Civil Wars: Resources, Repression, and Representation?

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Abstract: The mounting evidence for climate change has placed the onus on policymakers to prepare for negative security externalities. Researchers claim erratic rainfall reduces economic prospects and increases the incentives for conflict between groups over increasingly scarce resources. The incentive to fight, however, can potential be mollified when governments employee alternative coping mechanisms. Research to date has yet to yield any consensus regarding whether climate variability actually increases the risk of civil war compelling many to test impact of climate variability on lower levels of conflict specifically, communal violence. This argument is evaluated statistically utilizing a disaggregated dataset combining weather data with geo-referenced data on the onset of civil war in a global study from 1989 – 2008. The analysis indicates large positive deviations in rainfall from the historical average are positively associated with a higher degree of risk for civil war onsets.

Introduction

There has been mounting evidence that human development is having a profound impact on the global environment. The resulting climate change is believed to be entrenched in short run and there is little governments can do to prevent or turn back the trend. Consequently, there is increasing concern regarding the impacts of climate change on domestic and international politics. While the concepts of resource scarcity and demand are not new, indeed Malthus first wrote about the subject in the 1800's, the theorizing and empirical testing has lag considerably.

There have been attempts by various scholars over the last decade and two special issues in prominent political science journals dedicated to the subject. The findings, however, are described by the authors as weak, tentative and preliminary. These same findings, however, diverge greatly and no consensus regarding whether climate variability increases the risk of civil war has been reached.

The source of the diversion can be found in two places: systematic employment of the nation state as the unit of analysis, and a myriad of operational definitions pertaining to the primary independent variable rainfall.

I find no support of the Malthusian thesis when tested directly. The evidence suggests the absolute amount of rain and population densities are positively correlated with the onset of civil conflict. Other measures of resource scarcity are not statistically significant. I then move on to test the neo-Malthusian thesis that resource scarcity is moderated by political and economic variables. I find evidence to support this moderation, however, the direction of the coefficients run counter to the theorized direction.

The next section begins with a review of the Malthusian, Cornucopian, and neo-Malthusian theses. I then explore the construction of a relevant research designs and postulate that utilization of the country-year as the primary unit of analysis is not well suited to the answering the research questions at hand. With that insight in mind I outlay the neo-Malthusian thesis in terms of substantially smaller units of analysis. In the following section the research design is presented including a variety of short comings. In the fourth section tentative results are presented. The final section summarizes the findings and discusses their policy implications.

Literature Review

Theoretical Genesis

Malthus (1803/1992) assumed food production grows arithmetically while humans reproduce exponentially. He then theorized there will come a point in time where the sheer magnitude of the human population will surpass the Earth's carrying capacity. Beyond such a point humanity would face acute and periodically severe resource shortages contributing to widespread famine followed by disease, pestilence, and war. A Malthusian worldview prescribes a dark and dreary future as the prognosis is guaranteed and there is nothing humanity can do to prevent the inevitable.

Cornucopian's do not reject the Malthusian thesis that population pressure in conjunction with resource scarcity would lead to acute shortages and potential violence. Rather the assumptions of arithmetic growth in food production and exponential human reproduction are assaulted and refuted. Human ingenuity and perpetual innovation will forestall any such convergence of demand and supply rendering Malthus' conclusion moot.

Interestingly the Cornucopian's three most salient attacks against Malthus' assumptions originate from the supply rather than or in conjunction with the demand side of the calculus. Natural resources are never truly scarce when utilizing a global vantage point precluding the development of resources crises or follow on conflicts (Simon 1996, Lomborg 2001). Localized scarcity of natural resources is efficiently addressed and remedied through the adoption of market mechanisms (Deudney 1991). In the short term markets reduce demand for a resource by increasing commodity prices. For longer time horizons individuals internalize the market and develop alternatives including ways to conserve, recycle, substitute, and most importantly develop new technologies (Boserup & Schultz, 1990).

Thus far the historical record has not been kind to Malthus' assumptions when aggregated. The human population continues to expand because of the interaction of declining infant mortality and increased longevity. Such growth, however, is being moderated as birthrates in developing parts of the world contract due to income growth, or even fall beneath the replacement rate in a number of developed societies. Furthermore, a myriad of innovations including the genetic modification of seeds to increase crop yields and increased resistance to famine and drought food has dramatically increased production.

Realizing the Cornucopian and Malthusian theses represent extreme ideological positions Homer-Dixon did what any good politician would occupy and defend the median position. Homer-Dixon recognized the need to transition from globalized to localized production and supply and to differentiate between classes of goods.

Homer-Dixon redefines resource scarcity in terms of primary goods which are needed to satisfy the needs of a subsistent existence and secondary goods which satisfy higher levels of need. Specifically, Homer-Dixon & Blitt (1998) are interested in the availability of four resources: fresh-water, arable land, forests, and fisheries. Homer-Dixon (1999) contends that these resources have inelastic production in the short to medium terms and as a result resource availability decreases when either additional persons or per capita demand increases.

According to Homer-Dixon (1999:177) natural resource scarcity contributes to the onset of conflicts through either direct, indirect, or both causal pathways. The direct path posits the rapid degradation or anticipated exhaustion of a local natural resource within a society. When confronted with such a

scenario political elites will attempt to secure and redistribute those resources in a manner that preserves their own power often times at the expense of others.

