Local Determinants of African Civil Wars, 1970–2001

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Abstract

In large-N investigations, civil conflicts – like any significant political event – tend to be studied and understood at the country level. Popular explanations of why and where civil wars occur, however, refer to such factors as ethnic discrimination, wealth inequalities, access to contrabands, and peripheral havens. The intensity of such factors varies geographically within states. Therefore, any statistical study of civil war that applies country-level approximations is potentially flawed. In this paper, we disaggregate the country and let 100x100 km grids be the units of observation. Drawing on preliminary, geo-referenced conflict data from Uppsala/PRIO's conflict database, we use GIS to identify regions of peace and conflict and as a tool to generate sub-national measures of key explanatory variables. The results from an empirical analysis of African civil wars, 1970–2001, demonstrate spatial clustering of conflict that co-varies with the spatial distribution of several exogenous factors. Territorial conflict is more likely in sparsely populated regions near the state border, at a distance from the capital, and in the vicinity of petroleum fields. In contrast, governmental conflict is more likely in populous regions near the capital. These promising findings show the value of the innovative research design and offer nuanced explanations of the correlates of civil war.

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Introduction

A recent, prominent article argues that civil war is caused primarily by conditions that facilitate insurgency (Fearon & Laitin 2003). What makes this claim particularly interesting is that most of these conditions are not spatially invariant within countries – a fact that is largely overlooked in the literature. Insurgency, defined as rural guerrilla warfare, is favored by the presence of sparsely populated hinterlands, support of the local population, underdeveloped infrastructure, cross-border sanctuaries, valuable contrabands, and considerable rough terrain. To the extent that these factors have been measured and tested in quantitative analyses of civil conflict, they have been aggregated and applied to the country level. For example, rough terrain is approximated by the average share of mountainous and forested terrain in the country; availability of valuable natural resources is proxied by the ratio of primary commodity exports to GDP; and a Gini coefficient of population dispersion serves to measure the geographic distribution of the population in the country.

Insurgency – as well as other forms of domestic unrest – is further associated with newly established, institutionally inconsistent, poor, resource-dependent, corrupt, and discriminatory regimes. Some of these characteristics clearly pertain to the country as a single, political entity. For instance, the time since last regime change, type of political system, and whether or not the country is a major oil exporter, are constants within countries. Statistical studies that aim to explore the government side in civil war and consequently focus on political aspects of the regime will necessarily have to be conducted at the country/government level (see Herbst 2004 for an analysis of national militaries in African civil wars). Other aspects, however, such as ethnic diversity, inequality, unemployment, and secondary school enrolment may vary extensively between sub-national regions. Even so, socio-economic characteristics of a society are invariably measured at the aggregated country level.

We argue that a considerable portion of the empirical study of civil war suffers from a disturbing mismatch between theory and analysis.[3] While standard statistical investigations are conducted exclusively at the country level, most hypotheses actually pertain to a sub-national level. Consequently, quite a few commonly held notions about the correlates of civil war are still to be tested in an appropriate manner. Let us provide one example: The rough

[3] Although we only consider studies of risk (or onset) of civil war here, other assignments, such as studies of duration, resolution, and diffusion, may be similarly flawed (see Buhaug & Lujala 2005).

terrain proposition posits that inaccessible landscape (mountains, jungles, swamps, etc.) is favorable to rebel groups as it provides shelter from less mobile government forces and is ideal for guerrilla tactics (hit and run). Does this mean that Norway is more at risk of conflict than Spain because it has relatively more mountainous and forested terrain (assuming everything else is equal)? Not necessarily. Yet, this is essentially what is assumed when studies use aggregated country statistics to test the rough terrain argument. What the theory does predict is that rebels who seek refuge in the mountains are better able to withstand a militarily superior opposition, and consequently, that rebel groups will take advantage of such terrain, whenever available. We do not believe that terrain in and of itself is a cause of conflict, nor does the rough terrain proposition anticipate such a relationship. A more appropriate test of the theory would be to explore whether rebel groups tend to operate in the forested or hilly regions of the conflict-ridden countries.

Our central contention is that whenever we investigate theories of civil war that have an element of geography, we should abandon the habitual country level of analysis in favor of a disaggregated approach. The exploratory nature of this study means that we do not develop new theory or draw on one particular theoretical stand. Rather, the aim of this investigation is to study whether certain geographical factors associated with insurgency are able to explain the onset of domestic conflict at a sub-national level. In the following section, we discuss a few relevant conjectures and propose hypotheses that explicitly relate to the sub-national level. We then present an innovative research design where artificial grids constitute the units of observation. Through the use of Geographical Information Systems (GIS), we divide the spatial domain of our analysis – Africa – into grids with a resolution of 100x100 km. The sample of conflicts is based on an unpublished GIS version of the Uppsala/PRIO dataset (Gleditsch et al. 2002), where the conflicts are represented by polygons to reflect the geographical area of the battle zones. Grids that overlap with a conflict polygon are thus coded as having a civil war onset in the initial year of the conflict. Each grid is further assigned specific values on a number of space-varying and potentially conflict-promoting variables, including relative location, share of rough terrain, population density, proximity to resource production, level if infrastructure, and language. The results from the statistical analysis of African grids, 1970–2001, differ markedly between the territorial and governmental models. In the former case, we find considerable evidence that geography matters. The risk of separatist conflict is highest in regions with low population density, limited rough terrain, distant from the capital city, near the state border, and adjacent to petroleum fields. In contrast, the local risk of governmental conflict is highest in populous and mountainous regions near the capital city.

