Economic Deprivation and Civil War Events: A Disaggregated Study of Liberia*

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Version 22.02.07

ABSTRACT:
This paper examines the link between absolute and relative poverty and the location of civil war events. Drawing on the *ACLED* dataset, which breaks internal conflicts down to individual events at the local level, this paper takes a disaggregated approach to the study of conflict. The conflict data are linked with geographically referenced socioeconomic data from the Liberian Demographic and Health Survey (*DHS*) conducted in 1986. With geographical units (grid cells) of approximately 76 km^2 as the units of analysis, we test how both absolute and relative welfare levels affect the presence and number of conflict events in Liberia during the civil war in 1989–2002. We include a number of geographically disaggregated control variables, such as neighboring conflict events, distance to national borders, distance to the capital, population density, diamond deposit, and ethnic affiliations. Negative binomial regression results indicate that civil war events predominantly happen in the relatively richer provinces. We argue that this finding reflects the relative strength of the rebel group(s).

Paper prepared for the 48th Annual Convention of the International Studies Association, Chicago, MI, USA, 28 February–3 March 2007

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Thanks to Joachim Carlsen for programming tools to generate several of the variables used in the analysis and to Håvard Strand for facilitating the generation of the survey-based variables.

1. Introduction

The direct link from economic development to domestic peace is one of the most robust findings in recent large-N country-level studies of civil war (see e.g. Hegre & Sambanis, 2006; Collier & Hoeffler, 2004; de Soysa, 2002; Fearon & Laitin, 2003). Countries with income levels around 500 USD per capita (the current level of Vietnam or Liberia in the 1980s) are about three times as likely to experience conflict as countries at 4500 USD (e.g. Venezuela or Estonia). However, although there is agreement on this empirical relationship there is no consensus on the theoretical explanation for it. Fearon & Laitin (2003) maintain that GDP per capita is a proxy for state capacity, indicating that richer regimes are better able to monitor the population and conduct effective counterinsurgencies. Collier & Hoeffler (2004), on the other hand, focus on the viability of rebellion movements through opportunity costs. The recruits of the rebel groups must be paid, and their cost for joining the rebel organization is likely to decrease the lower their alternative income is. Consequently, Collier & Hoeffler claim that it is easier to maintain a rebellion in poor countries than in richer countries. Neither Collier & Hoeffler nor Fearon & Laitin attribute the relationship to the poverty of populations as such. This is partly because that neither Fearon & Laitin nor Collier & Hoeffler conclude that inequality (between individuals) does not increase the risk of conflict. However, their conclusions are exclusively based on inter-individual inequality data regardless of group-based or spatial variations in welfare within countries.

The empirical implications for the onset of armed conflict at the country level have been analyzed thoroughly. However, theoretical arguments regarding poverty and conflict all have implications for *where* we would expect to see civil wars. This applies to theories of relative deprivation (Davies, 1962; Gurr, 1970), the argument regarding greed versus grievance in Collier & Hoeffler (2004), and the impact of 'horizontal inequalities', or

systematic inequality between identity groups (Stewart, 2000; Østby, 2005). It is clear that country-level studies are in danger of masking the impact of all processes described in these arguments. Conflicts are often local. Country-level measures of average horizontal inequality, for instance, may fail to capture the relevant groups or the relevant dimension of inequality. The horizontal inequality argument only requires one under-privileged group to predict conflict. If the rest of the population in the country is homogenous or have small income differences, a country-level measure would be attenuated and unable to capture this.

This paper seeks to refine the empirical study of absolute and relative poverty in contrast to country-level studies, exploring the implications of these arguments for *where, within countries,* conflicts occur. This, however, requires a careful examination of the implications of these arguments for various outcomes, some of them observable, some of them not. In the present paper Liberia serves as a pilot study for testing our general expectations concerning the linkages between absolute and relative poverty and conflict. Later, we plan to expand the analysis to cover a larger part of Africa.

Using a GIS (Geographic Information System) we convert the territory of Liberia into grid cells[1] of approx. 8.5 km x 8.5 km (this is .08 decimal degrees, which in Albers projection is 8km across and 9km down). Based on geographically referenced data from the Demographic and Health Survey (DHS) in Liberia, 1986, we calculate local-level measures of economic wealth operationalized as an index of household consumer durables, education levels and local infant mortality rates. The conflict data stem from the ACLED dataset, which disaggregates internal conflicts into individual events, covering the Liberian civil war 1989-2002. The data are analyzed by means of negative binomial and logistic regression models.

[1] Other conflict studies that use the 'grid approach' include Buhaug & Rød (2006); Hegre & Raleigh (2006); and Raleigh & Urdal (2007).

The paper is organized as follows: Section 2 provides a theoretical framework for studying the relationship between regional distributions of welfare and the location of conflict events guided by the concepts ‘support level’ and ‘target value’. Section 3 starts out introducing Liberia as a pilot case and discusses how we can expand our spatial domain to cover larger parts of Africa, and ends with a brief introduction to the Liberian conflict. In section 4 we present the data and research design. Section 5 provides the empirical results. The negative binomial regression analysis indicates that civil war events predominantly happened in the relatively richer provinces of Liberia. We argue that this finding may be consistent with a horizontal inequliaty or relative deprivation explanation, if we take into account the implications of the relative strength of the rebel group(s). Section 6 concludes..

2. Theoretical Framework: Support Level and Target Value

Most theoretical reasoning around civil war takes local issues and center-periphery relations into account. Still, it is not straightforward to derive exact observable and quantifiable implications regarding *where, within countries,* conflicts occur from this literature. Relative deprivation arguments, for example, imply that the population of locations that are relatively poor and are ignored by the central government should be more likely to support and join a rebel group that works to topple the government. ‘Support’, however, is not easy to observe. A local population caught in the middle of a conflict will not signal support for a rebel group if they fear government retaliation against supporters.

A straightforwardly observable entity, however, is a clash between the government and a rebel group. The time and place of such ‘conflict events’ are often reported in news sources. The ACLED data set, described below, assembles such news reports for a set of African countries. There is no direct link between the theoretical arguments in the literature and the timing and location of conflict events, however. To substantiate this claim, and to

derive implications for the location of observable conflict events from the literature, we find it useful to distinguish between the concepts of *support level* and *target value*.

