribution to determine the likelihood of surviving various numbers of rounds of Russian roulette with two bullets in the chamber.

[9] As Poisson regressions assume the dependent variable is equal to $e^{(x\beta)}$ (see footnote 7), multiplying this by a random variable is equivalent to adding a random error term to the model (i.e. $e^{(x\beta)}\delta = e^{(x\beta + \varepsilon)}$ where $\delta = e^{\varepsilon}$ and ε is uncorrelated with all x's). In this respect, the negative binomial regression better approximates the assumptions of OLS than does Poisson regression.

[10] It should be noted that additional specifications were run using Poisson and OLS regression models with no significant effect on my results.

stated earlier) as the independent variable. Measuring caloric content alone offers only a narrow view of potential diet deficiencies and cannot capture the potential malnutrition or discontentment that arises with food supplies that are above starvation levels but consist purely of cheap cereals. Additionally, all specifications of my models will include the natural logarithm of food supply rather than the linear metric itself, since I expect the positive effects of food security on political stability to diminish as people become less at risk of starvation and deprivation.

Finally, I use fixed effects for both country and year in my models. Doing so allows me to control for many of the country-invariant structural variables we alluded to earlier. Both of these adjustments leverage the large number of observations in the dataset (over 5000) to avoid issues with the decreased precision they entail. However, some researchers have cautioned against using fixed effects with negative binomial regressions, as doing so interferes with the independent specification of the conditional variance (Allison and Waterman 2002). To adjust for this potential problem, I specify additional models for all regressions that use simple unconditional country and year dummies rather than relying on the conditional estimates generated by a fixed effects model.

Fixed effects models can only control for country-specific elements that remain constant over time and for time-specific elements that are constant across states. Certain secondary elements from my conceptual model vary over time within a country and will need to be controlled. Most notably, I anticipate that the magnitude of a country's population will govern both the overall food supply in a country and the number of events observed. Therefore, I include a measure of population per country-year in all models.[11] Likewise, a country's wealth, measured as gross domestic product (GDP), is controlled for, so that the wealthy, stable, and well-fed countries in Europe and North America do not overly influence my findings.[12] As with food supply, the effect of GDP is hypothesized to diminish as GDP increases, suggesting that a log-transformed variable would be more appropriate to include in all models. Additionally, I control for inflation rate per country-year, since rising food prices could influence more generalized inflation or vice versa, leading to political unrest.[13] Finally, regime type, measured as either more or less democratic, could influence both food security and political stability and thus would need to be accounted for in any model.[14] All four of these factors will need to be included

[11] Population measured in thousands of people per country per year, via FAOStats (2012).
[12] GDP per capita measured in constant (2005) international dollars and normalized for purchasing power parity, via the World Bank, http://databank.worldbank.org/ddp/home.do.
[13] Inflation rates per country measured yearly based on consumer prices, also via the World Bank, http://databank.worldbank.org/ddp/home.do.
[14] Regime type measured on a -10 to 10 scale, where -10 is maximally autocratic and 10 is maximally democratic, via Polity IV, http://systemicpeace.org/polity/polity4.htm.

as separate independent variables in all models specified.

With these considerations in place, my primary model for predicting events of political unrest is specified as:

$$Events_{it} = \beta_0 + \beta_1 ln(FoodSupply_{it}) + \beta_2 FoodQuality_{it} + \beta_3 Democracy_{it} + \beta_4 ln(GDP_{it}) + \beta_5 Inflation_{it} + \beta_6 Population_{it} + \alpha_t + \alpha_i + \eta_{it}$$

However, I test a number of alternate specifications as well, in order to control for the possibility that the findings are sensitive to certain assumptions implicit in the above model. In order to validate my model, I must first address the issue of reverse causality broached in my conceptual framework. I address this possibility using two different methods. In the first method, I lag the variables for food supply and food quality by one year, in effect attempting to predict the current year's level of political unrest with the previous year's level of food security. However, this approach requires that the current year's measures cannot cause the previous year's, a reasonable though unnecessary assumption.