A Disaggregated Theory of Civil War

Although the quantitative literature has been successful in identifying a handful of factors that, in general, co-vary with the occurrence of civil war, there is still more we do not know about the origins of these conflicts than the statistical models are able to explain. To some extent, this is because each conflict has an element of uniqueness – features that are impossible to operationalize and measure across space and time. However, the suboptimal performance of previous empirical investigations is also due to data limitations and unrealistic assumptions. One such imperfection is the procedure to let the country be the unit of observation. Whereas that setup (in addition to a dyadic structure) makes perfect sense in studies of international processes, where the state can be assumed to constitute a unitary actor, civil conflicts by definition involve at least two actors *within* the boundaries of the nation-state. So why do scholars continue to study onset of civil war at the level of the country? We can think of at least three reasons.

First, the most widely used datasets in empirical studies of civil war lack information on the location of the various conflicts beneath the level of the state. Without conflict data on a finer resolution, disaggregation simply is no option. Moreover, despite the recent release of the Uppsala/PRIO Armed Conflict Dataset (henceforth ACD), which contains reasonably accurate data on the location of the conflict zones, most scholars continue to use other sources of conflict data. As far as we know, there are no plans to add spatial information to these other datasets, which clearly indicates the unawareness in the community of the theory-empirics incompatibility.

Second, almost all proposed conflict-promoting factors, including economic, political, cultural, and demographic attributes, are measured at the state level. Admittedly, some of these factors only make sense when we treat the country as a single entity. Even though a country may contain regions with varying degrees of autonomy, it can only have one type of political system and one official regime at any given time. Studies that focus primarily on the government side will not benefit from a disaggregated research design. However, most aforementioned factors, including level of development, population characteristics, and type of terrain, vary quite extensively across space. You will not find a single country where the inhabitants are evenly distributed throughout its territory.[4] Moreover, ethnic groups in fragmented societies tend to cluster in specific areas, rather than being scattered around. Therefore, an aggregated measure of ethnic fractionalization says little about what might really be important: the composition of ethnic groups in specific regions. See Buhaug & Lujala (2005) for a more comprehensive discussion of this subject.

Third, analyses of risk of conflict need to include null cases; that is, units without conflict. In this regard, the country might appear to be the only suitable unit of observation. There are alternatives, though. What we propose in this investigation is to let artificial geometric units, or grids, be the units of analysis. The spatial domain – the African continent in our case – may thus be divided into grids of equal size, whereby each country is represented by at least one grid. Another option might be to study the first-order administrative regions, although we have some reservations against that approach. See the data section for further details. First, however, we review a few popular theories on the causes of civil war, and discuss these with a disaggregated approach in mind.

The most prominent and robust factor associated with the occurrence of civil war is poverty (Collier & Hoeffler 2002, 2004; Collier et al. 2003; de Soysa 2002; Fearon & Laitin 2003; Hegre et al. 2001).[5] The mechanisms through which wealth prevents conflict are less established, though. Some argue that poverty lowers the opportunity costs of rebellion. When wages are low and unemployment rates are high, in particular among young males, income forgone by joining a rebel group is comparably low (Collier & Hoeffler 2004; see also Gates 2002). Others maintain that per capita income is a proxy for state strength, meaning that richer regimes are better able to monitor the population and conduct effective counterinsurgencies (Fearon & Laitin).

Inevitably, poverty and wealth are spatially clustered within countries. Even in societies with low levels of inequalities, some regions are bound to be more prosperous than others. Drawing on the literature on inequality and instability (Alesina & Perotti 1996; Cramer 2001; Gurr 1970; Sen 1973), we would expect groups in the underprivileged regions to rise up to alter the status quo. Unfortunately, we do not have good indicators of wealth or social and economic inequalities for our spatio-temporal domain so we cannot test this conjecture directly. Rather, we investigate the nexus between another aspect of development

[4] See Herbst (2000) for some excellent maps of the population distribution in African countries.

[5] The relationship between poverty and conflict is most certainly a reciprocal one in that conflict might also lead to poverty (see Alesina & Perotti 1996).

and domestic armed conflict. Infrastructure presumably follows the spatial pattern of health and unemployment in that the most inauspicious regions are also the regions with the least developed road network. Moreover, roads are essential to the projection of state authority, and nowhere more so than in Africa. This explains why, according to Herbst (2000), colonial leaders who sought to physically extend their power were obsessed with roads. Roads provide the only form of access to most rural communities. Populated regions with few or no road connections to the capital are likely to be disadvantaged, politically as well as economically. Moreover, remote regions are harder to reach by government forces and are therefore ideal for organizing a rebellion. This compares well to Murshed & Gates (2005), who find that the Maoist insurgency has been particularly severe in the less developed Nepalese districts. Our first hypothesis, then, is:

> H1: Local road density is negatively associated with the risk of civil war, *ceteris paribus*

A number of recent articles, quantitative as well as case-oriented, explore the relationship between abundance of natural resources and civil war (Addison et al. 2002; Berdal & Malone 2000; Collier & Hoeffler 2004; Fairhead 2000; Le Billon 2001b; Renner 2002; Olsson & Fors 2004; Ross 2004a, b; Smillie 2002).[6] Advocates of the 'greed' proposition claim that rebels are quasi-criminals with an economic, rather than a political objective, and argue that countries with an abundance of precious stones, minerals, and drugs are more at risk because they contain better financial opportunities for rebellion. Most quantitative investigations fail to demonstrate such a relationship, although the evidence is more supportive regarding duration of conflict. Oil dependence, usually proxied by a dummy for major oil exporters, appears to be more robustly associated with the risk of civil war.