Support level relates to the extent to which a local population is likely to support either the rebel group or the government in a conflict. This support may be in the form of economic contributions, places to hide or set up bases, or as recruits to the rebel army. The residents of a region that have been consistently favored by the government are likely to support the government, whereas the local population of marginalized and systematically neglected regions may be more likely to support the rebel group. A government in war may see a need to target locations from where the rebel group derives strength. This support from a local population, however, is not necessarily translated into conflict events in their home location. An effective rebel group will obviously attempt to protect their zones of influence and rather take the conflict to the government's support base.

Target value, on the other hand, refers to the extent to which a location is a valuable target for either group. Obviously, the extent to which a local population supports the opponent increases its target value. But other factors also affect target value. The strategic importance of a location is obviously one such factor. Both parties to a conflict will target strategic locations such as crossroads, bridges, ports and airports held by the opponent, and invest resources to protect them. Another factor is the extent to which the location can provide revenue to the parties. Alluvial diamond deposits are only one example of such locations.

Support levels are almost by definition different for the various actors. The target value of a location, on the other hand, may be similar to all. Alluvial diamond deposits can easily be translated into finances by virtually all actors. Other locations may be more valuable to one actor than to others. Still, actors may want to target such locations in order to weaken the opponent.

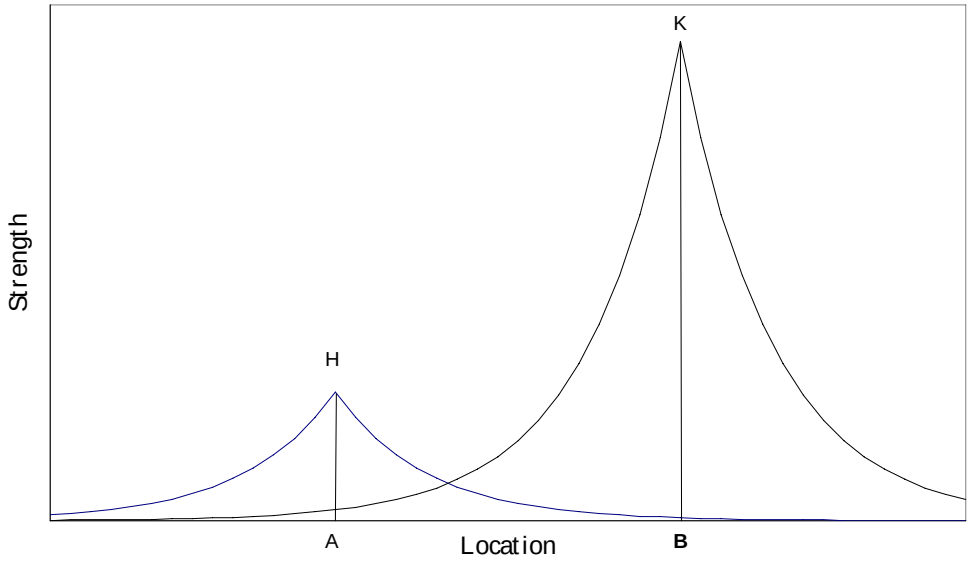
Whether support level or target value in a location results in observable war events depends on other factors. With limited resources, actors to a conflict will consider to attack or defend only the locations that are most valuable militarily or economically. Conflict events are observed only if both actors decide to engage at the same time. Whether we observe conflict events depends on the parties' strategic calculations. Actors are likely to engage only where both parties determine that expected utility of the event is higher than withdrawing. This, again, is a function of the relative strength of the contestants. The literature on the relationship between relative strength and likelihood does not provide exact and unambiguous guidance as to what we should expect. This literature is developed mainly in the context of interstate war.[2] Boulding's (1962) 'loss-of-strength gradient' provides some guidance to where we should observe conflict events. Figure 1 represents Boulding's model. The point 'A' represents the point at which actor *A* is stronger militarily, and 'B' the stronghold of *B*. In locations close to 'A', *B* has little chance of winning and is unlikely to attack. Likewise, conflict events are not likely close to 'B'. We should expect to see conflict

[2] Advocates of the `balance-of-power' argument in the context of interstate war (e.g. Wright, [1942] 1965; Morgenthau, 1967; and Waltz, 1979), claim that 'equality of power destroys the possibility of a guaranteed and easy victory and therefore no country will risk initiating conflict' (Kugler & Lemke, 1996: 5). When there is power preponderance, Waltz (1959: 232) argues that wars occur 'because there is nothing to prevent them'. According to this argument, the risk of war between two states is therefore lowest when they are approximately of equal size. Advocates of the 'power preponderance' argument, on the other hand (Blainey, 1988; Organski, 1968; Organski & Kugler, 1980; Lemke, 2002), argue that 'parity is the necessary condition for major war...' (Lemke & Kugler, 1996: 4). Fearon (1995) argues that war between two states should occur only when at least one of them is uncertain about the capabilities or the resolve of the other, or when they have difficulties committing to a negotiated outcome. When the power balance clearly favors one of the states, this uncertainty (although not the commitment problem) is negligible. Relatedly, Reed (2003: 637) formalizes the information component of the power preponderance logic, arguing that the variance or uncertainty of a challenger's estimate of the distribution of power is larger the closer the states are to parity.

events in locations where both actors are willing and able to engage the other, which is likely to be close to the point where their strengths are roughly equal.

In other words, if *B* is considerably stronger than *A*, we will see conflict events in locations close to *A*. In many instances, these are also locations that support *A*. The implication is that conflict events are more frequent in locations with high support levels for the weaker party to the conflict.

Figure 1. Boulding's (1962) Loss-of-Strength Gradient



2.1. Support level

What makes the local people at a location support a rebel movement? An essential factor relating to this is of course people's discontent with the status quo. Such discontent is often a result of economic deprivation.