I also perform an additional series of regressions using instruments for food supply.[15] I intend to predict food supply using two variables for a country's agricultural potential: the concentration of tractors in a country-year and the percentage of arable land in that country. In order to be effective, an instrument must be highly correlated with the independent variable it intends to predict without being correlated with the dependent variable. Both tractor density and the abundance of arable land serve as strong predictors of food supply (t = -11.46 and 14.42, respectively, when regressed with all other independent variables). Likewise, their joint significance (F = 143.81) is well above the traditional cutoff (of F=10) for an effective joint instrument (Wooldridge 2009). Likewise, it is hard to fathom how either variable or their combination could be correlated with political instability except through their effect on food supply once one controls for factors like economic development. Thus, I conclude that these variables together represent worthwhile instruments to control for reverse causation in the model, though I admit, given the impossibility of proving a negative, that I can never know for sure.

In addition, since my dependent variable is a simple sum of discrete events, it gives equal weighting to all events without regard to their individual magnitude. Though this specification accords with that of Bellemare, Lagi et al., and Hendrix and Salehyan, I find it plausible that not only the frequency but also the intensity of events increases with a decline in food security. An aggregate of all individuals killed in a country in a given year from events of political unrest would approximate the seriousness of the observed events

[15] As per Hardin, Schmiediche & Carroll (2003), we performed this process using one command, "qvf," which allows for the use of instrumental variables using a negative binomial regression. As "qvf" does not allow for fixed effects models to be specified, only the results for the country and year dummy models will be reported.

in addition to their quantity. As the number of individuals killed is a count variable and has the same highly skewed distribution as the original event count data, a negative binomial regression remains appropriate for predicting this data. Therefore, I specify an alternate model that approximates individuals killed rather than events observed for a given country-year as the principal dependent variable.

I likewise could have incorrectly specified my measures of food security. In my primary model, I measured absolute levels of food supply and quality, in keeping with both the previous quantitative literature and US food security policy. However, my conceptual model highlighted that spikes in food prices or declines in food availability were speculated to deteriorate a regime's output legitimacy and thus precipitate political unrest. This framework suggests that year-on-year percentage changes in food security, rather than their absolute levels in a given year, could represent the true cause of my dependent variable. Indeed, previous literature in psychology and sociology suggest a link between relative, rather than absolute, deprivation and crime or other social ills (Walker and Mann 1987; Kawachia, Kennedy, and Wilkinson 1999; Bossert, D'Ambrosio, and Peragine 2007). I shall thus test whether year-on-year percentage changes in my two food security variables better predict events of political unrest than do their absolute levels.

VI. RESULTS

The key results for my primary model do not corroborate the literature that suggests a negative relationship between food security and events of political unrest. Instead, I find a significant positive influence of a greater overall food supply on the number of events of political unrest experienced in a country in that year ($p < 0.001$, see Table 1.3).[16] This positive correlation between food security and political unrest remains, albeit slightly attenuated, when only country-level effects are held constant ($p < 0.001$, see Table 1.1). To control for the potential that using two-way fixed effects biased my estimates when using a negative binomial regression, I also use simple dummies for country and year. However, the effect remains equivalently significant ($p < 0.001$, see Table 1.2). By contrast, the effect of food quality appears inconsistently significant.

To help comprehend the magnitude of the relationship between food supply and instability, I produce several projected outcomes in which I varied the key food supply variable while keeping all other regressors at their means. Using the country/year dummy model (Table 1.2), this coefficient suggests that an increase of food supply from the 25th percentile to the median would increase the predicted

[16] I also specified models using a variety of pooled regressions and those using fixed effects with OLS or Poisson regression models. As stated earlier, I do not think these models are appropriate for predicting event count data with the distribution my data have. However, the use of these models instead do not alter my findings significantly.

number of events in a given country fivefold, while going from the median to the 75th percentile would yield an increase of almost tenfold (holding all other variables at their means).[17] Keeping in mind that 70 percent of country-years observed no events and the majority of the rest observed only one, the relationship between food supply and events of insecurity appears substantively positive in both specifications, wholly contrary to expectations.