According to Ross (2004a: 341–342), the lack of conformity among conflict studies may be caused by different conflict data being analyzed and by using "overly broad" measures of primary commodities and civil war. We argue that there is a more fundamental problem with the applied measures, namely the lack of spatial reference. For the abundance argument to *really* hold up, we should find that rebel groups operate in the resource-rich

[6] There is also a considerable literature focusing on the potential relationship between resource *scarcity* and conflict. That research focuses on depletion of renewable resources (water, soil) and is generally preoccupied with future scenarios, and therefore not immediately relevant to this assignment.

regions, whenever such exists. Similar thoughts have been proposed by Le Billon (2001b: 566), who emphasized that “the spatial distribution and *lootability* of resources are crucial with regard to the opportunities of belligerents to seize or retain control over resource revenues.” Unless the rebels control areas of extraction or transport routes, they cannot exploit the lootable commodity for financial gains. This explains why diamonds, not oil, was the prime source of revenue for UNITA (National Union for the Total Independence of Angola), whereas oil rather than diamonds is the primary motivation for the separatist FLEC (Liberation Front of the Cabinda Enclave) movement in the Angolan enclave of Cabinda (see Le Billon 2001a).[7] This leads to our second hypothesis:

> H2: Proximity to valuable resource deposits is positively associated with the risk of civil war, *ceteris paribus*

A considerable number of contemporary civil wars involve fighting between members of different ethno-national groups. According to Sambanis (2001), roughly 2/3rd of all civil wars between 1960 and 1999 are “identity conflicts”, i.e. they are rooted in ethnic or religious differences. Still, the empirical evidence linking country-level ethnic composition to civil conflict is actually quite weak. Some studies claim a parabolic relationship, where polarized societies are more at risk than homogenous and highly fractionalized countries (Collier & Hoeffler 2004; Elbadawi & Sambanis 2000; Ellingsen 2000). Easterly and Levine (1997) further find that ethnic fractionalization has adverse effects on economic policies, and thus indirectly on conflict. Others fail to find a systematic link between ethnicity and risk of conflict (Fearon & Laitin 2003; Fearon 2005). This lack of general support – which, of course, is strongly at odds with popular belief – has led some to consider conditions under which ethnicity might be linked to conflict. We agree with Sambanis (2003) in that regional distribution of ethnic groups may be more important than the extent of ethnic fragmentation in the country as a whole. This corresponds well to Melander (1999), who finds that violent conflict is more likely if an ethnic minority makes up more than 70% of the population in its home region. If this is indeed a general pattern, Africa should be particularly predisposed to ethnic conflict since African minority groups are more spatially concentrated than minorities in other regions (Herbst 2000).

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[7] Whether oil can be considered lootable is an open question, although recent events in e.g. Nigeria show that the sabotage of pipelines, or threat thereof, can be an important source of income.

According to Rokkan & Urwin (1983), the most significant determinant of an individual's identity is language. People with distinctly different native languages are less likely to share a strong feeling of common identity. Language and other cultural distinctions are prone to be amplified by political and rebel leaders in order to rally support and recruit soldiers. Therefore, we expect groups that belong to a different language family than the majority of the population in the capital – the center of state power – to have weaker national identities and thus to be more likely to initiate a rebellion.

> H3: Local dominance of a language that differs from the dominant language in the capital is positively associated with the risk of civil war, *ceteris paribus*

Another popular proposition that has received mixed empirical support relates to rough terrain. Mountainous and forested terrain is generally believed to facilitate rebel movements by providing shelter out of reach of government forces. For example, Fidel Castro's at first puny rebel movement had no other option than to hide in the *Sierra Maestra* mountains upon arrival in Cuba. Only when the revolutionary force grew stronger did it manage to conduct a more open warfare and push westwards toward Havana and, eventually, succeeded in its quest to expel General Batista (Pérez-Stable 1999). Previous attempts to test the rough terrain argument have used country statistics of mountainous and forested terrain. The problem is; terrain has a cruel tendency to vary across space, which means that aggregated measures are poor indicators of local conditions. This is particularly true for large countries. Rough terrain may well be linked to conflict without there being a general, causal relationship at the country level. The implication of the proposition is simply that rough terrain favors rebel groups, and that the rebels – assuming that they realize this – choose to operate from the hilly or forested regions of the country.

> H4: Local extent of rough terrain is positively associated with the risk of civil war, *ceteris paribus*

A related argument concerns cross-border sanctuaries. In several recent wars, including the ones in Rwanda, Burundi, DRC, and Liberia, the main rebel groups operate from bases beyond the national boundaries, often with the tacit or spoken support of the neighboring regime. Access to foreign soil not only eases access to important trade markets by also acts as a substitute for rough terrain.