Societies also face considerable indirect pressure. Homer-Dixon (1999:5) contents states face "increasingly complex, fast moving, and interacting environmental scarcities" which can overwhelm society's efforts to mitigating such scarcities through economic growth and innovation. Drawing the country into a vicious circle where physical crises persist and new scarcities emerge and the state's ability to marshal resources continually diminishes because the scarcities that require social ingenuity also act as a constraint on innovation. This ingenuity gap "erodes [both] the moral and coercive authority of government, which boosts the probability of serious turmoil and violence (Homer-Dixon 1999:7).

Homer-Dixon's (henceforth neo-Malthusian) theory is bereft with controversy and has been critiqued, criticized, and outright rejected by some. Their challenges fall into two distinct categories: methodological and theoretical. Researchers (Gleditsch 1998, 2012:6, de Soysa 2002) claim that there is an over reliance on the use of case studies to validate their theoretical propositions. Furthermore, these studies are inconsistent in both their approach and their independent variables resulting in shallow case studies and "theoretical myopia". Salehyan (2008:318) argues Neo-Malthusians are ignoring the dogs that don't bark and favoring the ones that do leading to consistent selection bias which limits the generalizability and predictive capacity of the theory. For every example of an environmental conflict there are many other examples where conflict does not take place.[1]

More commonly the neo-Malthusians are challenged on theoretical grounds stemming from omitted variable biases. Gleditsch (1998) was amongst the first to levy the critique that the neo-Malthusian approach was overly deterministic too. Contending the deterministic approach ignores other important and potentially mitigating factors including: cultural, economic, and political variables. Sen (1999) astutely points out states have a degree of responsibility in resource degradation and material shortfalls. It is the obligation of governments to design and implement policies to protect their citizens, states that fail to do so compound the negative externalities of environmental degradation and make conflict more likely.

[1] King, Keohane, and Verba (1994:130) suggest case studies should be avoided outright because of the dangers that are associated with selecting on the dependent variable and warn against any generalizations that can be made from extreme observations.

Despite the theoretical and methodological challenges levied against the neo-Malthusian perspective it remains the undisputed point of departure. The central theory that population pressure in conjunction with localized inelastic resource scarcity either through direct or indirect causal pathways leads to conflict is present in a majority of the environmental - conflict literature. Researchers frequently cannibalized this framework and reformulate it to test specific hypotheses in a variety of temporal and spatial settings. Finally, the research designs and subsequent findings are often portrayed by the authors as providing evidence in support of, or in opposition to the neo-Malthusian thesis.

Strengths and Weaknesses

The theoretical impetus for the study of resource scarcity, population density, and conflict is cloaked in a rich tradition. Despite this legacy the thesis has languished as a philosophical question and has only recently inspired serious quantitative inquiry in the social sciences. The preliminary nature of the analysis leaves significant room for improvement in terms of variable operationalization and fidelity to the neo-Malthusian theory. Three such areas for advancement include: regime type, discrepancies in the weather variables, and devotion to the nation state as the preferred unit of analysis.

Sen (1999) singles out states for the responsibility they have in the management of resource degradation and material shortfalls. Sen asserts governments have an obligation to design and implement policies to protect their citizens and states that fail to do so compound the negative externalities of environmental degradation and make conflict more likely.[2] To operationalize this responsibility researches have adopted a variety of different measures in their respective studies. The constructs of regime type, polity, binary democracy, freedom house, and other related measures, however, have two consistent problems. They are all positively correlated with gross domestic product and gross domestic product per capita which suggests they are proxies for wealth.

Moreover, the principal independent variable, water availability, suffers from inconsistency. Competing operationalizations are a result from multiple casual pathways; each captures a different aspect of the normative logic. Scholars have looked to absolute rainfall. This formalization essentially tests the effects of climate zones on conflict behavior, since absolute rainfall amounts are endogenous to geographic locales. Scholars have also utilized rainfall growth rates. This

[2] Homer-Dixon (1999) alluded to this reality in the formulation of the ingenuity gap.

formalization is computed as an annual percent change in rain amounts.[3] Third, scholars have used rainfall levels operationalized as deviations from the thirty year mean at an individual state level. This formulation of the independent variable is arguably superior to the first by establishing an individualized baseline for comparison.[4] Finally, scholars have utilized the standardized precipitation index which measures deviations in rainfall on a monthly basis. It is most commonly utilized as a measure of draught.

Historically, the state-year has been utilized as the relevant unit of analysis by political scientists. The approach was necessary for two reasons. First, early data collection projects like the Correlates of War amassed country specific data because more granular data were simply not available given the resource constraints. Second, the theories and questions that political scientists were interested in assumed the interaction of two or more states. Continued utilization of state-year, however, does not make sense when the questions that are being asked are sub-national. The kowtowing of geophysical variables to geopolitical units robs the former of their rich variation and explanatory power. The hegemony of geopolitical parsimony, aggregate level datum, has robbed inter-unit variations. The fix, geophysical units, not only makes more theoretical sense, it is also becoming increasingly available with wide-spread adoption of geographic information systems technology, and better suited to answering the question posed by the neo-Malthusian thesis.