As argued earlier, I have strong reason to believe that food security and political stability are intimately related and I suspect that the potential effect of political unrest on food security could skew my results. However, when I look instead at the effect of lagged food security metrics, the results appear virtually identical to those from comparable models using the given year's food data (see Table 2.1 and 2.2). I also use data on the number of tractors per 100 square kilometers of arable land and the percentage of total land that is arable to predict the overall food supply in a given country-year and then use those predicted

[17] Predicted events—25th percentile: 0.00390; 50th percentile: 0.0200; 75th percentile: 0.130.

Table 1. Primary Negative Binomial Regression Models

Variables	(1) Country FE	(2) Country/Year Dummy	(3) Country/Year FE
ln(Food Supply)	0.327*	1.813*	0.440*
(kcal/day)	(4.61)	(4.92)	(5.9)
Food Quality	1.106	-0.713	1.828*
(% kcal fat/protein)	(1.72)	(-0.37)	(2.7)
Polity IV Score	-0.0208*	-0.0262*	0.009
(-10 to 10)	(-3.92)	(-2.98)	(1.66)
ln(GDP)	-0.058	-1.281*	-0.014
(1000s of 2005 Int$)	(-0.99)	(-4.48)	(-0.22)
Inflation	0.000206*	0.000125	0.000148*
(annual % change)	(5.13)	(1.46)	(3.72)
Population	-0.000000811*	0.00000203	-0.000000572*
(1000s of people)	(-3.48)	(1.13)	(-2.28)
Country Effects	✓	✓	✓
Year Effects		✓	✓
N	3177	3300	3177
chi2	104.8	2699.5	349.2
p-value	2.44E-20	0	1.89E-53

t-statistics in parentheses
* $p < 0.05$

Table 2. Regressions for Endogeneity			
	Lagged Models		Instrumented Model
	(1)	(2)	(3)
	C/Y Dummy	C/Y FE	C/Y Dummy
ln(Food Supply)	2.169*	0.467*	
(Lagged one year)	(6.04)	(6.29)	
Food Quality	0.241	2.048*	
(Lagged one year)	(0.13)	(3.06)	
Food Quality			0.618
(% kcal fat/protein)			(0.25)
Polity IV Score	-0.0282*	0.009	-0.021
(-10 to 10)	(-3.20)	(1.62)	(-1.86)
ln(GDP)	-1.525*	-0.036	-1.778*
(1000s of 2005 Int$)	(-5.30)	(-0.57)	(-3.48)
Inflation	0.000130	0.000149*	0.0000926*
(annual % change)	(1.52)	(3.72)	(2.13)
Population	0.00000206	-0.000000597*	-0.00000157
(1000s of people)	(1.15)	(-2.38)	(-0.80)
ln(Food Supply)			4.625*
(Predicted)			(3.24)
Country Effects	✓	✓	✓
Year Effects	✓	✓	✓
N	3296	3175	2009
chi2	2715.5	352.9	
p-value	0	3.48E-54	

t-statistics in parentheses
* $p < 0.05$

values in the original regressions (see Table 2.3).[18] Even here, the effect of the instrumented food supply on the predicted number of events of political instability remains positive and significant. The inclusion of the instrumented food supply measure does not seem to impact the effect of food quality on events of political stability, which remains insignificant.