H5: Proximity to the state border is positively associated with the risk of civil war, *ceteris paribus*

A final factor that in fact lies implicit in much of the theorizing on civil war is location, or more specifically, periphery. “The fundamental problem facing state-builders in Africa”, Herbst (2000: 11) writes, “[..] has been to project authority over inhospitable territories that contain relatively low densities of people.” This is consistent with Fearon & Laitin, who note that the main factors determining civil violence are conditions that favor insurgency. Insurgency is here understood as a “technology of military conflict characterized by small, lightly armed bands practicing guerrilla warfare from rural bases” (2003: 75). Along the same line of reasoning, Collier & Hoeffler (2004) surmise that low population density, low urbanization, and a dispersed population inhibit government capability and thus facilitate rebellion. A government is less able to maintain control of the hinterlands because of the sheer distance from the center of state power, because of inferior knowledge of local conditions, and often because of lack of support from the local population.[8] Hence, we propose two final hypotheses:

H6: Distance from the capital is positively associated with the risk of civil war, *ceteris paribus*

H7: Local population density is negatively associated with the risk of civil war, *ceteris paribus*

A final issue should be noted. Previous research has demonstrated that several conflict-promoting factors vary in their impact between territorial and governmental conflict (Buhaug 2005). This was particularly apparent regarding “geographical” features, such as country size and ethnic fragmentation of the population, which were found only to affect outbreaks of territorial conflict. Since all explanatory factors discussed here contain some element of geography, and since insurgency almost by definition falls into the territorial conflict category, we expect the covariates to be most successful in explaining this type of

[8] Recognizing this, several African state leaders have (unsuccessfully) attempted to redistribute the population by force through “villagization” (Herbst 2000).

conflict. Nonetheless, given the exploratory nature of this study, we estimate the models on both governmental and territorial conflict in the analysis below.

Data and Research Design

A number of theories on the origins of civil war actually presuppose – if only implicitly – a disaggregated level of analysis. The purpose of this study, then, is to develop a more pertinent research design and conduct more precise tests of some of the most popular hypotheses in the literature. More specifically, we seek to uncover whether certain space-varying features, such as terrain, population, resources, and identity contribute to explaining where civil wars break out *on a sub-national level*. Such an undertaking requires a unit of observation below the scale of the country. In theory, one could think of a research design with the first-order administrative entity as the unit of observation. However, unlike international boundaries, which tend to be time-invariant when established and agreed upon, administrative regions frequently chance in shape and composition as some units merge while others split. Besides, the function and size of regions vary extensively from country to country. Most of Niger's seven *departments* are larger than Rwanda (12 *prefectures*) and Burundi (16 *provinces*) combined, so it might not be meaningful to divide all countries into smaller units.

As an alternative approach, we choose grids as the units of observation. In contrast to sub-national political regions, grids do not change in size or number over time. Also, a substantial portion of the relevant geo-referenced data are given as points, line, or polygon features or as raster data (e.g. coordinates of diamond sites, digital road maps, gridded population data), and are just as easily converted to the predefined grid structure as to the intuitively more sensible but less feasible administrative region approach.

Determining the size of the grids may not be a trivial task as it potentially has a substantial impact on the results. Ultimately, we might want to test various resolutions and compare the results, though at this stage we have generated data for grids of 100x100 km size only. This choice of resolution is admittedly somewhat arbitrary. However, the selected size ensures that even the smallest countries on the African continent are represented by at least one grid. A larger resolution, such as 50 km or 10 km, implies a considerable increase in the number of observations but not necessarily a similar increase in the level of precision. Even though many of our input data sources have higher resolution than 100 km, the conflict location data are at best only accurate with a 50 km confidence interval. For conflicts that are sparsely documented, the coded areas of the conflict zones are little more than suggestive.

As indicated in Figure 1, each grid cell is assigned to one country only. Grids that cover international boundaries and thus overlap several countries are defined as belonging to the country that lies at the center of the unit. This is done to allow for clustered standard errors and assigning country-specific parameters to each unit. Three years during our sample period saw major changes to the outline of some states; 1990, the separation of Namibia from South Africa; 1993, the separation of Eritrea from Ethiopia; 1994, the return of the Walvis Bay area to Namibia. Accordingly, we needed four grid representations of Africa. Figure 1 represents the final period, from 1994 to 2001. In all, our sample consists of 3,207 unique grids. Since each grid is observed once each year from 1970 (or year of independence) to 2001, the time-series cross-sectional sample consists of 101,425 observations, or "grid-years".

FIGURE 1 ABOUT HERE

The conflict data are based on the Uppsala/PRIO ACD project (Gleditsch et al. 2002), and include every contestation between a state government and an organized opposition group that caused at least 25 battle-deaths per year. A major benefit of this dataset, in addition to employing a comparatively low casualty threshold, is that it includes data on the spatial location of the battle zones (see Buhaug & Gates 2002). Each conflict is assigned a circular zone of conflict by means of a center point (latitude and longitude coordinates) and a radius variable.[9] In this study, we use a refined version of the conflict location data, where we relax the crude assumption of circular conflict zones and rather use polygons generated through GIS. These polygons can take on any shape and are thus better suited to represent the actual conflict zones. So far, we only have improved location data for the African conflicts, hence the limited spatial domain of this investigation. The analysis is further limited to the period since 1970 because we believe that the liberation- and post-colony wars of the 1950s and 1960s to a much larger extent were caused by factors exogenous to each particular grid. Besides, several of the covariates in the analysis are time-invariant, even if the spatial distribution of the measured concepts in reality varies over time (e.g. road data). To limit bias, we prefer not to extend our temporal coverage further.

Following Buhaug (2005), we distinguish between conflicts over territory (secession) and conflicts over governance (coups, revolutions) since these types of conflicts are shaped in part by different conditions. The two dichotomous dependent variables measure the outbreak of

[9] See Gleditsch et al. (2002) for further details on the definition and coding of the conflict zones.

territorial and governmental civil war, respectively. Grids that overlap with a given conflict zone are coded "1" in the initial year of the conflict (

Figure 2). Consecutive years of conflict are coded as missing, since units in conflict are not at risk of having a new onset. Grid-years without conflict are coded "0".