Theory

The argument begins with three simplifying assumptions. One, weather is exogenous to human behavior in the short to medium terms. Two, individuals have different degrees of personal wealth; this wealth can serve as either a constraint or opportunity and moderates an individual's ability to act. Three, people that rely on subsistence agriculture are more vulnerable to changes in weather variation. The environmental – conflict literature has shown environmental change is unlikely to serve as a trigger of conflict in isolation (Koubi et al. 2012, Clionadh & Urdal 2007, Hendrix & Glaser 2007). This suggests the Malthusian thesis of direct effects should be rejected. It is possible, however, that changes in the weather, coupled with extreme weather events could impact the agricultural landscape altering the productivity of crops thereby exacerbating resource scarcities as

[3] Ciccone (2011) formulates a compelling argument as to why this approach should be rejected. The argument proceeds in the following fashion. Environ a country that is experiencing above average rainfall in period one. In period two, the country experiences fifty percent less rain. Growth rates would should this country experienced a decline in rain from one year to the next while the subsequent years rainfall may remain greater than the historic norm.
[4] The weakness is that it cannot account for continuing shocks that lasts through a number of periods, since this effectively becomes the "new normal."

theorized in the neo-Malthusian model. Under such conditions individuals will compete for scarce resources increasing the likelihood of conflict.

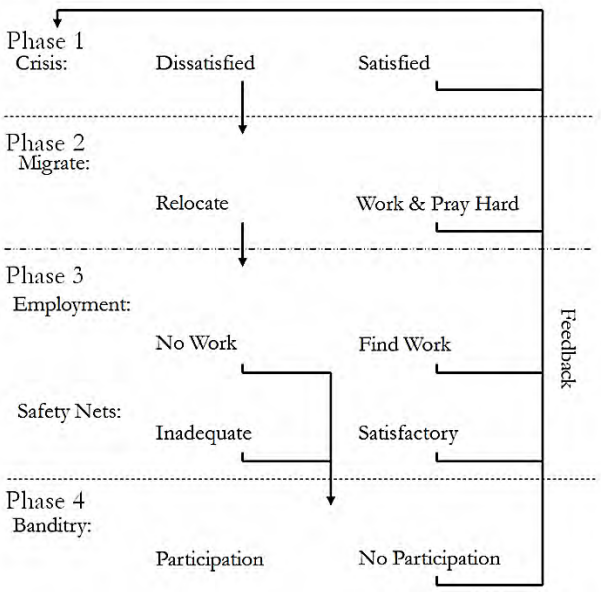
> Hypothesis 1: The Malthusian direct effects will be insufficient to explain *civil war onset*.
> Hypothesis 2: The occurrence of *civil war onset* increases in regions that are experiencing *resource scarcity*.
> Hypothesis 3: The occurrence of *civil war onset* increases in regions that have high *population density*.

Violence, however, is more likely to occur in areas where the capacity for dealing with resource scarcity is diminished. Therefore, governments with high degrees of political capacity in conjunction with other geophysical variables can serve to strengthen the rule of law and thus reduce the risk of conflict. The remainder of this section elaborates on the pathway through which weather variability could lead to civil conflict.

Causal Mechanism

Phase One: Changes in the weather impact the agricultural landscape potentially lowering the productivity of crops. If the scale of the environmental impact is long enough and the geographic reach large enough whole countries may face acute food shortages. At the individual level farmers must determine if they have the means to carry on (satisfaction) or if their stock of goods is diminishing to levels that may not be able to sustain their family. This initial realization is illustrated in phase one in the farmer's dilemma figure.

Figure 1. Farmer's Dilemma (Simplified)



In 2005 Malawian farmers faced just such a severe and protracted draught and as a result maize production decreased to its lowest level since 1992. Farmers produced 1.25 million tons of maize or 37% less than average yearly consumption.[5] The government estimated a third of the population would need assistance to fend off mass starvation. To further complicate things the Malawian calls for international assistance fell largely on deaf ears. Malawian's would be forced to shoulder their burden alone. Facing a protracted draught many quickly eroded their saving and reserves.[6] As the crisis persisted fully, "half of the country's farming families delayed harvesting their own crops so that members could earn vital cash elsewhere. This practice has seen some farms losing part of or all of their crops. In other areas, families have left land fallow because there is no one to look after the crops."[7]

Phase Two: Farmers persisted in the face of severe adversity and many continued to work hard on and off the farm, and many others simply endured because it was their only option. As time passed more and more farmers exhausted their savings. Farmers liquidated their personal belongings to make ends meet. Such a strategy cannot be used indefinitely. There will always come a point when

[5] http://www.wfp.org/news/news-release/southern-africa-faces-severe-food-shortages-millions-people-need-urgent-humanitarian-aid

[6] Kamkwamba (2009) writes in his biography that his family and many of those in his village began to sell their possessions including the very tin roofs over their own head to pay for food that grew increasingly expensive. Others foraged for food seeking out tubers, roots, and leafy plants that could be consumed. On occasion, however, hunger lead to devastating consequences.