Gurr's (1970) theory of relative deprivation implies that grievance-induced discontent due to the marginalization of certain groups is one main determinant of violent political mobilization. Yet, inequality is among the grievance factors largely dismissed by

recent large-*N* country-level studies of civil war (e.g. Collier and Hoeffler 2004; Fearon and Laitin 2003). However, such studies typically address economic inequality between individuals while ignoring spatial variations in socioeconomic welfare. Østby (2005) argues that such conclusions may be premature because of the neglect of the group aspect of inequality. Civil wars are organized group conflicts – not confrontations between individuals randomly fighting each other. Hence, the focus should be on inequality between identity groups, not between individuals. In line with this, case studies suggest that what matters for conflict is a concept closely linked to both economic and demographic polarization: so-called 'horizontal inequalities', or inequalities that coincide with identity-based cleavages (Stewart 2000, 2002). In brief, the argument is that inequalities coinciding with cultural cleavages may enhance group grievances and thus facilitate mobilization for conflict. Stewart (1998, 2002) discusses several case studies which suggest evidence for a positive relationship between horizontal inequalities and civil conflict in countries such as e.g. Cambodia, El Salvador, Nicaragua, Guatemala, Haiti, Burundi, Rwanda, Afghanistan, Somalia, Sierra Leone and Liberia. Stewart uses a very rich scheme for operationalizing horizontal inequalities. Her use of a wide diversity of different sources of horizontal inequalities is made possible by her individual case–study design.

Poverty and wealth tend to be spatially clustered within countries, and even in societies with low levels of overall inequality, some regions are richer than others (Buhaug & Rød, 2006). It is not only the absolute level of welfare at a location which is likely to affect people's support for rebel movements. Rather, the relative deprivation of the local population is more important for its support of rebel movements.

Support derives from such unequal geographical distribution of welfare. The local population is likely to feel frustration and antagonism, especially when their relative deprivation is the result of actual exploitation and discrimination from the government. Such

deliberately induced inequality is apparently often the case (for example in Uganda) (Stewart, 2002). And even when regional inequalities are due to factors beyond the control of the government, a local population may still perceive that they are discriminated against.

In line with the literature on inter-group inequality and conflict (Gurr, 1970; Stewart, 2000; Horowitz, 2000; Sen, 1973), we expect that people in locations which are relatively deprived compared to their geographical surroundings will be the most likely to support or join rebel groups in order to alter the status quo.

> *Proposition 1: Rebel group support levels increase with the level of relative socioeconomic deprivation at the location.*

Despite the intuitive logic of the above argument, one cannot, however, assume that it is only resentment by the disadvantaged groups that may spur support for one of the opposing sides in a conflict. People in relatively privileged regions are more likely to support the government, especially if their relative privilege is a result of the government's favoringof these regions. As Aristotle said, 'Inferiors revolt in order that they may be equal, and equals that they may be superior' (quoted in Sigelman & Simpson, 1977: 106). Since popular support can be directed either in favour of the government or in favour of a rebel it is complicated to evaluate the link between horizontal inequality and level of conflict events. In fact, Toft (2003: 5) argues that violence tends to plague rich and poor regions alike. If this is true, one should expect a relationship between a location's relative socioeconomic wellbeing and the risk of conflict that depends on the relative strength of the contestants. With geographically disaggregated data, we can single out the separate local effects of relative deprivation vs. privilege, which enables us to test the following proposition:

> *Proposition 2: The relative deprivation argument implies that the relationship between the relative socioeconomic status of a location and civil war events depends on rebel group strength: The most relatively deprived locations will see the most*

civil war events when the rebel group is weak, whereas the most relatively privileged will se the most civil war events when the rebel group is strong.

2.2. Relative Poverty and Target Value

In the previous section, we argued that relative poverty levels may affect a location's potential support level. This again is likely to affect whether we observe events there. But relative poverty levels may also affect the probability of observing events through impact on target value. Rebel groups depend on financing to sustain operations (Collier, 2000; Collier & Hoeffler, 2004). In Liberia and Sierra Leone, access to alluvial diamonds presented a useful source of revenue for the rebel groups. In addition, a portion of a rebel group's income is usually derived from looting. Looting, however, is most profitable in areas that are relatively well off, irrespective of whether the local population support one of the parties or not. In that sense, locations where the population is relatively well off should have a higher number of conflict events.

Target value also depends on military factors. Rebel leaders are likely to target locations that are easier to control, such as remote areas where the government is less able to monitor the population and conduct effective counterinsurgencies.

Proposition 3: The target value of a location decreases with the level of absolute socioeconomic deprivation at the location.

3. The Case of Liberia

Although perhaps not the best case for a disaggregated study of geographical and socioeconomic periphery and civil conflict, Liberia was chosen for various reasons. First, it has a great geographical variance in political violence as coded by the ACLED dataset. Second, disaggregated measures of socioeconomic status can be generated from the Liberian Demographic and Health Survey which is both geo-referenced and which dates back to 1986, three years prior to the civil war in Liberia. The availability of such data provides a

unique chance for testing the link between socioeconomic factors and conflict with much better precision than can be achieved in cross-national analyses. Third, Liberia is an interesting case in itself since it is a country where conflict is typically explained by 'greed' (in terms of looting of natural resources) rather than by group grievances (Collier & Hoeffler, 2004). For example, Reno (1999: 79) argues that the Liberian conflict has followed a clear logic, in which warlord pursuit of commerce has been the critical factor. Through commerce, strongmen have consolidated their political power within a coalition of interests among themselves, local fighters and business people. In such a setting our variable of relative deprivation would be put to the most demanding test possible.[3]

3.1. Liberia as a Pilot Study of a Larger Study

The study of Liberia serves as a pilot for testing our general expectations concerning the linkages between the various interpretations of periphery and conflict. In a future version of the paper we plan to expand the analysis to cover a larger part of Africa. The spatial domain of such an expansion is, naturally, restricted by data availability regarding conflict and local wealth. At present the ACLED dataset covers Central and West Africa, including Angola, Democratic Republic of Congo, Republic of Congo, Uganda, Rwanda, Burundi, Ivory Coast, Guinea, Sierra Leone and Liberia. Seven of these countries have also hosted Demographic Health Surveys (DHS), and could hence be included in a larger study. The DHS surveys have lately begun to include detailed information about the geographical location (i.e. geographical coordinates) of each enumerated area (EA) included in a survey. Figure 2 provides a map of Africa showing each of these cluster points represented by white dots.

[3] It could be argued that Liberia is not an ideal case for such an analysis because it essentially was without an actual governing force for a good while, during which the warlords fought amongst themselves for spoils. It is hence a challenge to capture the difference between the onset patterns and diffusion patterns of the war.