As these results conflict with both my own conceptual model and previous quantitative studies, I want to ensure that my particular specifications do not overly influence the results. Therefore, I specify similar models that predict the total number of individuals killed, across all events of political unrest,

[18]As stated earlier, I actually performed both steps in one motion, via the "qvf" extension for Stata (Hardin, Schmiediche, and Carroll 2003). However, the math and the concept are easier to comprehend as two separate steps and I thus describe it as such.

in a given country-year (see Table 3.1 and 3.2). Despite this, the relationship between the overall food supply and the number of deaths remain positive and statistically significant ($p = 0.009$ and $p > 0.001$, see Table 3.1 and 3.2, respectively). Interestingly, though, I find the relationship between food quality and the predicted number of deaths from political unrest to be the reverse of the previous regressions, though still inconsistent.

I also test a different set of specifications for the two food security variables (see Tables 3.3-3.6). I do this to investigate whether my initial choice of a level variable, instead of a change variable to measure the effect of changes in food security, is appropriate. As individuals might use their past experience as a reference point to judge their well-being, it is not unreasonable to assume that one's relative food security would weigh more heavily than one's overall food security on one's self-assessed level of well-being. Indeed, when I measure the year-on-year percentage change in food supply instead of overall levels of food supply, I find this variable has a statistically significantly negative association with events of political unrest across both the factor dummy and fixed effects specifications ($p = 0.003$ and $p = 0.025$, see Tables 3.3 and 3.4, respectively). In the interest of comparing these disparate effects, I test one more set of models that include both the level and the change variables for both food supply and food quality (see Tables 3.5-3.6).[19] Little changes between these models and those previous. The effect of absolute levels of food supply remains equally positive and significant ($p < 0.001$ for both). Similarly, the effect of change in food supply remains equally negative and significant ($p < 0.001$ and $p = 0.012$, respectively). The effect of both the absolute levels of and changes in food quality still appears ambiguous and infrequently significant.

VII. DISCUSSION

My results suggest that increases in the overall food supply within a country are associated with increases in the predicted number of events of political instability. This contradicts both my initial hypothesis and previous studies.

The mechanism for such an unintuitive effect is unclear. One possible explanation stems from the greed hypothesis, that greater levels of food availability empower dissident groups to fund themselves through food sales on the international market. A complication with this explanation stems from the bulk of food products relative to their price which makes them harder to smuggle, especially compared to more commonly exported commodities, like diamonds, metals, or oil. For instance, a previous study found no significant effect of the

[19] These combined models, insofar as they attempt to vary a level while holding the change variable constant—and vice versa—do not accurately reflect the partial effects of either variable and their results should therefore be interpreted with caution. I included them simply to note that the differential *ceteris paribus* effects of absolute and relative food security hold up even when controlling for each other.

Table 3. Regressions Using Alternate Specifications

	Models using Individuals Killed instead of Events		Models using Year-on-Year Percentage Change in Food Supply			
	(1)	(2)	(3)	(4)	(5)	(6)
	C/Y Dummy	C/Y FE	C/Y Dummy	C/Y FE	C/Y Dummy	C/Y FE
ln(Food Supply)	3.190*	0.354*			2.02*	0.454*
(kcal/day)	(2.62)	(4.32)			(5.48)	(6.06)
Food Quality	13.58*	-1.227			-0.367	1.86*
(% kcal fat/protein)	(2.33)	(-1.80)			(-0.18)	(2.74)
Polity IV Score	-0.007	0.0368*	-0.0267*	0.003	-0.027*	0.009
(-10 to 10)	(-0.23)	(5.43)	(-2.99)	(0.6)	(-3.07)	(-1.30)
ln(GDP)	-3.903*	0.025	-0.968*	0.291*	-1.47*	-0.028
(1000s of 2005 Int$)	(-4.33)	(0.39)	(-3.65)	(10.98)	(-5.10)	(-0.44)
Inflation	-0.000222	0.0000381	0.000133	0.000142*	0.000122	0.000148*
(annual % change)	(-1.11)	(0.46)	(1.54)	(3.59)	(1.46)	(3.65)
Population	0.00000780	-0.000000697*	0.00000175	0.00000155	0.00000189	-0.00000584*
(1000s of people)	(1.63)	(-2.71)	(0.95)	(0.75)	(1.05)	(-2.33)
Δ Food Supply			-3.08*	-1.894*	-3.73*	-2.12*
(annual % change)			(-3.00)	(-2.24)	(-3.65)	(-2.52)
Δ Food Quality			-1.38	-0.953	-1.39	-1.05
(annual % change)			(-1.34)	(-1.19)	(-1.31)	(-1.30)
Country Effects	✓	✓	✓	✓	✓	✓
Year Effects	✓	✓	✓	✓	✓	✓
N	3300	2878	3296	3175	3296	3175
chi2	1393.1	329.7	2688.7	316.3	2719.67	356.29
p-value	2.80E-202	2.75E-67	0	5.09E-47	0	0