[7] http://news.bbc.co.uk/2/hi/health/2512315.stm

the crisis is acute enough that farmers will have to make a stark choice. They can continue to stay on their farms and till the barren soil or they can elect to migrate to another region of the country in search of new opportunities (Rafael 2007). The farmers and families that abandon their homes and relocate choose to find another farm to till or move to the cities. Farmers and families with *means* at the onset will seek out relatives in places that they perceived as being better off. Others will turn to the cities as they search for work and the mean to support themselves and their families.

Malawi is not the only country to experience this type of migration patterns during periods of draught and economic collapse. In 2009 Syria entered into its second consecutive year of draught reducing crop production by 50% and impacting 60% of Syrian farm land. In July of 2009 the Syrian Ministry for Agriculture and Agrarian Reform estimated that between 20 and 50 thousand families had migrated from their farms to urban centers in search of work.[8] Tanzania is also facing a prolonged draught. In the city of *Dar es Salaams* the regional commissioner estimates that since the start of the draught that 100 young men enter the city every day in search of employment.[9] In all three cases cities are seen by the poor as a place of refugee with enhanced economic prospects. For many farmers then the choice of migration is logical but their ability to migrate is most prominently tempered by their economic wealth or the strength of their feet.

> Hypothesis 4: The occurrence of *civil war onset* decrease when a region that is experiencing *resource scarcity* is in closer proximity to an *urban center*.

Phase Three: Those that lack the economic reserves, physical prowess, or courage for such a journey opt to remain on their farms and carry on as best they can. Those that did relocate may or may not find work. Those that stayed on the farms and those that migrated but failed to find work find themselves in a dire situation. They are dependent on aid, be it monetary or direct food transfers and if that aid fails to be delivered many will simply not survive.

International and non-governmental organizations in conjunction with foreign governments occasionally come to lessen the burden. The research designs in the environmental-conflict literature to date suggest domestic democratic regimes are more likely to provide assistance than their authoritarian counterparts (Koubi et al 2012, Gartzke 2012 and Urdal 2005). Researchers justify this claim on the grounds of median voter, large electorates, adherence to liberal norms and interest

[8] http://www.irinnews.org/Report/85963/SYRIA-Drought-driving-farmers-to-the-cities
[9] http://allafrica.com/stories/201211130805.html

groups. In essence their claim is that democracies practice good governance and autocrats practice bad governance in terms of their effectiveness and normative values. But the ideological and structural composition of the local government may matter less than hypothesized. In the short cases presented above Syrian (authoritarian), Tanzania (autocratic), and Malawi (democratic) all attempted to feed their people.

The attempt to provide assistance then has little to do with ideology and more to do with their capacity to meet the challenge at hand. The ability of any government like an individual is constrained first by the available resources specifically wealth. Additionally, governments are constrained by how efficient they utilize those resources. A government that is fabulously wealthy but is bereft with corruption and poor planning may actually achieve less than a government with the meekest of resources but has an indomitable will.

Phase Four: On rare occasions, however, people will move and find nothing, work and pray to no avail, families, social and religious groups, governments, donors, and the international community may or may not provide social safety nets that might not be adequate to the task. It is at this point when farmers have nothing more to sell or grow, saving to sell, no prospects of employment, or assistance from civil society that they may take up arms to seize the goods they need to survive.

> Hypothesis 5: The occurrence of *civil war onset* decrease when *government capacity* to act increases in conjunction with the proximity to areas experiencing *resource scarcity*.

Research Design

Spatial and temporal in conjunction with the unit of analysis

In order to assess the neo-Malthusian argument on weather variability and societies ability to cope a global dataset is constructed that spans from 1989 – 2008. Data, however, is not universally collected at the state level rather it is most frequently amassed at the sub-national level generated from geospatial data. Geospatial data differs from traditional country-year approaches in three ways. The unit of analysis *grid-year* is considerably smaller that national geopolitical units. The dependent variable *civil war onset* is position to have occurred at a specific geophysical location as opposed to anywhere within a country. The independent variables are linked to specific geophysical locations too. This approach enhances the researches ability to capture local variation in conjunction with proximity to specific geophysical and geopolitical locations.

The PRIO-GRID utilizes a 0.5 x 0.5 decimal degree resolution. At the equator a grid cell corresponds to roughly 55 x 55 kilometers (3,025 square kilometers) with cell area decreasing at higher latitudes. Each grid-square is associated with a single country utilizing the Gleditsch & Ward (1999) country convention. Grid cells that contain multiple countries are awarded to the country with the largest share of the grid area. Additionally, while each grid cell is included on a yearly basis it may not have an association with a country because that geographical area did not meet the requirements of system membership. Grid cells that are covered with water, and or a part of Greenland or Antarctica are dropped. In total, there are 64,818 cell observations and 20 years of coverage yielding 1,296,360 total observations (Tollefsen et al 2012).

Dependent Variable

Georeferenced **Conflict Onset** data comes from version 4 of the UCDP/PRIO Armed Conflict Dataset (Dittrich Hallberg 2012). Armed civil conflict is defined as a contested incompatibility between two or parties where one is the government, concerning issues of governance or territory, where armed conflict between the parties has resulted in a minimum of 25 battle related deaths (Strand 2006). Conflict *Onset* is a dummy variable that identifies the grid cell hosting the initial battle for each unique intrastate conflict.