Figure 2. Demographic Health Survey Country Coverage, Africa, 1988–2005

So far, DHS in 21 countries have been geo-referenced. The hatched countries have hosted DHS surveys which have not been georeferenced, but these could also potentially be geo-referenced post-survey. In order to include the ACLED countries which have not hosted any DHS survey one could look elsewhere for disaggregated data on socioeconomic wealth. One example could be to follow Moradi (2004) who in a disaggregated study of civil war onsets in Africa uses data on nutrition from the FAO Food Balance Sheets[4] as a proxy for poverty.

[4] Data available at http://faostat.fao.org/

3.2. A Brief Overview of the Liberian Conflict

Figure 3. Map of Liberia

Source: Richards et al (2005).

On December 24th, 1989 a nascent warlord, Charles Taylor, led a band of one hundred insurgents into the Liberian border town of Butuo, Nimba from Cote d'Ivoire. With that attack, the National Patriotic Front of Liberia (NPLF) initiated over seven years of brutal violence, much of it directed toward civilians. More than half the population of Liberia

became refugees and 200,000, or about 8% of the population were killed in fighting or massacres (Humphreys & Richards, 2005). The NPFL morphed into the National Patriotic Party (NPP) when Charles Taylor became president of Liberia in August 1997.

The attack was largely assumed to be a second attempt to overthrow the Krahn dominated government of Samuel Doe. A failed coup in 1985 led by the Dahn (Gio) and Mano ethnic communities of Nimba county against the Doe government had resulted in widespread repression (Dunn, 1989: 68) and throughout 1989 the security situation in the state was rapidly deteriorating. The government response to the NPLF raid in December and January 1990 was a scorched-earth policy. The Armed Forces of Liberia (AFL) targeted members of the Dahn (Gio) and Mano communities. In retaliation, rebels targeted the Krahn community and their allies, the Mandingo (Dunn, 1989: 71). These initial ethnically based reprisals set the tone for the various wars that would last into 2003.

An anti-Taylor militia, ULIMO, was based in Freetown in neighboring Sierra Leone. Later, both ULIMO and NPFL splintered, and Liberia descended into chaos. At one stage the countryside was contested by no less than eight armed factions. By April 1990, the NPLF controlled over 90% of Liberian territory (Dunn, 1992:70). The NPLF's quick assault on the capital, Monrovia, was halted by the Economic Community of West African States (ECOWAS), Monitoring Group (ECOMOG). Under the command of a Ghanaian, Gen. Arnold Quainoo, ECOMOG settled in Monrovia in August, 1990. Denied the capital, Taylor created the National Patriotic Reconstruction Assembly Government (NPRAG) in July 1990 and settled in his base at Gbarnga.

In the years between the initial border attack and the internationally sanctioned overthrow of Taylor in 2003, multiple rebel groups emerged. These various groups, a combination of breakaway factions from the NPLF and factionalized opposition groups, participated in clashes and 'counter-insurgent' civilian violence that was socio-economic,

religious, and ethnic in character (Ellis, 1998: 157). The remaining AFL and ULIMO groups (both 'J' and 'K') claimed to represent Krahns and Mandingos while factions within the NPFL group were based on rival personal ambitions (Ellis, 1998:157-159). ULIMO, founded in Freetown in 1991 among Liberians who had fled from the NPFL, was split from its earliest days between rival leaders. The two main ULIMO factions mainly consisted of Mandingoes and of Krahns respectively who had held positions under the Doe government. By 1994, the ULIMO had turned into two separate and mutually hostile groups (Ellis, 1998:161-62). However, by 1993, the ethnic and religious bases for groups had become spurious as all the factions were more clearly associated with a personal warlord as opposed to a political ambition or group goal (Ellis, 1998:157; Dunn, 1992).

The various rebel groups survived in 'Greater Liberia', as Taylor had renamed his holdings, by engaging in battles against each other and accessing valuable natural commodities, such as diamonds, gold, and the looting of consumer goods (Reno, 1995). The peace process of 1996-97 is largely assumed to have come about at the warlords' realization that political maneuvering may present new possibilities for looting from government posts (Ellis, 1998: 163).

Taylor's eventual accession to the presidency in 1997 through a democratic election did not abate conflict, but resulted in a second civil war. Shifting rebel alliances led to the creation of two main groups- Liberians United for Reconciliation and Democracy (LURD) and Movement for Democracy in Liberia (MODEL), both dedicated to the overthrow of the Taylor government. LURD had developed from a northern insurgent movement to one which controlled a substantial proportion of the state by 1999, representing Krahn and Mandingo groups and supported by the Guinean government. MODEL was a southern-based rebel group with ties to the Cote d'Ivoire government (Kamara, 2003:7). An effective insurgent strategy by LURD led to Taylor's resignation in 2003, and a peace agreement

between warring parties was supervised by a United Nations peace-keeping force was signed in Accra on 18 August (a week after Taylor went into exile in Nigeria).

4. Research Design

4.1. Empirical Implications of a Disaggregated Study

The discussion in Section 2 implies that within-country variation in poverty levels should affect where and if conflicts emerge, where rebel groups are able to recruit soldiers, and where rebel groups operate. Country-level studies are not able to account for this variation, and are therefore limited in their ability to predict why and where civil wars occur and endure. The ACLED dataset provides information about the exact location of individual civil war events. Since we do not have geographically disaggregated data on recruitment we need to study how the observable events are produced.