FIGURE 2 ABOUT HERE

In order to test the proposed hypotheses, we have generated a number of relevant covariates that have values specific (if not necessarily unique) to each particular grid. To proxy economic opportunity (H2), we have measured the distances from the centroid of each grid to the nearest diamond, gemstone, and on-shore petroleum deposits. To reduce bias from extreme values and account for non-linearity, we log-transformed the distance measures before use. The resource data have been collected in a joint project between NTNU and PRIO (see Gilmore et al. 2005 for a description of the diamond dataset), where each resource deposit is registered with precise coordinates and date of discovery/extraction.

Prevailing theories on insurgency suggest that the conflicts occur predominantly in the rural countryside (H7); hence, we include a population density indicator. The population data are taken from UNEP-GRID[10], which has gathered gridded population data at a resolution of 2.5 arc minutes (approximately 5 km at equator). The data are available for every decade since 1960 and give estimates for the number of inhabitants in each cell (Tobler et al. 1997). We aggregated the population data to the desired grid resolution and applied linear interpolation to fill in data for missing years. Population values for 2001 were copied from 2000. As usual, we take the natural logarithm of the measure (modified to population in 1,000s) to reduce outlier bias. Since all grids are equally sized, the population variable is essentially a population density measure.

Our next variable is designed to capture local level of infrastructre (H1). Based on road data from *Digital Chart of the World*[11], we measured the total length (km) of major roads

[10] United Nations Environmental Programme – Global Resource Information Database, data available from: http://grid2.cr.usgs.gov/datasets/datalist.php3#unep

[11] http://www.esri.com/data/catalog/esri/esri_dcw.html. The Digital Chart of the World (DCW) is a comprehensive 1:1,000,000 scale vector base-map dataset of the world. It consists of spatial and textual data that can be accessed, queried, displayed and modified with GIS software. The database was originally developed by the Environmental Systems Research Institute, ESRI, for military use. The background data was derived from defense-mapping agencies in the US, Australia, Canada, and the UK. DCW was published in 1992, and then released for commercial use in the mid-1990s.

in each grid. Since road density is positively correlated with population density (r=0.63), we only analyze road density in combination with population. Admittedly, this is a suboptimal approximation of development and government reachability. When aggregated to the national level, the country average of logged road length per capita nevertheless correlates with logged GDP per capita at a respectable 0.56. Moreover, the lack of temporal variation in the road data is less problematic than initially feared, since Herbst (2000) reports a very strong positive correlation between density of roads at independence and density in 1997, meaning that the country rank order of roads per square kilometer is largely constant throughout the investigated period.

One possible improvement that we have considered is to follow Miguel et al. (2004) in using precipitation data to measure local economic shocks.[12] In addition, we might consider using demographic and health survey data (see www.measuredhs.com), which are available for several African regions (though only for recent years and obviously not for the most unstable areas). See Østby (2005) for an empirical analysis of civil war using these data.

A number of contemporary civil conflicts involve fighting between groups of different cultural heritages (H3). As a simple measure of cultural identity, we have generated a dummy variable signifying whether (0) or not (1) the majority of the population in each grid belongs to the same language family as the majority of the population in the grid that covers the capital city (i.e. the capital grid). The language variable is based on language maps from Ethnologue (Grimes 2000), which we digitalized and converted to the grid structure. This is evidently another crude operationalization of the measured concept, since the largest language group in the capital need not be represented in the state government. Moreover, it is probable that some groups belonging to the same language family still have very different identity ties. We are currently working on a refined language measure that will account for the size of different language families and thus indicate majority and minority regions.

A major advantage of rebel groups vis-à-vis the governments is that they can choose the area of operation. We test several indicators of relative location as well as measures of rough terrain. The mountain and forest variables give the logged percentage of each grid covered by the given type of terrain (H4). Gridded mountain data were received from UNEP (2002) and comparable forest data were downloaded from the web site of the Food and Agriculture Organization (FAO) of the UN (www.fao.org/forestry). Since neighboring

[12] Similar precipitation data are available from www.mara.org.za, the website of the *Mapping Malaria Risk in Africa* project.

territories might provide safe havens and access to vital trade markets, we calculated the logged distances (km) from the centroid of each grid to the nearest international boundary (H5). For grids in Sao Tome and Principe, Comoros, and Madagascar, which lack contiguous neighbor states, we set the distance-to-border variable artificially at 1,000 km. Our second indicator of relative location gives the logged distance (km) from the centroids to the capital city (H6). Since we expect relatively capable countries to be better able to project military force across space, the effect of the grid-capital distance measure is likely to vary with the country level of development. Therefore, we add an interaction term between logged grid-capital distance and logged GDP per capita. The GDP data are taken from Gleditsch (2002).

The units show very strong cross-sectional correlation – that is, the likelihood of conflict for any grid is largely conditional on the conflict involvement of contiguous units. To account for spatial autocorrelation, we include a spatially lagged dependent variable (see Anselin 1988). This variable measures the share of conflict among contiguous grids in the same country. In this context, we only consider first-order neighbors to the east, west, north, and south as contiguous (a.k.a. rook contiguity). The units in the sample have between zero (islands) and four neighboring grids, and the lagged conflict terms (one for each conflict type) take on values between zero (no neighbor grids in conflict) and one (all neighbors in conflict).