Independent Variables

Georeferenced **Weather Variables**: *Precipitation, Precipitation Level, and SPI6* are used to estimate the impact that resource scarcity has on the probability of civil conflict onset. Other geophysical variables including water scarcity and soil erosion are not utilized for two reasons. They are not available for the duration of the temporal domain. Furthermore, both variables are impacted by human behavior as an attempt to modify the local environment. Weather variables, however, are beyond human control in the short to medium terms limiting the endogenity problem that is frequently levied against the neo-Malthusian thesis.

Precipitation data gives the total amount of rain, in millimeters, that falls within a specific grid cell. The data is based off the monthly statistics at the University of Delaware (NOAA 2011). The data are available for the temporal period spanning 1946 – 2008. The variable *Precipitation Level* is derived from the University of Delaware data. To construct the variable 30 year moving averages were

created. Once achieved actual rainfall was subtracted from average rainfall to ascertain if rainfall was either above or below the 'historical average'.

Standardized Precipitation Index (*SPI6*) data comes from the International Research Institute for Climate and Society from the Global Precipitation Centre (see Rudolf et al. 2010). The measure is based on monthly data and is calculated as deviation from long-term normal rainfall over the previous six months and is then annualized and categorized. *SPI6* is coded 1 if there are three consecutive months of moderate draught; 1.5 in the case of severe draught; 2.5 in the case of extreme draught and 0 in the case of no draught.

Georeferenced **Governance and Society Variables**: *Bottom Billion*, *Travel Time*, *Relative Political Reach*, *Loss of Strength Gradient*, and *Population Density* are utilized to estimate the capacity of societal resiliency in the face of extreme weather and the threat of civil war onset. *Bottom Billion* data comes from Collier (2007). The logic is extremely poor countries are less capable of dealing with the impacts of changes in the weather because such countries have fewer resources to make a garden from a desert. The variable was collected at a national level and then disaggregated to each cell within the given country. The measure is binary in design where 1 indicates poverty and 0 indicates otherwise.

Travel Time data comes from Nelson (2008). It reports the estimated cell-averaged travel time from the grid cells center to the nearest city with a population greater than 50,000 inhabitants. Note *Travel Time* does not contain time-varying information. As a result it does not take into account the construction of new cities or population growth in cities which would negatively impact the averaged travel time.

Relative Political Reach (*RPR*) data comes from Kugler & Tammen (2012). The measure is calculated at a national level and measures the effectiveness of governments. It is utilized here as an alternative to the use of regime type because the authors attempt to ascertain how efficient a government is rather than how 'good' a government maybe. The data is normalized where one is equal to an average government compared to their peers, scores less than one are considered to be ineffective governments while scores greater than one are highly effective and efficient.

Loss of Strength Gradient is crafted by dividing *travel time / relative political reach*. Kenneth Bolding (1976) noted that in the international arena countries are more powerful the closer they are to their own territory. The military's capacity for waging war decreases the further they must travel to engage the enemy and the longer the lines of communication and supply. Dividing *travel time* by *relative political reach* therefore implicitly that a government's ability to interact with its citizenry is dependent on the distance from localized centers of power (cities).

Population Density data comes from the Gridded Population of the World, version 3 (CIESIN 2005). Total population for each cell is estimated at 5 year increments from 1990 to 2005. For those years that fall between observations the missing data was interpolated. This variable is then divided by total cell area obtained from (Tollefsen, Foro, Strand, Buhaug 2012).

Georeferenced **Geography Variables**: *Mountainous*, *Border Distance*, *Contagion* are utilized to control for variables found to be robust within the civil war literature. *Mountainous*, data comes from the World Conservation Monitoring Centre (2002). The data is measures the proportion of a cell that is covered by mountainous terrain. While the variable is only reported for the year 2000 it is time invariant and attributed to all observations for a specific grid cell over for the duration of the temporal period.

Border Distance is based on the Gleditsch and Ward (1999) world system membership. The variable captures the straight line distance, in kilometers, from the center of the grid cell to the nearest contiguous country. *Contagion* is a spatial indicator that reports the percentage of contiguous cells that have an ongoing conflict in that same calendar year. The variable takes on a value between 0 and 1. Where a cell has no continuous cell in conflict 0 is reported. If, a cell is neighbored by five immediately adjacent cells that are in conflict the assigned value is 5/8 = .625.

Methodology

The analytic method is logistic regression, where the dependent variable is conflict and the unit of analysis is grid square year. More specifically, random effects panel logistic regression is applied.

Results

Direct Effects

As noted previously Malthus theorized resource scarcity when coupled with population density would be sufficient for the onset of war. Contemporary researchers moderate his claims suggesting the existence of indirect effects rather than direct effects. They argue the probability of conflict is moderated by a series of intervening variables including: regime type, economic development, and physical terrain. To directly test the Malthusian hypothesis logistic regression is employed where the dependent variable is onset and only climate and population variables are utilized as substitutes for resource scarcity.