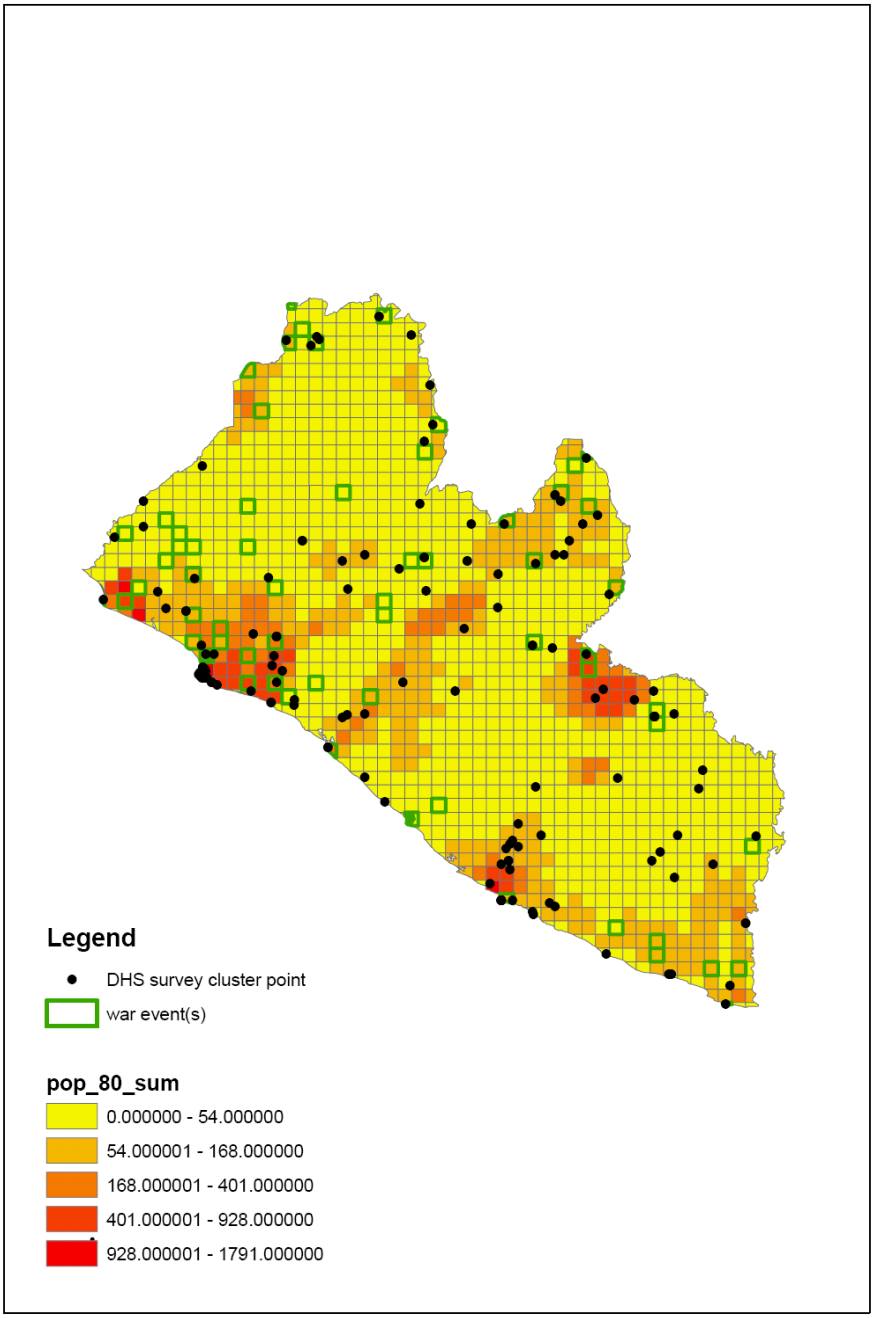
4.2. Data Structure and Description of Variables

Disaggregated conflict event data requires a disaggregated analysis structure and spatially varying attributes. The basic data structure for this project is a grid or 'lattice' stretched over Liberia. The final dataset is composed of 1375 grid squares. Each cell, or grid square, is 0.08 decimal degrees or approximately 8.5 km x 8.5 km (or 76 km^2). Spatially referenced variables, including conflict events, are added to this grid structure. The grid is shown as horizontal and vertical lines in Figure 4.

Spatially referenced variables are available in raster (pixel) or shapefile (point, line, or polygon) form. Population densities, major city locations, road densities, diamond deposit information are publicly available and have been used in previous studies of civil war (see Buhaug & Rød, 2006 and Raleigh & Urdal, 2006). Other variables such as conflict, ethnic

homelands, and development indices either require more significant manipulation for use in this study, or are new additions to the quantitative study of civil war. Below, we present all the variables used in the study in turn.

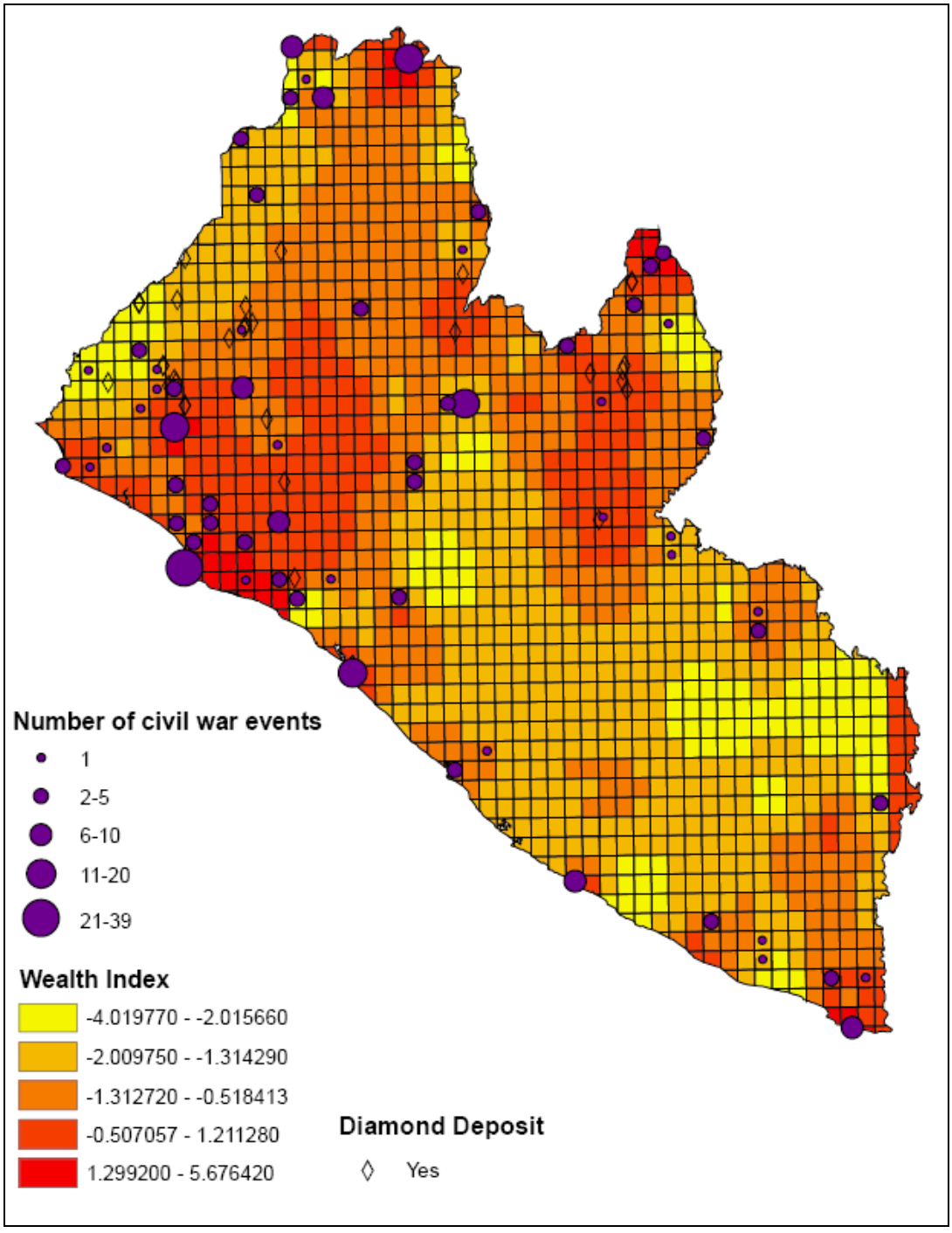
Figure 4. Location of DHS survey clusters point and variation in population densities, Liberia 1980–2002