The data are also likely to suffer from serial dependence in that the conflict status of a grid at any time is related to its status in the previous time period. We reduce this problem by coding *onset* of conflict (only first year of each conflict coded as "1") rather than incidence (all years in conflict coded as "1") and dropping consecutive years of conflict from the analysis. However, periods of peace (coded as "0") will still be correlated over time. One way to deal with this would be to employ survival analysis, in which we estimate the hazard (or risk) of conflict at certain time points, given that the units have survived so far. In this investigation, however, we choose a more conventional approach to handle temporal autocorrelation. We adopt the procedure of Beck et al. (1998) by adding a "peace-years" count variable (giving the number of consecutive years of peace) as well as three natural cubic splines.[13]

Finally, although the units are assumed to be independent across countries, they are likely to show some level of dependence within countries. This is because the baseline risk of

[13] We tested several alternative specifications where we altered the number and shape of the splines. Although some of these alternative models proved to be marginally superior, they did not affect the reported estimates in any substantial manner.

conflict in a country is determined by numerous country-specific factors that are not controlled for in the model. For example, the risk of conflict for the grids in Botswana may be lower than predicted by our model (i.e. lower than for grids with similar characteristics in other countries) since Botswana enjoys a comparably stable democratic regime. To account for cross-sectional heteroscedasticity (and to a certain extent spatial correlation), we cluster the units on country-years. We do not include country-level controls, even if they were to improve the fit of the models, as we have no reason to expect such factors to influence the relationship between the explanatory variables and the onset of civil war.

We used ArcGIS 9 with ArcInfo level to generate grid-specific measures and create the maps, and StatTransfer 7 to convert the GIS data to Stata format. The logit regression models were estimated using Stata 8.

Results

The results from the analysis of territorial and governmental conflicts are presented in Table 1 and Table 2, respectively. For each conflict type, we estimate five models. The first model in each case (Models 1 and 6) include only the base variables, i.e. the spatial lag and three indicators of location relative to the capital and nearest international border. These four variables are present in all models. In addition, Models 2 and 7 include the population and road density measures, Models 3 and 8 explore the role of rough terrain, Models 4 and 9 estimate the effect of proximity to three types of commodities, while Models 5 and 10 include the language dummy.

Not surprisingly, the neighboring conflict variable is extremely powerful. To some extent, this is a deterministic relationship. The nature of the conflict data implies that grids surrounded on all sides by conflict are themselves compelled to be in conflict. For grids with one or more neighbors without conflict, the risk of territorial onset is reduced to one tenth. Only 20 grid-years (0.02% of the sample) saw conflict while all contiguous grids were at peace. Accordingly, the onset of conflict shows clear spatial clustering – at least at the selected level of analysis.

Despite the overwhelming influence of the spatially lagged dependent variable, Table 1 shows that the relative location indicators add further explanation to where territorial conflicts are more likely to occur. In line with our predictions, the risk of civil war is higher in regions near the state borders and far from the capital. The negative sign of the interaction term means that the positive effect of distance to the capital is weaker for wealthier states.

This is consistent with capable regimes being better able to curb distant turmoil before fighting breaks out. Although the regression estimates for the three variables vary with the inclusion of additional covariates, they always remain statistically significant at the 5% level of uncertainty.

TABLE 1 ABOUT HERE

Model 2 includes two additional explanatory factors: population density and road density. Given the substantial correlation between these measures, they need to be analyzed simultaneously in order to discern their effects. The negative estimate for population adds further strength to the general theory of insurgency: territorial conflicts occur predominantly in the hinterlands and sparsely populated rims of the countries. In contrast, road density shows a positive, albeit weak and not particularly robust, effect. Controlling for population, it appears that separatist conflicts occur in relatively more, not less, developed regions.[14]

The next model presents some surprising results. At odds with popular belief, mountainous and forested landscape inhibits rebellion. Although the size and significance of the effects are sensitive to the inclusion of other covariates, they are always negative. One reason for the unexpected finding may be that the spatial conflict data represent the largest area affected by fighting during the conflict. Hence, the conflict polygons are not limited to rebel bases and often extend beyond the battle zones in the initial phase of the conflict, when terrain presumably plays the largest role. We speculated whether the result could also be a consequence of the negative correlation between extent of rough terrain and country size. Larger countries, on average, have relatively less rough terrain, and civil wars in larger countries usually cover larger areas (and thus more grids). Could it be that the negative impact of terrain on the risk of conflict is biased by the overrepresentation of conflict grids in a few large countries? Apparently not. When we tested alternative terrain variables that are standardized by the country average of rough terrain, we found a similar negative relationship. Territorial conflicts are not only associated with less-than-average extent of rough terrain compared to the random African grid; they also appear to occur in the relatively less forested and mountainous regions of the conflict-ridden countries. Whether this is a feature unique to African conflicts or whether it is indeed a universal relationship remains to be uncovered.

[14] If the population variable is dropped, road density assumes a negative and significant estimate.

Model 4 offers a test of the greed (or "opportunity") aspect of civil war where we measure the distances to certain resource deposits. Evidently, proximity to oil and gas installations increases the risk of separatist rebellion, and the reader is immediately reminded of the contemporary conflicts in Southern Sudan and Cabinda. Regions containing diamonds and other gemstones, however, do not appear to be more at risk of territorial conflict, although the negative sign of the estimates are as expected. The deviating performance between petroleum and gemstones may not come as a big surprise, though. In contrast to alluvial gems and diamonds, oil and gas are point resources that require skilled workers and specialized equipment to extract the commodity. Aside from sabotage and blackmailing, only a recognized state can gain revenues from oil. Therefore, groups in oil-rich regions that want to secure the benefits from the natural goods are likely to seek independence. Finally, Model 5 offers no support for the assumption that regions where the dominant language differs from the one in the capital are more likely to seek secession by military means.