Table 1. Logit Regression: Direct Effects

VARIABLES	COEFFICIENTS			
	Onset (RE)	*Onset* (FE)	*Conflict Zone* (RE)	*Conflict Zone* (FE)
population density	0.598***	-1.886**	0.624***	-2.129**
	(-0.044)	(-0.865)	(-0.0439)	(-0.9918)
precipitation	0.235*	0.446	0.266**	0.771***
	(-0.131)	(-0.823)	(-0.13)	(.0884)
spi6	-0.197*	-0.219	-0.156	-0.217
	(-0.115)	(-0.14)	(-0.106)	(-0.143)
precipitation level	-0.00082*	-0.00025	-0.00086**	-0.00038
	(-0.0004)	-0.00008	(-0.00039)	(-0.00036)
precipitation level squared	-0.0359	-0.0511	0.0273	0.0575
	(-8.76E-7)	(-0.0482)	(-0.0323)	(-0.0515)
constant	-12.64***		-14.48***	
	(-0.788)		-0.575	
n	889,183	1,542	889,183	1,382
Log likelihood	-1041.24	-303.39	-944.518	-273.35
Wald chi^2	236.59	8062	257.82	9.21
Prob > chi^2	0.0000	0.1251	0.000	0.1009

The models presented in table 1 provide very limited support for the existence of direct causal links between resource scarcity, population growth and conflict onset. Note population density is statistically significant at either the .01 or .05 level across all four models but when fixed effect panel regression is utilized the sign of the coefficient flips.[10] The signs associated with the weather variables are consistent across all models but only precipitation is statistically significant in the fixed effects model. While absolute levels of precipitation is statistically significant it says little about the

[10] A Hausman test was used to measure the validity of each model. In both instances the fixed effect estimator is superior to the random effects estimator. For the actual Stata outputs see appendix 1.1.

onset of conflict in terms of variations in weather. More specifically, precipitation captures climate zones; which suggests areas that are more arid are less likely to experience conflict that more tropical regions absent of other variables. Given the inconsistency of the population coefficient and the limited statistically significance associated with the remaining variables it appears that the Malthusian thesis is invalid.

Indirect Effects

Neo-Malthusian's argue the impact of population pressures and resource scarcity on the probability of conflict can be moderated or enhanced by other intervening variables. For instance Clionadh & Urdal (2007) find environmental factors have only modest explanatory power and in the absence of other political control including government type the environmental variables are frequently insignificant. Gizelis & Wooden (2010) find that governance is a key intermediary that in its absence environmental variables are unable to predict conflict. Koubi et al (2012) find that democratic countries are less likely to experience civil war than their autocratic counterparts.

In testing the neo-Malthusian thesis four questions were asked as outlined in the theory section above. First, borrowing directly from Malthusian thesis, resource scarcity and population density are likely to increase the probability of civil conflict onset. Second, when faced with resource scarcity people will relocate to places where they believe better opportunity exists. Frequently, such trips take people to cities in search of work. Therefore, as proximity to an urban area increases the probability of conflict should diminish. Lastly, people that stay on their farms and migrants that cannot find employment will look towards private and public safety nets. The ability to provide public benefits to the countries citizenry depends on the government's ability to efficiently transfer such goods. Governments that are have greater reach should be more effective in providing aid and therefore less likely experience civil conflict. This effect, however, is moderated by the distance that such goods will have to transit. The further away a region is from an urban area the less effective the government intervention and the greater the probability of conflict.

The models suggest a variety of interesting things.[11] Precipitation is not significant in any model potentially confirm my suspicion that it is a proxy for climate region. Furthermore, it suggests the

[11] As a robustness check an alternative dependent variable, conflict zone onset is utilized with the same model specifications. Conflict zone onset is created by interacting onset (first battle site) and areas in conflict during the same calendar year, increasing the total number of observations. The findings are consistent with original specification. The additional models can be found in Appendix 2.

effects of climate in a given region are easily moderated by other political, social, demographic, and geophysical factors. Secondly, precipitation squared is not significant across all models suggesting that the relationship between resource scarcity and conflict is linear rather than curvilinear which is counter to the findings to previous finding by Raleigh (2012), Hendrix & Glaser (2007), Hendrix & Salehyan (2012). The availability of water in terms of SPI6 index is consistent and statistically significant across all models. Higher SPI6 scores are associated with protracted and severe draught. Suggesting the probability of conflict diminishes during periods of protracted draught. When combined with the previous finding it suggest conflict is most likely to occur when water availability it at or above historical averages. This finding is counter to both the Malthusian and neo-Malthusian thesis and compels the author the reject hypothesis two.

Population density in the first set of regressions was statistically significant across all models in a direct test of the Malthusian theses. However, when additional neo-Malthusian variables are included the effects of the variable are more fragile. Population density remains statistically significant but the sign of the coefficient flips depending on the model specification. This suggests population density is not very robust and its impact while significant is over powered by other intervening variables. As a result hypothesis three should also be rejected.