The Armed Conflict Location and Event Dataset – ACLED (Raleigh & Hegre, 2005) provides information on the date, location, type, and frequency of conflict events in Liberia

from 1989 to 2002. 262 events are recorded for Liberia. The presence or frequency of conflict events is associated with each grid square and ranges from 0 events (in 1312 squares) to 39 events (in Monrovia). The circles in Figure 5 show the locations of war events in Liberia.

Figure 5. Location of war events, diamond deposits, and variation in wealth levels, Liberia 1989–2002.



Information on economic development is derived from Demographic and Health Survey's georeferenced information for Liberia. Data on the presence or absence of basic development facilities was collected in 1986 at 156 points across the state. These point data are georeferenced with latitude/longitude coordinates and their values are assigned to the grid square in which they fall. The DHS program interviews on the average 25 households in every location. Interviewees are exclusively women. The interviewers ask questions about the woman's recent births, health-related issues, and so forth. Unfortunately for our purpose, the DHS surveys lack information on income or consumption expenditures. However, we overcome this obstacle by using the information collected on household characteristics, female education and child health. We generate three main indicators of absolute regional socioeconomic welfare: a wealth index, a variable counting the years of education for each respondent, and local infant mortality rates. In our analysis, we use the average scores for all respondents in a grid cell.

The wealth index is constructed on the basis of the following set of variables from the Liberian DHS survey: the share of households in the grid cell which have piped water; toilet facilities; a radio; a refrigerator; metal/concrete roof; a table and chair; a bed with mattress; as well as the share of surveyed women that are literate, and their average number of years of education. Following Filmer & Pritchett (2001), we generate the welfare index based on each of these variables weighted according to their individual loadings resulting from a principal component analyses. As an alternative to the wealth index we also include a variable counting years of education as well as a calculation of infant mortality rate within each grid cell (based on the births of the 10 years preceding the survey).

Only 101 of the 1375 grid cells were covered by the Liberian DHS. The remaining 1275 grid squares have no information on development levels. In order to analyze whether conflict events are more common in relatively poor cells, we need to solve this missing data

issue. As may be discerned from Figure 4, there is no great overlap between grid cells with DHS surveys and cells with war events.

To allow for comparisons between two variables, we interpolate data on wealth levels using a method designed for spatial data in GIS. The 'Inverse Distance Weighted' (IDW) method is a spatial interpolation technique, which relies on the value of known sample points to estimate the values at surrounding points, using an inverse distance weighting method (see Philip & Watson, 1982; Watson & Philip, 1985).The basic idea underlying the IDW function is that the value of a variable at a particular location can be inferred from surrounding sampled locations, depending on the distance and the number of surrounding sample points.

The result of IDW is a surface where the value at any point is a function of proximity to (a) sampled point(s). The parameters chosen can alter the resultant surface considerably. For this project, the neighborhood method was chosen, where up to fifteen, and at least ten, surrounding points are used to estimate the new interpolated value for any point. All variables from the DHS data are interpolated for use in this study. The resulting country-wide estimates for our wealth index are shown as shades in Figure 5.The variable ranges from -4.02 (lowest of wealth) to 5.68 (highest level of wealth). The map shows that the wealthier parts of Liberia seem to be located in the North-East, in the provinces close to Monrovia, and in the Eastern-most provinces.

There are several ways to measure relative deprivation using these data. Since the study at present only includes one country, all estimated wealth levels may be interpreted as wealth relative to the average of Liberia. We also constructed a more geographically local measure based on the IDW-generated values. We measure local relative deprivation (LRD) as the absolute gap between each cell's value of the wealth index compared to the overall performance of the neighboring cells (3^{rd} order). Grid cells that are considerably poorer than the average of cells that are located roughly 25 km away, are coded as locally deprived. This

measure is obviously dependent on the quality of the interpolated data. We believe any bias should attenuate our results, however. Where DHS sample points are clustered (such as in the Monrovia region), our measure should accurately reflect local variations in income. Where cluster points are sparse, the interpolation technique yields small differences between adjacent cells, and the LRD measure is close to 0.

Control variables

In addition to the variables on absolute and relative wealth we include a set of control variables potentially associated with the location of civil war events. If the resource-curse argument on abundance of natural resources is valid, we would expect resource-rich regions to see more conflict events than regions without such endowments. Information on diamond deposits are derived from Lujala et al. (2005). We include a dummy which records whether a grid has diamonds within the 3rd order neighborhood.