With the exception of the terrain proxies, Table 1 offers generous support to the theory on insurgency. Separatist conflict is significantly more likely in regions that are:

- proximate to a neighboring country
- at a distance from the center of state power
- sparsely populated
- flat and without forests
- proximate to petroleum fields

Table 2 presents a radically different picture. Most strikingly, none of the relative location indicators appears to contribute to the fit of the governmental models. However, the very high correlation between the distance to the capital and the interaction with GDP per capita inflates the standard errors of the estimates. When the interaction term is dropped, the capital distance measure shows a robust, negative effect. Accordingly, the risk of governmental conflict, such as a coup d'état or a popular revolution, is – not particularly surprising – highest in the capital.

The positive estimate for population density in Model 7 means that governmental conflicts are mainly urban events. In fact, the population variable captures much of the effect of capital distance, which implies that these conflicts are not necessarily limited to the capital city. Model 8 offers modest support to the rough terrain proposition since mountainous terrain is positively associated with the risk of conflict. This finding holds up even if we use the alternative terrain measure that accounts for the amount of mountains in the country. The remaining explanatory factors tested in Models 8-10 fail to produce significant estimates.

Neither forest cover, proximity to certain valuable resources, or language is able to distinguish between zones of governmental conflict and zones of peace.

The joint insight from Table 1 and Table 2 strengthens the findings of Buhaug (2005) in that geography exerts a much larger influence on the risk of territorial conflict. Moreover, the results from the analysis imply that Fearon & Laitin (2003) are only half right. Whereas most factors associated with insurgency are well able to explain the local onset of territorial conflict (exactly because most territorial conflicts fit Fearon & Laitin's definition of insurgency), they are either unrelated to the onset of governmental war or show an opposite effect. In fact, since most civil wars are governmental, not territorial, one might argue that "conditions that favor insurgency" only explain a minority subset of all domestic conflicts.[15]

Conclusion

This study has presented an innovative research design where grid cells, rather than countries, are the cross-sectional unit of analysis. We argued that design is better suited to test theories of civil war that essentially relate to local conditions. Among these are theories on rough terrain, greed/opportunity, ethnic diversity, and center vs. periphery. The analysis, which was conducted separately for territorial and governmental conflicts, produced some promising findings. Territorial civil wars – that is, wars over autonomy or secession – are much more likely to occur in remote and sparsely populated regions, close to neighbor states. We also found an unexpected negative effect of rough terrain: the African regions that have seen territorial conflict since 1970 are, on average, less mountainous and forested than the country averages would indicate. Finally, our results suggest that oil-rich regions are significantly more at risk of separatist conflicts, whereas other valuable resources have no general impact. Overall, the territorial models correspond well to the broad theory of insurgency, as discussed by Fearon & Laitin (2003) and others. Governmental conflicts are less determined by geographical attributes of the region, even if a high population density and proximity to the capital were found to increase the risk of conflict. Rather, popular revolutions and coups are likely to be motivated by characteristics of the ruling regime and by a desire to reach state authority.

[15] Both the Uppsala/PRIO list of Armed Conflicts and Fearon & Laitin's sample of civil wars include a higher number of governmental wars (ca. 65%) than wars over territorial control (35%). For the spatio-temporal domain of this investigation – Africa since 1970 – the dominance of governmental conflicts is even more striking: 48 vs. 11 onsets of armed domestic conflict.

Several factors call for moderation when assessing the importance of the reported findings. First, the sample is limited to Africa since 1970, which calls into question the generalizability of the results. In fact, there are ample reasons to believe that Africa is more prone to conflict than other continents (Collier & Hoeffler 2002). Also, since African conflicts more often are contests for state control, the relative scarcity of territorial conflicts might potentially produce biased results. This should not be a huge problem, though, as we separate between these two types of conflict in the analysis. Even so, the reader should be cautious about making too general statements from the reported findings.

Second, there is always a potential for producing misleading findings due to poor operationalizations and omitted variables. In particular, we have had a hard time generating local measures of development and ethnicity, and some factors, such as economic inequality, are yet to be dealt with. While such data may be available on a sufficiently low level for the present time, it is obviously difficult to get good data for previous decades.

Third, the radical research design introduces a number of statistical peculiarities that must be accounted for. Some of these potential pitfalls may not have been handled in the best possible manner, so the results presented above are merely preliminary. In addition, sensitivity analysis has so far been limited to estimating the models without the most influential cases and testing a few alternative proxies for the explanatory factors. So far, the base variables in the territorial models – distance to the border, distance to the capital, and the interaction with GDP per capita – appear to be very robust. The remaining covariates are somewhat more sensitive to model specification.

We believe that the disaggregated approach has great potential and will prove invaluable as a supplement to conventional country-level analyses. When the researcher seeks to explore how attributes of governments and the political system affect the risk of domestic instability, countries constitute the natural units of analysis. If the researcher, however, seeks to understand the role of local conditions, a disaggregated design should be utilized. Consequently, we need to develop better sub-national measures of relevant conflict-promoting factors, as well as geo-referenced data on the location of the conflicts themselves. This work is already in progress at various institutions associated with PRIO’s Centre for the Study of Civil War.