t statistics in parentheses
* $p < 0.05$

endowment of timber resources, a similarly bulky commodity, on the incidence of civil war (Ross 1999). Alternatively, a greater food supply could have more internal benefits for potential dissidents, by perhaps providing the capacity to feed guerrilla forces or sustain localized opposition to the central government. The additional rents that governments can collect may provide another motivation: the resultant greater reward for holding reins of power may induce more frequent power struggles. Further research that disaggregates the kinds of political instability linked to an increased food supply and investigates the relationship between both of these factors and the rents governments receive from agriculture would help distinguish between these phenomena.

My results can also be partially reconciled with the previous quantitative literature if one also considers the ceteris paribus effect of change in the food supply. My models predict that decreases in food supply within a country, independent of the level at which one starts, would significantly increase the observed events of political unrest. This finding in part preserves the grievance-based explanations for the linkage between political unrest and food security. It also corresponds with Hendrix and Salehyan's findings that increased volatility in rainfall precipitates riots. In doing so, however, this finding directly contradicts Bellemare's conclusion that the level, and not the volatility of food prices, predicts increases in unrest. It also undermines the objectives of US food aid policy, which seeks to alleviate absolute hunger rather than increased hunger relative to a previous baseline. Further sociological and psychological research into the weight of relative deprivation with respect to hunger in motivating activism or anti-regime attitudes might help clarify this effect.

However, I offer a few caveats for those researchers and policymakers hoping to build off my results. My data are not entirely pristine, as I removed a number of countries from the sample for entirely lacking food supply data, often because of their high levels of unrest, leading to the potential of selection bias in the results. Further, since I aggregate my main dependent variable from a collection of observed events, biases inherent in that dataset towards North America and Europe could also skew the results. In addition, I make no attempt to control for potential autocorrelation in the model as a result of my choice to specify a negative binomial regression instead of standard OLS. I think this tradeoff worthwhile and avoid making conclusions based on results of spurious significance ($0.05 < p < 0.1$) in part to compensate. Finally, though I attempt to control for the most obvious time-variant confounding variables, others inevitably exist and thus could bias any or all of my estimates. The similar potential also exists for my instruments to in truth fail the exclusion condition. Further studies using alternate datasets or additional variables might mitigate these issues and determine whether my results are still valid.

VIII. CONCLUSION

This paper's findings, if sound, hold significant implications for US development policy. Policymakers traditionally assume that US developmental, diplomatic, and foreign policy goals are all consonant with increased global food security. However, the results suggest that the US government may have to weigh the obvious humanitarian benefits to fighting hunger abroad against the potential detriments to national security and global political stability. It may even be the case that the negative second order effects may overwhelm the first order benefits, leading current US food security efforts to potentially cause more harm than good.

If, as Vice President Biden suggested, US development policy seeks to increase both the well-being of its recipients along with US national security interests, it may be more profitable to focus on boosting individual wealth directly by working with national governments to control hyperinflation instead of concentrating on increasing food security, as the results suggest the former two interventions are better aligned with both goals. However, given the importance of my research question on US food security policy, future research might seek to ensure that my results are indeed sound before any substantial adjustments to development policy are made.

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