Ethnic identity is a factor which has received wide attention in the civil war literature. Some studies find that it is ethnic polarization rather than fractionalization which breeds conflict (e.g. Collier and Hoeffler 2004; Reynal-Querol 2002), whereas other studies fail to find any significant link between ethnic composition and conflict (e.g. Fearon and Laitin 2003). Regional distribution of ethnic groups may be more relevant for conflict than the overall national composition of ethnicity. Toft (2003) goes as far as to say that the key to understanding ethnic conflict is the geographical settlement patterns of ethnic groups. Ethnic homeland information is derived from Ethnologue shapefiles of linguistic communities. Converting ethnologue linguistic homeland designations to spatially referenced ethno-political groups is not straightforward, as linguistic communities are not, by nature, politicized. As a result, of the 27 linguistic communities noted by Ethnologue for Liberia, the present study uses a measure of whether the majority of each cell is dominated by the

Krahn group (associated with Samuel Doe) or the Liberian-English (associated with Charles Taylor).[5]

Figure 6. Linguistic Communities in Liberia

The number of war events in a cell could be largely conditional on conflict involvement in neighboring cells. In order to control for such potential spatial dependence between observations, we include a variable which records whether there was a conflict event going on in cells within the 3rd order neighborhood (i.e. the 48 closest cells to each cell).

Population is another variable which figures prominently in most studies of civil war. In a disaggregated study of civil wars in Central Africa, Hegre & Raleigh (2006) found that

[5] In a later version of this paper we will try to create more nuanced relevant ethnic groups, drawing on sources such as e.g. Scaritt & Mozaffar (1999).

conflict events tend to occur more often in locations that are relatively populous. The information on population density figures for 1980s and 1990s used in this analysis is derived from CIESIN (http://na.unep.net/globalpop/africa/part2.html). Proximity to international borders may provide rebel groups with safe-havens across the border, and weapons may be more easily smuggled into border regions. Proximity to the capital is another factor which may be relevant for where conflict events take place. For example, Buhaug & Rød (2006) found that conflict over state governance is more likely in regions that are near the capital city. We hence include variables measuring the distance to international borders and to Monrovia.

4.3. Statistical Method

The dependent variables in this study are the cumulative number of war events in each grid cell over the entire war period, and an indicator variable denoting whether the grid cell had war events or not. Events are not independent – an attack by one actor in a location is likely to lead to repeated attempts if unsuccessful, and to retaliations by the other actor if successful. With such clustering of events, the counts will not be Poisson-distributed. We therefore use a negative binomial regression model for the event count variable. For the indicator variable, we use logistic regression.

Events in one location may also be dependent on events in neighboring locations. To account for this spatial dependence we created variables representing the number of events in neighboring cells.

5. **Empirical Results**

An inspection of the map in Figure 5 seems to indicate that conflict events in Liberia predominantly occured in the relatively rich provinces. There are concentrations of events in

the Nimba province in the North East, in the provinces close to Monrovia and Robertport, and in the Eastern-most provinces. In all these provinces, the population had more assets in 1986 than the Liberian average.

The map in Figure 4, however, indicates that the same provinces are relatively populous. Conflict events are more frequent in populated areas (Hegre & Raleigh, 2006). Moreover, Figure 4 indicates that conflict events are concentrated close to Monrovia and to the borders to Sierra Leone, Guinea, and Cote d'Ivoire. These geographical tendencies have military-strategic reasons, and are probably not due to differences in income levels. Taylor's aim was to take control of the capital in order to be recognized as the head of state.

In Table 1, we estimate a negative binomial regression model of the number of conflict events in each grid cell, controlling for these factors. In Model 1, we use the wealth index generated by the principal component analysis. In Model 2, we use the average education level in the grid of women surveyed. Both measures are positive and significant at the 0.05 level. Conflict events are more frequent in locations that are relatively well off.

These results hold controlling for the population in the cell, distance to the closest borders, and distance to Monrovia. The parameter estimates for these variables have the expected signs. Conflict events are more frequent in populous grid cells, in grid cells close to the borders, and close to Monrovia.

In Model 3, we use our measure of infant mortality as indicator of relative income. The estimate for this variable is not significant, and also pulls in the opposite direction – higher infant mortality is associated with higher risk of conflict events. It is not clear to us why the result for this variable differs from those for the wealth index and the education variable.

Table 1 Negative binomial regression results, number of war events in Liberian grid cells, 1989-2002

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Wealth index	0.434**				0.424**
	(0.171)				(0.178)
Relative wealth index				0.378**	
				(0.155)	
Female education level		0.650***			
		(0.184)			
Ln(Infant mortality)			0.227		
			(0.249)		
Diamond deposit in cell					0.152*
					(1.30)
Krahn majority population					–0.678
					(0.753)
Liberian English majority population					0.371
					(1.470)
War events in neighboring cells					–0.022
					(0.521)
Log population in grid cell, 1980	0.202*	0.192	0.171	0.229*	0.202*
	(0.116)	(0.120)	(0.140)	(0.123)	(0.116)
Distance from closest border	–0.145**	–0.148**	–0.165**	-0.174***	–0.148**
	(0.057)	(0.055)	(0.077)	(0.056)	(0.063)
Distance from Monrovia (in degrees)	–0.568***	–0.684***	–0.652***	-0.708***	–0.492*
	(0.211)	(0.195)	(0.234)	(0.194)	(0.282)
Constant	–1.25	–2.35*	–2.19*	-1.48	–1.29
	(1.06)	(1.21)	(1.53)	(1.11)	(1.15)
Ln(alpha)	3.50***	3.47***	3.60***	3.52***	3.49***
	(0.220)	(0.217)	(0.200)	(0.212)	(0.186)
alpha	33.10	32.11	36.45	33.73	32.777
	(7.29)	(6.97)	(7.30)	(7.17)	(6.08)
Log likelihood0					
N	1375	1375	1375	1375	1375
Log likelihoodmodel	–332.41	–331.34	–331.34	-333.15	–331.98

Note: ***: *p*-value<0.01. **: *p*< 0.05. * *p*<0.10 (two-sided tests). (c) denotes that the variable is centered, i.e. the mean is subtracted from each score. (l) means the variable is lagged by one year. Figures are coefficients and estimated standard errors (in parentheses).

In Model 4, we enter the wealth relative to the neighborhood variable in the model. This variable is highly correlated with the wealth index (r= 0.80), and the parameter estimate and its standard error are roughly similar. Locations that are better off than the neighborhood (locations 25 km away) have more conflict events than locations that are at par or poorer than its surrounding.