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Appendices

Figure 1. African countries represented by 100 km grids (1994–2001)

Figure 2. Conflict polygons and conflict grids in Sudan, 1997–2001

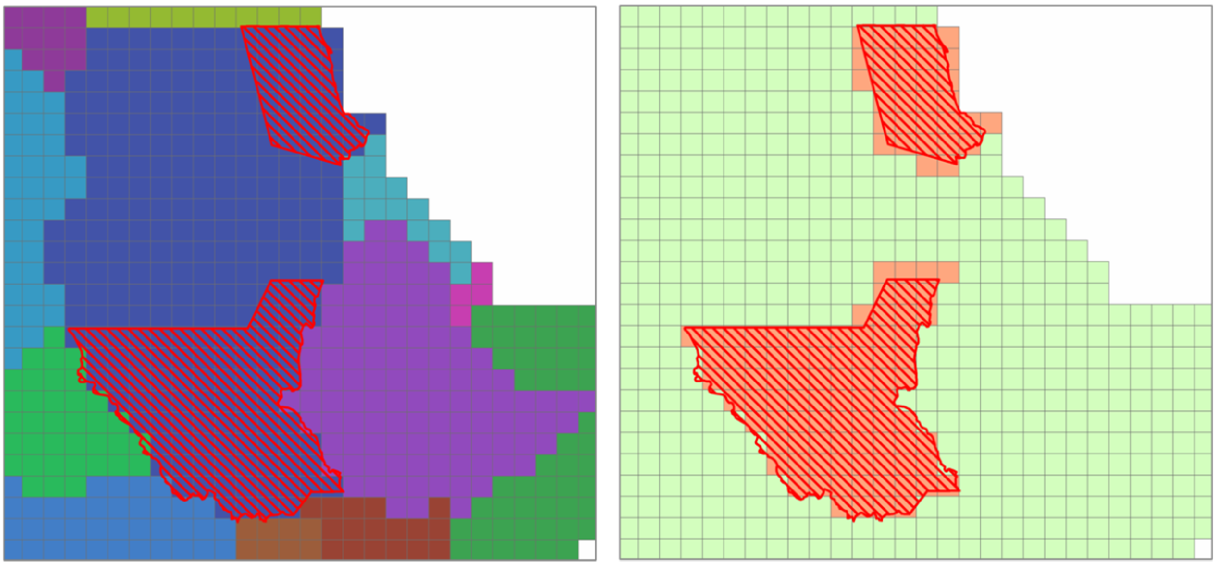

Table 1 Logit estimates of onset of territorial conflict

	(1)	(2)	(3)	(4)	(5)
Neighboring territorial conflict	12.586 ***	13.083 ***	13.271 ***	12.714 ***	12.725 ***
	(.667)	(.668)	(.998)	(.831)	(.671)
Distance to border [a]	-.446 ***	-.509 ***	-.542 ***	-.473 ***	-.455 ***
	(.097)	(.094)	(.100)	(.095)	(.097)
Distance to capital [a]	1.639 ***	1.759 **	2.268 ***	1.628 ***	1.734 ***
	(.593)	(.713)	(.556)	(.610)	(.590)
Distance to capital [a] × GDP per capita [a, b]	-.151 **	-.250 ***	-.315 ***	-.153 **	-.161 ***
	(.062)	(.072)	(.047)	(.063)	(.060)
Population density [a]		-.511 ***			
		(.088)			
Road density [a]		.127 *			
		(.076)			
Mountain [a]			-.431 **		
			(.186)		
Forest [a]			-.401 ***		
			(.138)		
Distance to petroleum [a]				-.308 ***	
				(.108)	
Distance to diamonds [a]				-.035	
				(.175)	
Distance to gemstones [a]				-.019	
				(.058)	
Language difference					-.475
					(.349)
Intercept	-9.129 ***	-4.592 *	-4.903 **	-6.738 ***	-9.132 ***
	(1.992)	(2.461)	(2.363)	(2.307)	(1.967)
N	85,202	85,202	85,202	85,202	85,202
Wald Chi^2	666.38	867.35	905.73	969.05	617.03

Note: Regression estimates with standard errors clustered on country years in parenthesis. Estimates for peace-years and three cubic splines not reported. [a] Logged; [b] lagged one year; * p<.1; ** p<.05; *** p<.01.

Table 2 Logit estimates of onset of governmental conflict

	(6)	(7)	(8)	(9)	(10)
Neighboring governmental conflict	11.828 ***	11.991 ***	11.865 ***	11.845 ***	11.863 ***
	(.408)	(.401)	(.410)	(.421)	(.412)
Distance to border [a]	-.107	-.089	-.094	-.094	-.089
	(.088)	(.089)	(.089)	(.094)	(.097)
Distance to capital [a]	-.218	-.053	-.187	-.288	-.210
	(.352)	(.369)	(.342)	(.345)	(.351)
Distance to capital [a] × GDP per capita [a, b]	-.022	-.005	-.023	-.016	-.027
	(.044)	(.044)	(.042)	(.043)	(.043)
Population density [a]		.212 ***			
		(.072)			
Road density [a]		.139			
		(.121)			
Mountain [a]			.134 ***		
			(.051)		
Forest [a]			.049		
			(.103)		
Distance to petroleum [a]				.139	
				(.103)	
Distance to diamonds [a]				-.072	
				(.079)	
Distance to gemstones [a]				.104	
				(.094)	
Language difference					.226
					(.315)
Intercept	-4.193 ***	-7.546 ***	-4.741 ***	-5.180 ***	-4.237 ***
	(.776)	(1.126)	(.866)	(1.169)	(.764)
N	86,131	86,131	86,131	86,131	86,131
Wald Chi^2	1,322.99	1,378.58	1,672.20	1,448.06	1,351.37

Note: Regression estimates with standard errors clustered on country years in parenthesis. Estimates for peace-years and three cubic splines not reported. [a] Logged; [b] lagged one year; * p<.1; ** p<.05; *** p<.01.