It is hypothesized that the probability of conflict onset diminishes the close a region is to an urban center. The exact opposition is, however, true. In all four models the further away a region is from an urban center the smaller the change of conflict. This finding is, however, moderated by the effectiveness of government. The coefficient of loss of strength is always positive. This means conflict is more likely to occur the further a region is from centers of power. Yet, loss of strength is statistically significant in random effect models. Coupled together these findings present an interesting problem. As regions become increasingly distant from centers of power the probability of conflict simultaneously increases and diminishes. This maybe the result of a curvilinear relationship: where people that are sufficiently far away from the government power centers are unlikely to start a conflict because the government has no power to reach there and a result they have de facto sovereignty.

Table 2. Logit Regression: Onset[12]

VARIABLES	COEFFICIENTS			
	Model 1 (RE)	Model 2 (FE)	Model 3 (RE)	Model 4 (FE)
mountainous	0.595**		0.563**	
	(-0.263)		(-0.262)	
bottom billion	0.963***		0.891***	
	(-0.242)		(-0.227)	
population density	0.230**	-2.344*	0.248***	-2.656**
	(-0.0949)	(-0.0293)	(-0.0895)	(-1.274)
precipitation	0.0061			
	(-0.155)			
spi6	-0.278**	-0.428**	-0.270**	-0.447**
	(-0.126)	(-0.18)	(-0.125)	(-0.181)
precipitation level	-0.00057	-0.00173	-0.00074	-0.00024
	(-0.0005)	(-0.00128)	(-0.00051)	(-0.0007)
precipitation level squared	0.0593	0.0293		
	(-0.0416)	(-0.06)		
border distance	-0.526***	-0.526***	-0.527***	-0.526***
	(-0.0634)	(-0.0634)	(-0.0632)	(-0.0634)
travel time	-0.746***	-0.746***	-0.725***	-0.746***
	(-0.254)	(-0.254)	(-0.249)	(-0.254)
relative political reach	1.050***	-3.383	1.127***	-3.565
	(-0.4)	(-2.837)	(-0.386)	(-2.81)
loss of strength gradient	40.69***	77.86	40.53***	87.34
	(-13.18)	(-237.2)	(-13.19)	(-237.1)
total area	-0.000583**		-0.000556**	
	(-0.00027)		(-0.00026)	
contagion	4.297***	4.450***	4.308***	4.394***
	(-0.292)	(-0.519)	(-0.291)	(-0.514)
constant	-9.640***		-9.357***	
	(-1.11)		(-0.947)	
n	792,693	1,239	792,693	1,239
Pseudo Log likelihood	-681.8	-175.01	-683.14	-176.02
Wald chi^2	399.7	156.05	403.28	154.11
Prob > chi^2	0.0000	0.0000	0.0000	0.000

[12] A Hausman test was used to measure the validity of each model. In both instances the null hypothesis could not be rejected suggesting both fixed and random effect models have utility. For the actual Stata outputs see appendix 1.2.

Discussion

The above research design suffers from a variety of operationalization and methodological short comings. In terms of theory a dummy variable, bottom billion, is utilized to suggest the wealth of society. Any future analysis would benefit from the inclusion of either a continuous measure of wealth. The Nordhaus (2010) data is one such source; it, however, utilizes a different level of analysis making it unusable for inclusion into this study.

The neo-Malthusian theory also hypothesizes the existence of feedback loops which can exasperate resource and population pressures. This correlates with the notion that there exists simultaneous interaction between variables. In order to address the issues of simultaneous interaction effects, temporal lags and temporal dependence alternative statistical tests should be utilized. Potential models include, hazard models, inclusion of splines into the panel logit, and bootstrapping to ensure accurate standard error.

Conclusion

The aim of the paper was to test the validity of the neo-Malthusian thesis. I ultimately found support for political, economic, and demographic moderation of the environmental – conflict nexus. The support, however, was not as anticipated resulting in the rejection of 3 of the 5 hypotheses. The paper provides several advancements over previous research. First, I articulate why a country-year level of analysis is unsuited for the task of studying weather and conflict at a sub-national level. To address this I rely on the PRIO-GRID data to undertake a 55km x 55km analysis. Secondly, I employ a global analysis covering the temporal domain of 1989 – 2005. In terms of policy, governments should realize that resource scarcity can and does lead to conflict at the sub-national level. However, there are many things that can lessen the probability of conflict and most of them are counter initiative. Like the researchers that have come before I offer only tentative results. I can soundly reject the Malthusian thesis. The neo-Malthusian thesis is correct in the sense that civil conflict is moderated by a series of intervening variables. Their coefficients are not, however, in the direction anticipated, yielding only new question as opposed to finalized answers.