That the relative and absolute wealth indicators yield similar results is not so surprising. Since the present study only includes one country, the wealth index should be interpreted as a measure of deviation from the mean value for Liberia.

In Model 5, we try three other control variables. None of them are significant. Conflict events seem not to be more frequent in locations with diamond deposits or in location where Krahn or Liberian-English is the dominant ethnic group.

Table 2 Logistic regression results, war events or not in Liberian grid cells, 1989-2002

Variables	Model 1	Model 2	Model 3
Wealth index	0.158		
	(0.131)		
Female education level		0.307	
		(0.148)	
Ln(Infant mortality)			0.236
			(0.187)
Diamond deposit in cell	1.24**	1.24**	1.42**
	(0.583)	(0.583)	(0.598)
Log population in grid cell, 1980	0.275***	0.269***	0.275***
	(0.100)	(0.100)	(0.100)
Distance from closest border	–0.210***	–0.200***	–0.222***
	(0.058)	(0.058)	(0.057)
Distance from Monrovia (in degrees)	–0.389***	–0.410***	–0.412***
	(0.173)	(0.167)	(0.170)
Constant	–3.24	–3.80	–4.39
	(0.887)	(0.900)	(1.18)
Log likelihood0	–228.70	–228.70	–228.70
N	1226	1226	1226
Log likelihoodmodel	–205.46	–205.46	–205.29

Note: ***: *p*-value<0.01. **: *p*< 0.05. * *p*<0.10 (two-sided tests). (c) denotes that the variable is centered, i.e. the mean is subtracted from each score. (l) means the variable is lagged by one year. Figures are coefficients and estimated standard errors (in parentheses).

In Table 2 we present the results for logistic regression models with the indicator variable conflict events or not as the dependent variable. These results differ markedly from the negative binomial regression models. The estimates for log population, distance from border, and distance from Monrovia are all significant and in the same direction as in Table 1. None of the wealth variables are significant, though, and the diamond deposit variable is positive and significant in all the models.

It is difficult to interpret these differences in findings. That the existence of a diamond deposit increases the likelihood of having at least one conflict event, but does not translate into a large number of events, may not be so strange. If the single conflict event leads to the rebel group acquiring control over the diamonds deposit may alter the power balance to such an extent that the war front moves far away from the diamond area. It is less straightforward to conclude anything from the change in results for the wealth variables, though. The results indicate that relatively well-off locations do not have a higher risk of experiencing at least one conflict event, but that they are likely to have more repeated events if they become involved in the conflict. The discrepancy may also be due to the shift in who controlled the government in 1997, such that the locations that were prime targets for the powerful actor changed in the middle of the data series. The analysis of the relationship between poverty and conflict locations may have to account better for temporal dynamics to yield clear conclusions.

6. Conclusion

To date, the bulk of large-N studies of civil conflict have been conducted at the country-level. However, popular and intuitive explanations of why and where civil wars occur often refer to variables like inequalities and discrimination of identity groups, phenomena which often vary geographically within states. This has contributed to a call for 'disaggregating the study of civil war', which implies investigating the causes of conflict below the national level (see e.g. Buhaug and Lujala 2005; Buhaug and Rød 2006; Hegre and Raleigh 2005; Raleigh and Urdal 2005). These studies have made important contributions to our understanding of the disaggregated causes of civil war, but neither incorporates any sub-national direct measure of economic welfare. Trying to fill this gap, this paper represents a first cut at testing the link between absolute and relative poverty and the location of civil war

events. The present study presents preliminary results for Liberia, but we plan to cover a larger part of Africa in a future version.

By means of spatial interpolation of the detailed information about the geographical location of each cluster of survey respondents from the Liberian DHS-1986, we were able to generate local-level variables for absolute and relative wealth, measured by durable household assets, education levels and infant mortality rates. These data were coupled with geographically recorded data from the ACLED dataset on the location of civil war events in Liberia in the period 1989-2002, as well as other geographical variables such as diamond, ethnic affiliations and distances to Monrovia and international borders.

In sum, our tests show that conflict events are more frequent in locations that were absolutely and relatively well off in the Liberian context in 1986. Furthermore, conflict events are more frequent in populous grid cells, in grid cells close to the borders, and close to Monrovia. However, with a dichotomous dependent variable taking the value 1 for at least one conflict event in the cell, all the wealth variables drop to insignificance (although the signs remain the same), and the diamond deposit variable becomes positive and significant.

Despite the preliminary nature of this paper and a number of shortcomings, our analysis highlights the value of bringing tools of survey data into the disaggregated study of conflict. Future research could take several steps to improve and expand upon the present analysis and contribute to a better understanding of the relationships between absolute and relative poverty and conflict location. First, disaggregated conflict studies should focus on refining and improving the theoretical arguments which underlie the causal mechanisms investigated, and derive from these propositions which can be tested with observables. Second, generalizations beyond the Liberian case would be possible if the sample was expanded to include more countries. As discussed in section 3, there may other sources of economic development in addition to the DHS which might help expanding the spatial

domain. Finally, future research should try to better account for temporal dynamics. The count process model employed in this analysis is possibly invalid due to the preponderance of '0'-observations. At the same time, the over-dispersion parameter indicates that there exists strong dependence between the war events observed. The source of this problem is not easily identified. On the one hand, several squares should perhaps not be included in the sample, as they are impenetrable and isolated. On the other hand, many squares could potentially have events observed but did not due to the reasons described in the model. Given the strong over-dispersion identified, we should expect that war events cluster in relatively few cells.

One possibility would be to fit a zero-inflated negative binomial model, but given our expectation that a substantial number of cells should not experience events, such a model would throw out a substantial (but unknown) chunk of the baby along with the bathwater. Another possibility is fitting a generalized negative binomial model, but this appears overly ambitious given the rather sparse amount of information present. The proper antidote should be to better utilize the information present in the dependent variable. The analysis presented here focuses on the cumulative number of events, but since these events are dated in the ACLED dataset, we can analyze each event at the point in time when they occurred. While none of the independent variables are time-varying, the history of each cell will be, and this history can help us identify the impact of the structural variables present.

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