Appendix 1.1

Onset

	Coefficients (b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
popden1	-1.886492	.597805	-2.484387	.8636273
prec1	.4464344	.2311504	.215264	.81281
spi6	-.2189025	-.1973383	-.0216541	.080063
gid_prec_30	-.0002489	-.0008148	.0005659	.0007156
gid_prec_3-1	.0513334	.0097481	.0413713	.0321425

b = consistent under Ho and Ha; obtained from xtlogit
B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

Test: Ho: difference in coefficients not systematic

chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 16.69
Prob>chi2 = 0.0051

Onset conflict zone

	Coefficients (b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
popden1	-2.128716	.6238483	-2.752565	.9169085
prec1	.4848314	.2682217	.2166097	.8584297
spi6	-.2177974	-.1559996	-.0618978	.0966733
gid_prec_30	-.0003785	-.0009559	.0005774	.0007655
gid_prec_3-1	.0575482	.0272574	.0302908	.0371466

b = consistent under Ho and Ha; obtained from xtlogit
B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

Test: Ho: difference in coefficients not systematic

chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 15.14
Prob>chi2 = 0.0098

Appendix 1.2

Onset

	Coefficients (b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
popden1	-2.343985	.2300389	-2.574024	1.292455
prec1	1.730455	.0060981	1.724357	1.128284
spi6	-.4276912	-.2775881	-.1501031	.1288741
gid_prec_30	-.0017333	-.0005673	-.001166	.0011754
gid_prec_3-1	.0293087	.0593236	-.0300149	.0432322
rpr_work	-3.382912	1.050065	-4.432977	2.808336
LOG63	77.85596	40.69037	37.16558	272.84
conflag1	4.450499	4.296678	.153821	.4291005

b = consistent under Ho and Ha; obtained from xtlogit
B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

Test: Ho: difference in coefficients not systematic

chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 10.97
Prob>chi2 = 0.1398

Onset conflict zone

	Coefficients (b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
popden1	-2.655968	.2480148	-2.903983	1.271312
spi6	-.4468866	-.2695633	-.1771234	.1317096
gid_prec_30	.0002392	-.0007409	.0009717	.0005378
rpr_work	-3.565424	1.126742	-4.692165	2.783688
LOG63	87.33596	40.53174	46.80422	272.7942
conflag1	4.393777	4.308175	.0856023	.4238874

b = consistent under Ho and Ha; obtained from xtlogit
B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

Test: Ho: difference in coefficients not systematic

chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 7.55
Prob>chi2 = 0.1831

Appendix 1.3

Onset

	Coefficients (b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
popden1	-2.57736	.1744423	-2.751802	1.415957
prec1	2.844374	.0410985	2.803275	1.328014
spi6	-.5231585	-.2764722	-.2466862	.1544052
gid_prec_30	-.0028891	-.0007944	-.0020947	.0013804
gid_prec_3-1	.0255214	.0562233	-.0307019	.0538534
rpr_work	-3.02091	1.058713	-4.079623	3.456669
LOG63	58.72383	51.89033	6.833498	378.091
conflag1	5.678727	5.790537	-.1118108	.6139438

b = consistent under Ho and Ha; obtained from xtlogit
B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

Test: Ho: difference in coefficients not systematic

chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 16.54
Prob>chi2 = 0.0222

Onset conflict zone

	Coefficients (b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
popden1	-3.18941	.1996638	-3.389073	1.399793
spi6	-.5502328	-.2699968	-.2802359	.161354
gid_prec_30	-.00043	-.0009801	.0005501	.0006187
rpr_work	-3.206953	1.16796	-4.374913	3.472749
LOG63	71.90823	51.58198	20.32627	375.8145
conflag1	5.310919	5.805512	-.2945929	.6039074

b = consistent under Ho and Ha; obtained from xtlogit
B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

Test: Ho: difference in coefficients not systematic

chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 10.37
Prob>chi2 = 0.0655

Appendix II

Table 3. Logit Regression: Conflict Zone Onset

VARIABLES	COEFFICIENTS			
	Model 1 (RE)	Model 2 (FE)	Model 3 (RE)	Model 4
mountainous	0.566**		0.531**	
	(-0.272)		(-0.269)	
bottom billion	1.050***		1.063***	
	(-0.234)		(-0.232)	
population density	0.174*	-2.577*	0.2**	-3.189**
	(-0.01)	(-1.419)	(-0.0938)	(-1.403)
precipitation	-0.219			
	(-0.133)			
spi6	-0.276**	-0.523***	-0.270**	-0.550***
	(-0.125)	(-0.199)	(-0.124)	(-0.209)
precipitation level	-0.00079*	-0.00289*	-0.00098*	-0.00043
	(-0.00051)	(-0.00147)	(-0.00051)	(-0.0008)
precipitation level squared	0.0562	0.0255		
	(-0.0424)	(-0.0686)		
border distance	-0.498***		-0.499***	
	(-0.0687)		(-0.0684)	
travel time	-0.731***		-0.697***	
	(-0.263)		(-0.256)	
relative political reach	1.059**	-3.021	1.168***	-3.207
	(-0.414)	(3.481)	(-0.398)	(-3.495)
lose of strength gradient	51.89***	58.72	51.58***	71.91
	(-14.74)	(-378.4)	(-14.75)	(-376.1)
total area	-0.00095***		-0.00092***	
	(-0.00027)		(-0.0003)	
contagion	-5.791***	5.679***	-5.806***	5.511***
	(-0.418)	(-0.743)	(-0.411)	(-0.731)
constant	-10.33***		-9.931***	
	-1.169		-1.016	
n	792,693	1,111	792,693	1,111
Pseudo Log likelihood	-597.32	-136.74	-599.61	-138.72
Wald chi^2	322.26	184.28	328.21	180.32
Prob > chi^2	0.0000	0.0000	0.0000	0.0000